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NASA/AMERICAN SOCIETY FOR ENGINEERING EDUCATION (ASEE) SUMMER FACULTY FELLOWSHIP PROGRAM 1988

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SECTION I

ORGANIZATION AND MANAGEMENT

The 1988 Hampton University (HU)-NASA-Langley Research Center (LaRC) Summer Faculty Fellowship Research Program, the twenty-fifth such institute to be held at LaRC was planned by a committee consisting of the University Co-Director, LaRC staff members from the research divisions and the Office of University Affairs. It was conducted under the auspices of the Langley Research Center's Chief Scientist, Dr. Richard W. Barnwell.

Each individual applying for the program was provided a listing of research problems available to the LaRC 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-LaRC 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, contact was made with each Division Coordinator 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-LaRC 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-LaRC University Affairs Officer introduced, Mr. Edwin Prior, representing the office of the Langley Research Center's Chief Scientist, who formally welcomed the summer Fellows. Mrs. Sue Seward from the Technical Library Branch briefed the Fellows on the use of the library. Mr. Richard Meeks, manager of the LaRC cafeteria, briefed the Fellows relevant to the cafeteria policies, hours, etc. Mr. James Harris of the Computer

Management Branch briefed the Fellows on the Computational Facilities. The subject of security at LaRC was discussed by John Ledeaux from the Security Branch. Safety procedures were discussed by Walter Hoggard from the Safety Branch. Patricia Gates presented programs and activities sponsored by the Activities Center. Further instructions were given and information disseminated by Dr. Samuel E. Massenberg and Professor John Spencer, Co-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. 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. Eleven excellent papers were presented to the Fellows, Research Associates, and invited guests.

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 (HU)-Langley Research Center (LaRC) Program was extended to those individuals who held 1987 LaRC Fellow appointments. Twenty individuals responded to the invitation, however, only nine were selected. Twenty-one applications were received from Fellows from previous years or from other programs. Three were selected.

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 Professor John Spencer of HU and Dr. Surendra Tiwari of Old Dominion University (ODU), requesting their assistance in bringing to the attention of their faculties the HU/ODU-LaRC program. In addition to the above, a number of departments of chemistry, 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 HU 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 nine formal applications, all indicating the HU-LaRC Program as their first choice and a total of forty-five indicating the HU-LaRC Program as their second choice. The total number of applications received came to one hundred fifty-four (Table 1).

Thirty-six applicants formally accepted the invitation to participate in the program. Six 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. Twenty-six positions were initially budgeted by NASA. Two Additional positions were funded by NASA for specific projects. Eight positions were funded by the LaRC divisions.

The average age of the participants was 51.6.

TABLE 1

FIRST CHOICE APPLICATIONS

Total	Females		Males		Minority Schools Represented
	Black	NonBlack	Black	NonBlack	
109	4	9	12	84	7

SECOND CHOICE APPLICATIONS

Total	Females		Males		Minority Schools Represented
	Black	NonBlack	Black	NonBlack	
45	0	4	1	40	5

NASA-LaRC FELLOWS

Total	Females		Males		Minority Schools Represented
	Black	NonBlack	Black	NonBlack	
36	1	3	4	28	6

First Year Fellows	Returnees	Number Declined
20	16	6

Positions Funded by NASA	Local Purchases
28	8

SECTION III

STIPEND AND TRAVEL

A ten week stipend of $8,000 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 HU regulations.

SECTION IV

LECTURE SERIES, PICNIC AND DINNER

LECTURE SERIES

In response to statements made by the Fellows, the Lecture Series was again arranged around research being done at LaRC and the speakers were LaRC research scientists.

Appendix III contains the agenda for the special ASEE Summer Lecture Series for 1988.

PICNIC AND DINNER

A picnic for the Fellows, their families, and guests was held on June 17, 1988. A seminar/dinner was held on August 10, 1988.

SECTION V

RESEARCH PARTICIPATION

The 1988 HU-LaRC 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 LaRC 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**
1	Analysis and Computation Division
3	Instrument Research Division
4	Flight Electronics Division
2	Structures and Dynamics Division
5	Materials Division
1	Acoustics Division
2	Transonic Aerodynamics Division
2	High-Speed Aerodynamics Division
2	Atmospheric Sciences Division
2	Space Systems Division
1	Information Systems Division
2	Guidance and Control Division
3	Flight Management Division
1	Personnel Division
1	Interdisciplinary Research Office
1	Acquisition
1	Operations Support Division
1	Loads and Aeroelasticity Division
1	Advanced Vehicles Division

Thirty-four (94.4%) of the participants were holders of the doctorate degree. Two (5.5%) 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**
2	Aeronautics
1	Aeronautical Science
2	Aerospace
2	Analytical Chemistry
1	Applied Physics/Dynamics

1	Chemical Engineering
1	Economics
1	Education Administration
1	Education Science (Chemistry)
5	Engineering Mechanics
1	Engineering Science
5	Mathematics
4	Mechanical Engineering
2	Meteorology
1	Nuclear Chemistry
2	Physical Chemistry
4	Physics

EXTENSIONS

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

Carl Andersen	1 Week
Baldassare Di Bartolo	1 Week
Leon Donaldson	1 Week
Cathine Garner-Gilchrist	1 Week
Louis Gratzer	1 Week
Edmond Koker	1 Week
William Patten	1 Week
Lawrence Zavodney	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 the 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:

Chaur-Ming Chou attended a workshop on Computational Aspects in the Control of Flexible Systems. He also attended a seminar on System ID. Issues pertinent to current Space Station Structural Characterization Experiment (SSSCE) Planning.

Barry Ganapol attended the meeting of the American Nuclear Society.

K. M. Isaac attended the AIAA/ASME/SAE Joint Propulsion Conference in Boston.

Richard Kiefer attended the NASA/SDIO Workshop on Space Environmental Effects on Materials.

Charles Mastin attended the 11th International Conference on Numerical Methods in Fluid Dynamics in Williamsburg, Va.

Robert Orwoll attended the NASA/SDIO Workshop on Space Environmental Effects on Materials.

Suzanne Smith attended the NASA Langley seminar on Space Station: Past, Present, and Future.

James Turner, Jr. attended the 11th International Conference on Numerical Methods in Fluid Dynamics in Williamsburg, Va.

Ronald Welch attended a meeting of the FIRE Science Experiment Team in Vail Colorado.

Larry Zavodney attended a workshop on Computational Aspects in the Control of Flexible Systems in Williamsburg, Va.

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

PAPERS PRESENTED

Dynamic Coupling of Local/Secondary Structures to Overall System Modeling-7th IMAC - Chaur-Ming Chou.

Spatial Location of Structural Model Errors using Measured Modes-30th SDM - Chaur-Ming Chou.

Mechanism of Cr to Nd Energy Transfer in Laser-Type Crystals, prepared with G. Armagan (NASA) and presented by the latter at the International School on Excited States of Transition Elements, held at the Ksiaz Castle (Wroclaw), Poland, June 20-25, 1988 - Baldassare Di Bartolo.

Methods for High Energy Hadronic Beam Transport - American Nuclear Society - Barry Ganapol.

Benchmark Solutions for the Galactic Ion Transport Equation-American Nuclear Society - Barry Ganapol.

A Turbulence Model for Boundary Layer Transition - American Institute of Aeronautics and Astronautics - Thomas Lund.

Larry Zavodney conducted two seminars at Langley during the summer:
Part I Principal and Fundamental Parametric Resonances in SDOF

Nonlinear Systems: Theory, Simulation (digital and analog), and Experiment.

Part II Modal Interactions (via autoparametric coupling) in the Nonlinear Response of Structural Elements: Theory and Experiment.

ANTICIPATED PAPERS

Rotational Rectifiers for use with Robotic End-Effectors-Applied Mechanisms Conference - William Brewer.

Electron Irradiation studies on High Temperature Superconductors - Journal of Applied Physics Letters - Randall Caton.

Low-Resistance Contacts to High Tc Superconductors - Journal of Applied Physics Letters - Randall Caton.

Affects of Electron Irradiation on the High Tc Superconductor $YB_{a2}\ Cu_3\ O_x$ - Journal of Applied Physics Letters - Randall Caton.

Mechanism of Cr to Nd Energy Transfer in Laser-Type Crystals, by G. Armagan, B. Di Bartolo, and G. Ozen, to appear in the book, "Excited States of Transition Elements," World Sci. Co. 1988.

Spectroscopic Investigation of the Cr to Tm Energy Transfer in Yttrium Aluminum Garnet Crystals, by G. Armagan, B. Di Bartolo, A. M. Buoncristiani, and C. E. Byvik, to be submitted to the J. Quant. Electron.

Nonlinear Methods in Fluid Dynamics to AIAA - Louis Gratzer.

Benchmark Solutions for the Galactic Heavy Ion Transport Equation= Energy and Spatially Independent Problems - Barry Ganapol.

Gravity Field of a Rotating Ring - American Journal of Physics-Joseph Hafele and A. M. Buoncristiani.

The Effect of Energetic Electrons and Ultraviolet Radiation on Several Polymeric Materials - Polymer Preprints - Richard Kiefer.

Energy Transfer Rate Determination in the Cr: Ho: Tm: YAG Laser Material -Applied Physics Letters Journal - Edmond Koker.

Travectory, Temperature Field and Diameter History of a Drop with Finite Internal and External Thermal Resistances - NASA Langley-Nenad Kondic.

Fast Interpolation Schemes for Moving Grids - Second International Conference on Numerical Grid Generation, Miami Beach, Fla., Dec. 1988 - Charles Mastin.

Equivalent Linearization for Fatigue life Estimates of a Nonlinear Structure - Journal of Sound and Vibration - Ronald Miles.

Effect of Damping on Fatigue Life of a Nonlinear Structure-Damping 89 and Journal of Sound and Vibration - Ronald Miles.

The Effect of Curing Conditions on the Coefficient of Thermal Expansion of Epoxy Resins and Effects of Energetic Electrons and Atomic Oxygen on the Tensile Strength of the Tether Materials Kevlar 29 and Nomex - Journal of Applied Polymer Science and/or The Polymeric Materials: Science and Engineering Division of the American Chemical Society - Robert A. Orwoll and Richard L. Kiefer.

On a Conjection of C. Johnson - Journal of Linear Algebra-George Rublein.

Locating Damaged Members in a Truss Structure using Modal Test Data - to be submitted to AIAA Structures, Structural Dynamics and Materials Conference - Suzanne Smith.

Comparative Study of Training Program: LaRC vs other Major Research Organizations - to be submitted to NASA Langley - Alan Tsao.

The Effects of Pretreatment Conditions on a $P+/S_n O_z$ Catalyst for the Oxidation of Co in CO_2 Lasers - to be submitted to Journal of Applied Catalysis - John Van Norman.

Parametric Vibration-A Decade in Review - to be published in Applied Mechanics Reviews - Larry Zavodney.

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

ANTICIPATED RESEARCH PROPOSALS

End-Effector-Joint Conjugates for Robotic Assembly of Large Truss Structures in Space: A Second Generation, 9/89-9/90 - to be submitted to NASA Langley - William Brewer.

Low-Resistance Contacts to High Tc Superconductors - to be submitted to Virginia Center for Innovative Technology - Randall Caton.

Development of Electrical Contacts to High Temperature Superconductors for Magnetic Energy Storage Devices - to be submitted to Virginia Center for Innovative Technology - Randall Caton.

Spectroscopic Studies of Laser Crystals - to be submitted to NASA Langley - Baldassare Di Bartolo.

Modifying PASVART to Solve Singular Nonlinear 2-Point Boundary Valve Problems - to be submitted to NASA Langley - James Fulton.

Curriculum Development for Middle School Teachers - to be submitted to NASA Headquarters, Washington, DC - Cathine Garner-Gilchrist.

Phased Program to Develop Methodology Based on Nonlinear Techniques - to be submitted to NASA Langley - Louis Gratzer.

Benchmark Solution for the Galactic Ion Transport Equations - to be submitted to NASA Langley - Barry Ganapol.

Atomic Clocks Time On and Near the Earth - to be submitted to NASA Langley - Joseph Hafele.

Continuation of Opposed Jet Plane Study - to be submitted to NASA Langley - K. M. Isaac.

Energy Transfer Mechanisms in the Ho: Tm: Er: YAG System - to be submitted to NASA Langley - Edmond Koker.

Modeling of Transitional Flows - to be submitted to NASA Langley - Thomas Lund.

Fatigue Life Estimates for a Complex Nonlinear Structure - to be submitted to be submitted to the National Science Foundation-Ronald Miles.

Some Applications of Matrix Theory to Problems in Control - to be submitted to NASA Langley - George Rublein.

Assessing Structural Model Identification Methods for Model Correlation and Damage Detection Applications in Large Spaces Trusses - to be submitted to NASA Langley - Suzanne Smith.

FUNDED RESEARCH PROPOSALS

End-Effector-Joint Conjugates for Robotic Assembly of Large Truss Structures in Space - NASA Langley, 9/88-9/89 - William Brewer.

Addendum to Laser Spectroscopy Involving High Temperature Superconductors - NASA Langley - Randall Caton.

Research on High Tc Superconductivity: Addendum to Laser Spectroscopy - NASA Langley - Randall Caton.

Extinction and Reignition of Counterflow Diffusion Flames - NASA Langley - K. M. Isaac.

The Effects of the Interaction of Polymeric Materials with the Space Environment - NASA Langley Cooperative Agreement - Richard Kiefer and Robert Orwoll.

Data Link Weather Information Requirements for Efficient Air Traffic Control Comparable Airplane Flight Paths - NASA Langley-Charles Scanlon.

Investigation of Methods for Detection of Low Molecular Weight Species of Space Vehicle Surfaces - NASA Langley - John Van Norman.

Measurement Methodology for Quantitative Characterization of Gas Permeability and Diffusion Mechanisms - NASA Langley - John Van Norman.

SECTION VI

SUMMARY OF PROGRAM EVALUATION

A program evaluation questionnaire was given to each Fellow and to each Research Associate involved with the program. A sample of each questionnaire is in Appendix V of this report. Thirty-three out of thirty-six 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 21 (64%)
Somewhat 10 (30%)
Minimally 2 (6%)

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

Very much so 31 (94%)
Somewhat 2 (6%)
Minimally 0

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

Very much so 24 (73%)
Somewhat 7 (21%)
Minimally 2 (6%)

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 26 (79%) No 7 (21%)

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 29 (88%)
Somewhat 3 (9%)
Minimally 1 (3%)

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 13 (4%)
Redirected 13 (4%)
Advanced 27 (81%)
Just maintained 0
Unaffected 1 (3%)

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 24 (73%)
Positively 9 (27%)
Without enthusiasm 0
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 25 (76%)
By starting new courses 5 (15%)
By sharing research experience 27 (82%)
By revealing opportunities for future employment in government agencies 19 (57%)
By deepening your own grasp and enthusiasm 16 (48%)
Will affect my teaching little, if at all 1 (3%)

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 20 (60%) No 11 (33%)
Don't Know 2 (6%)

C. Administration

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

(39%) 13 Received announcement in the mail.
(9%) 3 Read about it in a professional publication.
(39%) 13 Heard about it from colleague.
(21%) 7 Other (explain).

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

Yes 16 (48%) No 17 (52%)

0 DOE
11 Another NASA Center
6 Air Force
3 Army
3 Navy

ORIGINAL PAGE IS
OF POOR QUALITY

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

Army - 2 Airforce - 3 Navy - 4 NASA - 3

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

Many 6 (18%)
A few 25 (76%)
None 1 (3%)

5. Would the amount of the stipend ($800) be a factor in your returning as an ASEE Fellow next summer?

Yes 19 (58%)
No 14 (42%)
If not, why Stipend low but adequate - Research opportunities great - Experience outweighs money.

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

Yes 20 (61%) No 13 (39%)

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

Yes 24 (73%) No 5 (15%) NA 4 (12%)

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

Yes 26 (79%) No 5 (15%) NA 1 (3%)

9. How do you rate the seminar program?

Excellent 12 (36%)
Very good 16 (49%)
Good 3 (9%)
Fair 0
Poor 2 (6%)

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	10	14	1	8
Lectures	21	1	6	4
Tours				
Social/Recreational	17	7		7
Meetings	22			5

11. What is your overall evaluation of the program?

Excellent 22 (67%)
Very good 9 (27%)
Good 1 (3%)
Fair 1 (3%)
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.

1. Extend program into 1st semester of acedemic year to allow opportunity for continued development of research.
2. Tour of wind tunnels and other facilities.

D. Stipend

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

   $__________ per __________.

   Salary average was approximately 40,000 for the academic year.

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

   Yes ______ No 20 (61%) In part 13 (39%)

3. What, in your opinion, is an adequate stipend for the ten-week program during the summer of 1989.

   800 - 7 (21%) 900 - 7 (21%) Match Income - 1 (3%)
   850 - 2 (6%) 1000 - 15 (46%) Graduation - 1 (3%)

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

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

   Yes 3 (9%) No 30 (91%)

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

   Yes 24 (73%) No 7 (21%)

Percentages have been rounded off to next whole number.

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

Ninety-four percent of the Fellows responding felt that their research was of importance to the center (LaRC) and to NASA.

Eighty-one percent of the Fellows responding felt that their research capabilities had been advanced as a result of the summer experience.

One hundred percent of those responding would strongly recommend the program to faculty colleagues.

Sixty-one percent of the Fellows responding indicated that salary was not the primary motivation to participation in the program.

Ninety-one percent of the Fellows responding indicated that they are not currently members of the American Society for Engineering Education. Sixty-one percent of these persons are first year Fellows.

Forty-eight percent indicated a stipend range from $8,000 to $9,000 for the ten weeks as satisfactory.

Forty-six percent indicated a stipend of $10,000 for the ten weeks would be satisfactory.

FELLOWS' COMMENTS

The comments were as follows: Activities are well balanced, more activities would not be desirable; the Lecture Series conflicted with experiments; end of budget year restricts equipment purchases; I was disappointed that there was no money to exploit the ideas I had been asked to develop; Langley facilities are excellent - support people are knowledgeable and helpful; a program extended through a one or two year time line sponsored or supported by organizations such as ASEE/NASA could provide research experiences for academic faculty; I consider the ASEE/NASA program to be a great asset for getting researchers and NASA together for continuing research. Also the effect in the classroom has been positive; I have also received two one year research cooperative agreements through my NASA contacts; The program is excellent, it gives a rare opportunity to interact with authorities in respective fields - the atmosphere is conducive to productive work; a stipend of $9,000 represents 2/9 of an academic year salary of about $40,000 (probably close to average salary of all Fellows). If increasing the stipend means a reduction in numbers, I am opposed to the reduction, the experience is too valuable!

FELLOWS' RECOMMENDATIONS

Recommendations included the following: Change the evaluation forms for the seminars - leave room for comments; extend the program into the academic year to allow for research opportunities for teaching faculty; extend program to twelve or fifteen weeks; have a program match the three month (12 weeks) apartment lease period; the presentations (lectures) were given at a level beyond many in the audience (especially LARSS), suggest use of more lay terms; distribute guidelines of policies regarding work hours, etc.; finance a pre-visit; reimburse full costs of travel; influence housing agents to give short term leases; allocate a portion of the stipend to reimbursement of expenses, not as income; reinstate the tour of the facilities for new Fellows; alternate Research Associate's are needed especially if the advisor takes an extended trip or vacation.

RESEARCH ASSOCIATES' - SURVEY

Ninety-five percent of the responses indicated that the Fellows were adequately prepared for their research assignments. Some Fellows brought their own computer hardware, shipped data to the Research Associate prior to arrival, and visited the base for information. The one negative response was due to the lateness of identifying the assignment and the participant.

All Research Associates responding indicated satisfaction with the diligence, interest and enthusiasm of the Research Fellow. Some comments: Enthusiastic, energetic with broad interests;

highly motivated; unusual insight and professionalism.

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

All Research Associates responding expressed an interest in having the Fellow, if eligible, return for a second year.

RESEARCH ASSOCIATES' COMMENTS

Why limit participation to two years?

These summer experiences have been helpful to our programs and overall understanding of specific topics.

-----is making a valuable contribution to our branch research this summer because we do not have experts in his discipline. His research experience is helping us develop a research program.

Ten weeks is too short---extend the program to twelve weeks.

The program has been very important to our research efforts.

Research Fellows bring in a different perspective, a welcome change from our own approaches. Sometimes, a different viewpoint provides more fruitful views.

The opportunity to work and exchange ideas with individuals in the academic community----is beneficial and rewarding.

RESEARCH ASSOCIATES' RECOMMENDATIONS

Increase stipend.

Provide a senior position.

Extend program to twelve weeks.

SECTION VII

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Comments from the Research Fellows and from the Research Associates indicate continued satisfaction with the program. The Fellows feel their research activities to be important to them in terms of professional growth and important to the center and NASA.

The Research Fellows all stated that they would strongly recommend the program to faculty colleagues.

There is some indication of a need for improved communications between the Fellow and the Associate prior to arrival.

There is an indication of a need for more formal information regarding submission of research proposals.

More housing information is needed and sent out earlier to the Fellows.

The stipend is considered adequate. It is not the prime consideration when accepting the appointment.

RECOMMENDATIONS

Urge increased contact by the Research Associate prior to arrival. Increase pre-visit consultations.

Send housing information as soon as possible even if it requires several mailings.

APPENDIX I

PARTICIPANTS - ASEE/NASA LANGLEY SUMMER FACULTY RESEARCH PROGRAM

RETURNEES

1988 NASA-ASEE FELLOWS

HU - LANGLEY

RETURNEES

FELLOW	AGE	ASSIGNED TO	RESEARCH ASSOCIATE
Dr. Andersen, Carl M. Senior Research Associate Mathematics College of William and Mary Williamsburg, VA 23185	52	Transonic Aerodynamics Division	Lawrence E. Putnam Building 1229 Mail Stop 294 Tel. 865-2601
Dr. Brewer, William V. Associate Professor Technology Jackson State University Jackson, MS 39217	49	Information Systems Division	Ralph W. Will Building 1268A Mail Stop 152D Tel. 865-3871
Dr. Caton, Randall H. Assistant Professor Physics Christopher Newport College Newport News, VA 23601	46	FLight Electronics Division	Charles E. Byvik Building 1202 Mail Stop 468 Tel. 865-2818
Dr. Donaldson, Leon M. Chairman Comprehensive Science and Science Education Morgan State University Baltimore, MD 21239	55	Atmospheric Sciences Division	Joel S. Levine Building 1250 Mail Stop 401B Tel. 865-2187
Dr. Doria, Michael L. Associate Professor Mechanical Engineering Valparaiso University Valparaiso, IN 46383	49	Transonic Aerodynamics Division	Manuel D. Salas Building 1192D Mail Stop 159 Tel. 865-2627

FELLOW	AGE	ASSIGNED TO	RESEARCH ASSOCIATE
Dr. Ganapol, Barry D. Professor Nuclear and Energy Engineering University of Arizona Tucson, AZ 85721	44	Space Systems Division	John W. Wilson Building 1200 Mail Stop 493 Tel. 865-4211
Dr. Hafele, Joseph C. Assistant Professor Math and Physics Eureka College Eureka, IL 61530	55	Flight Electronics Division	Charles E. Byvik Building 1202 Mail Stop 468 Tel. 865-2818
Dr. Isaac, Kakkattukuzhy M. Assistant Professor Mechanical and Aerospace Engineering University of Missouri-Rolla Rolla, MO 65401	40	High-Speed Aerodynamics Division	Burton G. Northam Building 1221 Mail Stop 168 Tel. 865-2803
Dr. Kiefer, Richard L. Professor Chemistry College of William and Mary Williamsburg, VA 23185	50	Materials Division	Sheila T. Long Building 1293A Mail Stop 229 Tel. 865-3892
Dr. Koker, Edmond B. Assistant Professor Physical Sciences Elizabeth City State University Elizabeth City, NC 27909	39	Flight Electronics Division	Norman Barnes Building 1202 Mail Stop 474 Tel. 865-3761
Dr. Kondic, Nenad N. Professor Mechanical Engineering University of Puerto Rico Mayaguez, PR 00709-5000	61	Instrument Research Division	Jag. J. Singh Building 1230 Mail Stop 235 Tel. 865-3907

FELLOW	AGE	ASSIGNED TO	RESEARCH ASSOCIATE
Dr. Orwoll, Robert A. Professor Chemistry College of William and Mary Williamsburg, VA 23185	48	Materials Division	Sheila T. Long Building 1293A Mail Stop 229 Tel. 865-3892
Dr. Rublein, George T. Associate Professor Mathematics College of William and Mary Williamsburg, VA 23185	52	Guidance and Control Division	Claude R. Keckler Building 1268A Mail Stop 161 Tel. 865-4591
Dr. Scanlon, Charles H. Associate Professor Computer Science, Mathematics, and Physics Arkansas State University State University, AR 72467	50	Flight Management Division	Charles E. Knox Building 1168 Mail Stop 156A Tel. 865-3621
Dr. Turner, James C. Assistant Professor Mathematics Ohio State University Columbus, OH 43210	41	Loads and Aeroelasticity Division	George Olsen Building 1265 Mail Stop 395 Tel. 865-2325
Dr. Van Norman, John D. Professor Chemistry Old Dominion University Norfolk, VA 23508	54	Instrument Research Division	George M. Wood Building 1230 Tel. 865-2466

APPENDIX II

PARTICIPANTS - ASEE/NASA LANGLEY
SUMMER FACULTY RESEARCH PROGRAM

FIRST YEAR

1988 NASA-ASEE FELLOWS

FIRST YEAR

FELLOW	AGE	ASSIGNED TO	RESEARCH ASSOCIATE
Dr. Byrd, Gregory P. Assistant Professor Earth Sciences State University of New York College at Brockport Brockport, NY 14420	32	Flight Management Division	Roland L. Bowles Building 1168 Mail Stop 156A Tel. 865-3621
Dr. Chou, Chaur-Ming Assistant Professor Mechanical and Energy Engineering University of Lowell Lowell, MA 01854	36	Structures and Dynamics Division	Richard S. Pappa Building 1293B Mail Stop 230 Tel. 865-3196
Ms. DeWalt, Diane V. Instructor Aerospace Engineering Virginia Polytechnic Institute and State University Blacksburg, VA 24060	27	Space Systems Division	Lawrence F. Rowell Building 1232 Mail Stop 367 Tel. 865-3887
Dr. Di Bartolo, Baldassare Professor Physics Boston College Chestnut Hill, MA 02167	62	Flight Electronics Division	Charles E. Byvik Building 1202 Mail Stop 468 Tel. 865-2818
Dr. Fulton, James P. Assistant Professor Mathematics Hampton Universtiy Hampton, VA 23668	30	Structures and Dynamics Division	Gaylen A. Thurston Building 1148 Mail Stop 190 Tel. 865-3524

FELLOW	AGE	ASSIGNED TO	RESEARCH ASSOCIATE
Dr. Garner-Gilchrist, Cathine Professor Middle and Secondary Education Hampton University Hampton, VA 23668	47	Office of Public Services	Arlene S. Levine Building 1153 Mail Stop 154 Tel. 865-3966
Dr. Gratzer, Louis B. Associate Professor Aeronautics and Astronautics University of Washington Seattle, WA 98195	67	Advanced Vehicles Division	Jerry N. Hefner Building 1251 Mail Stop 406 Tel. 865-2196
Dr. Green, Terry J. Assistant Professor Science and Mathematics Bethune-Cookman College Daytona Beach, FL 32017	35	Instrument Research Division	Donald H. Phillips Building 1230 Mail Stop 234 Tel. 865-2466
Dr. Hansen, Marion G. Associate Professor Chemical Engineering 419 Dougherty Engineering Building University of Tennessee Knoxville, TN 37996-2200	47	Materials Division	Ruth A. Pater Building 1293A Mail Stop 226 Tel. 865-3041
Dr. Lund, Thomas S. Assistant Professor Aeronautics and Astronautics Purdue University West Lafayette, IN 47907	27	High-Speed Aerodynamics Division	Thomas A. Zang Building 1192D Mail Stop 156 Tel. 865-3171
Dr. Mastin, Charles W. Professor Mathematics and Statistics Mississippi State University Mississippi State, MS 39762	45	Analysis and Computation Division	Robert E. Smith Building 1268A Mail Stop 125 Tel. 865-3978

FELLOW	AGE	ASSIGNED TO	RESEARCH ASSOCIATE
Dr. Miles, Ronald N. Assistant Research Engineer and Lecturer Mechanical Engineering University of California Berkeley, CA 94720	34	Acoustics Division	Clemans Powell Building 1208 Mail Stop 463 Tel. 865-3561
Mrs. Newcomb, Linda C. Assistant Professor Airway Science Program Hampton University Hampton, VA 23668	42	Flight Management Division	Hugh Bergeron Building 1168 Mail Stop 156A Tel. 865-3621
Dr. Patten, William N. Assistant Professor Aerospace and Mechanical Engineering University of Oklahoma Norman, OK 73019	42	Guidance and Control Division	Aaron Ostroff Building 1298 Mail Stop 489 Tel. 865-3635
Dr. Smith, Suzanne W. Instructor Engineering Science and Mechanics Virginia Polytechnic Institute and State University Blacksburg, VA 24061	32	Interdisciplinary Research Office	Paul A. Cooper Building 1229 Mail Stop 246 Tel. 865-4913
Dr. Throne, James L. Professor Polymer Engineering University of Akron Akron, OH 44325	51	Materials Division	Robert Baucom Building 1293A Mail Stop 226 Tel. 865-4197

FELLOW	**AGE**	**ASSIGNED TO**	**RESEARCH ASSOCIATE**
Dr. Tsao, Alan H. Y. Associate Professor Management Norfolk State University Norfolk, VA 23508	63	Personnel	M. Pat Clark Building 1195C Mail Stop 309 Tel. 865-2611
Dr. Tuttle, Mark E. Assistant Professor Mechanical Engineering University of Washington Seattle, WA 98195	35	Materials Division	Charles Harris Building 1205 Mail Stop 188E Tel. 865-3013
Dr. Welch, Ronald M. Head, Data Acquisition and Analysis Group Institute of Atmospheric Sciences South Dakota School of Mines and Technology Rapid City, SD 57701	44	Atmospheric Sciences Division	Bruce Wielicki Building 1250 Mail Stop 420 Tel. 865-2977
Dr. Zavodney, Lawrence D. Assistant Professor Engineering Mechanics Ohio State University Columbus, OH 43210	37	Structures and Dynamics Division	Jer-Nan Juang Building 1293B Mail Stop 230 Tel. 865-2881

APPENDIX III

LECTURE SERIES

PRESENTATIONS BY RESEARCH FELLOWS

1988 ASEE/NASA
HAMPTON UNIVERSITY - LANGLEY RESEARCH CENTER
LECTURE SERIES

Location: Activities Center Auditorium, Bldg. 1222
Time: 9:00 a.m. to 10:30 a.m.

DATE	SPEAKER	TOPIC
June 6	**Edwin Prior** Office of Director	Langley Overview and Orientation
June 16	**Dr. Thomas Zang** High-Speed Aerodynamics Division	Super Computers in Aerospace Research
June 23	**Samuel Dollyhigh** Advanced Vehicles Division	Advanced Aircraft Concepts
June 27	**Dr. Joel Levine** Atmospheric Sciences Division	The Earth's Atmosphere: Past Present and Future
July 13	**Dr. Bruce Holmes** Low-Speed Aerodynamics Division	HYFIRE
July 21	**Dr. Joseph Heyman** Instrument Research Division	Non-Destructive Evaluation
July 25	**Dr. Charles Byvik** Flight Electronics Division	Super Conductivity

SCHEDULE OF PRESENTATIONS BY RESEARCH FELLOWS

Location: Building 1219, Room 225
Date: 11 August, 1988
Time: 8:00 a.m. to 3:30 p.m.

NAME/DIVISION/BRANCH	TOPIC
Chaur-Ming Chou Structures and Dynamics Division/Structural Dynamics Branch	Some Tests/Analysis Modeling Concepts for the Space Station Structural Characterization Experiment

NAME/DIVISION/BRANCH	TOPIC
Lawrence Zavodney Structures and Dynamics Division/Structural Dynamics Branch	The Influence of Nonlinearity on the Dynamic Response of Elastic Structures
James Fulton Structures and Dynamics Division/Structural Mechanics Branch	Modifying PASVART to Solve Singular Nonlinear 2-Point Boundary Problems
James Throne Materials Division/Polymeric Materials Branch	Polymer Powder Prepregging
Carl Andersen Transonic Aerodynamics Division/High-Reynolds-Number Aerodynamics Branch	Optimization of Slender Wings for Minimum Center-of Pressure Shift Due to Change in Mach Number
William Patten Guidance and Control Division/Aircraft Guidance and Control Branch	Modeling and Control of the Nonlinear Dynamic of a F-18 High Angle of Attack
Charles Mastin Analysis and Computation Division/Computer Applications Branch	Overlapping Grids for Flow Field Calculations
Charles Scanlon Flight Management Division/Vehicle Operations Research Branch	A Flight Test Design for Studying Pilot Interface, Procedures, and Operations of Air-to-Ground Duplex Data Link Communications
Baldassare Di Bartolo Flight Electronics Division/Laser Technology and Applications Branch	Energy Transfer Mechanisms in Solid State Laser Materials
Suzanne Smith Interdisciplinary Research Office/IMAT Office	Extension and Validation of a Method for Locating Damaged Members in Large Space Trusses
John Van Norman Instrument Research Division/General Research Instrumentation Branch	Pretreatment of CO Oxidation Catalysts

APPENDIX IV

ABSTRACTS

RESEARCH FELLOWS

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N89-14897

OPTIMIZATION OF SLENDER WINGS FOR CENTER-OF-PRESSURE SHIFT DUE TO CHANGE IN MACH NUMBER

by

CT393501

Carl M. Andersen
Senior Research Associate
Department of Mathematics
College of William and Mary in Virginia
Williamsburg, VA 23185

It is observed that the center of pressure on a wing shifts as the Mach number is changed. Such shifts are in general undesirable and are sometimes compensated for by actively shifting the center of gravity of the aircraft or by using active stability controls. To avoid this complication, it is desirable to design the wings of a high speed aircraft so as to minimize the extent of the center-of-pressure shifts. This, together with a desire to minimize the center-of-pressure shifts in missile control surfaces, provides the motivation for this project.

There are many design parameters which affect center-of-pressure shifts, but it is expected that the largest effects are due to the wing planform. Thus, for the sake of simplicity, this study is confined to an investigation of thin, flat (i.e., no camber or twist), relatively slender, pointed wings flying at a small angle of attack, α_{∞}. Once the dependence of the center of pressure on planform and Mach number is understood, we can expect to investigate the sensitivity of the center-of-pressure shifts to various other parameters.

The planform of the wing is specified by functions $\pm g(x)$ with $0 < x < c$ where c is the chord length. The fact that the wing is pointed requires $g(0) = 0$. It is further assumed that $g'(x) \geq 0$, $g'(c) = 0$(streamwise tips), and that the trailing edge is an unswept straight line. Viscosity, vorticity and nonlinear compressibility effects are assumed to be negligible. Therefore, the problem is formulated in terms of a velocity potential ϕ which satisfies the Prandtl-Glauert equation with a Kutta-Joukowski condition imposed on the trailing edge. Solutions are sought for both the supersonic and subsonic regimes.

The simplest approximate analytic solutions are given by Jones' slender wing theory[1] which is valid in the limiting case that the aspect ratio, $A = \frac{(span)^2}{Area}$, goes to zero. Then the location of the center-of-pressure is given as a function only of the planform function $g(x)$. In particular, there is no dependence on the Mach number, M.

To see a dependence on M, we turn to not-so-slender wing theory, which was developed by Adams and Sears[2] using classical transforms and recast into a modern form by Wang[3] using matched asymptotic expansions. Here the expansion parameter is $\beta A = \sqrt{|M^2 - 1|}A$. Two different expansions of ϕ are given by Wang depending on whether the flow is supersonic or subsonic, and both expansions include $\beta^2 A^2$ and $\beta^2 A^2 \log(\beta A)$ terms. Jones' results are independent of βA.

Wang's expressions for ϕ involve derivatives of integrals which in general cannot be evaluated in closed form. However, if $g(x)g'(x)$ can be expressed as a polynomial,

$g(x)g'(x) = \sum a_i x^i$, Squires[4] developed for the supersonic case closed-form analytic expressions for the chordwise loading and for the total lift. The comparable integral for the subsonic case is a little more complicated, but under the same condition comparable analytic expressions were found by the author this summer.

The expressions for the center-of-pressure involve another integration step, but this step requires some numerical quadrature. Center of pressure shifts for a number of planforms are being examined.

References

1. Jones, R.T., Properties of Low-Aspect-Ratio Pointed Wings at Speeds Below and Above the Speed of Sound, N.A.C.A. Report 835, 1946.
2. Adams, M.C. and Sears, W.R., Slender Body Theory, Review and Extension, J. Aeron. Sci., pp. 85-98, 1953.
3. Wang, K.C., A New Approach to Not-So-Slender Wing Theory, J. Math. and Physics, v. 47, pp. 391-406.
4. Squire, L.C., Some Applications of 'Not-So-Slender' Wing Theory to Wings with Curved Leading Edges, A.R.C. R. & M. No. 3278, 1962.

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N89-14898

END-EFFECTOR - JOINT CONJUGATES FOR ROBOTIC ASSEMBLY OF LARGE TRUSS STRUCTURES IN SPACE:

A SECOND GENERATION

JC 332955

by

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Department of Technology
School of Science & Technology
Jackson State University
Jackson MS 39217

INTRODUCTION

Current designs, a first generation intended for robotic assembly, have given priority to the ease and certainty of the assembly process under less than ideal conditions with a minimum of sensory feedback. As a consequence they are either heavy or expensive and all exhibit a relatively low packaging density. Low packaging density is caused by extensive "scars" applied to the node, increasing its envelope diameter by as much as 150 % . Strut envelopes are violated to a lessor extent with diameters increased by 25 % or more. This smaller percentage is still a significant problem owing to a much higher fraction of the packaged volume represented by struts. As structures in space become larger, packaging density becomes an important consideration.

OBJECTIVES

Develop end-effector - joint conjugates that do not violate the envelopes of a 2.5" diameter node or a 1.0" diameter strut.

Reduce cost by:
- increasing the fraction of "off the shelf" parts;
- reducing part complexity, diversity and count.

Incorporate feedback mechanisms as an integral part of the overall scheme.

DISCUSSION

Attachment of strut to node can be accomplished with a variety of mechanisms: references [1,2,3,4]. All require extensive scars or standoff elements added to the node. These permit compliance when a strut must be fitted between nodes whose separation distance is either greater or smaller than the strut length. Two methods that do not require standoffs are the screw thread and conical wedge (concrete anchor) [5]. They allow the node separation distance to be too great but depend on distortion of the truss in the case when the distance is too small. The present effort is designed around the screw thread as the simplest and most easily manufactured of all alternatives.

Torque and rotational motion must be transmitted across the strut to end-effector interface accomplishing the joining process and establishing the requisite 250 to 500 lb. preload. Four drive mechanisms were considered: worm gear, helical gear, bevel gear and differential gear. A strut-end design based on the differential gear was developed because it is the most compatible with the drive mechanism used on a first generation end-effector currently under fabrication. Torque capacities of available differential gears that would fit within the 1" envelope could not overcome friction in the screw threads generated by the requisite 250 lb. preload. Helical gears provide a much better basis for achieving the objectives of a 2nd generation based on screwthread assembly. Part complexity, count and cost are all reduced. Attaching a left-hand helical gear to the bolt shaft so that it "travels" with the bolt has an additional advange: axial thrust will always assist driving the bolt in the desired direction. The traveling helical assembly (Fig. 1) was integrated into a strut-end design (Fig. 2) that incorporates features which assist in the assembly process.

Capture of the node by a robotically manipulated strut-end can be assisted by active feedback mechanisms, parts of which are embedded in the strut-end (Fig.3) or by passive spring loading devises (Fig.4) without feedback. Active feedback is interfaced with the end-effector by means of a probe inserted thru a slot in the strut envelop and into a recepticle drilled in a non-rotating axial "traveler". This probe can assist in axial translation of the bolt as well as reading its location and the axial force applied to it.

REFERENCES

[1] Gralewski, M.,"Development of Joint Connector Model and Associated End Effector Concept for Automated Assembly of Large Space Truss Structures", Contract No. NAS1-17536, Doc. No. 36230-114, Astro Aerospace, Carpenteria CA 93013-2993, 2/29/88

[2] Final Report, " ... same as title above ... ", Response to AS&M RFP 18235-39-092887, Honeybee Robotics, New York NY 10002, 1988

[3] Everman, M. R.,"Final Report on the ASMI End Effector", AECR88336/429, Able Engineering Company, Goleta CA 93116-0588, 3/11/88

[4] Stout, D. A.,"Joint Connector Concept", D-300-01-001, Jewett Automation, 2/8/88

[5] Wesselski, C. J., "Space Station Lock Joint", Div/Off ES22, Johnson Space Center, Houston TX

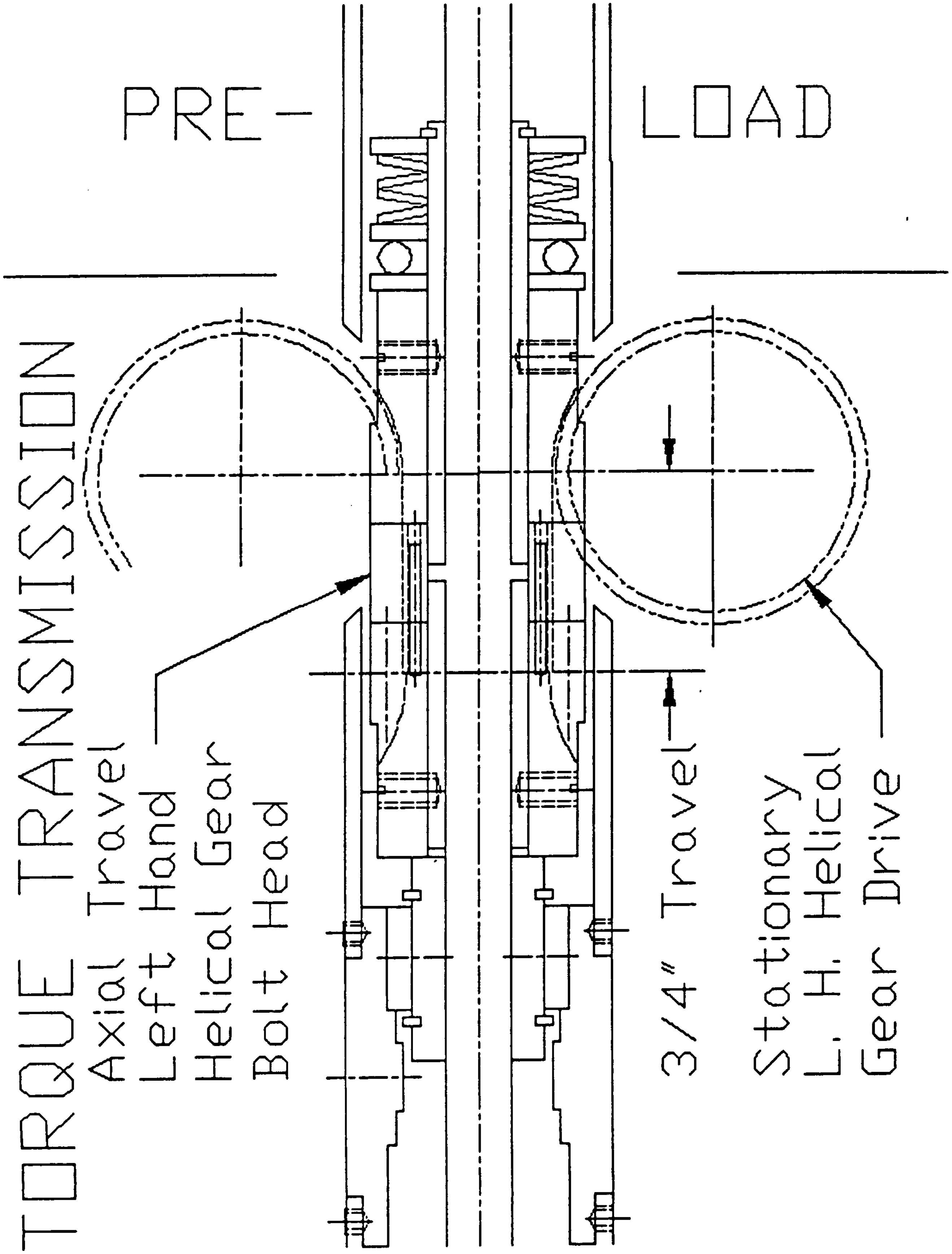
PRE- LOAD
TORQUE TRANSMISSION
Axial Travel
Left Hand
Helical Gear
Bolt Head
3/4" Travel
Stationary
L. H. Helical
Gear Drive

Figure 1

1" x 13" STRUT END
Helical Gear Drive

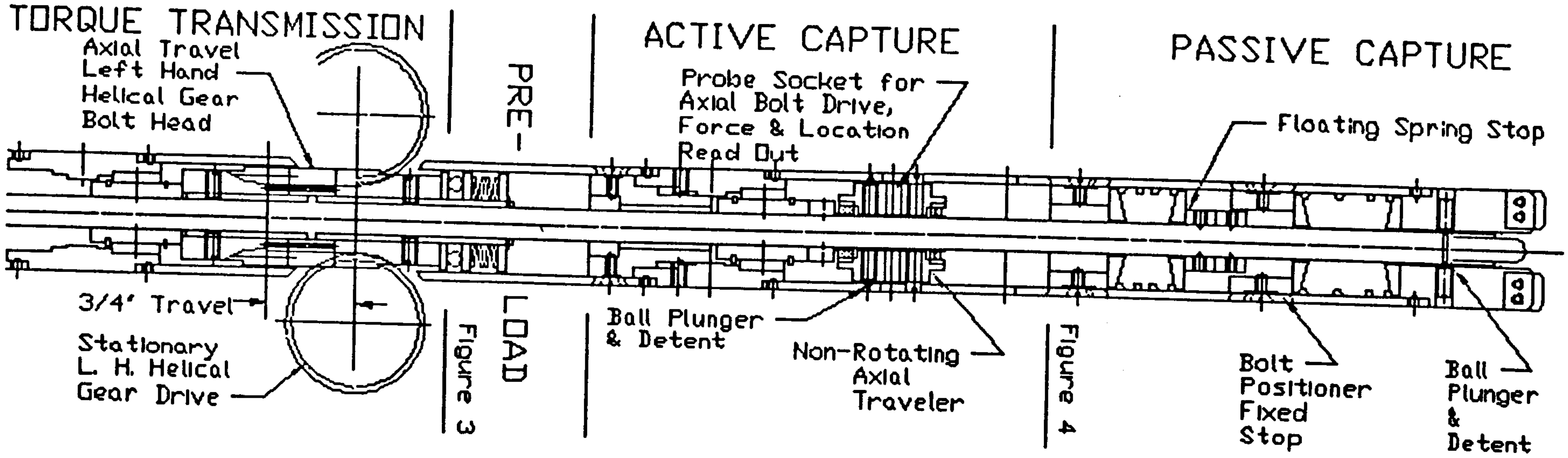

Figure 2

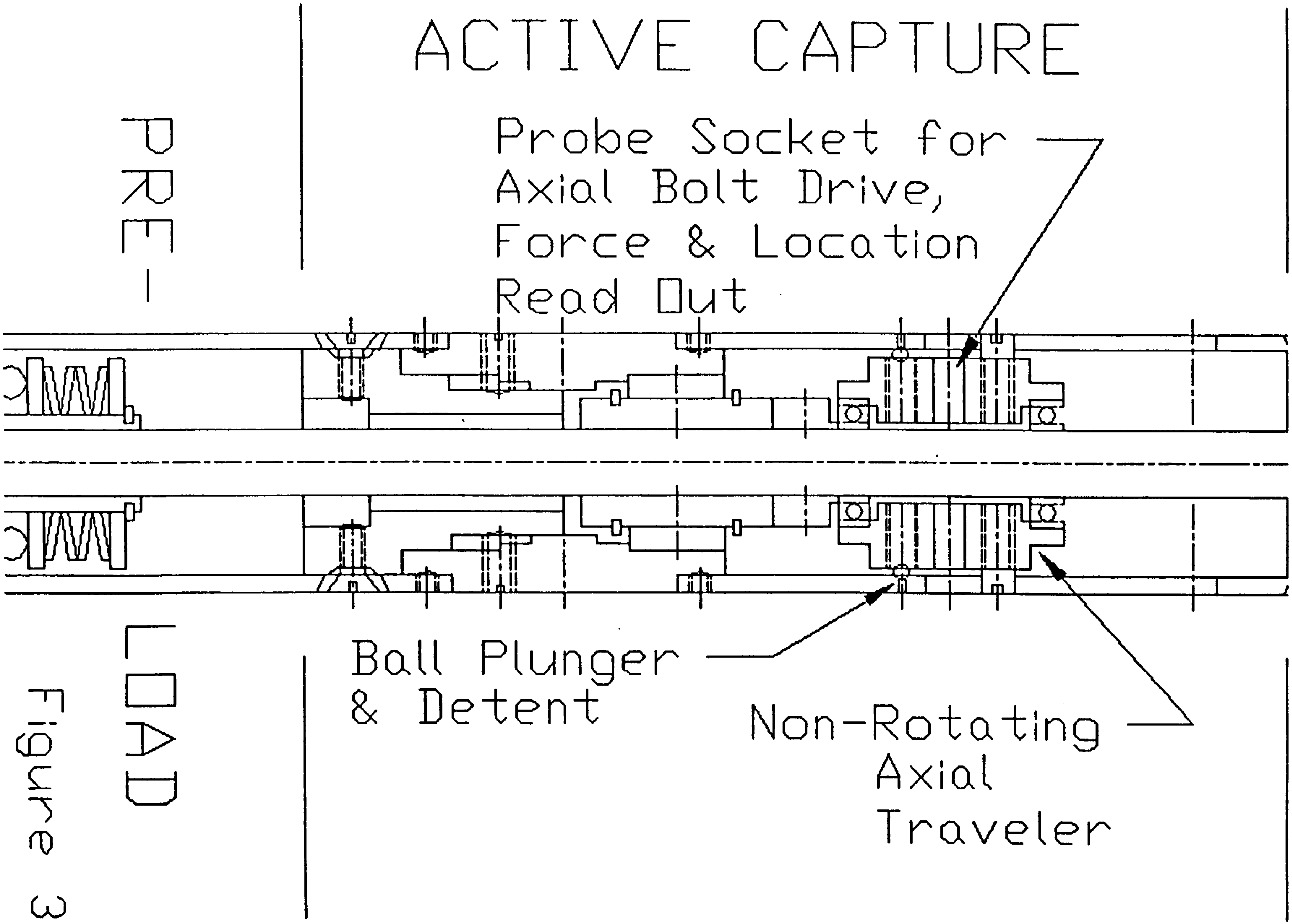
ACTIVE CAPTURE
Probe Socket for Axial Bolt Drive, Force & Location Read Out
Ball Plunger & Detent
Non-Rotating Axial Traveler
PRE-
LOAD

Figure 3

PASSIVE CAPTURE

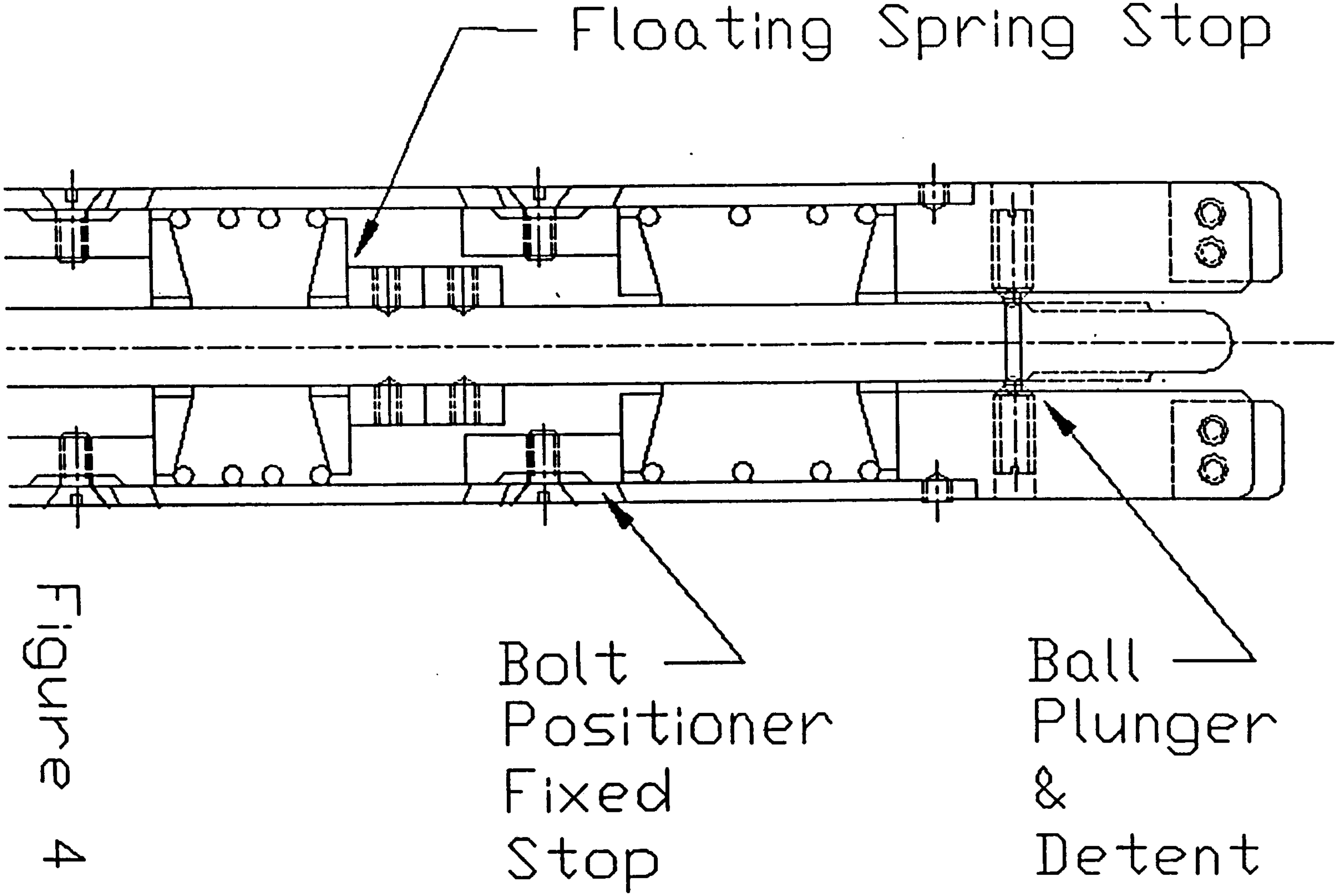

Figure 4

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N89 - 14899

USE OF THE TERMINAL AREA SIMULATION SYSTEM (TASS) TO STUDY MICROBURST WIND SHEARS

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by

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State University of New York College at Brockport
Brockport, NY 14420

9

Microburst wind shears can significantly affect aircraft performance and present a major to commercial passenger aircraft on landing approach or takeoff. A microburst is a strong, evaporatively-cooled downdraft which spreads out as it nears the ground. As a result, the aircraft entering a microburst first encounters a performance increasing headwind, followed by a loss of headwind, downdraft and tailwind, all of which act to decrease aircraft performance. Occasionally, full recovery from a microburst is not possible, resulting in an incident or accident such as the Delta Flight 191 accident at DFW airport which claimed 133 lives.

Ground-based and airborne Doppler radar and LIDAR systems are being designed to alert pilots when a hazardous windshear is present. A key element in this design effort is understanding the microburst itself. This is accomplished by means of the TASS model which was developed for NASA by Proctor (1987a,b). The time-dependent TASS model has two vesions: a two-dimensional high resolution axisymmetric model, and a three-dimensional model. The model includes a sophisticated parameterization of cloud microphysics and a friction layer, both of which are essential to a realistic simulation of the microburst phenomenon. The TASS model has been successfully tested on well-observed convective events, including the aforementioned DFW microburst of 2 August 1985 (Proctor, 1987b, 1988).

Horizontal and vertical wind output from TASS simulations were examined, since both are significant factors affecting aircraft performance. Evaluation of horizontal winds from TASS simulations show a variety of outflow intensities(u) and horizontal shears (du/dr) among the cases, as is shown in Figure 1. When the data are normalized by the maximum outflow (U/UMAX) and the radius of maximum outflow (R/RMAX), the plots show much more consistency (Figure 2). Figure 3 shows good agreement between a composite normalized radial outflow profile derived from 8 TASS microburst simulations and observational data derived from Doppler radar data by Hjelmfelt(1988).

Doppler and LIDAR sensors are designed to detect only the horizontal winds. Since vertical winds are also an important factor in aircraft performance, we investigated a method to deduce the vertical winds given the horizontal wind profile. Figures 4 and 5 show that by scaling the horizontal divergence (SCALE=0.4), a reasonable estimate of the normalized vertical wind (W/WMAX) is obtained. We propose to further investigate this relationship as it pertains to aircraft performance and to expand the investigation to asymmetric microburst cases using the three-dimensional version of TASS.

REFERENCES

Hjelmfelt, M.R., 1988: Structure and life cycle of microbust outflows observed in Colorado. J. Appl. Meteor. (in press).

Proctor, F. H., 1987a: The Terminal Area Simulation System. Volume I: Theoretical formulation. NASA Contractor Report 4046. DOT/FAA/PM-86/50,I. 176pp.\

Proctor, F.H. 1987b: The Terminal Area Simulation System. Volume II: Verification cases. NASA Contractor Report 4047. DOT/FAA/PM-86/50,II. 112pp.

Proctor, F.H. 1988: Numerical simulations of an isolated microburst. Part I: Dynamics and structure. J. Atmos. Sci. (in press)

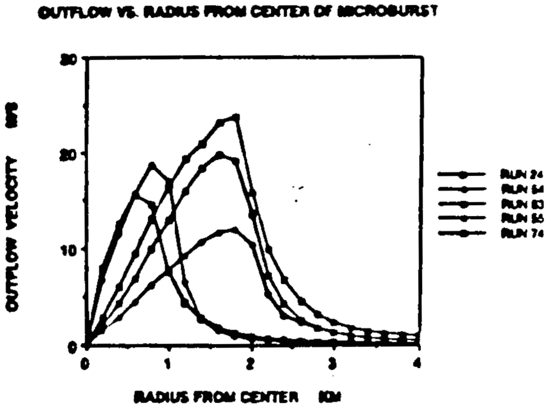

Figure 1

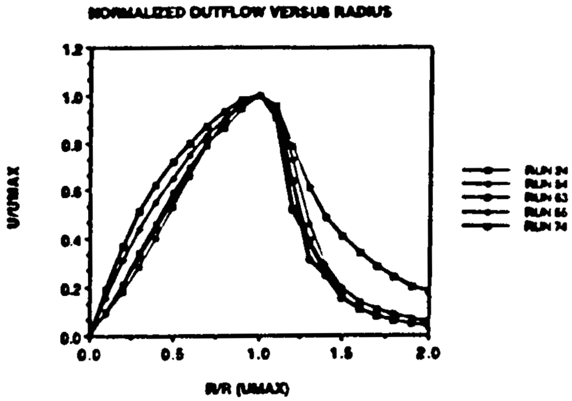

Figure 2

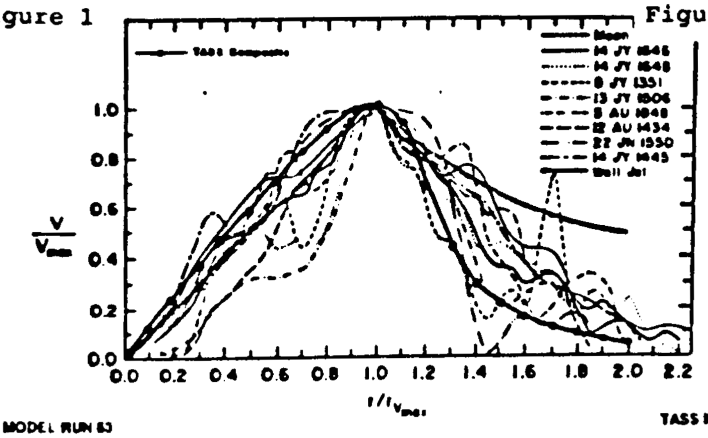

Figure 3

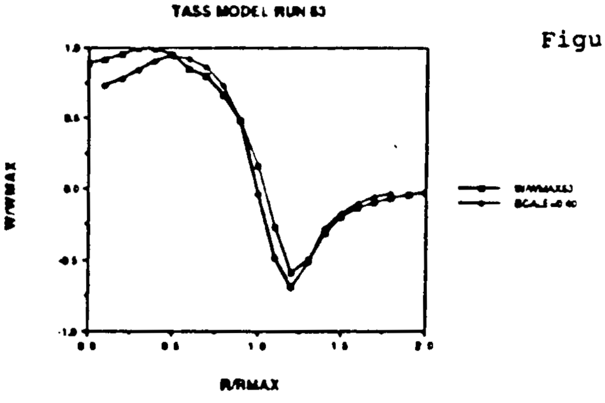

Figure 4

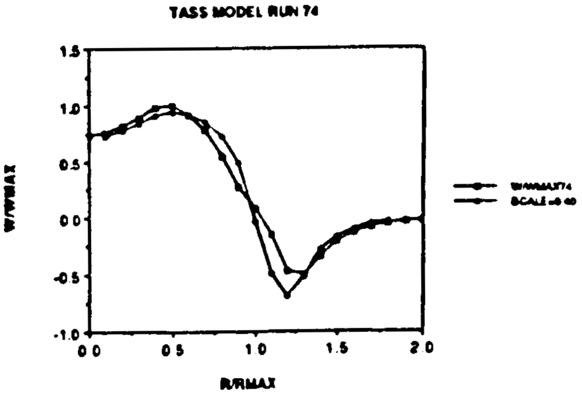

Figure 5

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EFFECTS OF ELECTRON IRRADIATION ON HIGH TEMPERATURE SUPERCONDUCTORS AND CONTACTS TO HIGH TEMPERATURE SUPERCONDUCTORS

N89-14900

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The discovery of a new class of ceramic superconductors with transition temperatures above liquid nitrogen has opened the doors for exciting space applications. Energy storage, pointing maneuvers, magnetic shielding, and sensitive detection of electromagnetic radiation are some of the longer term possible applications. One near term application involves low electrical resistance, high thermal resistance connections between a detector operating at ≈ 4K and the electronics operating at ≈ 77K. The new high temperature superconductors could accomplish this providing the necessary electrical connections to the ground plane while isolating the system thermally, thus prolonging the life of the mission. With such possibilities it is clearly of value to study the effects of radiation that would be experienced during a typical space mission. In this work we focused specifically on the effects of the electron radiation environment.

We used the electron radiation facility at NASA Langley which has a beam current of 63.5 nA/cm^2. Through a series of three exposures the samples accumulated a total dose equivalent to 90 years in geosynchronous orbit (4.3x10^{17} el/cm^2). Last year we developed high-quality, low-resistance contacts to the ceramic superconductors. These contacts were used in the radiation studies on $YBa_2Cu_3O_x$ superconductors. Using facilities at Christopher Newport College we measured the transition temperature, the normal state resistivity, the critical current, and the contact resistance. Figure 1 shows a blowup of the superconducting transition for the various irradiations. From these data it is clear that the transition temperature is not effected to within 1K by the electron irradiations. In figure 2 the change in the normal state resistivity from irradiation is plotted as a function of dose. This total change is about 35% of the unirradiated value. The critical current is an important measure of the supercondutor's current carrying ability. It varied about 20% in a non-systematic manner throughout the irradiations staying around 85 A/cm^2 on the average at 77K in zero magnetic field. Finally, the contact surface resistivity must maintain its integrity during the space voyage. It varied from ≈2 to ≈4 μΩcm^2 from the unirradiated sample to the final dose - all acceptably low values. Clearly we observe changes in the important parameters of the superconducting material (in fact, our observations indicate more sensitivity to electron radiation than the lower transition temperature superconductors such as the A15 class). However, these changes will not significantly affect the operation of the superconductor in the applications mentioned above. The electron radiation environment should not compromise space missions using the new high temperature superconductors.

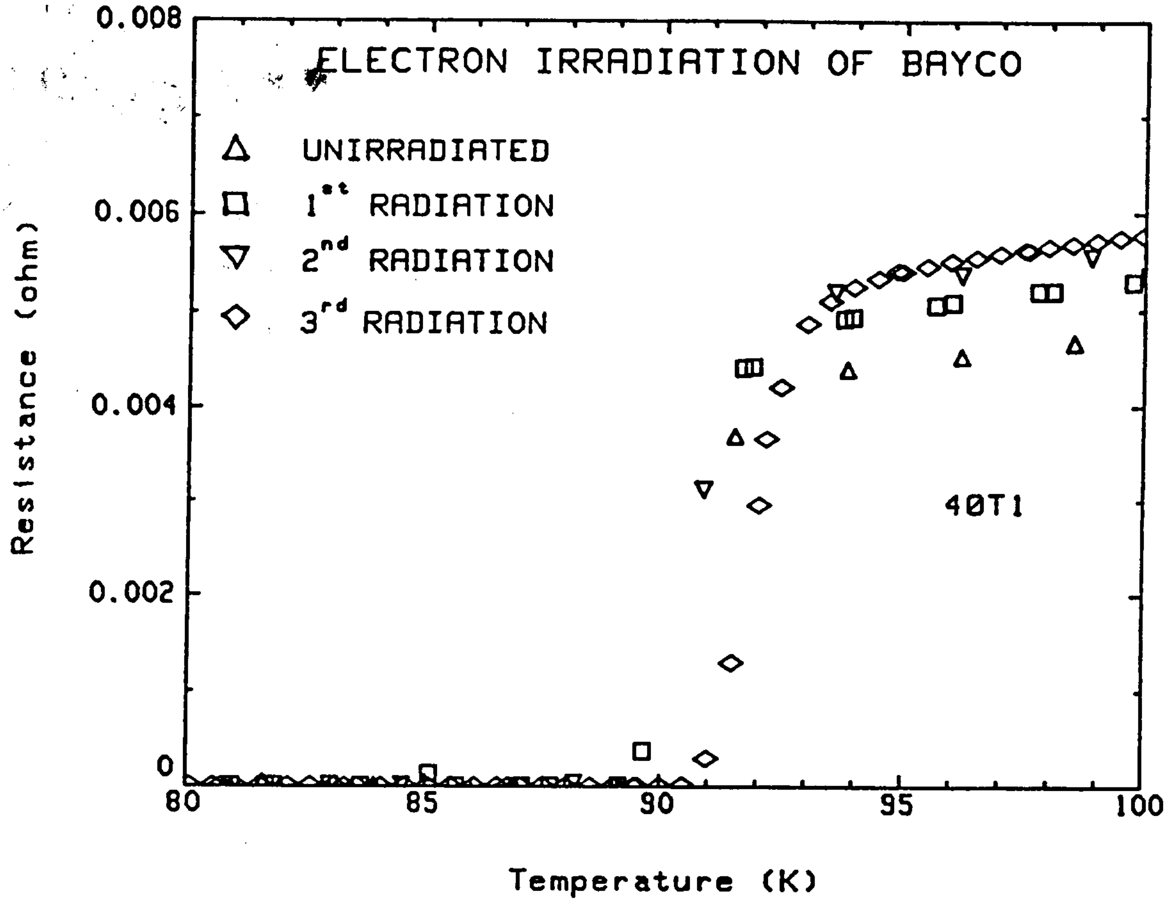

FIGURE 1

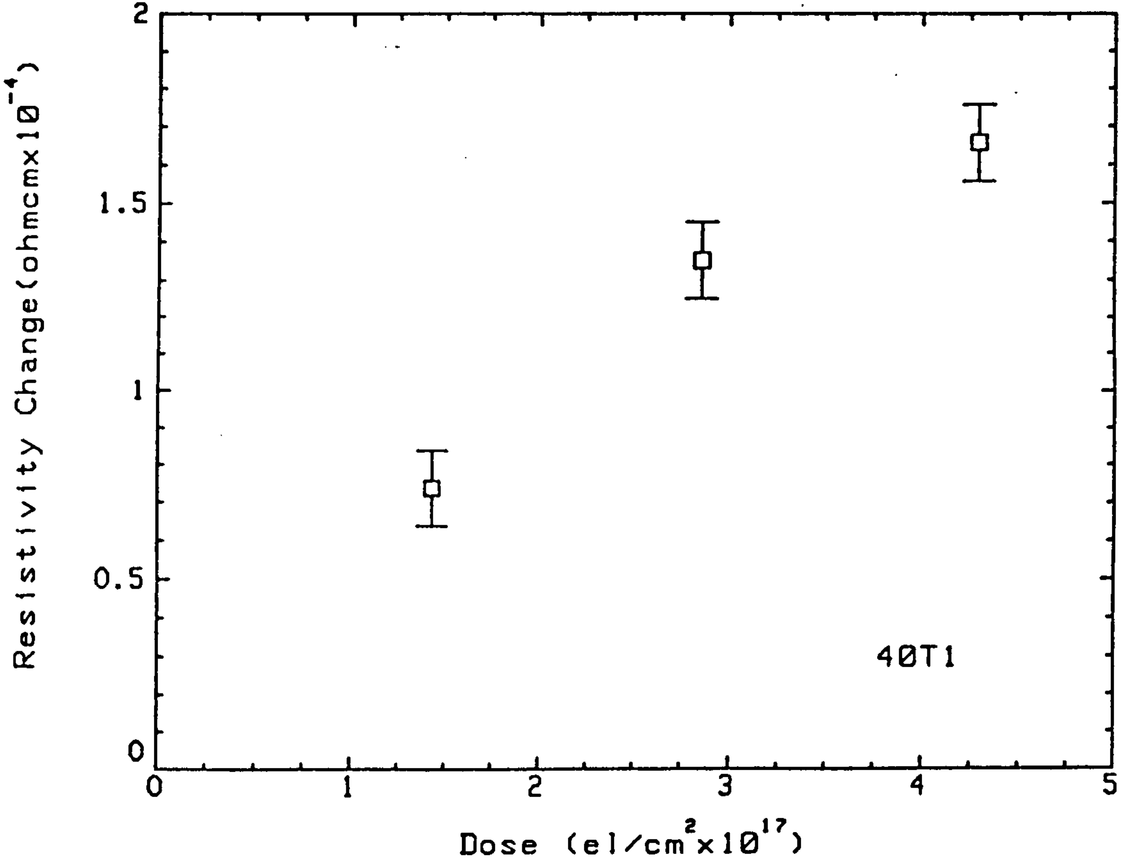

FIGURE 2

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SOME TEST / ANALYSIS ISSUES
FOR THE
SPACE STATION STRUCTURAL CHARACTERIZATION EXPERIMENT

by

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The Space Station Structural Characterization Experiment (SSSCE) [1,2] is an early space flight experiment that uses the space station as a generic structure to study the dynamic characteristics of Large Space Structures (LSS). On-orbit modal testing will be conducted to determine natural frequencies, mode shapes and damping of dominant structural modes of the space structure assembly. This experiment will utimately support the development of system identification and analytical modeling techniques for Large Space Structures.

In order to ensure the success of SSSCE (in-space validation of modeling techniques for LSS), adequate measurement and instrumentation requirements have to be established during the experiment-definition study. Among the issues affecting these requirements, spatial and modal coverages of the modal test data are of particular interest. Topics such as total number of sensors, type of measurements (translation and rotation), optimal sensor locations (measurement degrees-of-freedom), selection of target modes, effects of modal superposition and truncation, separation of global and local modes, etc. are all of fundamental importance and must be investigated.

A detailed analytical Finite Element Model (FEM) of the space station is generally available and can be used to study the spatial and modal coverages for SSSCE instrumentation requirements. Techniques involving the use of FEM mass and stiffness matrices as well as the frequencies and modal matrix are proposed in this research. A least squares filtering matrix obtained from the product of the modal matrix and its generalized inverse is utilized to assess the modal truncation effect on the measured data [3]. Modal kinetic energy distributed at each DOF is a good indicator to identify the global and local modes [4]. The optimal sensor locations can be determined by maximizing the totality of observed kinetic energy with respect to the selected measurement DOF [5,6].

In addition, system identification and model refinement techniques [7,8] developed in the Modal Analysis & Controls Laboratory (MACL) at University of Lowell can be implemented on the Test/Analysis model for SSSCE. Techniques such as System Equivalent Reduction/Expansion Process (SEREP), estimation of rotational DOF, modal vector correlation, analytical model improvement, model change localization (damage detection), and structural dynamics modifications, etc. can be integrated to systematically enhence the quality of Test/Analysis models.

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CONTROL OF THE FLEXIBLE MODES OF AN ADVANCED TECHNOLOGY GEOSTATIONARY PLATFORM

By

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A controls analysis is conducted on an advanced technology geostationary platform. This spacecraft is a large flexible structure with a payload of Earth-sensing instruments which will collect data from Earth's oceans, land, and atmosphere as part of the bold initiative mission to Planet Earth proposed by NASA. This program will provide a collection of data from a family of spacecraft in both low-Earth orbit and geostationary orbit, which will afford a global definition of the Earth as a system with the capability to predict future events resulting from human and natural forces.

The platform concept studied here is a large flexible structure with a payload of eighteen instruments. Because the platform is in geostationary orbit, these instruments have sensitive pointing accuracy requirements, in the range of 0.1 to 0.0001 degrees, which must be satisfied. The structure housing the instruments is large and flexible with characteristic low natural frequencies, so active control is necessary for vibration suppression.

A finite element model is built using IDEAS**2, and the controls analysis utilizes MATRIX$_x$. Open loop responses due to step and impulse inputs validate the model and the need for active control. It is desired to control the system within the specified pointing accuracy limits while the platform is subjected to on-orbit disturbances from the environment, such as solar pressure and thermal effects, and from self-induced effects, such as stationkeeping maneuvers. Feedback control using the LQR method gives closed-loop system responses of the platform in a disturbance environment which can be controlled within the pointing requirements, given large enough control forces.

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S7-76

SPECTROSCOPIC INVESTIGATION OF THE Cr TO Tm ENERGY TRANSFER IN YTTRIUM ALUMINUM GARNET CRYSTALS

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New and interesting schemes have recently been considered for the efficient operation of solid-state ionic laser systems. Often the available data on these systems were obtained only because they seemed directly related to the laser performance and provide no insight into the physical processes. A more systematic approach is desirable, where more attention is devoted to the elementary basic processes and to the nature of the mechanisms at work. It is with this aim that we have undertaken the present study.

Yttrium Aluminum Garnet ($Y_3Al_5O_{12}$), called YAG, has two desirable properties as host for rare earth impurities: 1) trivalent rare earth ions can replace the yttrium without any charge compensation problem, and 2) YAG crystals have high cutoff energies. The latter property is conducive to the presence of sharp emission spectral lines which lend themselves to laser applications. Several attempts have been made to improve the efficiency of these systems by assisting the rare earth emission by means of energy transfer from a co-dopant Cr^{3+} ion.

Cr^{3+} has lased in a great number of host lattices, as a three-level monochromatic system in ruby, and as a tunable four-level system in garnets with a low crystal field at the octahedral site that it occupies. In such garnets, Cr^{3+}, because of its broad band emission, has been used as an efficient sensitizer for Nd^{3+}.(1) It has also been used as sensitizer for other ions, such as Tm^{3+}, which may be pumped via Cr^{3+} with a good quantum efficiency.

In YAG, Cr^{3+} resides in a site with a strong crystal field and, consequently, it has sharply defined luminescent levels and an emission confined to a narrower region of the spectrum. However, there is a good spectral overlap between this emission and the Tm^{3+} absorption.

With these considerations in mind we have conducted a series of experiments in order to elucidate the nature of the energy transfer process between the Cr^{3+} and Tm^{3+} ions in YAG. We have obtained spectral data on various samples, single-doped with Cr^{3+} and Tm^{3+} and co-doped with these two ions, which include absorption, luminescence, excitation and response to pulsed excitation. We have found that the rate of the Cr^{3+} to Tm^{3+} energy transfer process varies in general with temperature and we have set up a model that explains this temperature dependence. We have studied the time evolution of the Cr emission in the double-doped samples and measured carefully the spectral overlap between this emission and the Tm^{3+} absorption in the 77-350K temperature region. From these data we have extracted the relevant parameters that give a measure of the Cr-Tm coupling.

The results of our measurements and calculations indicate that, despite the spectral confinement of the Cr emission, the Cr^{3+} ion in YAG can be used to sensitize efficiently the Tm^{3+} ion.

I wish to thank Drs. G. Armagan, and M. Buoncristiani who collaborated with me in this project, Dr. R. Hess for fruitful discussions, and Ms. T. Lazarus and Mr. A.T. Inge for technical assistance.

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THE EFFECTS OF BIOMASS BURNING ON THE CONCENTRATION OF TRACE GASES IN THE ATMOSPHERE

by

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Over the past several years, there has been considerable interest concerning the global effects of biomass burning on concentrations of trace gases in the atmosphere (reference 1-6). The paucity of reported studies and investigations into the effects of the "Greenhouse Gases" such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), up until about a decade ago, would suggest that the topic was not then one of universal concern. Efforts are now being made to understand the biogenic, anthropogenic and photochemical sources of atmospheric trace gases.

Biomass burning which includes the burning of forests for clearing, the burning of vegetative stubble after harvesting, and lightning and human-induced wildfires (reference 6) is but one consideration under the general paradigm of atmospheric perturbations. A team of researchers from the Langley Research Center (I was included) along with the Canadian Forest Ministry, Ontario, Canada collaborated in an experiment in a deforestation effort through a prescribed burn.

Through a specially designed experimental modeling and instrumentation, we were able to collect a substantial pre-burn data set. The primary focus of the pre-burn experimental activities was the emission of nitrous oxide (N_2O) gas from selected sites. Rational: Nitrous oxide (N_2O) as identified as one of the "Greenhouse Gases" has, potentially, serious environmental implications. In addition to its ability, along with other gases, to significantly impact the climate of our planet, it diffuses into the stratosphere where it is chemically transformed into nitric oxide (reference 1).

Experimental Design: Specifically designed collars were put into selected sites within the proposed prescribed burn area. Several of the sites chosen were covered with live vegetation while other sites were more barren other than thick organic mulch from decaying vegetation. Sample of gases were carefully taken by syringe from each selected site pursuant to experimental methodology as outlined in reference 1.

It has been known for some time that nitric oxide (NO) and nitrous oxide (N_2O) are both produced by biogenic processes in the soil. It was the intent of this experiment to determine whether or not the production and emission of N_2O was enhanced due to the biomass burn.

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AN INVESTIGATION OF TURBULENCE MODELS

by

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The accuracy to which a turbulent boundary layer or wake can be predicted numerically depends on the validity of the turbulence closure model used. The modeling of turbulence physics is one of the most difficult problems in computational fluid dynamics (CFD). In fact, it is one of the pacing factors in the development of CFD.

In general, there are three main approaches to the description of turbulence physics. First is turbulence modeling in which the Reynolds averaged Navier - Stokes equations are used and some closure approximation is made for the the Reynolds stresses. The various closure models are based partly on theory and partly on experiment. Included in this category are the eddy viscosity models in which the Reynolds stresses are equated to a coefficient times the local mean rate of shear. This eddy diffusion coefficient depends on a length scale and a velocity scale. The eddy viscosity models can be be further broken down into algebraic, one equation and two equation models. In the algebraic models, such as Prandtl's mixing length model, the eddy viscosity is related by algebraic equations to the properties of the local mean flow. Turbulence, however, is a non-local phenomenon and there are strong history effects. The algebraic models are not capable of treating history effects. The one and two equation models attempt to correct for this by making use of transport equations for the velocity and length scale in the eddy viscosity. The algebraic models work well for attached boundary layers. It is expected that the one and two equations models should work better for separated and re-attached boundary layers. There are also a class of turbulence models in which the Boussinesq approximation of an eddy viscosity is not made. Instead, the Reynolds stresses are modeled directly by means of transport equations. These equations require a closure assumption on the third order velocity correlations.

A second approach to turbulence is large eddy simulation (LES) in which the computational mesh is taken to be fine enough that the large scale structure of the turbulence can be calculated directly. An empirical assumption must be made for the small scale sub - grid turbulence. The third approach is direct simulation. In this technique the Navier-Stokes equations are solved directly on a mesh which is fine enough to resolve the smallest length scale of the turbulence. The Reynolds averaged equations are not used and no closure assumption is required. These last two approaches require extensive computer resources and as such are not engineering tools. They are useful for providing important checks for the engineering turbulence models.

The purpose of the work this summer was to investigate the various engineering turbulence models for accuracy and ease of programming. This involved the comparison of the models with each other and with experimental data. It was decided to choose a simple geometry with which to test the turbulence models. Therefore a computer program was written to solve the two dimensional, incompressible boundary layer on a flat plate at zero incidence. The flat plate has the added advantage that there is a wealth of good experimental data available for comparison. The governing equations were written in integral form and applied to a control volume consisting of a basic cell. This led to a set of finite difference equations for the tangential and normal components of velocity. The x momentum equation was solved by a Runge-Kutta scheme with the diffusion terms treated implicitly. The program was written in such a way that different eddy viscosity models can be easily inserted. At present the program is successfully running with an algebraic turbulence model. The results have been compared with empirical curve fits for turbulent boundary layers and the agreement is very good.

There are several areas where work needs to be done to advance the study. First, various iterative solution schemes should be tried to speed the convergence rate of the finite difference solution. The present scheme converges but is slow. Secondly, one and two equation turbulence models should be incorporated into the program so that comparisons can be made for accuracy and ease of programming. Third, compressibility should be added to the model so that transonic flows can be studied.

It is expected that all of the turbulence models should give fairly similar results for attached boundary layers. This is not the case for separated boundary layers. Therefore, it will be useful to extend the code so that it can model separation. This will require some additional terms in the momentum equations since the boundary layer equations are singular at a point of separation. This aspect of the problem should be investigated in the future.

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MODIFYING PASVART TO SOLVE SINGULAR NONLINEAR 2-POINT BOUNDARY PROBLEMS

28.

by

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To study the buckling and post-buckling behavior of shells and various other structures, one must solve a nonlinear 2-point boundary problem. Since closed-form analytic solutions for such problems are virtually nonexistent, numerical approximations are inevitable. This makes the availability of accurate and reliable software indispensable.

In a series of papers Lentini and Pereyra[4,5], expanding on the work of Keller[2], developed **PASVART**: an adaptive finite difference solver for nonlinear 2-point boundary problems. While the program does produce extremely accurate solutions with great efficiency, it is hindered by a major limitation. **PASVART** will only locate isolated solutions of the problem. In buckling problems, the solution set is not unique. It will contain singular or bifurcation points, where different branches of the solution set may intersect. Thus, **PASVART** is useless precisely when the problem becomes interesting.

To resolve this deficiency we propose a modification of **PASVART** that will enable the user to perform a more complete bifurcation analysis. **PASVART** would be combined with the Thurston bifurcation solution: an adaptation of Newton's method that was motivated by the work of Koiter[3] and reinterpreted in terms of an iterative computational method by Thurston [8,9]. Roughly speaking, Thurston's method incorporates higher order terms in the Taylor expansion to solve for approximate solutions that will converge on different branches of the solution set.

A drawback of the approach is that it requires extensive programming by the user. However, it is possible, with the use of symbolic manipulation programs, to generate the necessary computer code automatically[1,6]. Thus, we will also combine the modified version of **PASVART** with Macsyma (a symbolic manipulation program developed at MIT). This will eliminate the need for the user to perform a complex programming task. The new version of **PASVART** will be easier to use and capable of a much more sophisticated analysis.

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BENCHMARK SOLUTIONS FOR THE GALACTIC ION TRANSPORT EQUATIONS WITH SPATIAL AND ENERGY COUPLING

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BY

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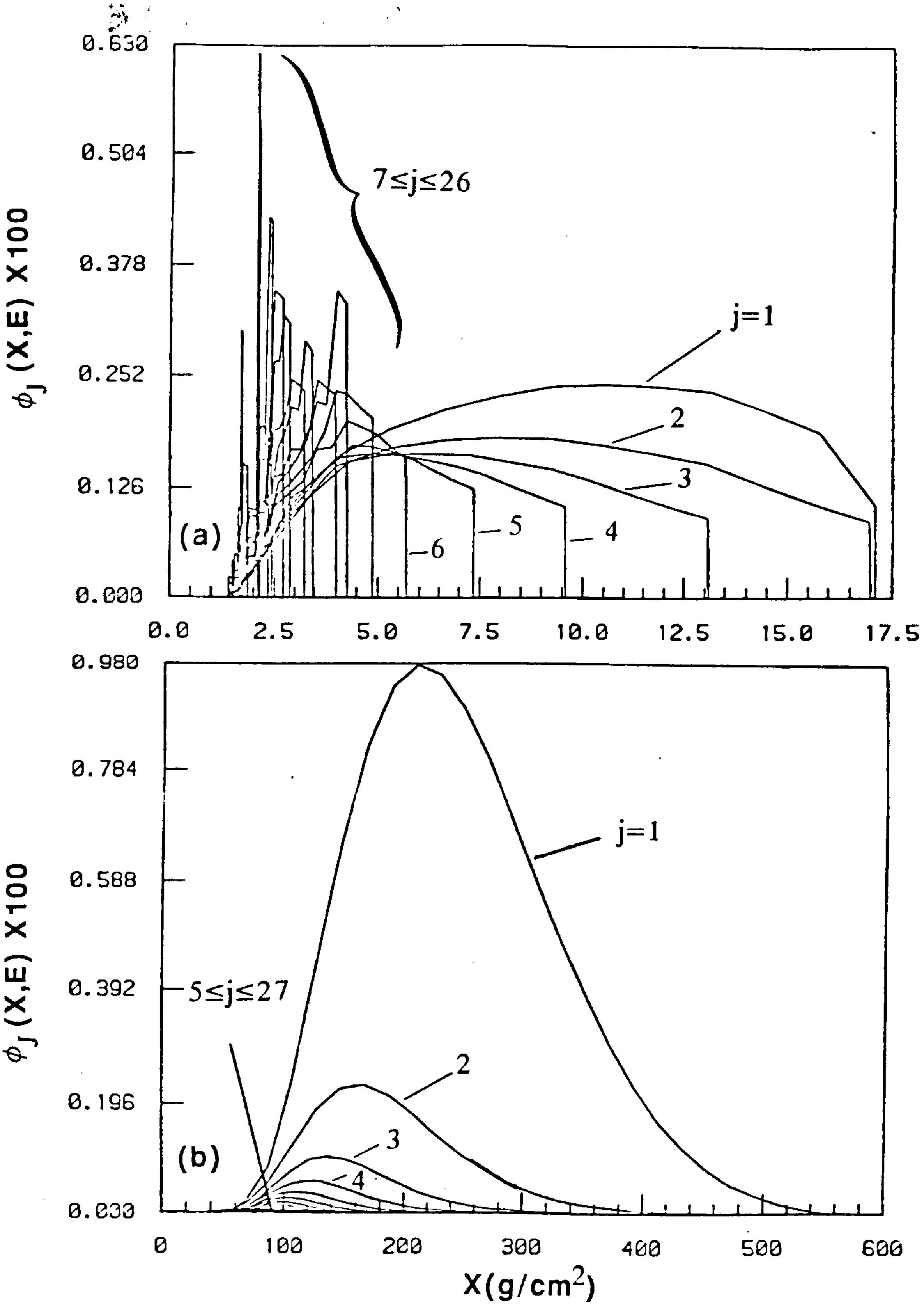
With our ever-increasing interest in establishing mankind's presence in space, the protection of personnel from energetic radiation in the space environment has become a relevant issue. As high energy radiation, composed of heavy ions called galactic cosmic rays (GCR's) originating in deep space and/or protons from solar flares, interacts with target nuclei, the incident ions undergo nuclear fragmentation and energy degradation. The fragments generated by direct nuclear impact or electromagnetic dissociation form a secondary radiation field which again interacts with target nuclei to prolong the biological hazard engendered by the incident ions. Thus, to ensure that the habitat in the space environment is properly shielded from energetic radiation, a knowledge of the changing nature of the incident radiation field as it penetrates protective spacecraft shielding is required.

In order to anticipate future space shielding requirements, NASA has initiated an effort to formulate computational methods to simulate radiation effects in space. As part of the program, numerical transport algorithms have been developed for the deterministic Boltzmann equation describing GCR interactions with matter. It thus becomes necessary to assess the accuracy of proposed deterministic algorithms. For this reason, analytical benchmark solutions to mathematically tractable galactic cosmic ray equations have recently been obtained. Even though these problems involve simplifying assumptions of the associated physics, they still contain the essential features of the basic transport processes. The solutions obtained are compared to results from numerical algorithms in order to ensure proper coding and to provide a measure of the accuracy of the numerical methods used in the algorithm.

For the first time, mathematical methods have been applied to the galactic ion transport (GIT) equations in the straight ahead approximation with constant nuclear properties. The approach utilizes a Laplace transform inversion yielding a closed form benchmark solution which is also computationally efficient. The spatial flux profiles (ϕ_j for ions of charge number j) at high and low energies resulting from an incident GCR beam composed of ions from Flourine to Iron is shown in the accompanying figure. The rather discontinuous behavior at high energy is a direct reflection of the singular source of the incident ions. In contrast, the much smoother variation at low energy with the proton field dominating and the heavy ions almost totally depleted provides a demonstration of the changing nature of the radiation field. This solution will prove useful in assessing the numerical GCR algorithms currently under development.



Flux profiles for GCR beam (composed of F - Fe ions) (a) near source energy (b) at low energy.

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CURRICULUM IN AEROSPACE SCIENCE AND TECHNOLOGY IN COOPERATION WITH NASA LANGLEY RESEARCH CENTER

by

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In 1958, Congress established a Federal agency to plan, coordinate, conduct and implement aerospace research and activities. Since that time, the National Aeronautical Space Administration has planned, directed, conducted and implemented numerous research projects and activities. Because of the vast amount of research that has been conducted at NASA, and its concern for the future of this country and its young people, NASA wanted to disseminate some of its research to the general public and to public school systems.

NASA established the Teacher Resource Center in 1983 to help disseminate information to the general public and to public school systems about its research. There are many resources available for teachers to use to help students understand the research that is being conducted at NASA.

Curriculum was written to show teachers how to best use the many resources that are available at the Teacher Resource Center. This curriculum packet was written using teaching units that teachers in both the elementary and middle schools can use to help students better understand some of the research that has been conducted at NASA and will be conducted in the future.

The units are written with certain standards. Each unit contains: (1) specific objectives, using the Virginia standards of learning, (2) the materials that are available from the TRC, (3) many activities that teachers can use in a variety of ways, and (4) specific strategies for measuring the objectives to determine if the students mastered the knowledge, concepts or skills that were taught.

The curriculum units can be used in a variety of ways. Teachers may assign specific activities to students individually, in small groups and in teams.

They may also direct large or small group activities or allow students to direct their own activities.

There is no time limit on the different units. Teachers may decide how long to remain on any particular unit. The length of time and depth of involvement will depend upon the needs, interests and abilities of the students.

The curriculum packet contains specific units on several topics. They are:

1. Careers in Aerospace Science and Technology
2. The History of Flight
3. The History of Satellites
4. The History of the Manned Space Projects and the Future of the Future of the Space Program
5. The Solar System
6. The History of Rockets

Teachers who are interested in obtaining a copy to the curriculum should contact the Teacher Resource Center at NASA Langley Research Center, Hampton, Virginia.

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APPROACHES TO NON-LINEAR AERODYNAMIC ANALYSIS AND DESIGN

By

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Within the last two decades, there has been increasing emphasis on developing more sophisticated computational fluid dynamics (CFD) methods to handle a wide range of problems of interest to the aerospace community. The reasons for this are well-covered in the references which also provide a fairly comprehensive picture of the status of CFD development and capability as well as an assessment of requirements and future directions. An independent review and assessment was also carried out by the author as part of the current assignment and the results are outlined herein.

As the problems faced by vehicle and systems designers become more complex and critical, particularly at very high speeds and altitudes, the need to predict flow characteristics about intricate body shapes under conditions involving complex physical phenomena becomes more acute. Problems which previously were handled (however inadequately) by solving the linearized equations governing fluid flow must now take account of the essential non-linear character of these relationships. Since no known mathematical techniques exist to accomplish this, the focus has shifted to methods based on finite difference techniques using timewise integration to determine the flow variables throughout the fluid. This includes the creation of a three-dimensional (3-D) mesh or grid within the zone of interest which provides the framework for systematic calculations leading to a (usually) steady state or stationary solution. In order to achieve the desired definition and accuracy, a grid comprising large numbers of very small elements is usually necessary. Typically, billions of calculations are required to establish dynamic compatibility at matching faces of the grid elements for each increment in time. The computer capability required is of gigantic proportions such that only very special facilities supported at the national level are sufficient to approach the quality of simulation needed. As computer capabilities increase, the objectives become more demanding and the focus changes to problems of ever increasing complexity. Ultimately, this will include such micro-scale phenomena as turbulence and combustion dynamics or the mega-scale of planetary atmospherics. Such goals now appear visionary and would require orders of magnitude improvement in computer speed and capacity.

Consideration of the current status of computer development and the need for more realistic and affordable analysis and design capability has inspired the current study to identify alternative approaches to cope with the wide spectrum of physical phenomena involved with the design and operation of aerospace vehicles and systems. The continued reliance on grid methods appears to present some fundamental limitations in terms of simulation quality, time and cost. Thus, the present effort has focused on a hierarchy of methods based on fundamental solutions of the linearized system equations. To handle the non-linear aspects several schemes have been identified for efficient algorithms applicable to both analysis and design in 4-D.

An architecture for a CFD system utilizing these or similar concepts has been proposed which would include the following characteristics:

- Essential physics and mathematics
- Realistic configurations in 4-D
- Avoids basic limitations of grid methods
- Small to large-scale phenomena
- Affordable computing time and cost
- Verifiable accuracy
- Logical progression to complex problems
- Methods matched to needs and resources

Figure 1 shows the elements of such a system arranged in a logical sequence for development.

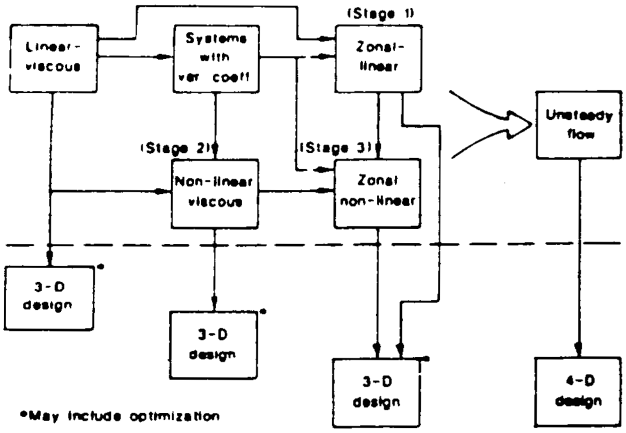

Figure 1. - Architecture for CFD System

To support this initiative, an exploratory approach is recommended as an extension to the present study. The initial steps would involve, 1) development of fundamental solutions to the linearized Navier-Stokes equations for compressible, heat conducting fluids and 2) identification and evaluation of promising algorithms for non-linear CFD codes needed to implement the proposed systems.

It is concluded that this approach could lead to a more-effective CFD systems complex to support advanced aerospace vehicle design and the creation of new leading edge technologies. Properly implemented, such a system would find wide application within the private sector as well and help to reestablish U.S. preeminence in industry.

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COMPUTER MODELING OF POLYMERS

by

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A Polymer Molecular Analysis Display System (p-MADS) was developed for computer modeling of polymers. This method of modeling allows for the theoretical calculation of molecular properties such as equilibrium geometries, conformational energies, heats of formations, crystal packing arrangements, and other properties. Furthermore, p-MADS has the following capabilities:

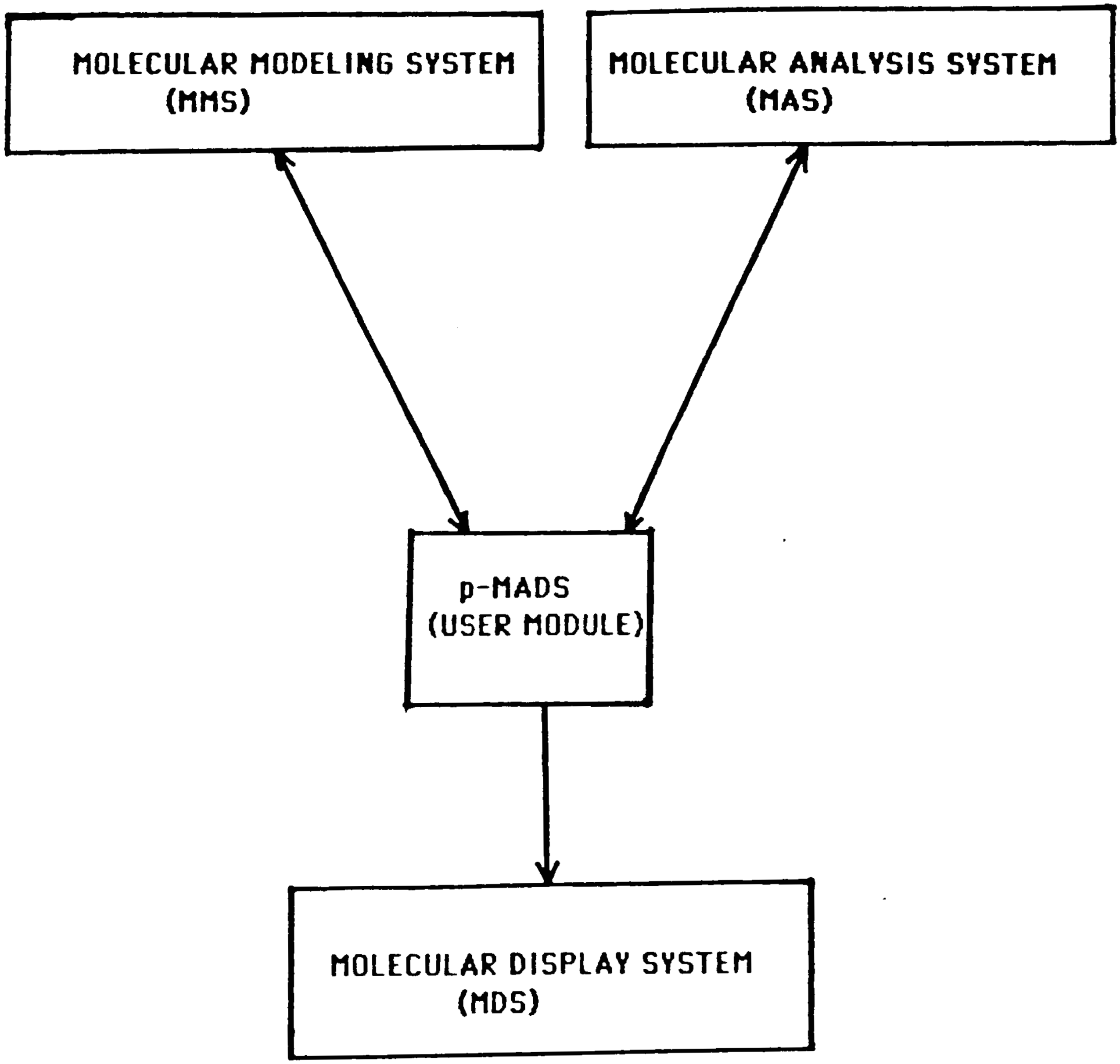
* Constructing molecules from internal coordinates (bonds lengths, angles, and dihedral angles), Cartesian coordinates (such as X-ray structures), or from stick drawings.
* Manipulating molecules using Graphics and to make hard copy representation of the molecules on a graphics printer.
* Performing geometry optimization calculations on molecules using the methods of Molecular Mechanics or Molecular Orbital Theory.

As shown in figure 1, p-MADS is a modular system consisting of four modules:

1. Main System (user module). This module links the other modules. User log into this module to extract information from one module and process it in another module.
2. Molecular Modeling System. Three dimensional structures are generated in the module for performing molecular operations such as rotation of molecules, comparision of two structures, and the examination of molecular distances.
3. Molecular Analysis System. The function of this module is to perform theoretical calculations on molecules.
4. Molecular Display System. This module outputs the information from the other modules to a printer or a graphics screen.

This particular design was chosen for p-MADS because it can be easily updated and readily adapted to new and improve hardware.

FIGURE 1. BLOCK DIAGRAM OF A POLYMER MOLECULAR ANALYSIS DISPLAY SYSTEM (p-MADS).



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LASER CLOCKS AND NEAR FIELD GRAVITY OF ROTATING OBJECTS

by

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3P

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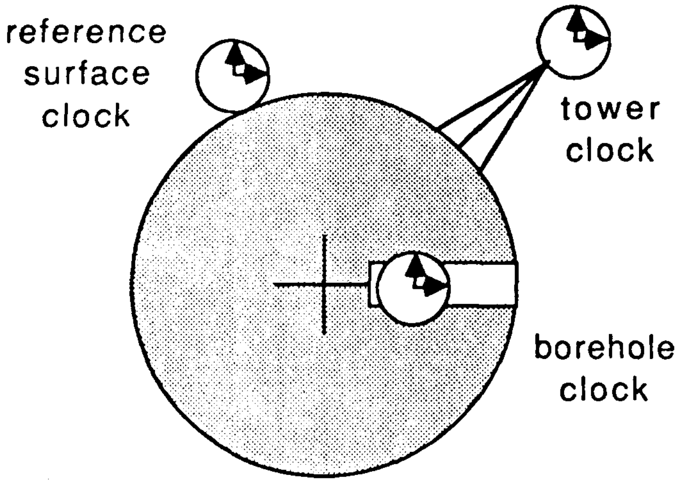
This work explores the feasibility of using high performance laser clocks to detect effects of rotation in the near field region of the Earth's gravitational field. According to general relativity, the time recorded by an independent clock is the proper time of the space-time metric that applies to the system under consideration. If the gravitational source is stationary (nonrotating), proper time involves only the speed of the clocks and the scalar gravitational potential at the position of the clocks. However, if the source is rotating, the motion of the source could have an effect on the metric. Previous attempts to calculate the relativistic timekeeping for terrestrial clocks have used the metric for a nonrotating system, primarily because metrics for a rotating system were not available. This work investigates the specific effects of rotation on the Earth's gravitational field and the corresponding effect on timekeeping of laser clocks in the near field environment.

An important application of high performance laser clocks, those that are expected from the Stanford University - NASA Laser In Space Technology Experiment (SUNLITE), is shown in Fig. 1, which illustrates a technique that might be used to measure the gradient in the Earth's gravitational field near the surface. The probe clocks would be linked to the surface reference clock by a flexible fiber optic cable, and the difference in clock frequencies would be observed by detecting the interference beat frequency at the reference clock. The gravitational potential difference would be measured by intercomparing the clocks via the fiber optic link when they are located at different altitudes and depths.

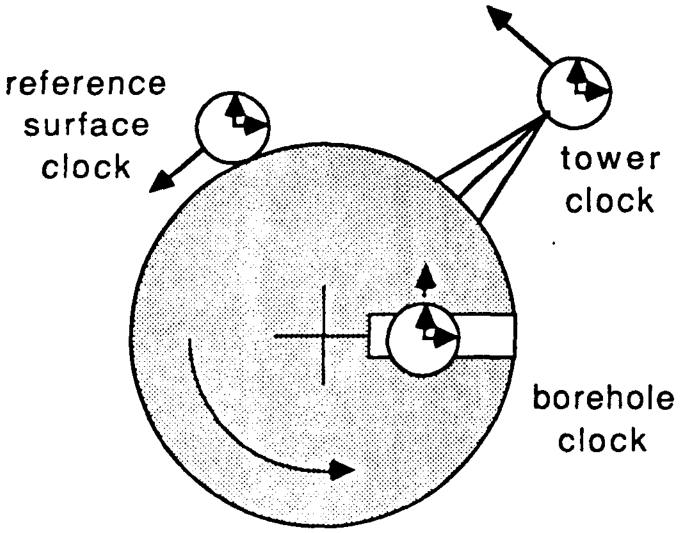
The classical "Universal Law of Gravity", first postulated by Isaac Newton more than 300 years ago, states that all matter in the universe exerts a force of attraction on all other elements of matter according to an inverse square law. However, Newton's theory falls silent on effects of rotation of a centrally located extended source of gravity because of an implicit assumption that gravity propagates *instantaneously*, that is, that the speed of gravity is infinite. This assumption is no longer tenable. If gravity is assumed to propagate with Nature's own speed limit, the speed of light, it turns out that significant effects of rotation are predicted in the near field region of a rotating sphere, particularly on or near the surface of the sphere. The finite speed theory predicts a sensible peaking at the surface in the acceleration of gravity.

A recent report in Physics Today ("From Mine Shafts to Cliffs - The 'Fifth Force' Remains Elusive", July, 1988, p. 21) provides observational support for a peak near the surface. The "Fifth Force" may actually be a manifestation of the finite speed of gravity. The surface peaking effect has previously been considered "anomalous" because it is not predicted by the standard stationary-source theory. It now appears that a peak at the surface is a natural consequence of finite speed gravity, and may not be an "anomaly" in the inverse square law. In fact, it may be possible to use the available gravity data to infer the speed of the gravitational interaction.

If gravity propagates with the speed of light, there should be two components in the gravitational

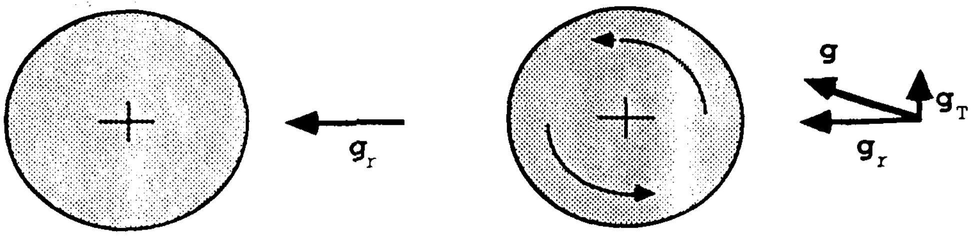


a) Stationary System



b) Rotating System

Fig. 1. Physical arrangement to use clocks as gravity meters. Standard clocks above and below the surface record time relative to the surface reference clock according to the difference in the gravitational field above and below the surface. Effects of rotation on the gravitational field in b) compared with the stationary field in a) can be detected with high performance laser clocks.

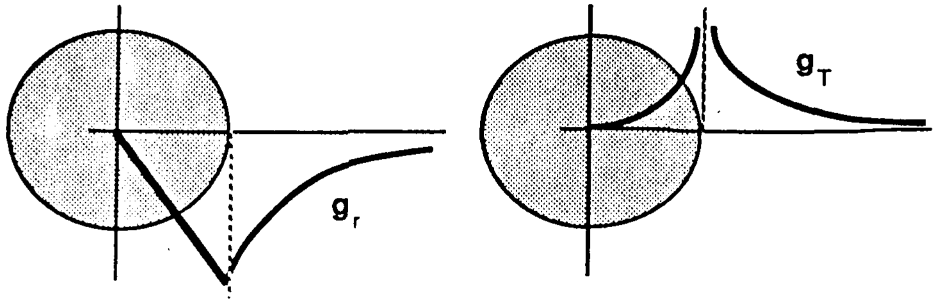


a) Stationary Body b) Rotating Body

Fig. 2. Components of the gravitational field for a) a nonrotating spherical body and b) a rotating spherical body. The transverse component g_T lies in the plane of rotation and is perpendicular to the radial component g_r.

field, the standard radial component for a stationary body, and an additional transverse component that is caused by the motion of the body, as illustrated in Fig. 2. For a uniform rotating sphere, the radial component would obey the standard inverse square law, but the transverse component would follow an inverse cube law. A highly sloped inverse cube dependence would cause the transverse component to rise more quickly than the radial component. Therefore, the gravitational field of a rotating body should exhibit a rise above the inverse square force as the surface is approached, in a manner not unlike the peak that has been observed in the gravity data.

Figure 3 graphs the strength of the radial component, which follows the standard inverse square law, and the strength for the new transverse component, which follows an inverse cube law.



a) Radial Component b) Transverse Component

Fig. 3. Components of the gravitational field of a rotating body: a) standard radial component and b) transverse component.

I thank Dr. C. E. Byvik for patient support of this work and Dr. A. M. Buoncristiani for sharing ideas and providing crucial help with integral transformation techniques.

JCHafele
NASA Langley
August 1988

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Semi-Interpenetrating Polymer Network's of Polyimides: Fracture Toughness

by

TN840743

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PMR-15 thermosetting polyimide is easy to process in making a graphite fiber composite, but is brittle and is prone to microcracking, when subjected to thermal cycling. The objective of this research was to improve the fracture toughness of PMR-15 by co-dissolving LaRC-TPI, a thermoplastic polyimide. The co-solvation of a thermoplastic into a thermoset produces an interpenetration of the thermoplastic polymer into the thermoset polyimide network, (Semi-IPN). At the end of the second week of the ASEE-NASA program, it was determined that the Rheometrics System IV Rheometer, a key instrument to our research program, would not be functioning until October. Thus, this research program was put on hold until that time.

A second research program was planned around the concept that to improve the fracture toughness of a thermoset polyimide polymer, the molecular weight between crosslink points would be an important macromolecular topological parameter in producing a fracture toughened semi-IPN polyimide. A New NE, (a monofunctional endcapping crosslinking reactant) had earlier been produced by Dr. Ruth Pater (ASEE-NASA Mentor, Senior Polymer Scientist, Polymer Materials Branch) and this reactant was used to synthesize prepolymers with molecular weights between crosslink points varying form 1,500 to 20,000. For these neat resin polymers, it was determined that the tensile modulus only lightly decreased as molecular weight increased, while the fracture toughness in mode I increased monotonically and asymptotically as molecular weight increased.

These joint research programs will be continued at NASA & UT.

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MODELING OF HYDROGEN-AIR DIFFUSION FLAME

by
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Abstract

The presence of significant contaminants in high enthalpy "air" streams, produced and used by supersonic ground test facilities for Scramjet engine development (e.g. from preheating by hydrogen-air or hydrocarbon-air combustion with oxygen replenishment), requires that possible effects of contaminants on ignition, flameholding, and stability of fuel-air diffusion flames be accounted for, in order to predict performance of airbreathing engines under free-flight conditions. For example, test air may contain 3 to 30 mole percent water vapor, depending on method of heating, Mach number, and pressure. Obviously, with such high concentrations, a sound technical basis is needed to assess the effects of excess water and to adjust experimental engine designs and performance predictions.

The present research objective is to determine the effects of contaminants on extinction limits of simple, well defined, counterflow H_2-air diffusion flames, with combustion at 1 atmosphere. Results of extinction studies and other flame characterizations, with appropriate mechanistic modeling (presently underway), will be used to rationalize the observed effects of contamination over a resonably wide range of diffusion flame conditions. The knowledge gained should help efforts to anticipate the effects of contaminants on combustion processes in H_2-fueled scramjets.

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RADIATION EFFECTS ON POLYMERIC MATERIALS

By

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Materials placed in the geosynchronous earth orbit will be subjected to a radiation environment consisting of electrons and protons each with a flux of 10^8 particles cm^{-2} sec^{-1} and ultraviolet radiation with an energy flux of 0.14 joules cm^{-2} sec^{-1}. Future satelites will likely be constructed of polymer matrix composites because of their light weight and high strength. In the presence of such radiations, polymeric materials are known to suffer a degradation of properties due to both chain sission and crosslinking. ~~Thus~~, it is important to study changes in properties of polymers after irradiation with charged particles, with ultraviolet radiation, and with combinations of both. An apparatus for this purpose has been built at the NASA Langley Research Center. It consists of a chamber 9 inches in diameter and 9 inches high with a port for an electron gun, another port for a mass spectrometer, and a quartz window through which an ultraviolet lamp can be focused. The chamber, including the electron gun and the mass spectrometer, can be evacuated to a pressure of 10^{-8} torr. A sample placed in the chamber can be irradiated with electrons and ultraviolet radiation separately, sequentially, or simultaneously, while volatile products can be monitored during all irradiations with the mass spectrometer.

The apparatus described above has been used to study three different polymer films: lexan, a polycarbonate; P1700, a polysulfone; and mylar, a polyethylene terephthalate. The repeat units of the three polymers are ~~shown in figure~~ 1. All three polymers had been studied extensively with both electrons and ultraviolet radiation separately, but not simultaneously. Also, volatile products had not been monitored during irradiation for the materials. A high electron dose rate of 530 Mrads/hr was used so that a sufficient concentration of volatile products would be formed to yield a reasonable mass spectrum. The intensity of the ultraviolet source (a 1000 watt xenon lamp) was set to 1.5 solar constants with a calibrated photometer. The temperature of the sample could be monitored with a thermocouple, but it could not be controlled. Thus, in the electron irradiations, the sample temperature was 35 to 40° C, while it went up to 110° C in the ultraviolet irradiations. All irradiations were for 8 hours.

The mass spectrometer results showed that for lexan and mylar the largest concentrations of volatile products had masses of 44, 28, 16, and 12, corresponding to products of CO_2, CO, O, and C. This indicates that chain sission occurs most readily at the carbonyl group in these polymers. For the polysulfone, masses seen were 64, 48, 32, and 12, corresponding to products of SO_2, SO, O_2 or SO_2(doubly charged), and C. This indicates that the sulfone group most readily participates in chain sission.

Comparisons of separate, sequential, and simultaneous irradiations with electrons and ultraviolet radiation were made for each polymer. The radiation damage in each irradiation was monitored by noting changes in the uv/visible spectrum from the baseline spectrum taken on unirradiated films. Absorbance spectra were integrated by the spectrometer and the baseline area was subtracted from the area after irradiation. The results are shown in figures 2, 3, and 4 for lexan, P1700, and mylar respectively. The notation e-/uv means an 8 hour electron irradiation followed by an 8 hour ultraviolet irradiation. The notation, uv/e-, means the reverse. The result for the ultraviolet irradiation of mylar indicates that the film probably contains an ultraviolet inhibitor. The results show that synergistic effects appear in the sequential irradiations for P1700 and mylar and in the simultaneous irradiation for lexan. Further work is anticipated to determine the reasons for these effects.

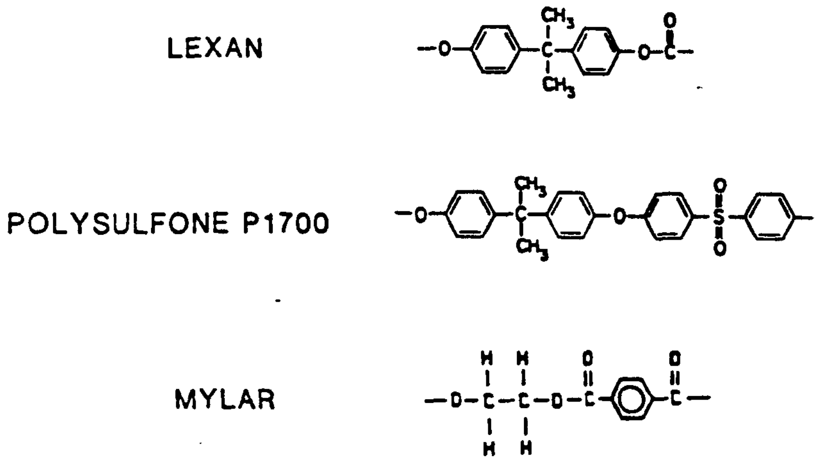

Figure 1. MATERIALS STUDIED

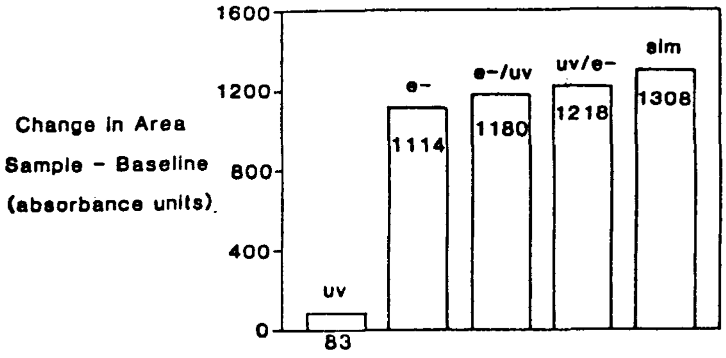

Figure 2. Change in Area in UV/Visible Spectra for Lexan Irradiations

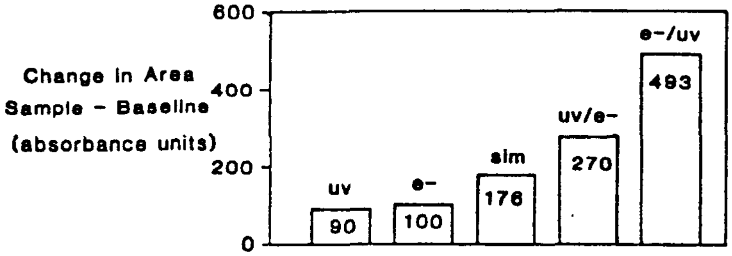

Figure 3. Change in Area in UV/Visible Spectra for Polysulfone P1700 Irradiations

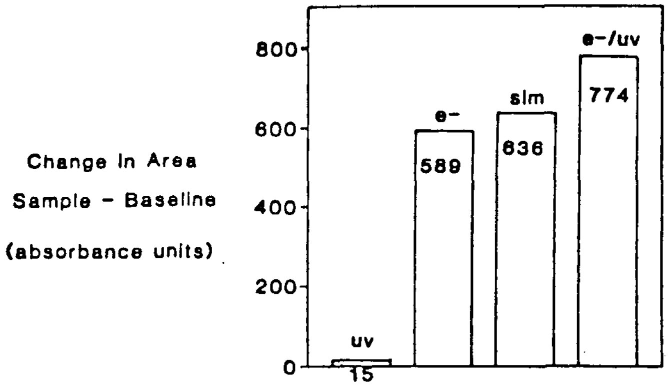

Figure 4. Change in Area in UV/Visible Spectra for Mylar Irradiations

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THE DETERMINATION OF ENERGY TRANSFER RATES IN THE Ho:Tm:Cr:YAG LASER MATERIAL

By

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Energy transfer processes occurring between atomic, ionic, or molecular systems are very widespread in nature. The applications of such processes range from radiation physics and chemistry to biology. In the field of laser physics, energy transfer processes have been used to extend the lasing range, increase the output efficiency, and influence the spectral and temporal characteristics of the output pulses of energy transfer dye lasers or solid-state laser materials. Thus in the development of solid-state lasers, it is important to investigate the basic energy transfer (ET) mechanisms and processes in order to gain detailed knowledge so that successful technical utilization can be achieved. The aim of the present research is to measure the ET rate from a given manifold associated with the chromium (Cr) sensitizer atom to a given manifold in the holmium (Ho) activator atom via the thulium (Tm) transfer atom, in the Ho:Tm:Cr:YAG laser material.

The energy level diagram for this material is illustrated in Figure 1. The specific mechanism of the process by which the excitation energy is transferred from sensitizer to activator is not quite clear at the present time. However, the following possibilities may account for what is believed to be occurring. Firstly, absorption of the incident 532 nm photon by the chromium atom excites it to the $^4T_2$ manifold. This is followed by relaxation of the lattice surrounding it resulting in a phonon transition to the ^2E manifold, from which some emission occurs. Secondly, some of the available electronic energy from the $^4T_2$ manifold is transferred to the $^4F_4 + {}^5S_2$ manifold of the activator, Ho, and the $^3F_3$ manifold of Tm resulting in emission from these levels. The third possibility is that the emission of a photon from the sensitizer is followed by reabsorption by the transfer ion, Tm, resulting in its excitation to lower-lying excited manifolds from which emission and/or transfer can occur to the $^5I_7$ manifold of holmium. Emission from $^5I_7$ to $^5I_8$ follows. The fourth possibility is for up-conversion to take place in the transfer ion; for example, from the Cr $^4T_2$ level to the Tm $^1G_4$ manifold. This level then emits to the $^3H_5$ manifold. Measurements of the lifetimes of these manifolds will shed some light on the exact mechanism.

The measurement is performed as a function of the upper and lower manifolds, the concentration of the activator and the temperature. The probability of transfer is concentration, and to some extent, temperature dependent. Transfer rates are inferred by exciting the sensitizer atom and measuring the rate of rise of the fluorescence from the activator atom. Typical emission spectra, shown in Figure 2, were generated using an Nd:YAG laser as the pump source. The 532 nm output from this laser was impinged on the doped crystal situated in a modified variable temperature dewar. The emission from the material was dispersed through a monochromator, at right angles to the pump source, and detected using a cooled photomultiplier tube (PMT). The PMT signal was processed by a gated integrator and boxcar averager, and fed to an IBM XT computer system. The rate of rise and decay of the fluorescence signal, shown in Figure 3, was monitored by scanning the gate of the boxcar across the signal from the manifold to which the monochromator was tuned.

All manifolds to which the excited manifold transfers energy were monitored, in addition to the ones to which it decays. By doing the latter, an independent check of the data would be obtained. This technique will be applied in the energy transfer rate elucidation of other component systems, such as Ho:Er:YAG, Ho:Tm:YAG,and Tm:Er:YAG in the near future.

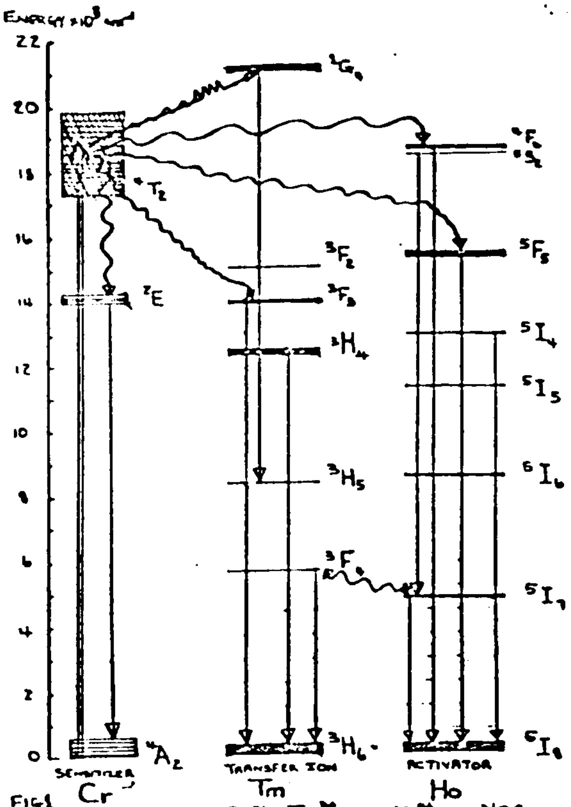

FIG 1
ENERGY LEVELS OF Cr³⁺, Tm³⁺ AND Ho³⁺ IN YAG

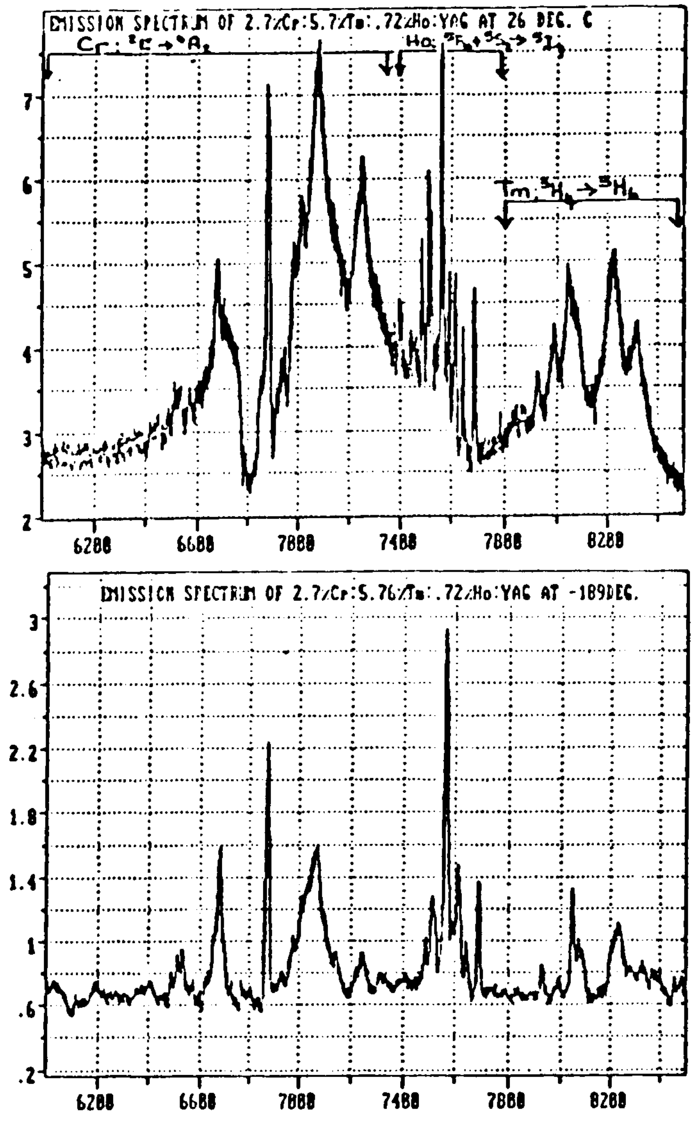

FIG. 2

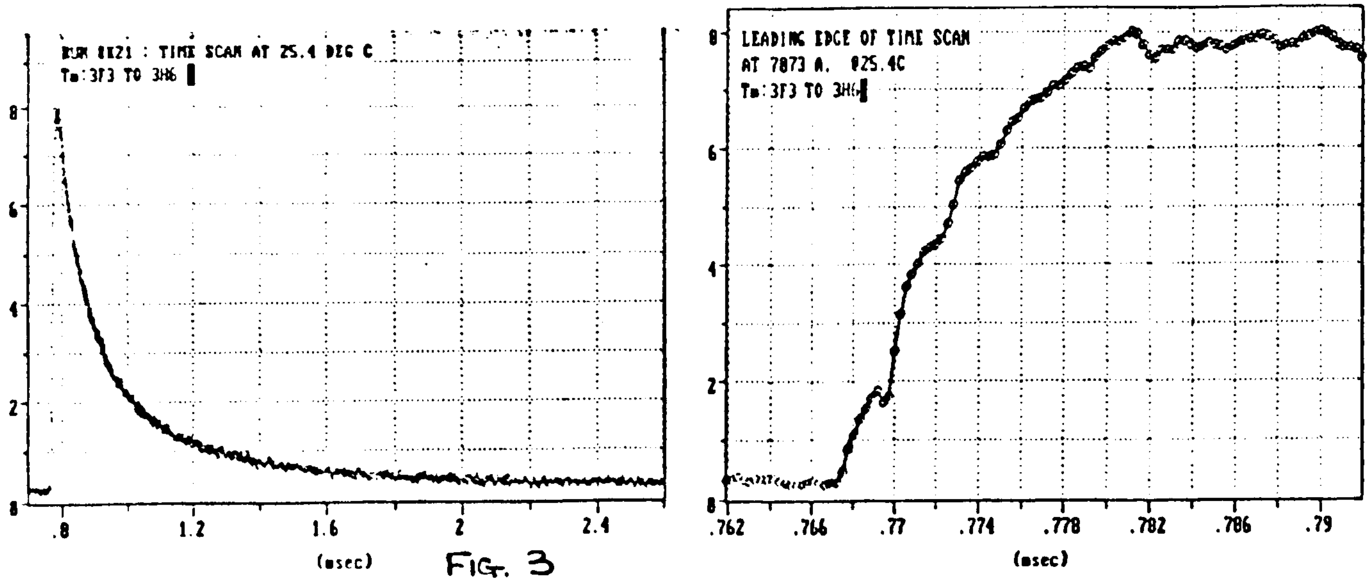

FIG. 3

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TRANSIENT HEAT TRANSFER FROM SHRINKING LOX-DROP

BY

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In order to achieve prescribed experimental conditions in wind tunnels, the nitrogen-oxygen mixture is enriched by injection of liquid oxygen (LOX) upstream of methane burners.

The objective of the study is to determine the LOX drop evaporation rate, which is dominated by heat transfer from the air stream (mass transfer mechanism can be later coupled with the solution from the present work). Since the concentration of drops in the surrounding gas is quite high, the concept of "infinite medium" cannot be utilized. Drop evaporation, as part of system's mass balance, is an important source-term in the finite-difference 2/3-dimensional network along and across the flow duct. This network is expressed in terms of laboratory-system (Eulerian) coordinates, while individual drop behavior, including its thermal history, is analyzed in Lagrangian coordinates.

The drop-to-carrier gas coupling involves not only the above mentioned mass balance, but also momentum/force interactions. The relative velocity between the drop and the surrounding gas affects the heat transfer to the drop; thus, it represents a time-dependent boundary condition. Drop velocity is obtained from the drop ballistics analysis. However, the initial ballistic analysis pertains to a constant-radius drop, and will now be applied to a shrinking drop. After the first-run solution of drop-size history, an improved ballistic analysis (of the shrinking drop) will be done, and the new relative velocity will be introduced in the drop heat transfer cycle. The result will be a more accurate drop-size history. After a number of iterations, the joint/coupled ballistic and thermal analysis of the individual drop will be completed. The next step is the mass- and energy-coupling of a multitude of drops (as sources of O_2) and the surrounding gas in the Eulerian network. This task, also involving iterations, is the continuation of the present study. The final analysis will be directed at the gas-to-gas turbulent diffusion, and will include the whole-time history after LOX injection.

The individual drop thermal history includes two distinct phases:

I. Heat transport with a constant-drop radius, but a variable (increasing) drop-surface temperature (internal drop temperature is also increasing). This phase ends at time, θ_c when the surface reaches t_c, the critical temperature of LOX.

II. Heat transport (including conduction and convection) with a variable drop size, i.e., radius, $r_d = f(\theta)$, but with a steady drop-surface temperature, $t_s = t_c$. The internal temperature field depends on time and the relative radius, $\rho = r/r_d$. The drop shrinks during Phase II, because the spherical surface at t_c penetrates as an isothermal front into the drop, "shedding-off" the outside layers, with $t > t_c$. When r_d reaches zero, the drop has ended its existence as a discrete, discontinuous entity.

Although the above description relates to drops receiving heat from the environment, the analysis results allow for the reversal of the heat flux direction. Also, the solution applies readily (or with minor adaptations) to solid spheres, various pairs of components, at diverse P/T conditions (e.g., for fuel injection in internal combustion engines).

The solution approach was aimed at obtaining/delivering primarily analytical solutions, because they offer generality, simpler and more conclusive parametric and feasibility studies. Also, for the same accuracy, they usually require much shorter computing time.

A survey of cases is given below, showing a variety of real situations; only for few of them the solutions either exist in available literature or can be adapted from published solutions. Most solutions are derived during the performance of this work; in particular, this applies to variable drop-radius cases, as well as to variable thermal conductivity and diffusivity of drops, when these are expressed as products of functions (see notes 2 and 3.).

I. Constant Drop Radius: Nu = Nusselt group ("Number") constant or time dependent; for either Nu, drop thermal conductivity, k can be constant or temperature dependent. For all Nu and k options, thermal diffusivity, α can be constant or temperature dependent.

II. Time Dependent (Diminishing) Drop Radius: Same alternatives (cases) as above, except that Nu cannot be constant: by definition, it is proportional to a (variable) drop radius.

Notes: 1. Variable Nu means a time dependent boundary condition (through the heat transfer coefficient), and/or a variable drop radius.

2. By splitting the temperature dependency of $\alpha(t)$ into $\alpha_1(r, \text{ or } \rho) \cdot \alpha_2(\theta)$, separation of variables can be achieved, i.e., $t(r, \text{ or } \rho, \theta) = R\ (r, \text{ or } \rho) \cdot T\ (\theta)$.

3. Similarly, using $k(t) = k_1(r, \text{ or } \rho) \cdot k_2\ (\theta)$, the time-dependent boundary condition can be replaced by the steady one, with separated variables in the temperature field solution.

4. For most cases, the solution for the temporal temperature function T, is an explicit, finite form exponential function, while the radial component of the temperature function, R, is the solution of a linear second order differential equation, easily transferrable into a Riccatti-type first order differential equation, reference 1.

Items 2 and 3 were derived in course of this task, as well as several analytical adaptations of existing (published) solutions found in references 2 and 3.

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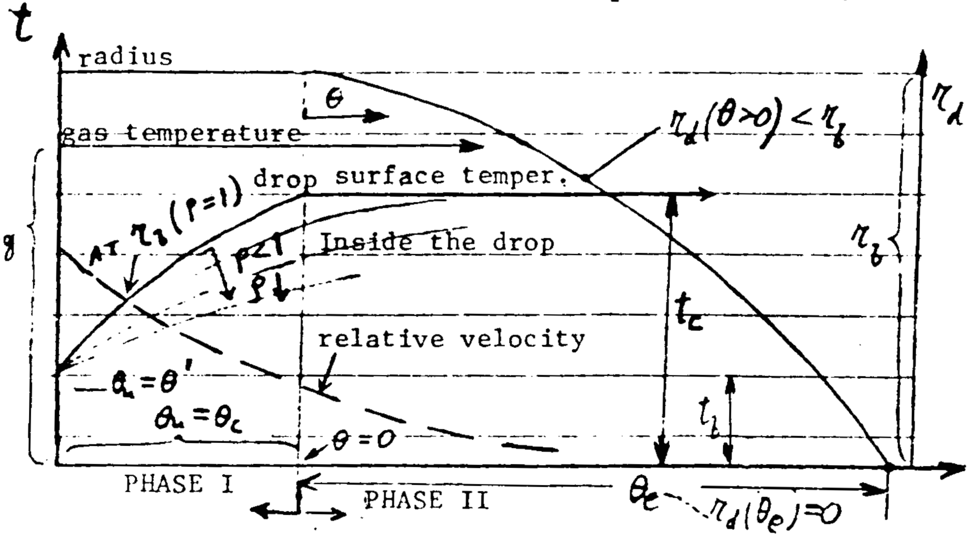
Figure: History of Drop Size, Temperatures and Relative Velocity (Qualitative Representation)



$\rho = r/r_d$

Phase I: $r_d = r_b =$ const

Phase II: $r_d = f(\theta)$

$\theta = \theta_u - \theta_c$

θ_u = universal time

θ = time during Phase II.

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MODELING OF TRANSITIONAL FLOWS

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P9391092

ABSTRACT

With the current resurgence of interest in hypersonic flight, there is a great need to improve methods of predicting skin friction and heating that result from the boundary layers which develop over the vehicle surface. Such predictions are currently hampered by uncertainties in the modeling of turbulent stresses that occur over the lengthy transitional region typical of hypersonic boundary layers.

~~During the course~~ of this summer an effort directed at developing improved transitional models was initiated. The focus of this work was concentrated on the critical assessment of a popular existing transitional model developed by McDonald and Fish in 1972[1]. The objective of this effort was to identify the shortcomings of the McDonald-Fish model and to use the insights gained to suggest modifications or alterations of the basic model.

In order to evaluate the transitional model, a compressible boundary layer code was required. Accordingly, a two-dimensional compressible boundary layer code was developed. The program was based on a three-point fully implicit finite difference algorithm where the equations were solved in an uncoupled manner with second order extrapolation used to evaluate the non-linear coefficients. Iteration was offered as an option if the extrapolation error could not be tolerated. The differencing scheme was arranged to be second order in both spatial directions on an arbitrarily stretched mesh. A variety of boundary condition options were implemented including specification of an external pressure gradient, specification of a

wall temperature distribution, and specification of an external temperature distribution.

The boundary layer code and the transition model were coupled together and a series of test cases run for a flat-plate geometry. Although the long-term goal of this project is to study transitional boundary layers at hypersonic speeds, the first test cases were run for incompressible flow. The primary reason for conducting the initial tests at low speeds is that a large data base of both experimental and computational results exist for incompressible flows. From this large data base of transitional data, direct numerical simulation results generated by Zang[2] were used as a base of comparison for the McDonald-Fish transitional model. Figure 1 shows a comparison of the evolution of the Reynolds stress profile as computed by the McDonald-Fish model and the direct numerical simulation. It is clear that the profile predicted by the McDonald-Fish model differs significantly from that predicted by the direct simulation. Note that the agreement becomes progressively worse as the downstream distance increases. Shown in Figure 2 is a comparison of the amplification of the peak Reynolds stress as a function of the local Reynolds number. This figure indicates that the McDonald-Fish model greatly underpredicts the Reynolds stress spatial growth rate.

Overall the results of the initial phase of this work indicate that the McDonald-Fish model does a poor job at predicting the details of the turbulent flow structure during the transition region. If the transitional region is to be modeled accurately a more sophisticated model must be developed which has the capability of simulating more of the essential structure of the developing instabilities. A two-equation k-ϵ model is suggested as a candidate for an improved model.

epsilon

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[2] Zang, T.A., Private communication, Mail stop 156, NASA Langley Research Center, Hampton VA, 23669.

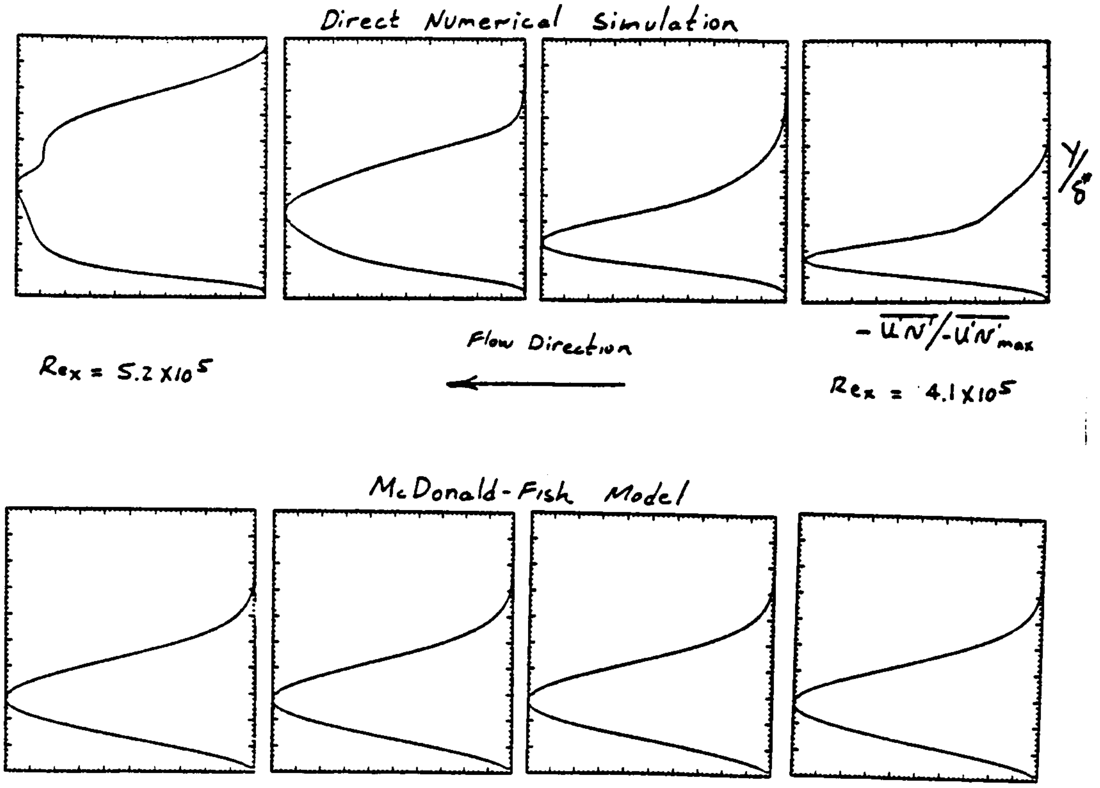

Figure 1: Reynolds stress profiles compared

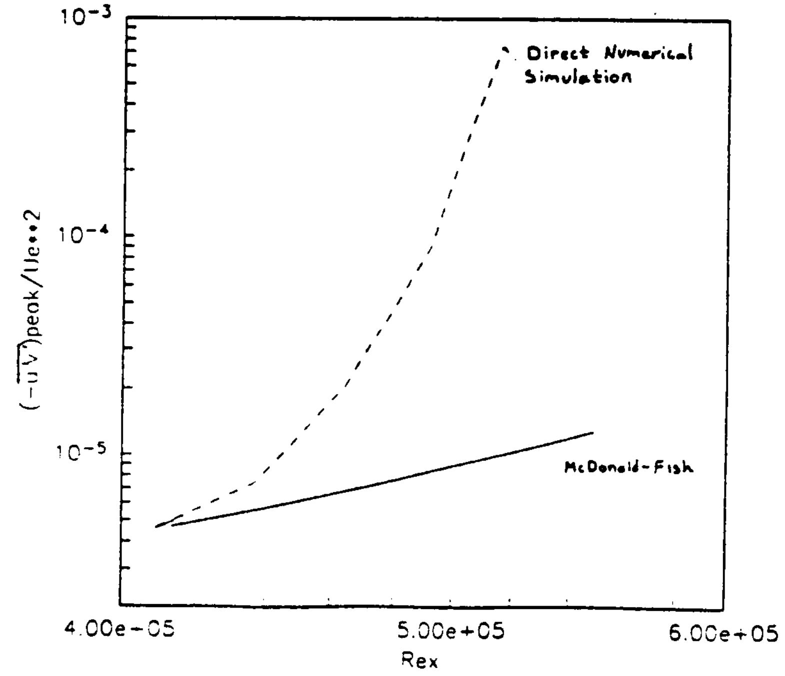

Figure 2: Reynolds stress amplification compared

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OVERLAPPING GRIDS FOR FLOW FIELD CALCULATIONS

by

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Many problems in computational fluid dynamics (CFD) involve the calculation of flow fields within or around complex geometric configurations. The flow solution is computed on a computational grid. The construction of the grid is one of the major difficulties in the application of CFD to the analysis of flow about actual aircraft configurations. Due to geometric complexity, the grid has to be constructed in simple subregions and then all of these subgrids have to be pieced together to form a complete grid for the entire flow field. The entire grid, which is called a composite grid because it is formed from many parts, may have subgrids which meet along their boundaries or which overlap on some common region. In either case, the computation of a flow field, using any numerical algorithm, will require the transfer of information between individual subgrids. The transfer of information is more difficult with overlapping grids.

Algorithms have been developed and tested for automating the transfer of information between two overlapping grids. Whenever information at a given point of one grid is needed, a search is made in the other grid to find a set of points close to the given point. Information on this set of points is then interpolated to provide the necessary information at the given point. In CFD problems, the information that must be exchanged between subgrids is either solution values or fluxes or both. The number and location of the interpolation points that must be found will depend on the numerical scheme used to compute the flow field and the desired accuracy of the interpolation formula. Efficient and robust search procedures have been developed for locating interpolation points. These methods can be used even if one grid moves independently of a second grid. A simple two-dimensional illustration that was used in testing the algorithm appears in Figure 1. The inner elliptical grid rotates in a fixed cartesian grid. A fluid enclosed by the inner ellipse and the outer rectangle is set in motion by the rotation of the ellipse. The success of overlapping grids in this simple problem raises the prospect of using overlapping grids to model flow about moving aircraft components such as propellers, flaps, and turbine blades.

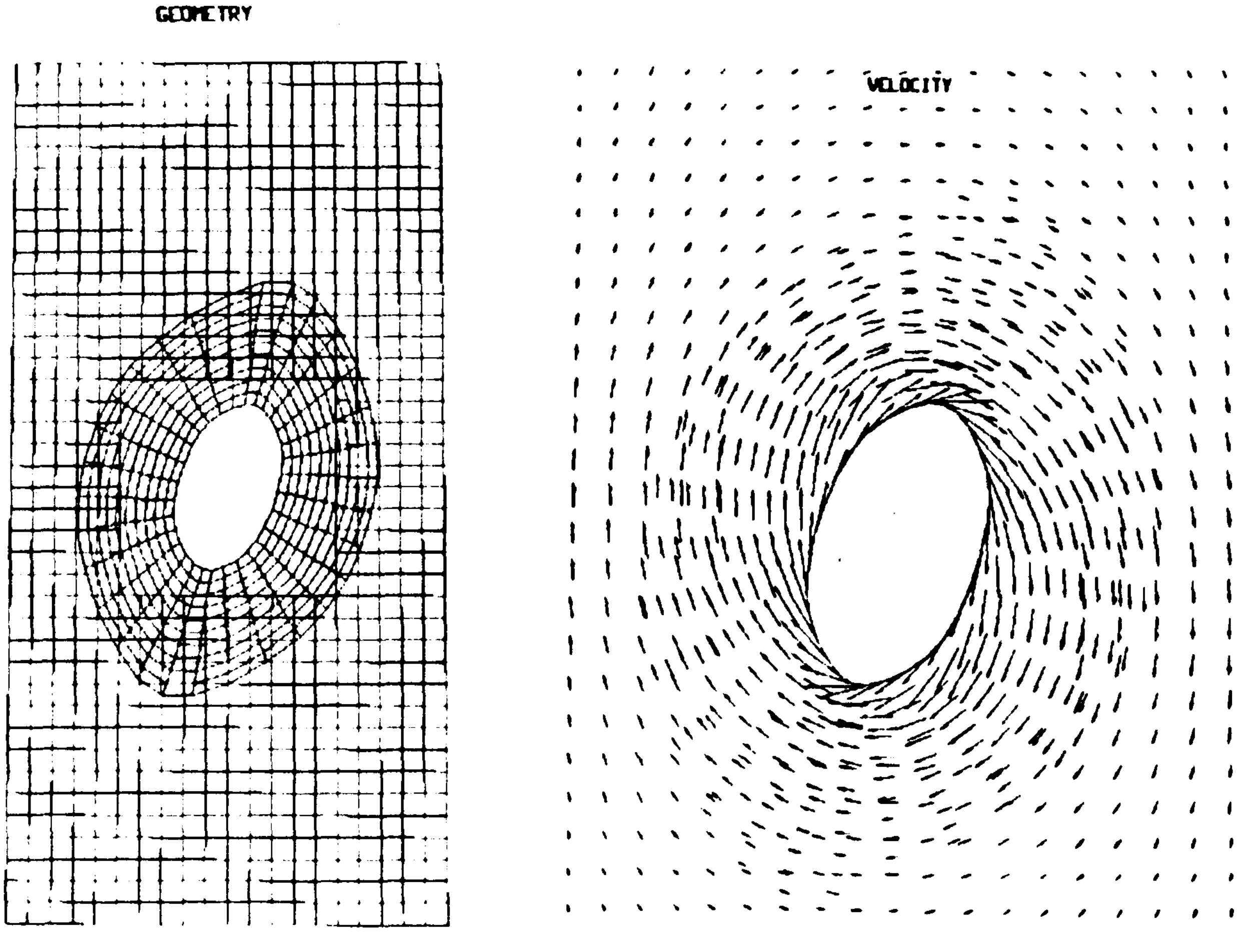

Figure 1. Grid and velocity vectors about rotating ellipse.

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EQUIVALENT LINEARIZATION FOR FATIGUE LIFE ESTIMATES OF A NONLINEAR STRUCTURE

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CC 747787

ABSTRACT

An adaptation of the method of equivalent linearization is developed in order to estimate the fatigue life of a nonlinear structure excited by Gaussian white noise. While conventional equivalent linearization has been successfully applied to approximate the mean square responses of a variety of complex nonlinear systems, it has not been possible to apply the method for fatigue predictions. This limitation results from the assumption that the probability density of the response of the nonlinear system is Gaussian, which is not generally true. In the present effort, a modification of equivalent linearization, developed by the author, is employed which has been shown in recent studies to provide a much more accurate description of the random response of a nonlinear structure than provided by conventional equivalent linearization. A method is presented for estimating fatigue life based on this approach and results are compared with those obtained using both numerical simulation and the 'classical' method. The fatigue life is estimated for a nonlinear plate vibrating in a single resonant mode with random white noise excitation. Excellent agreement is found between all three methods. These results indicate that equivalent linearization may be extended to predict the fatigue life of more complex nonlinear systems than can be analyzed at present.

Results are also presented of the predicted peak probability density of the response of a nonlinear plate using numerical simulation, equivalent linearization and the classical result. The three methods are again found to agree very closely. It is found that although the spectrum of the response loses its narrowband appearance at high response levels, the peak probability density of the response closely resembles that of a narrowband random process. This characteristic greatly simplifies the task of estimating the fatigue life of a nonlinear structure which is vibrating in a single resonant mode.

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EVALUATION OF THE PSEUDO PILOT EFFECT ON BASELINE CONTROLLER STUDY DATA

by

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The Baseline Controller Study requires the support of pseudo pilots who input computer commands in response to air traffic controller instructions for the purpose of collecting data in a simulated environment. Errors committed either by pseudo pilots, or by the computer's failure to accept commands, can result in data that is not representative of controller capabilities. Therefore, it became necessary to evaluate the actions of the pseudo pilots and determine what effect, if any, those actions had upon a given set of baseline data.

The Pseudo Pilot Stations (PPS) associated with the Baseline Controller Study are user unfriendly. This fact, coupled with the human factor of the pilots themselves, required exploration of the degree the pseudo pilot's actions affected the subject air traffic controller actions during the collection of baseline data.

Initially, it was thought that the subject controller would compensate for any missed keystrokes on the part of the pseudo pilot. Preliminary examination of the data revealed that this was so; however, as the controller compensated, simulated aircraft were extended and the traffic pattern was adjusted while the controller corrected the errant aircraft's route of flight, altitude, et cetera. The result was that fuel consumption for the simulation was greater than normal and, therefore, not truely representative of an actual traffic situation. Additional abnormalities noted ranged from a relatively insignificant reissuance of the instruction by the controller to a serious conflict arising from a decrease in airspace between two aircraft, the latter of which could invalidate data collected during the simulation.

Examination of the preliminary data collected by the Basline Controller Study subjectively determined that pseudo pilot actions do, indeed, affect the the research data. Further study is needed to quantify that affect and, perhaps, assign a value to the pseudo pilot factor rather than merely decide which simulations are valid and which are not.

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THE EFFECTS OF ATOMIC OXYGEN ON POLYMERIC MATERIALS

by

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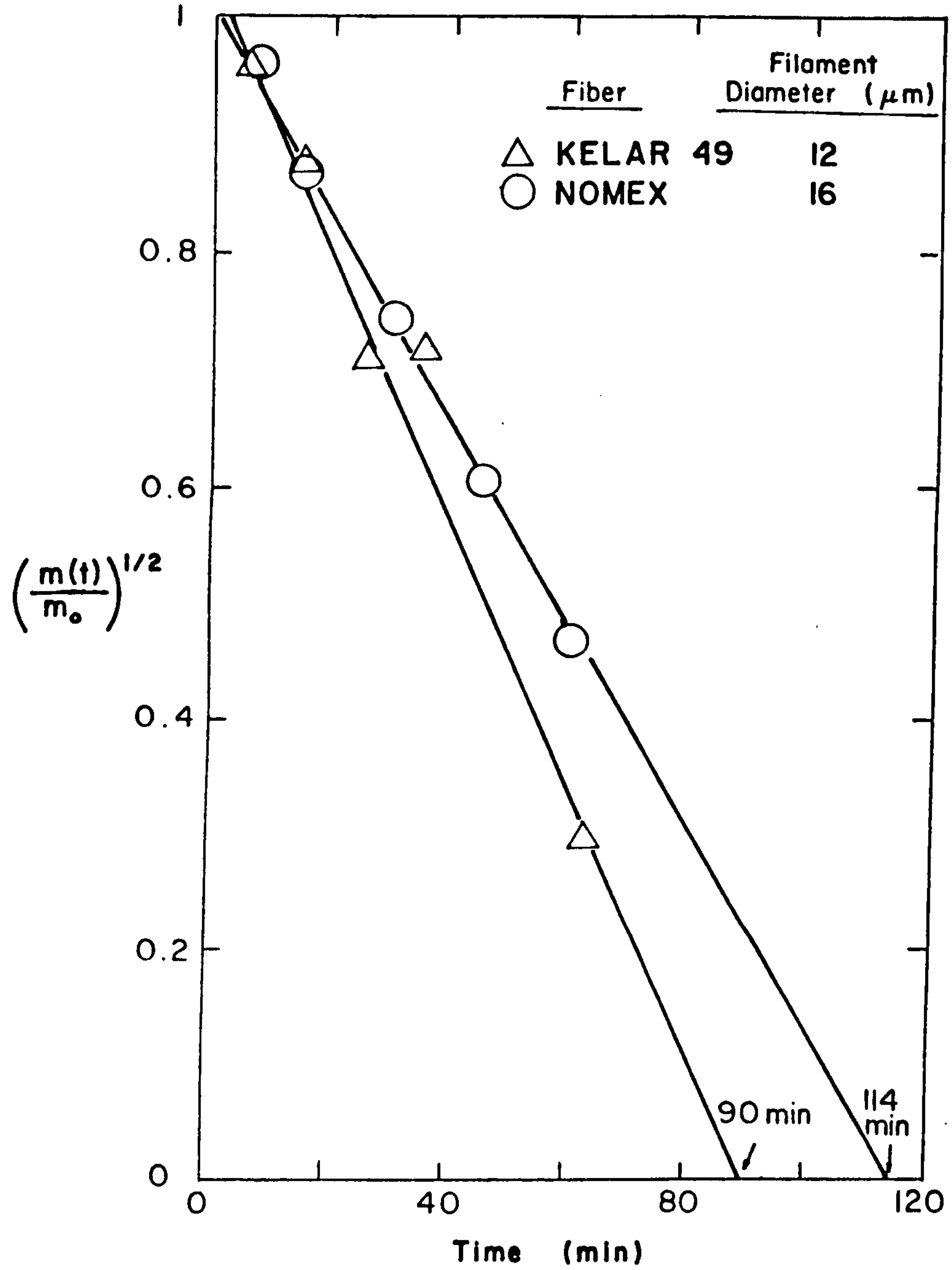
At the altitudes of low-earth orbit (LEO) atomic oxygen (AO) is the most abundant chemical species. This strong oxidizing agent reacts with virtually any organic material that is not already fully oxidized. Erosion by AO can be extensive and jeopardizes any protective coatings, thermal blankets, adhesives, and structural composites exposed on the exterior of satellites in LEO.

We have prepared and tested organic materials for their susceptibility to AO using a commercial plasma asher which approximately simulates the oxygen effects in LEO. Experiments have been performed on a polyimide, a polysulfone, and two epoxy adhesives into which low molecular-weight additives have been dissolved. Incorporated in the molecular structure of these additives are elements such as silicon whose nonvolatile oxides, which are formed on exposure to AO, remain as a coating on the surface to create a barrier between the remainder of the organic material and the AO. We find that the additives protect the materials but the low solubility of some limit their utility. Concurrent studies are underway to measure the effect of the additives on the thermal expansion coefficients of the materials.

Tows of aramid fibers, which are important components in the proposed tether satellite systems, have been eroded in the asher. The results which show that the square root of the mass remaining decreases linearly with the time of exposure (see the figure) are consistent with a constant rate of surface erosion. The tensile strength of these eroded tows decreases with time of exposure also; additional measurements are in progress.



Variation of mass for Kevlar and Nomex aramid fibers as a function of time in the asher; here m and m_0 are the masses at time t and at $t = 0$.

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The Poststall Nonlinear Dynamics and Control of an F-18
A Preliminary Investigation

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One cost effective way of keeping pace with the need to improve the operational effectiveness of today's high speed fighter aircraft is to make it possible to maneuver these vehicles without regard to the angle of attack they are flown at. Extending the operational envelope of the craft in this manner would provide the pilot of tomorrow with a repertoire of tactics that could measurably affect the combat effectiveness of these man/machine systems.

Providing an aircraft with increased levels of agility at poststall conditions is no small task. Maneuvers conducted at high angles of attack (HAOA) include unignoreable nonlinearities in the dynamics of both the aircraft, and it's control surfaces. In addition, the pilot flying the craft at HAOA is required to provide heightened levels of mental and physical effort in order to achieve control objectives. The problem is exacerbated by the fact that the correct response to phenomenon encountered during flight at HAOA (e.g. limit cycles and bifurcations) is in general counter intuitive and can produce pilot induced oscillations, which in the extreme, may result in the loss of the craft.

The successful HAOA operation of fighter aircraft will necessarily require the introduction of a new onboard control methodology that address the nonlinearity of the system when flown at the stall/poststall limits of the craft's flight envelope. As a precursor to this task, this ASEE researcher has endeavored this summer to familiarize himself with the dynamics of one specific aircraft, the F-18, when it is flown at HAOA. This was accomplished by conducting a number of real time flight sorties using the NASA-Langley Research Center's F-18 simulator, which was operated with a pilot in the loop.

Figure 1 below is offered as an example of the marginal stability of the F-18 when operated at HAOA. That figure depicts the angle of attack versus time, where the pilot was instructed to trim the plant at 45 degree AOA, and hold his heading. The plant response to a gradual lateral stick input is indicated in Fig. 1, where it is clear that the lateral dynamics of the plant,

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* ASEE Summer Fellow, 1988, NASA Langley Research Center, Flight Directorate, Guidance and Control Division.

including side slip and roll rate become unstable. While not shown, the pilot's attempt to correct for this disturbing oscillation results, in general, in a departure of the system.

In addition to developing a first hand familarity with the aircraft's dynamic characteristic at HAOA, work was also performed to identify the input/output operational footprint of the F-18's control surfaces. Fig. 2, for example, depicts the nonlinear relationship between side force produced versus aileron position. This investigator proposes to employ the nonlinear models of the plant identified this summer in a subsequent research effort to provide a command following, near optimal feedback controller that will make it possible to fly the F-18 effectively at poststall angles of attack. The controller design used there will rely on a new technique proposed by this investigator, (Ref.1) that provides for the automatic generation of online optimal control solutions for nonlinear dynamical systems.

Finally, the author acknowledges the support extended during this effort by A. Ostroff and J. Elliot (Division Leader) both with NASA Langley Research Center, and the gracious guidance and direction given by Dr. S. Massemburger, Coordinator of the NASA Langley Research Center's summer 1988 ASEE Program.

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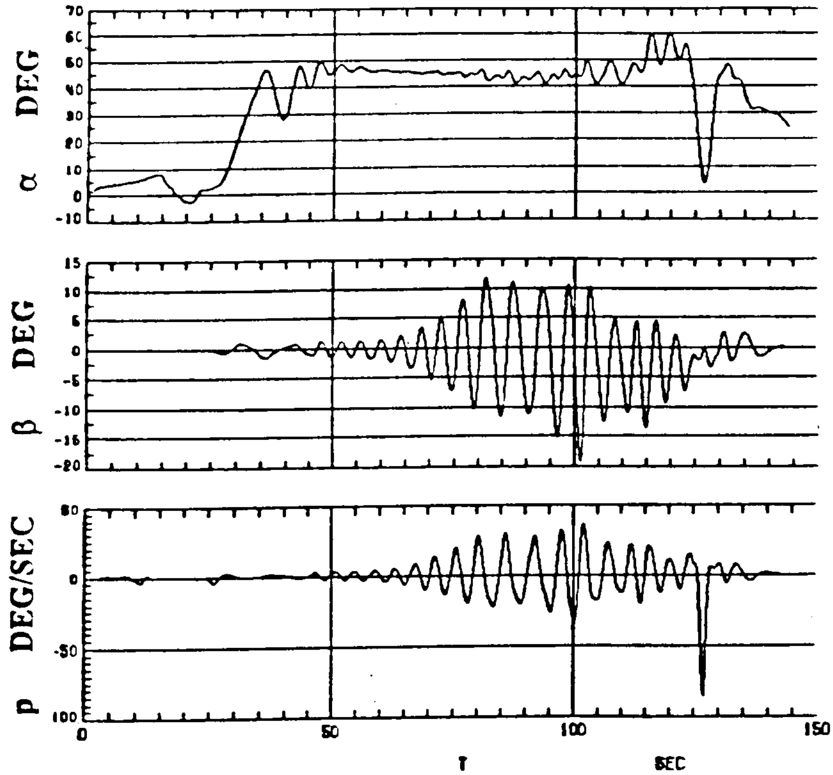

Fiqure 1 Angle of Attack (α), Side Slip Angle (β), and Body Axis Roll Rate vs Time for the F-18a flown at 20,000 feet

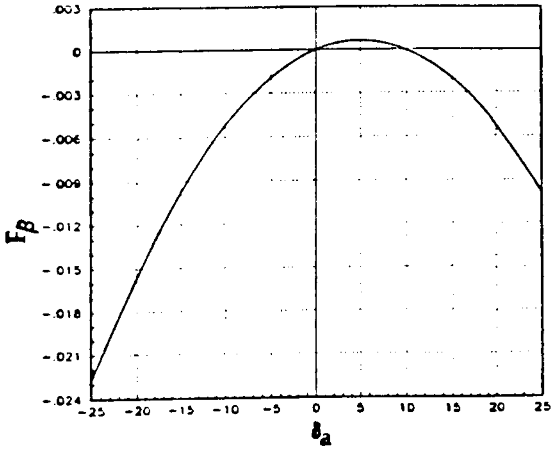

Figure 2 Side Force vs Aileron Angle.

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GENERALIZED EIGENVALUES FOR PAIRS OF HERMITIAN MATRICES

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by

CT393801

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A study was made of certain special cases of a generalized eigenvalue problem. Let A and B be nxn matrices. One may construct a certain polynomial, P(A,B,λ) which specializes to the characteristic polynomial of B when A = I. In particular, when B is hermitian, that characteristic polynomial, P(I,B,λ) has real roots, and one can ask: are the roots of P(A,B,λ) real when B is hermitian ?

We consider the case where A is positive definite and show that when n = 3, the roots are indeed real. The basic tools needed in the proof are Shur's theorem on majorization for eigenvalues of hermitian matrices and the interlacing theorem for the eigenvalues of a positive definite hermitian matrix and one of its principal (n-1)x(n-1) minors.

The method of proof first reduces the general problem to one where the diagonal of B has a certain structure: either diag(B) =diag(1,1,1) or diag(1,1,-1). or else the 2x2 principal minors of B are all 1. According as B has one of these three structures, we use an appropriate method to replace A by a positive diagonal matrix. Since it can be easily verified that P(D,B,λ) has real roots, the result follows.

For other configurations of B we use a scaling and a continuity argument to prove the result in general.

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A FLIGHT TEST DESIGN FOR STUDYING AIRBORNE APPLICATIONS OF AIR TO GROUND DUPLEX DATA LINK COMMUNICATIONS

by

AX969017

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The Federal Aviation Administration (FAA) maintains a National Airspace System (NAS) plan that charts a strategy for modernizing and improving air traffic control and airway facilities. The overall goals and objectives of this plan include timely implementation of features of the NAS, accommodating increased utilization, allowing airspace utilization with minimum errors, reduction of risk of accidents and collisions, increased air traffic controller and flight specialist productivity, improvements in reliability, decreased costs of maintaining NAS facilities, and implementation and utilization of a Mode-S data link communication system for digital duplex air to ground communications. Initially, the FAA plan calls for inflight airplane data link access to the Weather Communications Processor (WCP) for transfer of such information as aviation route forecasts, notices to airmen, pilot reports, winds and temperature aloft forecasts, flight assistance, and weather alerts. The Automatic En Route Air Traffic Control (AERA) and the Advanced Automated System (AAS) of the NAS plan, call for utilization of data link for such items as computer generated flight clearances, enroute minimum safe altitude warnings, sector probes, out of conformance check, automated flight services, and flow management of advisories. A major technical challenge remaining is the integration, flight testing, and validation of data link equipment and procedures in the aircraft cockpit.

The flight test organizational chart, figure 1, was designed to have the airplane side of data link experiments implemented in the NASA Langley Research Center (LaRC) experimental Boeing 737 airplane. This design would enable investigations into implementation of data link equipment and pilot interface, operations, and procedures. The illustrated ground system, which could be utilized to emulate ATC and WCP, consists of a work station with links to a national weather database and a data link transceiver system. The data link transceiver system could be a Mode-S transponder, ACARS, AVSAT, or another type of radio system such as the military type HF data link. The airborne system was designed so that a data link transceiver, workstation, and touch panel could be interfaced with an input output processor to the aircraft system bus and thus have communications access to other digital airplane systems. The clear touch panel will be overlaid on a multicolored CRT display unit for pilot input and output. Pilot input can then be implemented in user friendly software by displaying menu selected touch sensitive areas for pilot touch. The airborne workstation can function as a transcriber for conversion of voice communications to digital format for ATC data link emulation. Each work station also serves as a communications processor and time stamped packet data logger.

AN ARCHITECTURE FOR DATA LINK RESEARCH

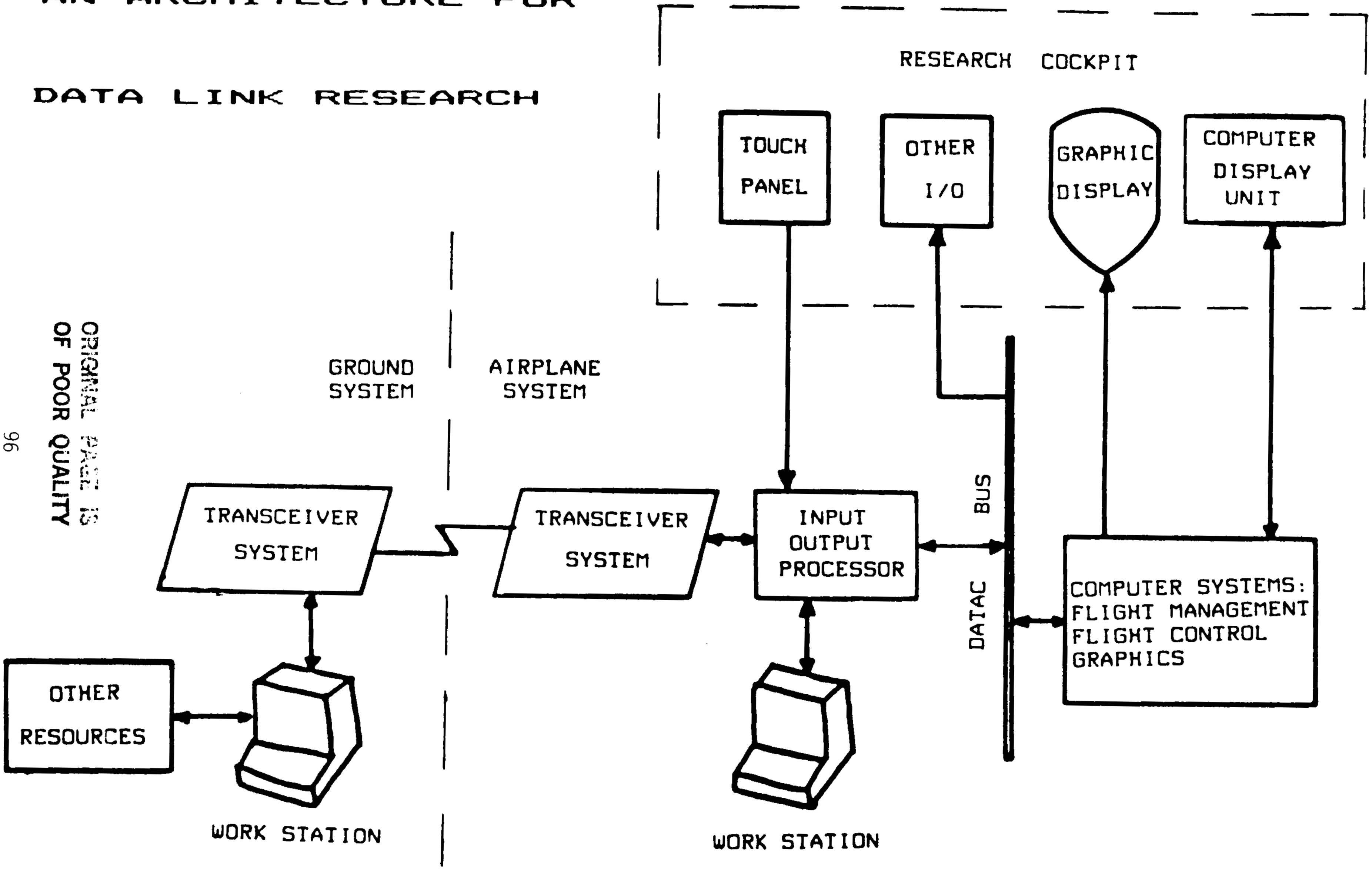

Figure 1

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EXTENSION AND VALIDATION OF A METHOD FOR LOCATING DAMAGED MEMBERS IN LARGE SPACE TRUSSES

by

V1610169

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Researchers pursuing the goal to construct a large orbiting space structure are considering many issues, including on-orbit verification of the structure. In previous work, a method was developed for locating damaged members of a large space truss [1,2]. Simulation studies indicated that damage can be located with the approach, although applications for larger structures were limited by the considerable computational effort. Extension of the method was required to overcome this drawback. Also, validation of the method with experimental data was necessary to confirm the method's performance.

The damage location approach employs the control system capabilities for the structure to "test" the structure and measure the dynamic response. The measurements are then used in a system identification algorithm to produce a model of the damaged structure. The model is compared to one for the undamaged structure to find regions of reduced stiffness which indicate the location of damage. Kabe's [3,4] stiffness matrix adjustment method was the central identification algorithm. The strength of his method is that, with minimal data, it preserves the representation of the physical connectivity of the structure in the resulting model of the damaged truss. However, extensive storage and computational effort were required as a result.

Extension of the damage location method to overcome these problems is the first part of the current work. The central system identification algorithm is replaced with the MSMT method of stiffness matrix adjustment which was previously derived by generalizing an optimal-update secant method from quasi-Newton approaches for nonlinear optimization [5]. Structural connectivity is preserved in the resulting stiffness matrix with minimal storage and computational effort. Simulation studies conducted to evaluate the performance of the extended damage location method indicate that results with the MSMT algorithm are comparable to those with Kabe's method. Applications for larger space structures are now possible.

Validation of the extended damage location method is the second goal. Tests on and analyses of a laboratory scale model truss structure [6] were planned to accomplish this. The test article exhibits characteristics expected for large space trusses (ie. closely-spaced frequencies and low damping, among others). Tests with the undamaged structure provide a correlated analysis model which becomes the "original model" in the identification process. Tests on various damaged configurations (one member removed for each case) produce modal data for the damage location process. To date, an initial model is established. Damage location tests are under way.

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Polymer Powder Prepregging - Scoping Study

by

AM 351973

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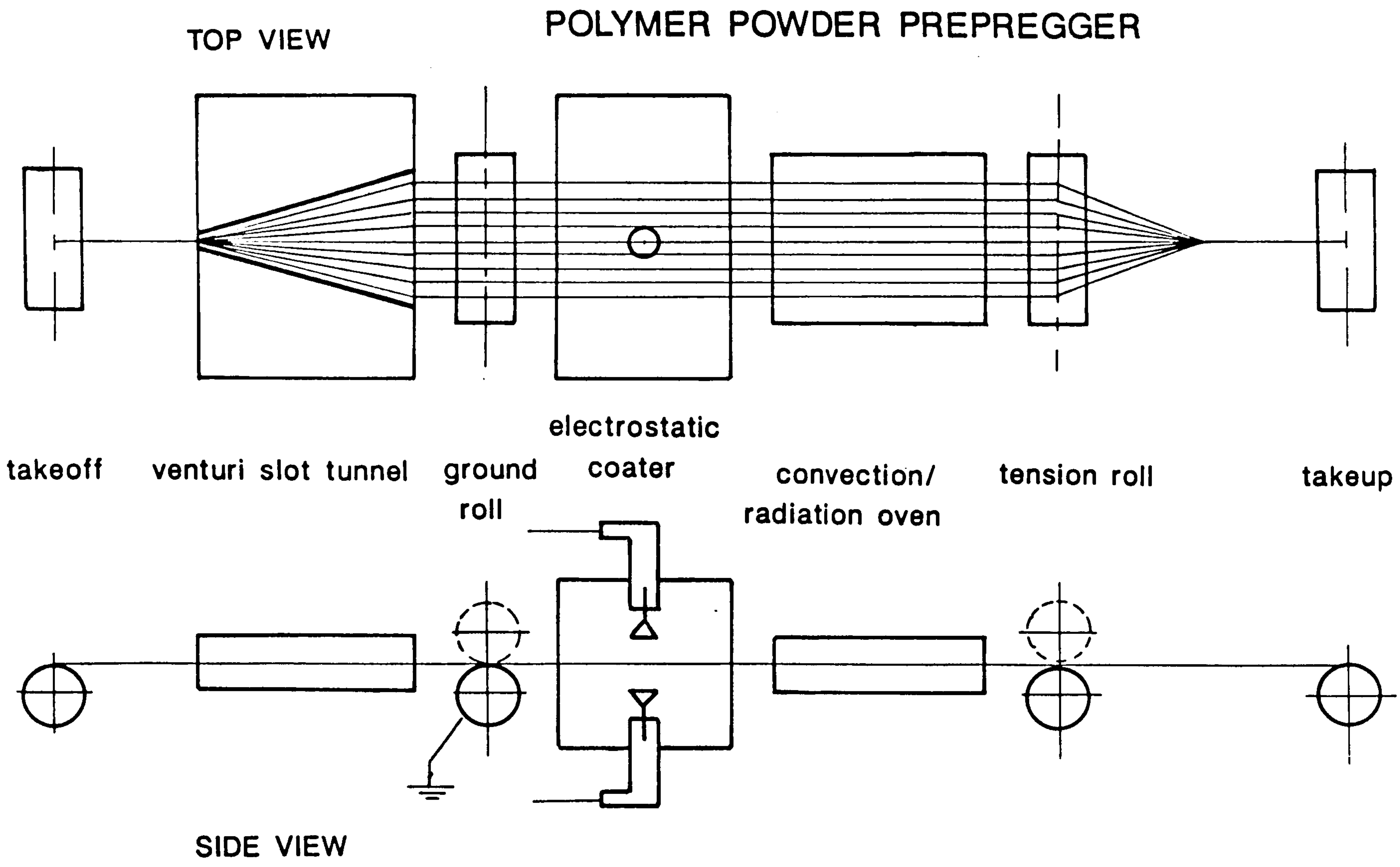
There are several ways of interacting thermoplastic resins and carbon fiber tow to produce prepreg unitape. To some degree, nearly all compromise composite fabrication operations that follow. The ideal process is one in which an average 1 micron thick film of polymer is applied to individual unsized 5 to 7 micron diameter carbon fibers, without residual adducts such as binders, solvents, vehicles, carriers, surfactants or dopants. Most high-performance thermoplastic resins are available as fine reactor powders. LARC-TPI thermoplastic polyimide powder has squared-egg shape and is 1 to 10 micron in dimension. These powder characteristics are similar to those of DuPont Vespel PI and Amoco Torlon PAI. LARC-TPI is the candidate powder used here.

Early on, it was found that NEAT LARC-TPI behaved elastoplastically at pressures to 20 ksi and temperatures to 260°C (below MP). At high resin assay, resin powder could be continuously "cold-flowed" around individual carbon fibers in a metal rolling mill. At low resin assay (2:1, C:TPI), fiber breakage was prohibitive. Thus, although processing of TPI below MP would be quite unique, it appears that the polymer must be melted and flowed to produce low resin assay prepreg.

Fiber tow was spread to 75 mm using a venturi slot tunnel. This allowed intimate powder/fiber interaction. Two techniques have been examined for getting room temperature powder onto the room temperature fiber surface. Electrostatic powder coating allows the charged powder to cling tenaciously to the fiber, even while heated with a hot air gun to above its melt temperature. Figure 1 is a schematic of the proposed continuous prototype prepregging line. A variant of the wet slurry coating process has also been explored. The carbon fibers are first wetted with water. Then dry powder is sprinkled onto the wet tow and doctor-rolled between the fibers. The wet structure is then taken onto a heated roll, with hot air guns drying and sinter-melting the powder onto the fiber surfaces. In both cases, SEM shows individual fibers coated with powder particles that have melted in place and flowed along the fiber surface via surface tension. It is recommended that the electrostatic powder coating technique be developed here and the wet slurry process be developed under the NASA-VPI program.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venturi slot tunnel
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electrostatic coater
convection/ radiation oven
tension roll
takeup
SIDE VIEW

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COMPARATIVE STUDY OF CAREER DEVELOPMENT AND TRAINING PROGRAMS

by

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Improvement of human capital has been identified as the key to any further increase of productivity for any country engaged in the global economic competition. The same can be said of any organization seeking to enhance its overall performance.

This study is aimed at (a) surveying the current practices of career development and training programs at major corporations and government research organizations, (b) presenting the distributions of various program features among survey respondents, (c) identifying the profile of the training program of a typical research organization, against which each organization can check and identify its relative strengths as well as areas needing further strengthening, (d) conducting an economic analysis of the effectiveness of the training programs at Langley Research Center, and (e) making recommendations as to how to enhance existing training programs.

A 30-item questionnaire has been prepared for distribution to participants at the Second Aerospace Career Development Network Conference on September 29 and 30, 1986, and other organizations. The questionnaire seeks information in such areas as the number of scientists and engineers (S&E) pursuing graduate studies or taking training courses; the graduate degrees they pursue; funding of such graduate study programs; on- or off-site graduate study; variety of training media; obligations of S&E pursuing funded graduate studies; composition of training board, if any; level of management responsible for training; training budget; training as personnel evaluation factor; co-op programs, 'mentor system'; policy on attending professional conferences, issues related to professional advancement for S&E, etc.

The questionnaires will be analyzed, and a report, written on the results for distribution to questionnaire respondents, together with suggestions and recommendations on issues regarding career development which confront the management of all organizations.

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NUMERICAL METHODS FOR TURBULENT FLOW

by

ΦM 593208

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Turbulence, as a field of scientific inquiry, was probably born the day Osborne Reynolds noticed that the measured drag on a pipe, due to a flow in its interior, did not agree with that determined from the known (laminar) solution of the Navier-Stokes equations. However, it has generally become accepted that the Navier-Stokes equations predict the dynamic behavior of turbulent as well as laminar flows of a fluid at a point in space away from a discontinuity such as a shock wave. Turbulence is also closely related to the phenomena of non-uniqueness of solutions of the Navier-Stokes equations. These second order, nonlinear partial differential equations can be solved analytically for only a few simple flows. Turbulent flow fields are much to complex to lend themselves to these few analytical methods. Numerical methods, therefore, offer the only possibility of achieving a solution of turbulent flow equations.

In spite of recent advances in computer technology, the direct solution, by discrete methods, of the Navier-Stokes equations for turbulent flow fields is today, and in the foreseeable future, impossible. Thus the only economically feasible way to solve practical turbulent flow problems numerically is to use statistically averaged equations governing mean-flow quantities. It is our objective to study some recent developments relating to the use of numerical methods to study turbulent flow.

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The Viscoplastic Behavior of SCS_6/Ti-15-3 Metal Matrix Composite Materials at Elevated Temperatures

by

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WF835159

Titanium-based metal matrix composite materials (MMC'S) are being considered for use in the National Aerospace Plane. It is expected that these materials will be subjected to temperatures ranging up to about 820°C (1500°F). The present study was a preliminary investigation intended to quantify the level of viscoplastic behavior exhibited by SCS_6/Ti-15-3 MMC'S at elevated temperatures.

The study consisted of a series of uniaxial creep/creep recovery tests. These tests were conducted in air at a temperature of 535°C (1000°F). Three distinct types of specimens were tested: Ti-15-3 "neat matrix" specimens, $[0_2/\pm 45]_s$ composite specimens, and $[90_2/\pm 45]_s$ composite specimens. Tensile loads were applied to the specimens using a lever-arm creep frame equipped with a high temperature furnace. Specimen creep stains were monitored using an LVDT-based extensometer.

A typical test schedule involved heating the specimen from room temperature to 535°C at an average rate of roughly 9°C/min. The specimen was then allowed to equilibrate for 1 hour at this temperature. A creep load was applied and held constant for a 3 hr (10,800 sec) period. After the 3 hr creep period the load was removed and the creep recovery response was monitored for an additional 1 hr (3600 sec) period.

Typical results are shown in Figures 1 and 2. The creep/creep recovery response of a Ti-15-3 neat matrix specimen tested at a creep stress level of 100 MPa (14.5 ksi) is shown in Figure 1. Note that axial creep strains approaching 1% accumulated during the 3 hr creep test. Analogous results for a $[0_2/\pm 45]_s$ composite specimen are presented in Figure 2. In this case the specimen was subjected to a creep stress of 142 MPa (20.6 ksi). An axial creep strain of roughly 0.07% accumulated during the 3-hr creep test.

These preliminary results indicate that titanium-based MMC's may exhibit significant creep behavior at the elevated temperatures anticipated for the NASP. Future research will investigate the creep behavior of such materials as a function of stress level, temperature, and layup.

FIG 1: Ti-15-3 NEAT MATRIX SPECIMEN #A5

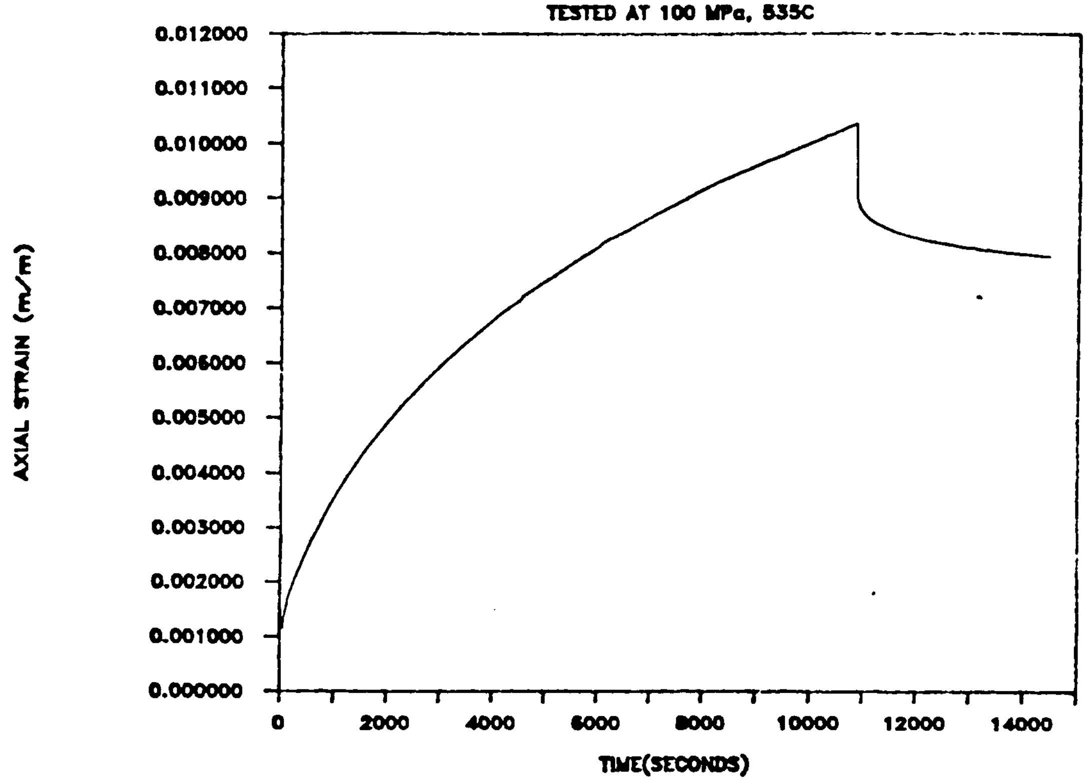
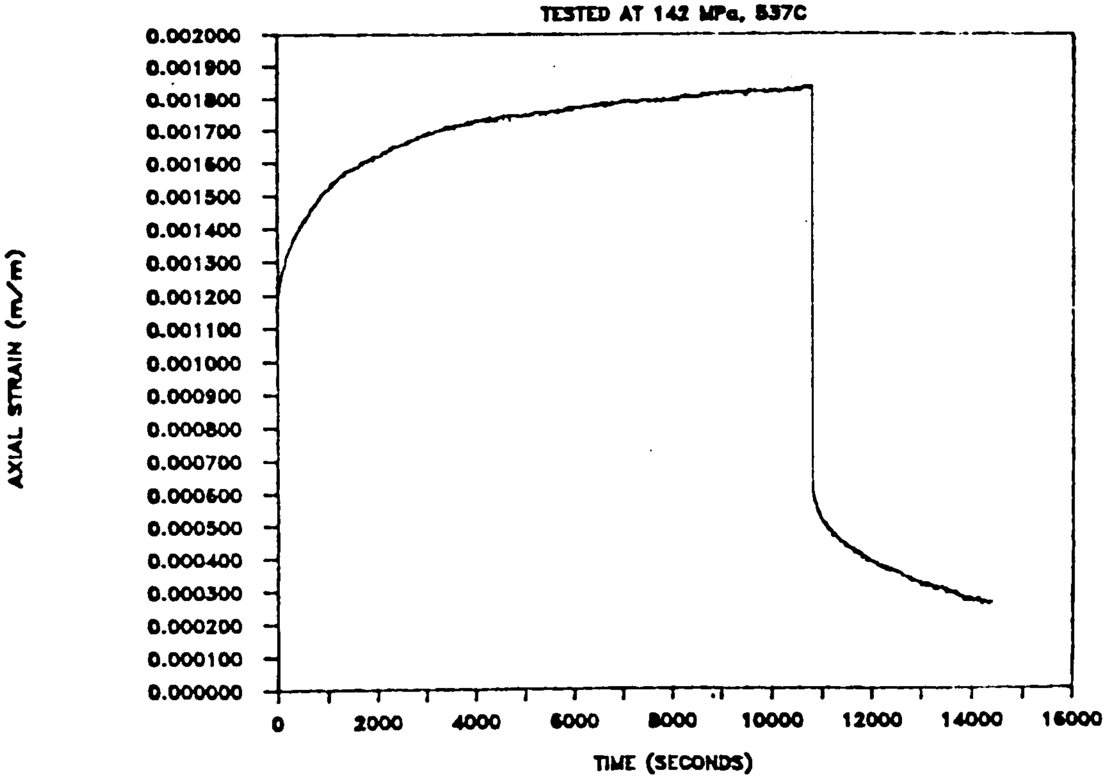


FIG 2: SPECIMEN #B10 - [0/±45]s



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PRETREATMENT OF CO OXIDATION CATALYSTS

By

John D. Van Norman
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Old Dominion University
Norfolk, VA 23508

CO oxidation catalysts with high activity in the range of 25°C to 100°C are important for long-life, closed-cycle operation of pulsed CO_2 lasers. A reductive pretreatment with either CO or H_2 has been shown to significantly enhance the activity of a commercially-available platinum on tin (IV) oxide (Pt/SnO_2) catalyst relative to an oxidative or inert pretreatment or no pretreatment. Pretreatment at temperatures of 175°C and above caused an initial dip in observed CO or O_2 loss or CO_2 formation in a test gas mixture of 1% CO and 0.5% O_2 in a He gas matrix before a steady-state yield was obtained. This dip was found to be caused by dehydration of the surface of the catalyst and was readily eliminated by humidifying the catalyst or the test gas mixture. It was also found that too much moisture resulted in a lower overall yield of CO_2 under similar conditions It is hypothesized that the effect of the humidification is to increase the concentration of OH groups on the surface of the catalyst.

The effect of having high concentrations of CO_2 in the test gas mixture upon the loss of CO and O_2 as well as the effect of periods of relaxation of the catalyst under non-test gas conditions was studied. The purpose of these studies was to gain an insight into the mechanism of CO oxidation on this type of catalyst.

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TEXTURE-BASED CLOUD CLASSIFICATION

by

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I. INTRODUCTION

Clouds have a large impact upon the earth's radiative budget. Accurate monitoring of climate change, as well as improved modeling of general circulation and climate, requires more complete understanding of cloud-radiative interactions. For instance, recent studies have shown that GCM calculations are sensitive to the way that clouds are parameterized indicating that more accurate parameterization of cloud types is required, as well as more accurate treatment of the cloud-radiative interaction. GCM and climate models do not yet consider the important effect of fractional cloud cover and spatial inhomogeneities. However, numerous studies have shown that the radiative properties of broken cloudiness are much different from their plane-parallel counterparts. Therefore, not only is cloud type important in classification studies, but also the subspecies (e.g., cirrus, cirrocumulus, and cirrostratus).

Standard cloud classification algorithms rely on multispectral signatures to identify high, medium and low clouds. However, single-channel, high spatial resolution satellite imagery is found sufficient to classify cloud types wit accuracies of about 85% using texture-based features. It is significant that this method is capable of distinguishing high cirrus clouds from low clouds strictly on the basis of spatial brightness patterns.

The purpose of the 1988 ASEE Summer Program has been 1) to broaden the application of texture-based cloud classification approaches to lower spatial resolution goes imagery, and 2) to design texture-based approaches for determining cloud cover over high albedo surfaces.

II. GOES IMAGERY.

A large number of 256 x 256 pixel regions in the visible spectrum have been selected from goes imagery, along with coincident 64 x 64 pixel regions in the infrared spectrum. Each of these subregions have been identified according to cloud and surface type. For each subregion, the spectral and textural features have been determined. Textural features have been computed using the gray level difference vector method and the gray level sum/difference methods. These approaches provide classification accuracy equivalent to that obtained using the gray level co-occurrence matrix method, but with significant savings in both computer storage requirements and runtime. The main effort has been focused upon accumulation of a database sufficient to insure statistical reliability in the classifier. Stepwise discriminant analysis has been used for classification. This is a sequence of analysis steps which adds or deletes a feature variable at each step of the classification process. The variable which provides the greatest separation between classes is added to (or the variable which adds the least separation is sometimes deleted from) the discriminant function.

The procedure is as follows:

1) The gray levels of the visible image are divided by the cosine of the solar zenith angle to produce uniform brightness ranges;
2) Thresholds in the visible and infrared spectrums are determined which separate cloud from surface;
3) Difference vectors and sum/difference vectors are computed as a function of pixel separation;
4) Textural measures are computed - angular second moment, contrast, entropy, local homogeneity, correlation, asymmetry, kurtosis, etc;
5) Discriminant analysis is applied to classify each could and surface type; and
6) Monte Carlo analysis is used to determine theoretical accuracy of the classification procedure.

II. HIGH ALBEDO SURFACES.

Over high albedo surfaces, such as ice and snow, complex terrain, and deserts, the brightness of the surface may be equal to or even greater than cloud brightness (measure radiance). Standard brightness thresholding techniques are inadequate to distinguish and recognize cloud regions in such environments.

A number of high surface albedo images were digitized using the digital image processing facility, stored on mag tape, and textural processed. The purpose of these studies was to determine potential class separability for these surface types. The results show that detection of clouds over snow-covered mountainous terrain, over deserts, and over relatively smooth ice- and show-covered arctic regions can be attained with high accuracy. However, one problem area was identified. Cloud detection over regions of broken and severely cracked ice is more difficult, requiring further study. The goal of this program is the development of region growing and morphological filter algorithms capable of mapping cloud cover over these regions.

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The Influence Of and The Identification Of Nonlinearity In Flexible Structures

DM 543208

by

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The Ohio State University
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All structures exhibit nonlinear dynamic behavior to some degree; for some it is quite small and in these cases linear models are adequate. For other structures it is appreciable, and for a few, the nonlinear behavior dominates the dynamic response. Nonlinear behavior may be due to material properties (nonlinear constitutive law), geometrical asymmetry, mid-plane stretching, nonlinear damping, large amplitude vibration, or any combination of these and other sources. In most cases, the nonlinearity causes a deviation from linear behavior, but for others it introduces new and unique phenomena--such as subharmonic, superharmonic, combination and internal resonances, parametric resonances and autoparametric interaction, jumps, saturation, self-excited oscillations, bifurcations, chaos, and nonexistence of periodic oscillation--that have no counterparts in linear theory. Hence, a linear mathematical model is in general the least precise model because it can always be improved by including nonlinear terms to do three things: (1) to increase the accuracy of the predicted response, (2) to extend the range of useable solutions, say of larger displacements, and (3) to explain or predict new phenomena that have no counterparts in linear theory.

Several models were built at NASA Langley and used to demonstrate the following nonlinear behavior: internal resonance in a free response, principal parametric resonance and subcritical instability in a cantilever beam-lumped mass structure, combination resonance in a parametrically excited flexible beam, autoparametric interaction in a two-degree-of-freedom system, instability of the linear solution, saturation of the excited mode, subharmonic bifurcation, modulation of excited modes in the "steady-state" response, and chaotic responses. A video tape documenting these phenomena was made.

An attempt to identify a "simple structure" consisting of two light-weight beams and two lumped masses using the Eigensystem Realization Algorithm showed the inherent difficulty of using a linear based theory to identify a particular nonlinearity. Preliminary results show the technique requires novel interpretation, and hence may not be useful for structural modes that are coupled by a quadratic nonlinearity. For example, an identification based on three cycles of free response (0.3 seconds) predicted divergence after nine cycles (1.0 seconds) when the actual response consisted of most of the energy having been transferred to the second mode.

A literature survey was also completed on recent work in parametrically excited nonlinear systems.

In summary, nonlinear systems may possess unique behaviors that require nonlinear identification techniques based on an understanding of how nonlinearity affects the dynamic response of structures. In this way, the unique behaviors of nonlinear systems may be properly identified. Moreover, more accurate quantifiable estimates can be made once the qualitative model has been determined.

APPENDIX V

SAMPLE QUESTIONNAIRES

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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. <u>Administration</u>

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

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 ($800) 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 1989.

   $__________________

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

NASA-ASEE

SUMMER FACULTY RESEARCH PROGRAM

QUESTIONNAIRE FOR RESEARCH ASSOCIATES

Please complete and return to John Spencer by 5 August 1988, NASA MAIL STOP 105A.

1. Would you say that your Fellow was adequately prepared for his/her research assignment?

   YES NO (Circle One)

   Comments:

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

   Comments:

3. Would you be interested in serving as a Research Associate again?

   YES NO (Circle One)

   Comments:

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

YES NO (Circle One)

Comments: ____

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

Comments: ____

Signature ____________________

APPENDIX VI

GROUP PICTURE OF RESEARCH FELLOWS

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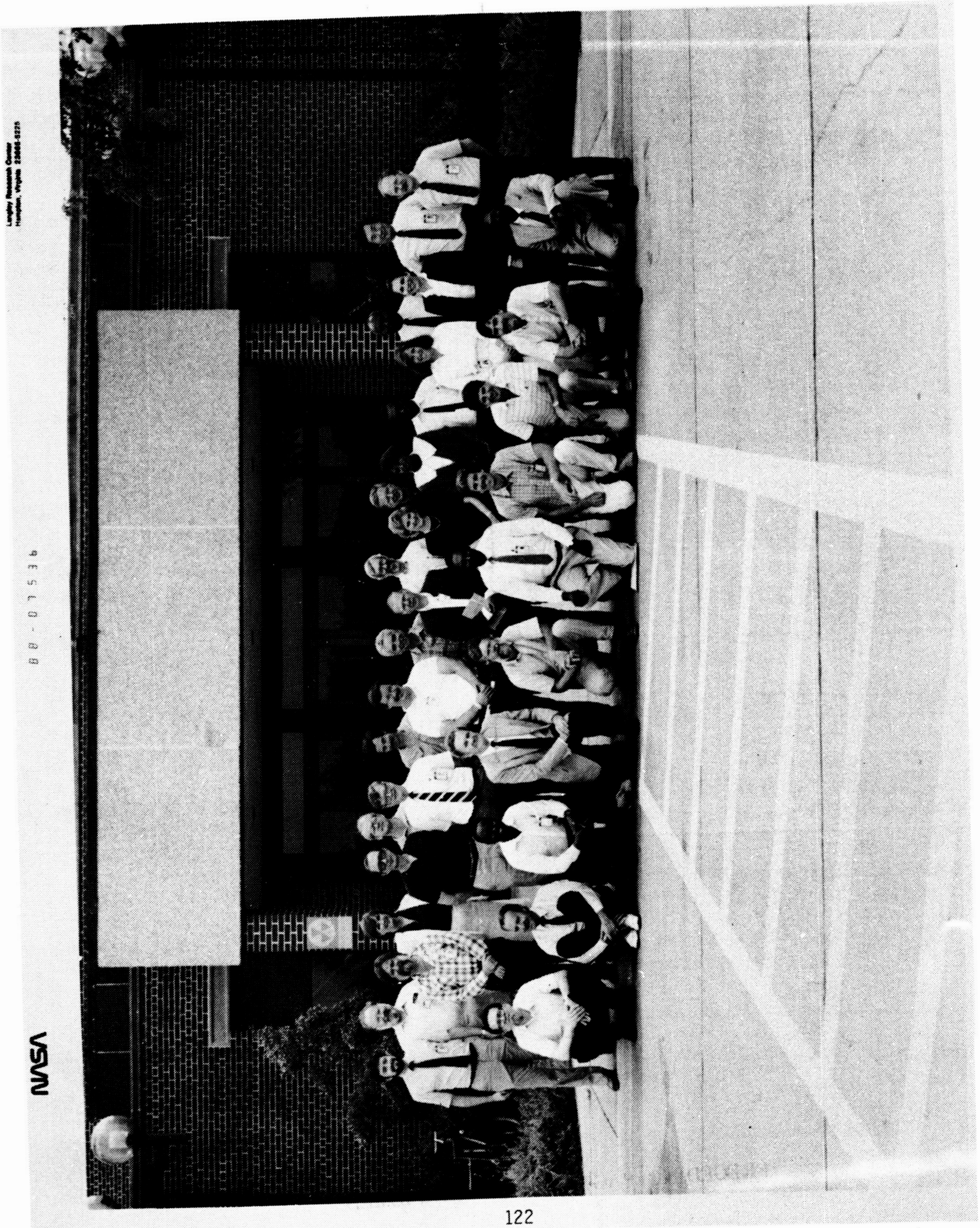

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BLACK AND WHITE PHOTOGRAPH

BOTTOM ROW - LEFT TO RIGHT:

Carl Andersen, Nenad Kondic, Edmond Koker, Louis Gratzer, Randall Caton,
James Turner, Thomas Lund, Michael Doria, Mark Tuttle, Samuel Massenberg

SECOND ROW - LEFT TO RIGHT:

James Fulton, Barry Ganapol, Marion Hansen, James Throne, Gregory Byrd,
Joseph Hafele, Diane DeWalt, June Blount, Suzanne Smith,
Cathine Garner-Gilchrist, Lawrence Zavodney

THIRD ROW (TOP) - LEFT TO RIGHT:

John Van Norman, Linda Newcomb, George Rublein, Ronald Miles,
Baldassare Di Bartolo, Richard Kiefer, Robert Orwoll, Terry Green,
John Spencer, Chaur-Ming Chou

NOT SHOWN:

William Brewer
Leon Donaldson
Kakkattukuzhy Isaac
Charles Mastin
William Patten
Charles Scanlon
Alan Tsao
Ronald Welch

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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 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 interest or that are directly relevant to the Fellows' research topic. The lectures and seminar leaders will be distinguished scientists and engineers from NASA, education or industry.

17. Key Words (Suggested by Author(s))
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ASEE-NASA Administrative Report

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