

CENTER FOR APPLIED MATHEMATICS AND STATISTICS

ANNUAL REPORT

1992

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I. FROM THE DIRECTOR

The Center for Applied Mathematics and Statistics (CAMS) was established in 1986 to promote research in the mathematical sciences at the New Jersey Institute of Technology. Members of the Department of Mathematics naturally form the core of CAMS membership, but the importance of mathematics for science and technology has made CAMS an interdisciplinary organization. The formal structure of CAMS in 1992 consisted of the Director, the Committee on Research and Scholarly Activities, the Committee on Seminars and Colloquia, and the Committee on Computer Research Facilities. But the essential nature of the organization is that of a voluntary association of individual researchers joined in a collegial collaboration to enhance mathematical work at NJIT. This report, documenting the accomplishments of CAMS and its members in 1992, shows the high level of success we have had in this endeavor.

CAMS undertakes a wide range of activities in pursuing its mission.

Since cutting edge research requires that its members be in steady contact with international scientific and engineering communities, CAMS brings researchers from academia, industry, and government to NJIT for both short term visits (e.g., seminar presentations) and for long term stays (e.g., sabbatical leaves). CAMS fosters research collaborations between NJIT and other Institutions by organizing interdisciplinary workshops and by bringing together researchers whose strengths are complementary and whose goals are common. And in some cases, CAMS has appointed Research Professors to formalize this relationship so that grants can be jointly pursued.

CAMS activities also include submitting proposals to support its research efforts. It does so by disseminating information, organizing group efforts, and providing administrative assistance to proposers. Senior members of CAMS commit significant amounts time and effort in providing guidance and advice to young researchers in their efforts to procure funding. And finally, CAMS fosters and encourages research amongst its members by arranging the acquisition of necessary resources.

Looking to the future, CAMS hopes and expects to maintain it high standards of professionalism and scholarship. It plans to extend its activities to include fostering student research and developing long-term relationships with industry.

The accomplishments of CAMS are built on the efforts and support of many individuals. CAMS is deeply indebted to President Saul Fenster whose vision has created an environment in which the aspirations of CAMS are espoused and appreciated. CAMS is also deeply indebted to Provost Gary Thomas for his pivotal role in realizing this vision and in particular for his unflagging assistance and support. And finally, CAMS is very appreciative of the deep commitments of John Tavantzis, former Acting Chairman, and Gregory Kriegsmann, Chairman and Foundation Chair of Applied Mathematics, whose generous supply of resources, advice, and energy have been instrumental in CAMS' success.

II. MEMBERS OF THE CENTER FOR APPLIED MATHEMATICS & STATISTICS

Ahluwalia, Daljit S. - Director

Department of Mathematics CAMS Members (1992)

Andrushkiw, Roman

Bhattacharjee, Manish

Blackmore, Denis

Bukiet, Bruce

Dhar, Sunil

Dios, Rose

Goldberg, Vladislav

Huang, Xun-Cheng

Kriegsmann, Gregory

Lacker, Michael

Luke, Jonathan

Milojevic, Petronije

Nachbin, Andre

Papageorgiou, Demetrius

Perez, Manuel

Porter, Michael

Ray, Bonnie

Sran, Kewal

Stickler, David

Tavantzis, John

Varatharajah, Paramanathan

Wagner, Barbara

Department of Mechanical & Industrial Engineering

Rosato, Anthony

Dave, Rajesh

Department of Civil & Environmental Engineering

Meegoda, Namunu

CAMS Research Professors

Chaudhry, Hans

Findley, Thomas

III. SEMINARS AND WORKSHOPS

To assure its members continuous contact with the latest scientific results and ideas, CAMS hosts frequent seminars, workshops, and short courses. The weekly Seminar in Applied Mathematics and Statistics (jointly sponsored by the Department of Mathematics) brings distinguished scientists and engineers from academia, industry, and government laboratories to NJIT. Recent speakers include members of the National Academy of Sciences, the National Academy of Engineering, and Fellows of the Institute of Electric and Electronic Engineers. The monthly

Workshops on Mathematical Problems at NJIT promote research collaborations by giving members of the NJIT community an opportunity to present problems of current research interest.

CAMS SEMINARS 1992

Volodymyr Korolevich, S.I.Subbotin Institute of Geophysics, Academy of Sciences of Ukraine

Selforganization in Strongly Nonequilibria Condensed Matter

Barbara Wagner, Department of Mathematics, New Jersey Institute of Technology

Robust Fluid Dynamical Closures of the Broadwell Model

Sylvan Cappell, Courant Institute, New York University

The Maslov Index and Spectral Flow

Rajesh Dave, Department of Mechanical and Industrial Engineering, New Jersey Institute of Technology

Non-Intrusive Particle Tracking System

Dinesh S. Bhoj, Statistics Department, Rutgers University, Camden

On Approximating the Distribution of Linear Combinations of Independent Chi-Squared Variables with Applications

Mike Shelley, Courant Institute, New York University

Topological Transition in Hele-Shaw Flow

Robert Barat, Department of Chemical Engineering and Environmental Science, New Jersey Institute of Technology

Modeling Complex Chemistry in Combustion Environments

Sunil Dhar, Department of Mathematics, New Jersey Institute of Technology

Extension of a Negative Multinomial Model

Shi Jin, Courant Institute, New York University

Numerical Schemes for Hyperbolic Systems

N.J.A. Sloane, Mathematical Sciences Research Center, AT&T Bell Labs, Murray Hill, New Jersey

GOSSET, a General-Purpose Program for Designing Experiments

David Muraki, Program in Applied & Computational Mathematics,
Princeton University

Optical Self-Focusing in a Liquid Crystal

Juan Jose Egozcue, Department of Applied Mathematics, Universidad
Politecnica de Cataluna, Barcelona, Spain

*Estimating Directional Spectra of Ocean Waves Using the Instantaneous
Direction Method*

Michael Miksis, Department of Engineering Sciences and Applied
Mathematics, Northwestern University

Stability of a Ridge of Fluid

B. S. Dandapat, Physical & Earth Sciences Division, Indian
Statistical Institute

On the Flow of a Thin Liquid Film over a Cold or Hot Rotating Disk

Alexander Chorin, Department of Mathematics, University of
California, Berkeley

Turbulence, Polymers and Percolation

Sergey Belikov, Courant Institute, New York University

Averaging and Optimal Control of Strongly Oscillating

Systems

John Rinzel, Mathematical Research Branch, National Institute of
Health, Bethesda, Maryland

Novel Rhythmogenic Mechanisms for Coupled Neuron Models

Andre Nachbin, Department of Mathematics, Ohio State University

Stable Methods for Vortex Sheet Motion in the Presence of Surface Tension

Michael Ward, Courant Institute, New York University

Summary Logarithmic Expansions for Strong Localized Perturbations of Linear & Nonlinear Eigenvalue Problems

John Lowengrub, Mathematics Department, Stanford University & Institute for Advance Studies, Stanford

2 Phase Interfacial Fluid Flows with Surface Tension

Fern Hunt, National Institute of Standards and Technology,
Gaithersburg, Maryland

Approximate Methods of Calculating Smooth Invariant

Measures Arising from Discrete Dynamical Systems

Tuncay Aktosun, Department of Mathematics, Southern Methodist University

Inverse Problems and Riemann Boundary Value Problems

Herb Kranzer, Mathematics & Computer Science Department, Adelphi University

Singular Shocks

Michael Booty, Department of Mathematics, Southern Methodist University

The Modeling and Analysis of Filtration Combustion

Michael D. Collins, Naval Research Laboratory, Washington, D.C.

Parabolic Equation Methods for Propagation, Scattering, and Boundary Conditions

Leonid Kalachev, Department of Applied Mathematics, University of Washington, Seattle, Washington

A Relaxation Wave Solution of the FitzHugh-Nagumo Equations and Related Problems

Brian Jersky, Economic & Social Statistic Department, Cornell University

Identifying and Modeling Non-stationarity and Non-linearity in Time Series Analysis

Bonnie Ray, Department of Operations Research,

Post Naval Postgraduate School, Monterey, California

Modeling Long Memory Process for Optimal Long-range Prediction

F. Jay Bourland, Department of Mathematics, Stanford University

Connections Across A Separatrix with Dissipation

Michael Tortorella, Modeling and Analysis, Bell Laboratories, Holmdel, New Jersey

Engineering and Modeling Perspectives into Availability Theories for Maintained Systems

Asit P. Basu, Department of Mathematics, University of California at Los Angeles

Order Statistics and Exponential Distributions

Russ Caflisch, Department of Mathematics, University of

California at Los Angeles

Singularity Formation for Complex Solution

of the Incompressible Euler Equations

Richard Meyer, Mathematics Department, University of Wisconsin

Problems in Applied Mathematics

Joseph Flaherty, Department of Computer Science, Rensselaer Polytechnic Institute

High-Order Adaptive Methods for Parabolic and Elliptic Systems

Edward Spiegel, Department of Astronomy, Columbia University

Dynamics of Interacting Solitary Waves

Bengt Fornberg, Corporate Research, Exxon Research & Engineering, Annandale, New Jersey

Fast Generation of Weight in Finite Difference Formulas

Edward J. Dudewicz, Department of Mathematics, Syracuse University

The Most Frequently Occurring Problem In Applied Statistics: Exact Solutions for the Comparison of Two Means, & Comparisons

Jonathan Bell, Department of Mathematics, State University of New York at Buffalo

Studies of the Sense-of-Touch System from a Mathematical Modeling Standpoint

Paul Davis, Mathematical Sciences Department, Worcester Polytechnic Institute

Some Mathematical Problems in Electrical Power Network

Monitoring and Control

A.S. Fokas, Department of Mathematics & Computer Science, Institute of Nonlinear Studies, Clarkson University

Some Remarks on Integrability

Richard Meyer, Mathematics Department, University of Wisconsin

Problems in Applied Mathematics

William Peter, Department of Physics, Ben Gurion University,
Berrsheva, Israel

Hydrodynamic Collimation of Precessing Jets

Steve A. Piacsek, Naval Research Laboratory, Stennis Space Center
Detachment, Mississippi

*Numerical Simulation of 3-D Convective Flows in a Freezing Oceanic
Surface Layer*

1992 CAMS WORKSHOPS

PROBLEMS IN ENGINEERING

Ming Leu, Department of Mechanical Engineering & Industrial
Engineering, NJIT

*Representation and Analysis of Swept Volumes with Applications to
Manufacturing Automation*

Namunu Meegoda, Department of Mechanical Engineering & Industrial
Engineering, NJIT

Macroscopically Compatible Expression for Hydrodynamic

Dispersion

PROBLEMS IN STATISTICS

Manish Bhattacharjee, Department of Mathematics and CAMS, NJIT

Repairable Systems: Bad-as-Old or Good-as New?

Rajesh Dave, Department of Mechanical Engineering & Industrial Engineering, NJIT

Robust Cluster Analysis

Thomas Spencer, AT&T, Basking Ridge, New Jersey

Recent Applications of Statistics in Consulting at AT&T

IV. GRANTS AND PROPOSALS FOR THE CENTER FOR APPLIED MATHEMATICS AND STATISTICS

The Center for Applied Mathematics and Statistics (CAMS) encourages and assists its members in the preparation and submission of research proposals. As part of its mission to improve the general research environment in the mathematical sciences, CAMS has regularly organized group proposals to enhance its computational equipment. The funding of two of these proposals in 1992 has permitted substantial upgrading of CAMS computational facilities. An additional equipment proposal has been submitted for 1993.

Sponsored CAMS Projects: _

1. "Mathematical Sciences: Mathematical Science Computing

Research Environments"

National Science Foundation: July 1992 - December 1993

Daljit S. Ahluwalia

Gregory Kriegsmann

Bruce Bukiet

Michael Porter

2. "Mathematical Sciences: Mathematical Science Computing

Research Environments"

National Science Foundation: July 1992 - December 1993

Daljit S. Ahluwalia

Jonathan Luke

Demetrius Papageorgiou

Tony Rosato

Rajesh Dave

3. "Analysis of Swept Volumes"

National Science Foundation: September 1991 - August 1993

Denis Blackmore

Ming C. Leu

4. "Representation and Analysis of Swept Volumes with

Tolerance and Deformation"

Office of Naval Research: September 1992 - August 1995

Denis Blackmore

Ming C. Leu

Frank Shih

5. "A Three Dimensional Particle Tracking System"

Sun Microsystem AEG Program: May, 1992 - May, 1993

Rajesh N. Dave

Anthony Rosato

Bruce Bukiet

6. "Applied Mathematical Problems in Electromagnetics"

Air Force Office of Scientific Research: June 1991 - May 1994

Gregory A. Kriegsmann

7. "Mathematical Methods in Applied Wave Propagation"

Office of Naval Research: January 1992 - September 1993

Gregory A. Kriegsmann

Michael Porter

8. "Mathematical Modeling of Amputee Gait"

National Institute on Disability and Rehabilitation:

July, 1992 - March, 1993

Michael Lacker

Hans Chaudhry

9. "Dynamics of Dissipative-Dispersive PDE's Modelling

Two-Phase Flow in a Pipe"

"Infinite Dimensional Dissipative Dispersive Dynamical
Systems.

NATO Collaborative Research Grant: April 1991 - April 1992

Demetrius Papageorgiou

10. "Common Grid Acoustics"

Naval Research Laboratory: September 1991 - September 1992

Michael Porter

Submitted CAMS Projects:

1. "Mathematical Sciences: Mathematical Science Computing
Research Environments"

National Science Foundation granted, sept. 1993

Daljit S. Ahluwalia

Sunil Dhar

Manish Bhattacharjee

Rose Dios

Bonnie Ray

2. "Visitor Exchange with the Newly Independent States of the
Former Soviet Union"

National Research Council - CAST Grant granted, sept. 1993.

Roman Andrushkiw

Anatoli Prykarpatsky

Valeri Samoilenko

3. "Path Planning Using Sweep Differential Techniques"

Office of Naval Research

Denis Blackmore

Ming C. Leu

Z. Dong

4. "SDE Based Tools for Integrated Design and Manufacturing"

National Science Foundation

Denis Blackmore

M.C. Leu

5. "Fracture and Fatigue Crack Growth Rate of Metal"

National Center for Infrastructure Studies

Denis Blackmore

C.T. Thomas Hsu

6. "Microwave Processing of Ceramic Materials"

National Science Foundation

Gregory A. Kriegsmann

7. "Integrated 3-D Dynamic Model of AK/BK Socket and Gait"

National Institute of Health granted 30K

Michael Lacker

Hans Chaudhry

Thomas W. Findley

Wanda Boda

8. "Simulation and Modeling of Filtration in Porous Media"

National Science Foundation

Anthony Rosato

Jonathan Luke

VII. FACILITIES

A. COMPUTATIONAL LABORATORY

Committee on Computer Facilities

Michael Porter - Chairperson

Andre Nachbin

Demetrius Papageorgiou

Laboratory Assistants

Nicholas Antoniou

Perhaps the most notable success this year was the funding of two separate NSF proposals for computer equipment. The first by Profs. Luke, Papageorgiou, Rosato and Dave was directed towards a computational server, that is, a machine that could handle the most computer intensive scientific simulations. As a result of this interdisciplinary effort, a high-performance HP 735 workstation with significant RAM and hard-disk storage has been ordered. Separately, Profs. Bukiet, Kriegsmann and Porter were awarded an NSF grant for a machine devoted to scientific visualization. As a result, a new Silicon Graphics Indigo with a high-quality color PostScript printer has been installed in the computer lab. The SGI also comes with a sophisticated 3D visualization tool called EXPLORER.

The number of faculty using computers, especially work-stations, has increased significantly in the last few years. A number of changes have been made or are planned to improve the connectivity of the different machines.

The first step was to `cross-mount' all the disks in the department. This means that every workstation can directly access the files of every machine in the department. In addition the `plan9' disk has been mounted on all the workstations and on the m-server. This disk is maintained by the Computer Services Division and contains a wealth of valuable public-domain software. Thus, TeX, various graphics packages, previewers and utilities are available to all the Sun workstations.

A separate effort was undertaken by Prof. Nachbin to select and install standard software for use on all workstations. The three categories he considered were (1) graphics, (2) scientific libraries and (3) symbolic manipulators. In the graphics category GNU PLOT was made available to everybody through the plan9 disk. The GNU PLOT package is quite popular but is strictly a command line interface program. As an alternative the XMGR/XVGR was also installed. This packages uses pull-down windows and is so easy to use it is essentially self-explanatory. Work is in progress to install LAPACK and additional scientific libraries. With regard to symbolic manipulation programs, MAPLE, MATLAB and MATHEMATICA were all considered. In the near term, the decision was made to obtain a copy of MATHEMATICA to be installed on the HP computational server.

To better serve the PC users in the department, the DESQviewX package has been installed on a trial basis. This package allows a PC to provide the same windows environment that is used on the workstations. Similarly, the X-Windows installation was completed on the 'm' server machine so that users of this older generation of workstations could access the newer systems in the department.

In the coming year further changes are anticipated. One key goal is to improve the software and hardware available for the statisticians in the Center. A new NSF equipment proposal has been prepared by Profs. Bhattacharjee, Dios, Dhar, and Ray for this purpose.

The other key goal is to provide a reliable back-up of the various disks. Professor Papageorgiou has taken responsibility for setting up such a system together with our system manager, Michael Sideras. In the short term they have set up a system to provide backups on a 150 mbyte tape drive. Since the department now has some 10 giga-bytes of storage this is not adequate over the long term. Arrangements are now being made to obtain a high-capacity (5 giga-byte) 8 mm drive.

This should be in place in the summer of 1993.

The above described additions and modifications have consumed a significant amount of time. A great deal of credit goes to our new lab assistant/system manager Michael Sideras.

VI. SPECIAL ACHIEVEMENTS OF THE MEMBERS OF THE CENTER FOR

APPLIED MATHEMATICS & STATISTICS

AWARDS & RECOGNITIONS

Dios, Rose

Presented the "Outstanding Woman Scientist Award" by the New York Metropolitan Chapter of the Association for Women in Science, June, 1992.

Kriegsmann, Gregory

Elected Fellow of the Institute for Mathematics and Its Applications (United Kingdom), October, 1992.

Appointed Associate Editor for the Journal of Electromagnetic Waves and Applications.

Appointed Associate Editor for the Journal of Engineering Mathematics, 1992.

Selected Chairman of the organizing committee for the National Meeting of the Society of Industrial and Applied Mathematics, (SIAM) 1992.

Lacker, Michael

Appointed Associate Editor for the Journal of
Theoretical Biology, May, 1992.

Porter, Michael

Appointed Associate Editor for the Journal of the
Acoustical Society of America, 1992.