RECENT AWARDS IN ENGINEERING

NATIONAL SCIENCE FOUNDATION WASHINGTON, D.C. 20550

SECOND QUARTER
FISCAL YEAR 1983

CONTENTS

NATIONAL SCIENCE FOUNDATION DIRECTORATE FOR ENGINEERING

INTRODUCTION

The National Science Foundation's Directorate for Engineering supports basic and applied research that improves our knowledge of fundamental engineering principles and provides the knowledge needed to advance engineering technology. The Directorate also seeks to strengthen our Nation's academic engineering base by its support of research at academic institutions, and through such activities as research equipment grants and special award programs for new investigators.

The activities of the Directorate ultimately impact many important National concerns, such as the U.S.'s economic growth and competitiveness in world markets, technological innovation and industrial productivity, and National defense capabilities.

The Directorate for Engineering's budget for fiscal year 1983 is approximately $100 million, and is used chiefly to support unsolicited proposals received from the scientific and engineering community.

The Directorate consists of four Divisions and the Office of Interdisciplinary Research. These Divisions and their programs are described below.

DIVISION OF CHEMICAL AND PROCESS ENGINEERING (CPE)

Supports research on the basic mechanisms of catalysis and various chemical and biochemical processes, general theories of mass transfer and separation processes, and efficient recovery and use of resources in industrial processes. CPE's objective is to enhance basic knowledge relevant for technological innovation in the chemical, petroleum/petro-chemical, food, biochemical/pharmaceutical, mineral, and allied industries. Research efforts include development of fundamental principles, design and control strategies, mathematical models, and experimental techniques applicable to industries and processes. Fundamental phenomena and basic principles governing chemical and transport processes are studied, as are the interactive effects of these processes and phenomena. Cooperative projects between university and industry groups are encouraged. The programs of CPE are:

- **Chemical and Biochemical Processes (CBP)**
  Explores enzymatic, microbial, electrochemical, and polymeric processes in terms of both the individual reactions and the dynamics and control of the reaction system as a whole. Incorporates areas formerly contained by the Renewable Materials Engineering program (conversion and utilization of biologically based raw materials).

- **Engineering Energetics (ENE)**
  Emphasizes principles of energy conversion and material processing under high-temperature and/or energy-intensive conditions.

- **Kinetics, Catalysis, and Reaction Engineering (KCR)**
  Examines chemical reaction rates and mechanisms and their implication for reactor performance, stability, and design.

- **Minerals and Primary Materials Processing (MPM)**
  Supports research on the production and handling of essential minerals and their subsequent conversion to pure metals and related products.

- **Particulate and Multiphase Processes (PMP)**
  Studies characterization, generation, size modification, handling, and processing of systems where solid phase particulates are present.

- **Renewable Materials Engineering (RME)**
  Supports research involving engineering problems relevant to conversion and utilization of biologically based raw materials.

- **Separation Processes (SEP)**
  Emphasizes the separation of chemical species, with particular emphasis on unconventional techniques and/or combinations of processes which maximize energy efficiencies.

- **Thermodynamics and Transport Phenomena (TTP)**
  Supports theoretical and experimental research on equilibrium and transport properties to develop correlations and data bases relevant to industrially important chemical and transport processes, such as synfuels.

DIVISION OF CIVIL AND ENVIRONMENTAL ENGINEERING (CEE)

Supports research on structures and phenomena involving the earth's surface (such as near surface solids, e.g., soils, rocks, and ice, foundations and dams), the design of structures, and the flow of above- and below-ground water. Such research is fundamental to the development and building of structures and facilities, to minimize the negative impact of the natural environment on them. The programs of CEE are:

- **Geotechnical Engineering (GEO)**
  Deals with the mechanical behavior of the near-surface solids of the earth, i.e., soils, rocks, and ice under conditions of pressure, temperature, size, and time scales relevant to construction, mining, drilling, and natural hazards.

- **Structural Mechanics (STM)**
  Develops engineering knowledge basic to the design and construction of safe, long-lived, economical structures. STM is concerned with construction materials, structural systems and components, and their response to loads and environmental conditions.

- **Hydraulics, Hydrology, and Water Resources Engineering (HHW)**
  Emphasizes the empirical practices often found in hydraulics, hydrology, and water resources engineering with attention to groundwater flow, erosion, sediment transport, and coastal and ocean engineering.

- **Environmental and Water Quality Engineering (EWQ)**
  Supports research on empirical procedures used in water supply, water and wastewater treatment, and environmental effects of contaminants on the quality of water resources.

- **Earthquake Hazard Mitigation (EHM)**
  Supports research in many disciplines to develop an understanding of how earthquakes impact natural and manmade facilities in order to reduce casualties, damage, and social and economic disruption. This program consists of three subelements:

Design Research
Aims to develop procedures for performing dynamic analysis of proposed or existing construction under earthquake loadings, to devleop an understanding of material components subjected to damaging dynamic loads, and to develop procedures for the analysis and design of nonstructural and architectural systems subject to earthquake loadings.

Siting Research
Seeks to determine from instrumental data the nature of strong ground shaking during earthquakes, to develop analytical procedures to predict the spatial and temporal distribution of strong ground motion at different sites, to understand the dynamic behavior of soil and rocks subject to strong shaking, and to understand the behavior of the ocean, particularly its margins, due to underwater earthquakes producing damaging tsunamis.

Societal Response Research
Studies and evaluates measures used to mitigate society's loss due to earthquake (and other natural hazards) impacts, including emergency preparedness, land use planning, building codes, insurance and other economic incentives, and information and education, so as to enable communities to organize to withstand disasters with minimal impact on life and property.

DIVISION OF ELECTRICAL, COMPUTER, AND SYSTEMS ENGINEERING (ECSE)

Supports basic and applied research on electronic materials and devices, sensors and imaging systems, very large-scale integrated optics and opto-electronics, information theory and communications, machine intelligence and robotics, automation, laser systems and plasmas, and control and systems design methodologies, networks, and simulation. New knowledge resulting from this research provides the basis for improvements in communications and data networks, more efficient energy generation and transmission, better computing structures and machines, and more efficient design and control of manufacturing processes, including those which would benefit from use of intelligent robots. The programs of ECSE are:

- **Automation, Bioengineering, and Sensing Systems (ABS)**
  Studies improved machine intelligence and control of industrial and non-industrial processes, with emphasis on intelligent robotic systems and cognitive systems engineering.

- **Computer Engineering (COM)**
  Broadens the understanding of principles of design and construction of computers through research to increase the payoff of Very Large Scale Integrated (VLSI) systems in new computing structures, research on Computer-Aided Design (CAD) tools, and computer hardware/software interactions.

- **Electrical and Optical Communications (EOC)**
  Studies optical communications, large-scale computer communication networks, information theory, and electronic circuit theory, all in the modern context of Very Large Scale Integrated (VLSI) microelectronic technology, to create economical, reliable communication and signal processing systems.

- **Quantum Electronics, Waves, and Beams (QWB)**
  Emphasizes lasers, plasmas, and electromagnetic and acoustic phenomena, including

new or improved coherent sources, generation of ultrashort optical pulses, non-linear optics, and basic studies of medium-temperature, medium-density plasmas.

- **Science and Technology to Aid the Handicapped (STH)**
  Supports research which develops and applies innovative engineering concepts and devices to improve opportunities for physically handicapped people.

- **Solid State and Microstructures Engineering (SSM)**
  Seeks the fundamental understanding needed to produce electronic devices with dimensions a fraction of those now used in commercial and defense applications, with emphasis on new device concepts, new electronic materials, and advanced fabrication techniques.

- **Systems Theory and Operations Research (STO)**
  Develops mathematical and computational methods for analysis, modeling, simulation, optimization, and control of natural and manmade systems and processes.

DIVISION OF MECHANICAL ENGINEERING AND APPLIED MECHANICS (MEAM)

Supports research on the transfer of heat; the problems of engineering materials under high stress and strain; questions such as lubrication and turbulence; and the synthesis of all these elements into appropriate "design" capabilities. Special emphasis is placed on applications in production research. MEAM seeks an understanding of the basic phenomena of fluid and solid mechanics and heat transfer inherent in virtually all manufacturing processes and in many industrial products in order to improve National productivity. The programs of MEAM are:

- **Fluid Mechanics (FLM)**
  Studies the dynamic behavior of liquids and gases in combustion, turbulent flow, mixing and dispersion, bioengineering, cryogenics, and other processes.

- **Heat Transfer (HET)**
  Studies conduction, convection and radiative phenomena including multiphase media, high flux heat transfer, porous media, and high temperature radiative transfer. This area develops much of the knowledge base necessary for the understanding of systems used in the generation of power.

- **Mechanical Systems (MES)**
  Studies kinematics and kinetics of machines, robotics, vibrations, acoustics, mechanical control systems, and tribology, and synthesizes all these investigations in system design.

- **Production Research (PRR)**
  Generates knowledge applicable to the automation of production and improvement of manufacturing, such as computer controlled unit operations and robot-aided assembly.

- **Solid Mechanics (SOM)**
  Studies the mechanical performance of solids and structures, including the constitutive (stress-strain) behavior, as well as material damage and failure, for materials such as metals, fiber-reinforced composites, and porous and granular materials.

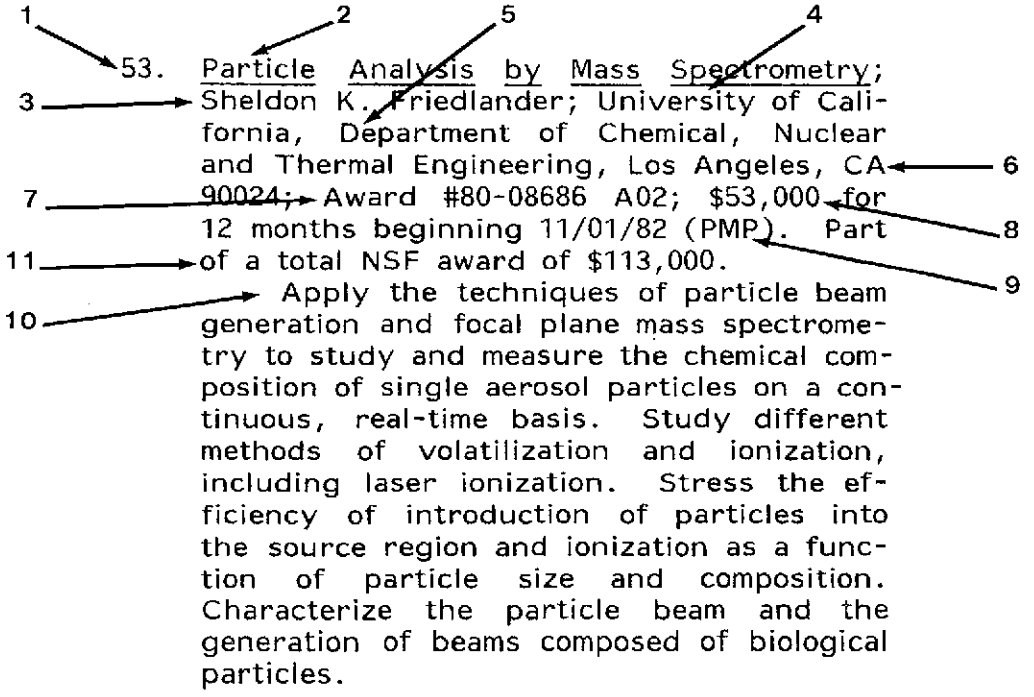
DEFINITIONS AND EXPLANATION OF FORMAT (FOR ALL DIVISIONS EXCEPT OIR)

All awards are listed under their originating (primary) Division and numbered sequentially 276-665) in this issue. Within each Division, awards are grouped by program. Within each program, awards are listed alphabetically by the Principal Investigator's surname. Split-funded awards are numbered only under their originating program. Amounts awarded by secondary or tertiary programs are given. A cross reference is made where the split occurs across two or more Divisions of ENG. The cross reference is then found under the secondary Division/program under the Principal Investigator's surname. When a split-funded award occurs between ENG and another NSF Directorate, the total amount of the award is given.

The data have been reconciled with the NSF's Management Information System.

The index at the end of this issue lists Principal Investigators in alphabetical order by surname and gives the corresponding entry number for each award.

EXAMPLE #1 This example shows an award made by the Primary and Materials Processing Program (PMP) within the Division of Chemical and Process Engineering (CPE).



1 Entry Number: each award has been assigned a unique entry number, arranged in sequential order, and referenced in the index.

2 Title of the Award.

3 Principal Investigator: the chief scientist or administrator who is responsible for the research plan and fiscal expenditures as an NSF awardee.

4 Institution Conducting the Research: any college, university, laboratory, industry, or other organization, whether operating on a profit or nonprofit basis, as well as State governments and Federal organizations.

5 Department or section of the institution conducting the research with which the Principal Investigator is affiliated.

6 Institution's Mailing Address.

7 Award Number: the award number, and amendment number, if applicable.

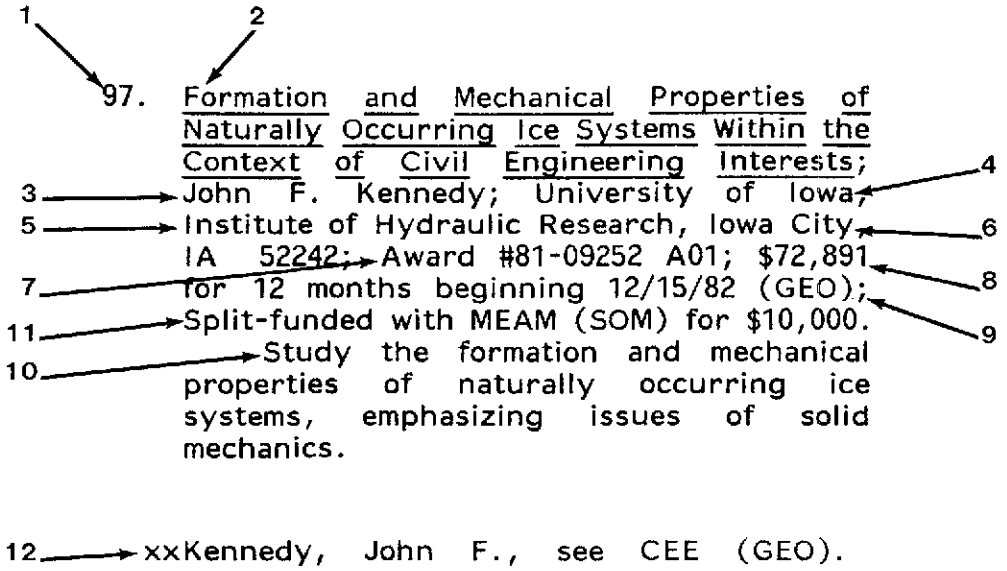
8 Award Amount, Duration, and Starting Date of the Award.

9 Program Abbreviation: this 3-letter abbreviation indicates the program which has funded the award. Directorate for Engineering programs and corresponding abbreviations are described in the Introduction.

10 Abstract: a brief summary highlighting important aspects of the project to be undertaken.

11 Split-Funded Award: a split-funded award is one which has received funds from two or more programs within the same Division of the Directorate for Engineering, or from two programs housed in different Divisions of the Directorate for Engineering. Complete award information is listed under the originating or primary program, and a cross reference is given under the co-funding or secondary program. For split-funded awards across Directorates within NSF, the total amount of the award is given.

EXAMPLE #2 This example shows an award made by the Geotechnical Program (GEO) within the Division of Civil and Environmental Engineering (CEE).



1 - 11 Same as above.

12 Cross References to Split-Funded Awards: a cross reference such as the one shown above can be found in alphabetical order by the Principal Investigator's surname under the secondary or co-funding Division/program for each split-funded award. In example #2, therefore, the cross reference for John F. Kennedy is found under MEAM (SOM). The main entry for the award is found under CEE (GEO).

OFFICE OF INTERDISCIPLINARY RESEARCH

INTRODUCTION

The Office of Interdisciplinary Research (OIR) was established in November 1981, to facilitate and coordinate the support of interdisciplinary research by the National Science Foundation. The Foundation recognizes the need to strengthen its ability to fund interdisciplinary research, including its basic, applied, and problem-oriented aspects.

Because scientific, engineering, and societal problems often cannot be addressed using the knowledge and methods from a single discipline, interdisciplinary research is becoming increasingly important. Through the encouragement and coordination of interdisciplinary research, the Foundation can bring scientific and engineering expertise to bear most effectively on problems spanning several fields.

The Office of Interdisciplinary Research undertakes activities to identify potential research areas and to stimulate quality interdisciplinary research proposals. In cooperation with NSF program directors, the Office develops and supports special studies, conferences, workshops, and other appropriate activities. In addition, the OIR supports the study of interdisciplinary research to improve both the effectiveness of the process itself and the mechanisms for research support.

The OIR concentrates on those interdisciplinary proposals that cut across the Foundation's current programs. Proposals are submitted by applicants through the regular proposal submission process. An information copy should be sent to OIR. The OIR staff will assist in processing those proposals too complex to be handled by one program director. The final funding recommendation is made by the responsible program directors or appropriate division directors.

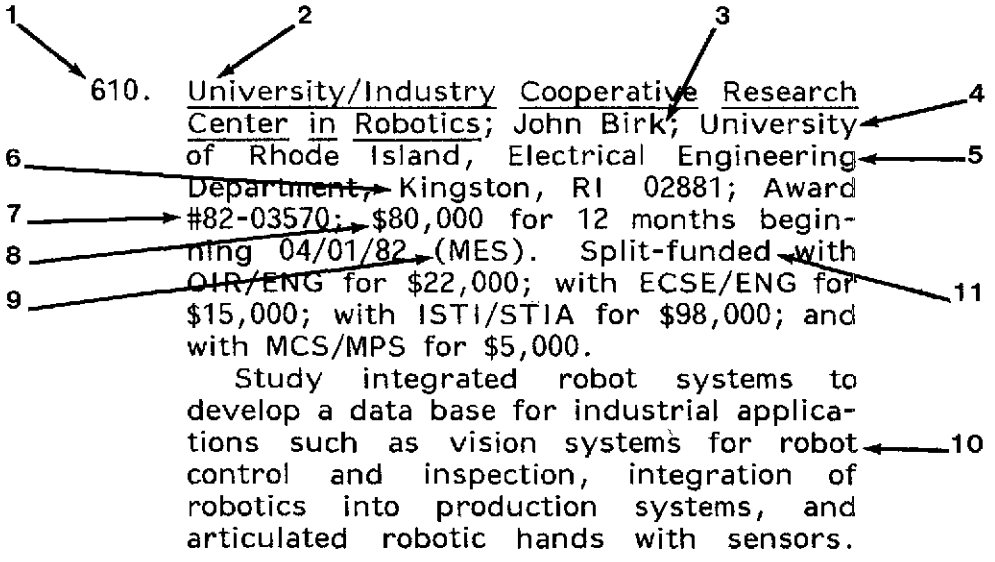
In addition to individual interdisciplinary proposals, the OIR also coordinates diverse research programs related to major issues, sometimes forming committees of relevant program directors to address them. Currently, programs are being coordinated in the areas of robotics and biotechnology.

The OIR has a special responsibility to conduct problem analyses by means of conferences, workshops, and interdisciplinary state-of-the-art review papers. The objectives of these activities are to identify societal or scientific and engineering problems, research gaps, and needs; or, to provide rationale for emerging or complex interdisciplinary areas. Researchers interested in conducting such interdisciplinary conferences or workshops are invited to consult with OIR Staff.

DEFINITIONS AND EXPLANATION OF FORMAT FOR THE OFFICE OF INTERDISCIPLINARY RESEARCH (OIR)

All awards funded by OIR are listed and numbered sequentially following awards from the other Divisions of ENG. For each award, the NSF Division and Directorate are noted in an abbreviated form followed by the amount awarded. Abbreviations used are detailed below.

EXAMPLE #3 This example shows an award with split funding from OIR, MES, ECSE, ISTI, and MCS.



1 - 11 Same as above.

NSF DIRECTORATE AND DIVISION NAMES AND ABBREVIATIONS

1) Directorate for Administration (A)
   Division of Administrative Services
   Division of Financial Management (DFM)
   Division of Grants and Contracts (DGC)
   Division of Information Systems (DIS)
   Division of Personnel and Management (DPM)

2) Directorate for Astronomical, Atmospheric, Earth, and Ocean Sciences (AAEO)
   Division of Astronomical Sciences (AST)
   Division of Atmospheric Sciences (ATM)
   Division of Earth Sciences (EAR)
   Division of Ocean Sciences (OCE)
   Division of Polar Programs (DPP)

3) Directorate for Biological, Behavioral, and Social Sciences (BBS)
   Division of Behavioral and Neural Sciences (BNS)
   Division of Biotic Systems and Resources (BSR)
   Division of Information Science and Technology (IST)
   Division of Physiology, Cellular and Molecular Biology (PCM)
   Division of Social and Economic Science (SES)

4) Directorate for Engineering (E)
   Division of Chemical and Process Engineering (CPE)
   Division of Civil and Environmental Engineering (CEE)
   Division of Electrical, Computer, and Systems Engineering (ECSE)
   Division of Mechanical Engineering and Applied Mechanics (MEAM)

5) Directorate for Mathematical and Physical Sciences (MPS)
   Division of Chemistry (CHEM)
   Division of Materials Research (DMR)
   Division of Mathematical and Computer Sciences (MCS)
   Division of Physics (PHY)

6) Directorate for Scientific, Technological, and International Affairs (STIA)
   Division of Industrial Science and Technological Innovation (ISTI)
   Division of Research Initiation and Improvement (RII)
   Division of International Programs (INT)
   Division of Policy Research and Analysis (PRA)
   Division of Science Resources Studies (SRS)

"The Foundation provides awards for research in the sciences and engineering. The awardee is wholly responsible for the conduct of such research and preparation of the results for publication. The Foundation, therefore, does not assume responsibility for such findings or their interpretation."

"The Foundation welcomes proposals on behalf of all qualified scientists and engineers, and strongly encourages women and minorities to compete fully in any of the research and research-related Programs described in this document."

"Catalog of Federal Domestic Assistance Number 47.041 Engineering Grants"

Division of Chemical and Process Engineering (CPE)

Chemical and Biochemical Processes (CBP)

276 **Reaction Kinetics and Biological Reactor for Cell-Lytic Enzyme Systems;** Juan A. Asenjo; Columbia University, Department of Chemical Engineering and Applied Chemistry, New York, NY 10027; Award #82-11604; $74,156 for 12 months beginning 01/15/82 (CBP).

Investigate the kinetics of the production of different lytic enzymes which participate in the breakage of whole microbial cells. Examine the effects of different factors affecting enzyme production in constitutive and inducible systems and analyze their advantages and disadvantages. Study the kinetics and process considerations involved in the degradation of whole microbial cells by the action of these lytic enzymes. Develop a mathematical model for the degradation of the cell wall, taking into account the role of the different enzymes of the complex. Characterize reaction end products and end product and substrate inhibition effects. Evaluate mass transfer and rheological effects at high substrate concentrations.

277 **Structure-Function Relationships in Immobilized Enzyme Catalysis;** James E. Bailey; California Institute of Technology, Department of Chemical Engineering, Pasadena, CA 91104; Award #82-13551; $2,055 for 12 months beginning 03/15/83 (CBP); Split-funded with RME for $25,000.

Examine the factors which determine the amount and internal distribution of immobilized enzymes in porous supports and extend equations and solution methods for simulating these immobilization processes. Analyze molecular structure-function relationships in immobilized enzyme systems. Conduct experiments using electron paramagnetic resonance (EPR) spectroscopy to probe the influence of enzyme immobilization on the molecular structure of the immobilized enzyme active site and the associated alterations in enzyme specific catalytic activity. Perform research on free and immobilized chymotrypsin to explore molecular structure-activity-stability relationships in different reaction environments. Obtain information on the state of the immobilized enzyme population provided by intrinsic activity determinations, active enzyme and specific residue titrations, and EPR spectrometry.

278 **Rheological Modeling of the Food Extrusion Process;** Donald G. Baird; Virginia Polytechnic Institute, Department of Chemical Engineering, Blacksburg, VA 24061; Award #81-22088 A02; $52,338 for 12 months beginning 06/01/83 (CBP).

Conduct experiments to identify the transport mechanisms in a food extruder using defatted soy flour dough as the material. Measure extruder exit temperature as a function of extruder RPM, barrel temperature, and die characteristic and temperature. Develop an extrusion model useful for the prediction of the relation between torque, volumetric flow rate, screw RPM, and final dough temperature.

279 **Engineering Studies With a Dissolved Oxygen Microelectrode;** Henry R. Bungay; Rensselaer Polytechnic Institute, Department of Chemical and Environmental Engineering, Troy, NY 12181; Award #82-17676; $39,189 for 12 months beginning 02/15/83 (CBP).

Study the respiration of microorganisms in photosynthetic microbial systems, particularly in streams, lakes, and ponds. Measure oxygen diffusivities, oxygen uptake rates, and the photosynthetic evolution of oxygen at point locations; incorporate these measurements into a model of the overall performance of the system. Determine the effects of dissolved oxygen concentrations, stream flow, nutrient concentration, acidity, and temperature on the oxygen transfer behavior and the thickness and area of microbial slimes. Analyze the frequency response of dissolved oxygen in the microbial slime to sinusoidal variations in light intensity in order to relate oxygen evolution and uptake to steps in the photosynthetic pathway.

280 **Dynamics of the Melt Spinning Process;** Morton M. Denn; University of California, Department of Chemical Engineering, Berkeley, CA 94720; Award #82-16381; $40,000 for 12 months beginning 03/01/83 (CBP).

Study the process dynamics of melt spinning in order to relate process sensitivity to operating variables and polymer properties, with particular attention to the dynamical effects of cooling air. Develop dynamic linear model and frequency response representation of a high speed spinline to explore the sensitivity and stability of various process operating regimes to identify critical disturbance characteristics. Perform experiments to measure frequency response characteristics.

281 **Synthesis of Optimal Tower Fermentors for Viscous Fermentations;** Larry E. Erickson; Kansas State University, Department of Chemical Engineering, Manhattan, KS 66506; Award #81-08799 A01; $38,490 for 12 months beginning 01/17/83 (CBP).

Study multiphase flow, mass transfer, and bubble phenomena in viscous fermentation broths in tower type fermentors. Improve mass transfer and mass transfer efficiency in viscous fermentation processes. Research bubble breakup and bubble size distributions in airlift fermentors and investigate oxygen transfer rates and efficiencies in single and multistage airlift columns. Use the results in the synthesis of optimal designs for high viscosity fermentation broths.

282 **Flow Properties of Polymers;** William W. Graessley; Northwestern University, Department of Chemical Engineering, Evanston, IL 60201; Award #80-00030 A03; $61,159 beginning 01/17/83 (CBP).

Investigate the influence of molecular variables on rheological behavior in polymer liquids. Study the effects of long-chain branching and molecular weight distribution on linear viscoelasticity. Use mixtures of structurally well characterized (model) polymers to determine how the parameters governing melt elasticity depend on interactions between molecules of widely different size and structure. Analyze the effects of chain regularity on melt flow properties. Measure nonlinear viscoelastic properties in a specially modified and computerized Weissenberg Rheogoniometer for a variety of shear flow histories. Vary molecular weight, structure, and concentration to search for broad generalizations about their effects on constitutive behavior. Interpret results in a theoretical framework such as that suggested by the Rouse and Doi-Edwards molecular theories.

283 **Industry/University Cooperative Research Activity: Rheology-Processing-Property Relationships of Reinforced Thermoset Composites;** Chang D. Han; Polytechnic Institute of New York, Department of Chemical Engineering, Brooklyn, NY 11201; Award #82-11426; $49,993 for 12 months beginning 02/15/83 (CBP).

Investigate the rheology-processing-property relationships of unsaturated polyester molding compounds. Construct a laboratory-scale plunger-type injection molding apparatus and use a rectangular mold cavity with glass windows to make visual observations of mold filling patterns. Analyze pure and reinforced unsaturated polyester resins and various grades of premix molding compounds. Identify the roles that various components, such as low-profile thermoplastics, filler, viscosity thickener, and glass fibers play in influencing the rheological behavior of premix molding compounds and in affecting the end-use properties of molded specimens obtained under various processing conditions. Determine the network formation of the thermoset resins during cure by rheological measurements, differential scanning calorimetry, and dynamic mechanical analysis. Examine the effect of various additives and processing conditions on the network formation and on the rheological behavior of the materials during thickening. Study the morphology and the mechanical (static and dynamic) properties of molded specimens.

284 **Prediction, Simulation and Optimization of Nutrient Content of Processed Foods;** Marcus Karel; Massachusetts Institute of Technology, Nutrition and Food Science Department, Cambridge, MA 02139; Award #81-04582 A01; $78,684 for 12 months beginning 03/01/83 (CBP).

Use a computer to simulate food behavior during processing and storage. Optimize processing and storage conditions to produce the minimum loss of eating quality, as well as nutrient content. Use dynamic methods of model development; search for general models applicable to classes of foods; develop a kinetic data file of food behavior; optimize dehydration processes with respect to retention of vitamins; and develop a model of oxidation of foods at low oxygen pressure.

285 **Modeling and Control of Fermentation Processes;** M. Nazmul Karim; Colorado State University, Department of Agricultural and Chemical Engineering, Fort Collins, CO 80523; Award #82-14454; $2,111 for 12 months beginning 04/01/83 (CBP); Split-funded with OIR for $25,000.

Study the modeling and computer control of fermentation processes. Examine operation of batch, fed-batch, and continuous processes and consider advanced control strategies for interacting systems and adaptive control for the *Zymomonas mobilis* fermentation for alcohol production.

286 **Fundamental Studies in Computer Control;** W. Harmon Ray; University of Wisconsin, Department of Chemical Engineering, Madison, WI 53706; Award #82-03395 A01; $103,975 for 24 months beginning 01/01/83 (CBP).

Study advanced process control concepts for two important classes of chemical processes: multivariable processes with multiple time delays such as distillation columns, and packed bed reactors having selectivity and yield problems. Test the control systems on a pilot-scale distillation column and chemical reactor.

287 **Advanced Strategies for Process Control;** Dale E. Seborg; University of California, Department of Chemical and Nuclear Engineering, Santa Barbara, CA 93106; Award #82-00274 A01; $96,028 for 24 months beginning 01/07/83 (CBP).

Develop advanced chemical process control strategies for two broad classes of problems: those which include inequality constraints on manipulated and controlled variables, and those which contain nonlinearities and/or time-varying parameters. Use a linear programming approach for the constraint control problem. Develop a new control system design strategy based on simple transfer function models with model parameters which vary with process conditions, for nonlinear and time-varying systems.

288 **Entrapped Plant Cell Cultures;** Michael L. Shuler; Cornell University, Department of Chemical Engineering, Ithaca, NY 14853; Award #81-14995 A01; $51,910 for 12 months beginning 03/01/83 (CBP).

Study entrapped plant cell cultures. Examine the effects of nutrient composition, temperature, pH, and aggregate size on plant cell differentiation and non-growth associated product formation. Determine the stability and long-term productivity of cells maintained in a confined volume with access to continuously renewable nutrient solution. Perform experiments using a

novel cell culture device consisting of a cell chamber, membrane, and nutrient flow chamber to determine changes in morphology with concentration gradients of substrate and product. Examine the production of total extracellular phenolics from soybean and tobacco cell cultures.

289 **Study on the State Estimation and Control of Biochemical Reactors;** Gregory N. Stephanopoul; California Institute of Technology, Department of Chemical Engineering, Pasadena, CA 91104; Award #81-18877 A01; $50,609 for 12 months beginning 02/04/83 (CBP).

Study the state estimation of growing microbial cultures from the commonly available measurements of oxygen and carbon dioxide partial pressure, pH, and dissolved oxygen concentration. Use these estimates for optimal adaptive control and for basic studies of the characteristic properties of microbial cultures. Perform simulation studies to assess the estimation and control techniques, followed by an experimental program with pure and mixed cultures of *E. coli* and *S. metamorphum*. Conduct pure culture studies with yeast and methanol utilizing bacteria.

290 **Conference on Foundations of Computer-Aided Chemical Process Design (FOCAPD-83), Snowmass, Colorado, June 19-24, 1983;** Arthur W. Westerberg; CACHE Corporation, Departments of Engineering, Chemistry and Energetics, Salt Lake City, UT 84112; Award #82-13101; $19,500 for 12 months beginning 02/01/83 (CBP); Split-funded with TTP for $2,000.

Bring together industrial practitioners and university researchers to assess the present status and future needs in FOCAPD emphasizing basic engineering advances in this field. Cover computer science developments and new computational algorithms, estimation and computational aspects of thermochemical and physical properties for design, developments in flowsheeting systems, computational methods for analyzing complex single process units, design of batch processes, and important criteria other than economics in design.

Engineering Energetics (ENE)

291 **Effects of Turbulence of Recirculation, Vortex Shedding and Flame Stabilization Mechanisms;** Robert G. Bill; Columbia University, Department of Mechanical Engineering, New York, NY 10027; Award #81-12662 A01; $62,728 for 12 months beginning 01/28/83 (ENE).

Use hot-wire anemometry in a cold flow to determine flow characteristics of recirculation and vortex shedding from bluff bodies with and without free stream turbulence. Measure the effects of free stream turbulence on the development of wake turbulence and measure flame stability limits for bluff body stabilized flames to determine the effects of vortex shedding on flame stability. Analyze the recirculating flow fields for flow configurations with and without free stream turbulence and combustion using laser anemometry. Correlate flame blow-off and flame speed. Use Rayleigh scattering as a diagnostic tool for gas density to measure density fluctuation within the flame.

292 **Electronegative Gas Glow Discharge Investigations;** Lorne M. Chanin; University of Minnesota, Department of Electrical Engineering, Minneapolis, MN 55455; Award #81-22086 A01; $80,000 for 12 months beginning 05/01/83 (ENE).

Characterize chemically active electronegative gas discharges. Investigate non-uniform plasma phenomena such as discharge instabilities and electrophoretic and cataphoretic effects using measurements from active discharges. Use afterglow techniques for the evaluation of needed rate constant data for various gas mixtures. Make radiation emission measurements on electronegative and noble gas mixtures using direct current discharges to evaluate electrophoretic and cataphoretic non-uniform glow discharge phenomena. Employ electrostatic probes in non-uniformity studies to detect time-dependent and spatially dependent changes in the electron energy distributions.

293 **Resonance Ionization Probe Techniques for Combustion Diagnostics;** Terrill A. Cool; Cornell University, Department of Applied and Engineering Physics, Ithaca, NY 14853; Award #81-19408 A01; $80,000 for 12 months beginning 02/03/83 (ENE).

Develop resonance ionization spectroscopy for the direct quantitative measurement of the concentrations of important free radicals in combustion flames. Take nitric oxide measurements to demonstrate and evaluate the technique and measure carbon dimer, carbon-hydrogen radical, oxygen-hydrogen radical, and hydrogen-carbon-oxygen radical in the presence of large concentrations of background gases in laboratory flames and simulated combustion environments. Determine potential limitations and interferences of the technique.

294 **Research in Laser Spectroscopy for Combustion;** David R. Crosley; SRI International, Molecular Physics Laboratory, Menlo Park, CA 94025; Award #80-17521 A02; $80,000 for 12 months beginning 02/01/83 (ENE).

Conduct experiments using spectroscopy and laser techniques for the detection of molecular species in flames. Extend sensitivity limits and provide correlated measurements of temperature and reactive species concentrations. Study multiphoton excitation of fluorescence, focusing on carbon monoxide in flames; study the development and use of Raman-frequency shifted radiation for laser-based flame spectroscopy in the near and far ultraviolet; analyze opto-acoustic detection of the selective absorption of tunable laser radiation by molecules that do not fluoresce due to high quenching, internal conversion, or predissociation; and examine energy transfer thermometry, in which the measurement of vibrational energy transfer in a laser-pumped

electronically excited state furnishes simultaneous values for the temperature and a reactive species density.

295 **Experimental Investigation of Turbulent Combustion Stabilized in a Free Shear Layer;** John H. Daily; University of California, Department of Mechanical Engineering, Berkeley, CA 94720; Award #81-16841 A01; $67,190 for 12 months beginning 02/01/83 (ENE).

Obtain information on the entrainment and mixing rates of chemically reacting flows and their variations with Reynolds number, velocity ratio, density ratio, heat release, and geometry and model the information. Use and observe nongaseous fuels and determine their physical and chemical influence. Study the effect of coal particle combustion of a free shear layer and establish the characteristics of such flames.

296 **Measurements in Turbulent Premixed Flames to Assess a New Flame Model;** James F. Driscoll; University of Michigan, Department of Aerospace Engineering, Ann Arbor, MI 48109; Award #82-13319; $53,623 for 12 months beginning 02/18/83 (ENE).

Measure density-velocity correlations and conditional averages in a turbulent premixed flame. Use the data to assess the basic closure assumptions proposed in a new theory of Bray and Libby. Systematically vary four major flame parameters identified in the model. Measure each term in the assumed closure relations and compare the measured profiles of flame properties with final results predicted by the model.

297 **Supersonic Free Jets — Properties and Applications;** John B. Fenn; Yale University, Department of Chemical Engineering, New Haven, CT 06520; Award #82-16647; $70,028 for 12 months beginning 01/26/83 (ENE).

Perform three related tasks which use supersonic free jets of specific gases issued from small nozzles into vacuum: study intermolecular energy exchange by determining internal energy states of the jet molecules by Fourier Transform Infrared Spectrometry (FTIS) in emission and absorption modes; investigate reaction mechanisms and accommodation of internal degrees of freedom by FTIS examination of molecules undergoing inelastic and/or reactive collisions with surfaces; and develop an ion source for mass spectrometry of fragile species.

298 **Microstructure Evolution in Irradiated Structure Materials;** Nasr M. Ghoniem; University of California, Department of Chemical, Nuclear, and Thermal Engineering, Los Angeles, CA 90024; Award #81-15571 A01; $54,963 for 12 months beginning 03/15/83 (ENE).

Develop and solve systems of rate equations that describe the main microstructural features of irradiated structural materials. Solve kinetic equations describing the behavior of the dislocation network, interstitial dislocation loops, vacancy dislocation loops and gas filled cavities. Perform extensive data gathering and analysis. Isolate effects that are thought to be due to local changes in the microchemistry. Study the interactive nature of the microstructural components and their response to irradiation temperature; neutron fluence or total displacement damage; helium concentration and mode of injection (sequential versus simultaneous with damage); helium-to-displacement damage ratio; mode of operation (continuous versus interrupted); spectral effects (effects of collision cascades); and initial (unirradiated) microstructure. Develop theoretical methods for the accurate description of various components of the microstructure.

299 **Development of Tunable Laser Absorption and Fluorescence Techniques for Shock Tube and Flow Reactor Kinetics Studies and Applications to the NO-NH3 System;** Ronald K. Hanson; Stanford University, Department of Mechanical Engineering, Stanford, CA 94305; Award #81-21989 A01; $80,000 for 12 months beginning 01/28/83 (ENE).

Develop improved methods, utilizing tunable lasers, for absorption and/or fluorescence measurements of species concentrations in shock tubes and high temperature flow reactors. Apply these techniques to measure species relevant to the kinetics of the nitric oxide-ammonia system. Develop continuous-wave tunable dye laser techniques and pulsed tunable dye laser techniques for shock tube measurements and continuous-wave tunable dye laser techniques for high temperature flow reactor measurements.

300 **Generation of Coherent Radiation by Non-Linear Mixing in Gases;** Thomas J. McIlrath; University of Maryland, Institute of Physical Science and Technology, College Park, MD 20742; Award #81-19250 A01; $66,752 for 12 months beginning 03/01/83 (ENE).

Use two-photon resonances in xenon, krypton, and argon to achieve tunable outputs by mixing with visible dye laser radiation or near infrared radiation obtained by stimulated Raman scattering. Cover the entire region from 1500A to below 800A with a resolution of better than 0.1 cm^{-1}. Complete and characterize a Fizeau wavemeter with an accuracy of one part in ten. Compare measurements of scattering from rare gas Rydberg states, using the Fizeau wavemeter as a standard, with measurements of very high resolution.

301 **Conference on Radiation Shielding in Japan and Visit to Institute of Atomic Energy, China, May 1983;** Paul Nelson; Texas Tech University, Department of Mathematics, Lubbock, TX 79409; Award #83-08831; $1,679 for 6 months beginning 05/15/83 (ENE).

Support international travel for a participant to the Sixth International Conference on Radiation Shielding in Tokyo, Japan, and for his visit to researchers at the Institute of Atomic Energy, Beijing, China, May 1983.

302 **Calculations of Probability Density Functions in Turbulent Shear Flows in Combustion;** Stephen B. Pope; Cornell

University, Department of Mechanical and Aerospace Engineering, Ithaca, NY 14853; Award #82-12661; $69,716 for 24 months beginning 02/15/83 (ENE).

Develop a calculation procedure for turbulent reactive flows based on the solution of the transport equation for the joint probability density function of the velocity and fluid composition. Model the effects of the fluctuating pressure and viscous and diffusive mixing. Develop the calculation procedure for a sequence of flows of increasing difficulty. Compare calculations at each stage with experimental data.

303 **Laser Photochemistry and Diagnostics with Aligned Molecules;** Erhard W. Rothe; Wayne State University, Department of Chemical/Metallurgical Engineering, Detroit, MI 48202; Award #81-06325 A01; $80,000 for 12 months beginning 01/15/83 (ENE).

Investigate three broad areas which use laser spectroscopy and molecular beams to gain insight into collision dynamics and chemical reactions: preparation of beams of molecules which have been aligned by interactions with appropriately polarized laser beams; the use of two-photon ionization to characterize the state distribution and alignment of the reaction products of simple three -and four-center reactions; and the use of lasers to promote chemical reactions by the preparation of excited electronic states with known alignment.

304 **Studies of High Pressure, Convection-Stabilized Arcs;** David T. Tuma; Carnegie-Mellon University, Department of Electrical Engineering, Pittsburgh, PA 15213; Award #81-11625 A01; $62,351 for 12 months beginning 01/21/83 (ENE).

Examine nitrogen and sulfur hexafluoride convection stabilized arcs. Study dynamic arc behavior through a two-dimensional spatial model; investigate turbulence effects on arc interruption; and study nonequilibrium effects on arc behavior.

Kinetics, Catalysis, and Reaction Engineering (KCR)

305 **Application of Transient Response Techniques to the Study of Nitric Oxide Decomposition and Reduction Over Group VIII Metal Catalysts;** Alexis T. Bell; University of California, Department of Chemical Engineering, Berkeley, CA 94720; Award #82-16537; $52,983 for 12 months beginning 01/01/83 (KCR).

Use various transient-response approaches (analysis of the response to perturbations in feed concentration, isotopic tracing, and temperature-programmed desorption spectroscopy) in conjunction with *in situ* infrared spectrosocpy to investigate the decomposition and reduction of nitric oxide over rhodium, platinum, and palladium catalysts. Address questions concerning the extent to which the mechanisms and kinetics of nitric oxide decomposition and reduction are similar for platinum, palladium, and rhodium; how catalyst oxidation or reduction influences catalyst selectivity and activity; and how catalyst-support interactions influence catalyst activity and selectivity for nitric oxide decomposition and reduction.

306 **Transient Studies of the Hydrogen/Carbon Monoxide Reaction Over Various Supported Transition Metals;** Carroll O. Bennett; University of Connecticut, Department of Chemical Engineering, Storrs, CT 06268; Award #81-20499 A01; $60,375 for 12 months beginning 02/01/83 (KCR).

Study iron, nickel, rhodium, and molybdenum on a variety of supports such as silica, alumina, titania, magnesia, and carbon. Explore the nature and reactivity of reaction intermediates in the reactions of hydrogen and carbon monoxide in these systems.

307 **Comprehensive Infrared Spectroscopy Study of Hydrodesulfurization Chemistry;** Jay B. Benziger; Princeton University, Department of Chemical Engineering, Princeton, NJ 08544; Award #82-17364; $79,141 for 12 months beginning 02/01/83 (KCR).

Apply transmission, reflection, and photoacoustic infrared spectroscopies to study the adsorption of carbon monoxide on nickel catalysts and to study hydrodesulfurization reaction. Develop a Helmholtz resonator photoacoustic cell to perform high-temperature photoacoustic spectroscopy and mirage-effect spectroscopy to permit spectroscopy to be done on simulated three-phase reaction systems such as those typically encountered in hydrodesulfurization reactors.

308 **Catalytic Activity of Platinum Clusters with Fewer than Ten Atoms;** Michel Boudart; Stanford University, Department of Chemical Engineering, Stanford, CA 94305; Award #82-19066; $83,000 for 12 months beginning 03/01/83 (KCR).

Determine the minimum number of metal atoms required in a cluster for that cluster to possess the activity of the bulk metal surface for catalysis of a structure-insensitive reaction. Study a catalyst consisting of platinum clusters in the supercages of the Y-zeolite structure. Use X-ray methods as well as electron microscopy, infrared spectroscopy, and a new nuclear magnetic resonance technique using xenon as a probe to characterize the clusters.

309 **Catalytic Studies on Rhodium Phosphine Complexes Utilizing a Novel Immobilization Technique;** Mark E. Davis; Virginia Polytechnic Institute, Department of Chemical Engineering/Chemistry, Blacksburg, VA 24061; Award #82-16296; $111,902 for 24 months beginning 03/01/83 (KCR).

Develop a new procedure to "heterogenize" homogeneous catalysts: entrap complexes by *in situ* formation in zeolites for which tertiary size requirements prohibit metal elution. Use the hydroformylation of propylene by rhodium phosphine complexes as the test system. Perform activity, selectivity, and stability studies in a flow reactor and model the kinetics of the system mathematically. Perform full characterization of the

catalyst systems using X-ray photoelectron spectroscopy, infrared spectroscopy, and solid-state phosphorus-31 nuclear magnetic resonance. Record infrared spectra under reaction conditions and use these data, along with product distribution data, to postulate reaction mechanisms.

310 **Industry/University Cooperative Research Activity: Geometrically Designed Catalysts in the Study of Multi-Component Catalysis;** James A. Dumesic; University of Wisconsin, Department of Chemical Engineering, Madison, WI 53706; Award #81-21717 A01; $35,210 for 12 months beginning 04/01/83 (KCR). Part of a total NSF Award of $70,420.

Formulate new classes of multicomponent catalysts for carbon gasification utilizing specific interactions between individual constituents. Perform catalytic and adsorption studies on high-surface-area materials and structural and surface studies on well-defined low-surface-area model catalyst systems. Explore correlations between chemical properties and solid-state properties. Conduct ammonia synthesis studies. Prepare geometrically designed catalysts and study three classes of multicomponent catalysts: multicomponent metals on strongly interacting supports, metals on multicomponent supports, and combinations of multicomponent metals and multicomponent supports. Use components including iron, platinum, titania, silica, alumina, and carbon to formulate these materials.

311 **Development of Non-Noble Metal Electrocatalysts—Phase II;** Morris Eisenberg; Electrochimica Corporation, Mountain View, CA 94043; Award #82-12869; For 24 months beginning 01/15/83 (KCR). Part of a total NSF Award of $264,663.

Optimize compositions and preparation methods of nonstoichiometric oxospinels and sulfospinels and characterize their material properties and catalytic activities.

312 **Purchase of an Infrared Fourier Transform Spectrometer;** James L. Fasching; University of Rhode Island, Department of Chemistry, Kingston, RI 02881; Award #82-16482; $10,000 for 12 months beginning 03/15/83 (KCR). Part of a total NSF Award of $50,700.

Purchase a Fourier-transform infrared spectrometer for the Chemistry Department for research in surface chemistry and heterogeneous catalysis, metallic clusters, chemical dynamics, new conducting organic polymers, and for the development of a combined supercritical fluid chromatograph-spectrometer.

313 **Molecular Metal Clusters Supported on Oxides: Synthesis, Characterization, and Catalysis;** Bruce C. Gates; University of Delaware, Department of Chemical Engineering, Newark, DE 19711; Award #82-18311; $82,027 for 12 months beginning 03/01/83 (KCR).

Prepare and characterize oxide-supported metal-cluster catalysts with unique molecular structures. Test the material as catalysts for a variety of reactions and determine catalytic kinetics for selected materials.

314 **Simultaneous Infrared and Kinetic Studies of Supported Metals and Bimetallic Clusters;** Richard D. Gonzalez; University of Rhode Island, Department of Chemistry, Kingston, RI 02881; Award #82-17582; $35,049 for 12 months beginning 03/15/83 (KCR).

Study methanation and Fischer-Tropsch reactions over well-characterized supported cobalt-ruthenium bimetallic clusters and over alkali-promoted ruthenium catalysts. Use an infrared cell that permits simultaneous infrared and kinetic measurements, simultaneous infrared, temperature-programmed desorption, and temperature-programmed reaction studies, surface composition measurements from experimental extinction coefficients, and surface concentrations of catalytically active species under *in situ* conditions. Examine the effects of the alkali-metal promoter on the binding states of carbon monoxide, hydrocarbon distributions, and paraffin/olefin ratios. Study the reaction of carbon monoxide with hydrogen over supported bimetallic clusters with a range of surface compositions on both silica and alumina. Investigate the effects of platinum dispersion and platinum surface composition on the oxidation of carbon monoxide over supported platinum or platinum-ruthenium bimetallic clusters.

315 **Oscillations and Chaos in a Chemical Reactor;** John L. Hudson; University of Virginia, Department of Chemical Engineering, Charlottesville, VA 22906; Award #80-21950 A02; $45,247 for 12 months beginning 01/11/83 (KCR).

Perform experiments on self-sustained oscillations in a continuous stirred reactor. Investigate the effect of external disturbances. Elucidate the characteristics of and the determination of the conditions under which complex oscillations and chaos will arise. Study reactions including the Belousov-Zhabotinskii reaction, the reaction of gallic acid and bromate in acid solution, and the exothermic liquid-phase reaction of sodium thiosulfate and hydrogen peroxide. Feed data directly to a microcomputer; construct trajectories, Poincare maps, power spectra, autocorrelation functions, and disorder parameters.

316 **Effects of Surface Composition and Structure of Chemical Reactions on Metal Surfaces;** Robert J. Madix; Stanford University, Department of Chemical Engineering, Stanford, CA 94305; Award #80-23815 A02; $80,000 for 12 months beginning 04/01/83 (KCR).

Study the effects of adsorbed layers on surface reactivity, including kinetics and mechanism. Use low-energy electron diffraction, Auger electron spectroscopy, x-ray photoelectron spectroscopy, ultraviolet photoelectron spectroscopy, high-resolution energy-loss spectroscopy, and temperature-programmed reaction spectroscopy to examine the reactive nature of adsorbed oxygen with emphasis on the mechanism of catalytic oxidation. Investigate the effects of structurally defined sulfur adlayers on the nature of the adsorbed state and on desorption kinetics.

317 **Sulfur Dioxide Regenerative Absorption in Vanadia-Potassia Melt;** Gregory N. Stephanopoul; California Institute of Technology, Department of Chemical Engineering, Pasadena, CA 91104; Award #81-21892 A01; $70,697 for 12 months beginning 03/11/83 (KCR).

Investigate the catalytic and absorptive properties of molten vanadia-potassia (or sodia) coating the pore surface of a support material relative to the oxidation and reduction of sulfur oxides. Prepare absorbent-catalysts of various compositions and characterize them by physisorption, x-ray diffraction, and scanning electron microscopy. Examine catalyst composition and support properties with respect to their effects on reactivity, selectivity, and absorptive capacity. Conduct kinetic studies using a thermogravimetric balance and continuous product analysis to measure reaction kinetics and diffusion rates in the pores and in the melt layer. Develop a model describing the transient kinetic and transport processes.

318 **Solid Electrolyte Aided Study of Catalytic and Electrocatalytic Oxidations;** Michael Stoukides; Tufts University, Department of Chemical Engineering, Medford, MA 02155; Award #82-15085; $76,876 for 24 months beginning 02/01/83 (KCR).

Use solid electrolyte potentiometry to study the catalytic oxidation of methane to formaldehyde over silver catalysts. Explore conventional and electrochemical means to improve the selectivity to formaldehyde.

319 **Inelastic Electron Tunneling Spectroscopic Studies of Metal Tetrahydroborates and Organometallic Polymerization Catalysts;** W. Henry Weinberg; California Institute of Technology, Department of Chemical and Chemistry Engineering, Pasadena, CA 91104; Award #80-24597 A02; $70,000 for 12 months beginning 01/11/83 (KCR).

Conduct a study using inelastic electron tunneling spectroscopy of supported polymerization cluster catalysts and their interactions with and polymerization of various monomers. Use catalysts including zirconium borohydride, uranium borohydride, tetrabenzylzirconium, bis-benzene, titanium, and dicyclopentadrenylzirconium borohydride and monomers including ethylene, propylene, acetylene, butadiene, cyclohexene, and styrene. Employ planar (diode) geometry consisting of a metal film, a thin oxide layer, and a top metal film.

320 **Transient Multicomponent Adsorption and Reaction Studies;** Gregory P. Wotzak; Cleveland State University, Department of Chemical Engineering, Cleveland, OH 44115; Award #82-17981; $76,000 for 24 months beginning 04/01/83 (KCR).

Combine a jet-stirred reactor with the "dynamic balance" technique to provide direct multicomponent adsorption and reaction rate data for systems characterized by relatively rapid adsorption of reactant species. Maintain selected intermediate species at preset levels while monitoring the amounts of reactant or adsorbate species required to maintain this quasi-steady-state situation. Use a minicomputer data acquisition system employing digital filtering and direct digital control to implement the technique.

Minerals and Primary Materials Processing (MPM)

321 **Nucleation Growth and Settling of a Metal Phase During Gaseous Reduction of Oxide Melts;** T. Deb Roy; Pennsylvania State University, Department of Materials Science and Engineering, University Park, PA 16802; Award #81-20874 A01; $8,985 for 6 months beginning 01/15/83 (MPM).

Study the rate processes involving the nucleation and growth of a metallic phase from molten slags by a combination of established and novel techniques. Monitor the inception and growth of the metal phase in the slag by the application of Carl Wagner's dispersed phase electrical conductivity theory. Determine the energy necessary to induce nucleation of a metallic phase by the EMF cell measurement of the oxygen potential in the slag. Measure the overall rate of reaction by thermogravimetric experiments. Study the roles played by the gas/slag and slag/refractory interfaces on reduction, morphology, and growth of the metallic dispersion. Examine quenched, partially reduced slag samples by a combination of optical and scanning electron microscopy, electron probe micro-analysis, and Auger spectroscopy. Examine the two high temperature systems involving the reduction of $PbO\text{-}SiO_2$ and tin slags containing SnO, SiO_2, CaO, and FeO, with and without minor additives of other compounds in both systems in H_2/N_2, H_2/H_2O and CO/CO_2 mixtures.

322 **Performance and Transient Behavior of Fluidized Bed Electrodes During Electrodeposition of Zinc;** James W. Evans; University of California, Department of Materials Science and Mineral Engineering, Berkeley, CA 94720; Award #82-11806; $75,510 for 24 months beginning 02/01/83 (MPM).

Investigate the electrodeposition of zinc in a fluidized bed cathode. Measure current efficiency, voltage distribution and energy consumption as functions of electrolyte concentration and pH, presence of additives or impurities in the electrolyte, bed expansion, particle size, and cell design. Focus on the transient behavior of the particle potentials in the fluidized cathode. Measure these transient potentials and simulate them at conventional electrodes to explain the anomalous electrochemical performance of fluidized cathodes observed in the preliminary experiments.

323 **Fundamental Studies on the Hydrometallurgical Extraction of the Platinum Group Metals;** Henry Freiser; University of Arizona, Department of Chemistry, Tucson, AZ 85721; Award #82-14778; $35,000 for 12 months beginning 01/15/83 (MPM).

Examine the solvent extraction chemistry of the platinum group metals. Prepare various chelating extractants, selected as model compounds, and study their metal behavior. Identify desirable structural characteristics of chelating extractants that can be used to design reagents and extraction procedures capable of large-scale separations and recovery of the platinum group metals.

324 **Interfacial Properties of Coal and Their Role in Coal Beneficiation;** Douglas W. Fuerstenau; University of California, Department of Materials Science and Mineral Engineering, Berkeley, CA 94720; Award #82-15874; $47,082 for 12 months beginning 01/15/83 (MPM).

Investigate interfacial phenomena involved in raw coal systems and delineate conditions for improving the beneficiation of fine coal. Examine the nature of coal/water interfacial reactions and the role of oxygen and contained fine-mineral matter in controlling surface properties. Characterize the external and internal surfaces of the organic components of coal and determine how the surface oxidation of coal particulates affects the surface charge, wetability and acid-base properties of coals.

325 **Solvent Extraction of Heavy Metal Cations Using Macrocyclic Ligands with Application to Hydrometallurgical Extraction;** Reed M. Izatt; Brigham Young University, Thermochemical Institute, Provo, UT 84602; Award #81-19634 A01; $39,766 for 12 months beginning 03/15/83 (MPM).

Study the effectiveness of macrocyclic ligands as extractants and co-extractants in liquid-liquid extraction of heavy metal cations Hg^{2+}, Cd^{2+}, Pb^{2+}, Ag^{2+}, and Tl^{+} for which they have a demonstrated affinity. Examine neutral macrocycles as synergists in cation exchange solvent extraction using conventional strong acid extractants such as di (2-ethylhexyl) phosphoric acid. Measure distribution coefficients for the macrocycles themselves (using toluene diluent), and for heavy metal cations in the presence of macrocycles only, conventional extractant only, and both of these to determine synergistic factors.

326 **Microbial Leaching of Sulfur Compounds from Coal by the Thermophilic Microorganism Sulfolobus Acidocaldarius;** Fikret Kargi; Lehigh University, Department of Chemical Engineering, Bethlehem, PA 18015; Award #82-01196 A01; $39,955 for 12 months beginning 03/11/83 (MPM).

Develop an economically feasible process for the microbial removal of inorganic and part of the organic sulfur from coal by *Sulfolobus acidocaldarius* (a thermophilic, sulfur-oxidizing, facultative autotroph). Elucidate the intrinsic kinetics of sulfur removal based upon surface area of coal particles and develop a specific rate expression to characterize microbial utilization of particulate solid substrates. Study the microbial oxidation kinetics of model organic sulfur compounds present in coal by *S. acidocaldarius.*

327 **Selective Magnetic Mineral Component Separation;** David R. Kelland; Massachusetts Institute of Technology, Francis Bitter National Magnet Laboratory, Cambridge, MA 02139; Award #81-20442 A01; $60,000 for 12 months beginning 04/01/83 (MPM).

Investigate the selective magnetic separation of mineral components. Accomplish separations under ideal experimental conditions of known surface charge, particle sizes, and in the absence of drag.

328 **Chemistry of Gold Anions, Au-.;** Joseph J. Lagowski; University of Texas, Department of Chemistry, Austin, TX 78712; Award #81-17677 A01; $40,000 for 12 months beginning 02/01/83 (MPM).

Investigate the chemical properties of recently discovered stable gold anion in liquid ammonia. Find a suitable solvent and a set of experimental conditions for rapid oxidation and/or hydrolysis of gold anion to metallic gold, and establish electrochemical parameters for macroscale anodic electroplating of gold.

329 **Quantitative Study of Comminution and Its Role in Determining the Physicochemical Behavior of the Comminuted Solid;** Donald E. Mikkola; Michigan Technological University, Department of Metallurgical Engineering, Houghton, MI 49931; Award #82-16258; $40,002 for 12 months beginning 03/01/83 (MPM).

Produce fine solid particles by various comminution methods, quantitatively characterize the structure of the disturbed layer and the amount of associated stored energy, and measure the effects of this stored energy on the response to certain mineral processing unit operations. Using quartz and galena, employ comminution methods including wet and dry grinding, roll crushing, pulverizing, and shock loading. Measure the effects of the stored energy on grindability, interactions at the solid-solution interface, and electrodynamic separations. Elucidate the influence of the comminution processes on the physicochemical properties of the resulting products.

330 **Electrorefining of Aluminum;** J. Paul Pemsler; Castle Technology Corporation, Lexington, MA 02173; Award #81-15213 A02; For 12 months beginning 11/01/82 (MPM). Part of a total NSF Award of $210,126.

Develop the process of electrorefining contaminated aluminum scrap to demonstrate its commercial feasibility. Optimize the electrolyte and additive composition by investigating the fundamental chemistry of the decomposition process and the role the additive plays. Obtain operating data necessary to design a scaled-up electrorefining cell and prepare a cost analysis.

331 **Iron As a Reductant in Ammoniacal Solutions;** J. Paul Pemsler; Castle Technology Corporation, Lexington, MA 02173; Award #81-11229 A01; $44,834 for 12

months beginning 03/01/83 (MPM). Part of a total NSF Award of $89,668.

Investigate the use of reduced iron species in solution as reagents for application in hydrometallurgical extraction of value metals from ammoniacal leach solutions. Determine the thermodynamics and kinetics of the reduction reactions of these species and explore factors related to product recovery and reagent recycling. Include the rate and mechanism of the reduction of nickel to the carbonyl by carbonyl ferrate ion.

332 **High Purity Manganese By Fused Chloride Electrolysis;** Donald R. Sadoway; Massachusetts Institute of Technology, Materials Processing Center, Cambridge, MA 02139; Award #81-16641 A01; $59,674 for 12 months beginning 02/18/83 (MPM).

Study electrochemical cell design and consider the effects of fluid flow in the molten salt electrolyte on the electrodeposition of manganese. Use experimental techniques including digital signal analysis by fast Fourier transform of the electrolytic cell voltage measured during operation. Model elecrolyte flow behavior as a function of cell design.

333 **Electrochemical Recovery and/or Treatment Procedures Involving Dilute Solutions;** Glenn E. Stoner; University of Virginia, Department of Materials Science, Charlottesville, VA 22906; Award #81-19765 A01; $43,478 for 12 months beginning 01/17/83 (MPM).

Investigate the electrochemical recovery of gallium metal from dilute solutions. Include variation of electrochemical waveforms, electrocatalysis, and electrode configurations. Study the recovery from alkaline solution in a specially designed cell. Perform experiments using pulsed potential, pulsed current, and intermittent potential electrolysis techniques.

334 **New Refining Process of Molten Iron and Iron Alloys Soda Ash Treatment Combined with Slagless BOP Blowing;** Harue Wada; University of Michigan, Department of Materials and Metal Engineering, Ann Arbor, MI 48109; Award #81-17084 A02; $3,611 for 12 months beginning 02/01/83 (MPM).

Investigate the mechanisms of simultaneous desulfurization and dephosphorization reactions. Examine the behavior of nitrogen during the soda-ash treatment and study the reaction mechanisms of soda-ash slag involved in the treatment.

Particulate and Multiphase Processes (PMP)

335 **Industry/University Cooperative Research Activity: One-Dimensional Wave Phenomena in Two-Phase Flow;** Sanjoy Banerjee; University of California, Department of Chemical and Nuclear Engineering, Santa Barbara, CA 93106; Award #81-12667 A01; $56,123 for 12 months beginning 01/21/83 (PMP).

Study the propagation, damping, and dispersion of one-dimensional waves in two-phase flows. Measure dispersion relationships by cross-correlating the inherent pressure and void fraction fluctuations in bubbly, annular, and inverted annular flows. Compare these data with theoretical dispersion relationships based on multifluid models. Obtain information regarding interfluid drag and heat transfer. Measure the propagation of large amplitude pressure waves to examine nonlinear phenomena. Compare the data with perturbation analyses of multifluid models that take finite amplitude effects, and the possibility of waves of permanent shape (solitons), into account.

336 **Morphological Analysis;** John K. Beddow; University of Iowa, Department of Materials Engineering, Iowa City, IA 52242; Award #80-23868 A02; $70,000 for 12 months beginning 03/25/83 (PMP).

Extend morphological analysis of particulate materials to growth and diminution processes in static and dynamic situations. Investigate crystallization, dissolution, apparent and tap density, and effective angle of friction and effective yield locus measurements. Determine the effect of particle morphology and test the identification capability of a three-feature pattern (size, shape, and color).

337 **Forced Convection Two-Phase Hydrodynamics and Heat Transfer in Non-Newtonian Polymer Solution-Gas Mixtures;** Alfred A. Bishop; University of Pittsburgh, Department of Chemical and Petroleum Engineering, Pittsburgh, PA 15260; Award #81-15208 A01; $68,373 for 12 months beginning 02/01/83 (PMP).

Determine thermal/hydraulic characteristics of two-phase, non-Newtonian, pseudoplastic, water-soluble, polymer/gas mixtures flowing through heated, horizontal, and vertical tubes. Obtain two-phase pressure drop, void fraction, and heat transfer data under forced convection, non-isothermal conditions. Construct analytical, physical, and semi-empirical models and compare them with the experimental data.

338 **Industry/University Cooperative Research Activity: Size, Shape, and Composition Characterization of Dielectric Particulates by Light Scattering;** Richard K. Chang; Yale University, Applied Physics Department, New Haven, CT 06520; Award #81-12835 A01; $30,000 for 12 months beginning 01/28/83 (PMP). Part of a total NSF Award of $60,000.

Develop a real-time and on-line characterization technique for dielectric microparticles, determining their size, shape, and material properties. Investigate the effects of inhomogeneous surroundings (caused when the microparticle is on or near a dielectric or metallic substrate) simulating a two-particle cluster.

339 **Nucleation Rate Measurement;** Richard A. Dobbins; Brown University, Division of Engineering, Providence, RI 02912; Award #79-26764 A02; $44,000 for 12 months beginning 03/01/83 (PMP).

Study the dynamics of nucleation, focusing on the interacting roles of nucleation rates, droplet growth rates, and the expansion rate. Measure nucleation rates, and observe nucleation in pure steam at elevated temperatures and droplet growth rates in pure steam. Analyze the elements of nucleation dynamics and test the ability of accepted nucleation and growth expressions.

340 **Formation and Stabilization of Miniemulsions and Latexes;** Mohamed S. El-Aasser; Lehigh University, Emulsion Polymers Institute, Bethlehem, PA 18015; Award #81-19223 A01; $50,000 for 12 months beginning 03/25/83 (PMP).

Use two component mixed emulsifier systems, in concentrations of 1-3 percent, to prepare stable oil-in-water miniemulsions with droplet diameters of 100-300 nm. Identify the mechanisms involved in formation and stabilization of miniemulsions, and quantify the various physico-chemical parameters involved in this emulsification process. Identify and quantify the physico-chemical parameters which control the shapes of the conductivity curves. Develop a mathematical treatment, using these measured parameters, to model the emulsification conductivity curves.

341 **Industry/University Cooperative Research Activity: Structure and Stability of Three-Phase Foams;** Stig E. Friberg; University of Missouri, Department of Chemistry, Rolla, MO 65211; Award #82-13378; $42,450 for 12 months beginning 03/15/83 (PMP).

Determine the relative influence of different mechanisms for the enhanced stability of three-phase foams due to the presence of the liquid crystalline phase. Focus on a suitable choice of model systems; experimental techniques for preparing the foam and for determining its stability and drainage; and experimental techniques for determining the gross structure of the foam. Determine the relative amounts of the isotropic hydrocarbon solution and the liquid crystalline phase after separation by centrifugation and equilibration at constant temperature. Use low angle x-ray diffraction and an optical microscope with polarized light to determine the structure of the liquid crystalline phase. Examine the structure of the multiphase thin film of the foam in polarized light with an optical microscope, and use an electron microscope to study freeze-fractured samples. Evaluate the basis for the stability of the foam after the structural information is obtained. Employ layered model systems in the calculations used to evaluate the colloidal forces across the thin films. Calculate the influence of the highly viscous liquid crystalline phase on the mechanical properties and transport conditions.

342 **Industry/University Cooperative Research Activity: High Gradient Magnetic Research;** Fritz J. Friedlaender; Purdue University, Department of Electrical Engineering, Lafayette, IN 47907; Award #80-23184 A02; $51,881 for 12 months beginning 03/01/83 (PMP). Part of a total NSF Award of $130,000.

Study the behavior of weakly magnetic (including diamagnetic) particles to determine the limits of particle capture including particle trajectory, buildup, and removal from wires in a high gradient magnetic field. Investigate the influence of particle size, shape, particle and carrier susceptibility, carrier viscosity, and matrix shape and configuration (single fiber of matrix with extension to arrays). Examine the behavior of emulsions in high gradient magnetic separations for the removal of heavy metal ions in aqueous solution.

343 **Study of the Behavior of Constant Rate Aerosol Flow Reactors;** Sheldon K. Friedlander; University of California, Department of Chemical, Nuclear, and Thermal Engineering, Los Angeles, CA 90024; Award #81-17288 A01; $49,068 for 12 months beginning 03/01/83 (PMP).

Study the behavior of the constant rate aerosol reactor in a systematic fashion. Develop useful design relationships based on theory and test these relations using a tubular flow reactor.

344 **Separation of Particles from Non-Aqueous Media Based on the Electrokinetic Phenomena;** Dimitri Gidaspow; Illinois Institute of Technology, Department of Chemical Engineering, Chicago, IL 60616; Award #82-18444; $64,000 for 12 months beginning 02/15/83 (PMP).

Study electrokinetic phenomena in particle-fluid separation processes in electrofiltration, settling, and packed bed filtration. Examine surface charge characteristics of colloidal particles using the streaming potential apparatus as a function of asphaltene concentration, adsorbed water, and different organic liquids. Use an instrumented packed bed streaming potential apparatus to investigate the feasibility of selectively separating various colloidal particles based on their charge characteristics. Build, test, evaluate, and model an improved electrofilter. Study batch settling of colloidal particles and develop a two-fluid model involving conservation of mass and momentum equations for the particle and the fluid including surface charges and solid-stresses. Compare the calculated particle concentration, pressure, and electrical potential profiles with the experimental measurements.

345 **Industry/University Cooperative Research Activity: Mechanics of Flow of Particulate Media;** Roy Jackson; Princeton University, Department of Chemical Engineering, Princeton, NJ 08544; Award #83-02772; $31,342 for 12 months beginning 04/01/83 (PMP). Part of a total NSF Award of $62,735.

Construct equations of motion adequate to describe the behavior of systems in which dense assemblies of solid particles move in interaction with a fluid, liquid, or gas. Concentrate on the behavior of material discharging from conical hoppers, with and without aeration, and on the performance of standpipes.

346 **Pressure Drop Required to Move a Plug of Bulk Solids Through a Pneumatic Transport Pipeline;** Kenneth

Konrad; Virginia Polytechnic Institute, Department of Chemical Engineering, Blacksburg, VA 24061; Award #82-17628; $23,220 for 12 months beginning 07/01/83 (PMP).

Conduct tests to measure the pressure drop required to sustain the movement of single plugs through horizontal and vertical pipes that are between 25mm and 100mm in internal diameter. Measure the pressure drop as a function of the plug length, the pipe diameter, the stress applied to the front end of the plug, the particle diameter and density, and the particle/pipe shear properties. Compare the results with approximate theory for possible modification. Explore compressible and/or cohesive solids.

347 **Spouted Fluidized Beds;** Howard Littman; Rensselaer Polytechnic Institute, Department of Chemical and Environmental Engineering, Troy, NY 12181; Award #82-17886; $60,962 for 12 months beginning 04/01/83 (PMP).

Present a theory of particle circulation for the spout and annular regions of a spouted bed which predicts the axial voidage distribution in the spout and provides a means for identifying and classifying spouting regimes. Verify predicted axial spout voidage distributions, identify and classify spouting regimes, and determine particle circulation rates between the spout and annular regions of the bed.

348 **Fundamental Hydrodynamic Aspects of Trickle-Bed Reactors;** K.M. Ng; University of Massachusetts, Department of Chemical Engineering, Amherst, MA 01003; Award #82-09920; $23,934 for 12 months beginning 02/01/83 (PMP); Split-funded with KCR for $10,000.

Study the nature of interstitial flows within the catalyst bed and focus on trickling, pulsing, spray, and bubble models capable of predicting flow pattern, pressure drop, and liquid holdup of these regimes. Design and perform studies involving pilot-scale beds to acquire data to confirm the theory.

349 **Industry/University Cooperative Research Activity: Surface Interactions and Segregation in Food Powders;** Micha Peleg; University of Massachusetts, Department of Food Engineering, Amherst, MA 01003; Award #82-06765; $36,770 for 12 months beginning 02/01/83 (PMP).

Investigate the mechanisms that are involved in food powder segregation, with special emphasis on selective interactions between food powders of different chemical species, and the role of powder cohesiveness in regulating the segregation tendency. Develop quantitative segregation criteria for food powders and select the appropriate experimental procedures for their determination.

350 **Coherent Detection of Scattered Light from Submicron Particles;** Thomas W. Peterson; University of Arizona, Department of Chemical Engineering, Tucson, AZ 85721; Award #82-16749; $41,200 for 12 months beginning 03/01/83 (PMP).

Calibrate and process the signal generated by the coherent optical particle spectrometer and develop the theoretical basis for its operation. Conduct experiments with titanium dioxide-doped hydrogen flames to demonstrate the *in situ* applicability of the spectrometer.

351 **Nucleation Rate Measurements of Ethanol and Ethanol-Water;** John L. Schmitt; University of Missouri, Graduate Center for Cloud Physics Research, Rolla, MO 65211; Award #82-03398 A01; $43,249 for 12 months beginning 06/01/83 (PMP).

Compare homogeneous nucleation data sets for water, ethanol (limited), nonane, and toluene to the classical Becker-Doring-Zeldovitch theory. Perform calculations to put all of the data in "reduced form" for comparison with nucleation behavior expected for simple fluids. Extend homogeneous nucleation measurements on ethanol to the -20°C to +45°C range (pre-expansion temperature) and from 10^{0} to 10^{6} drops/cm^{3} sec nucleation rate. Make comparisons among polar, non-polar, hydrogen bonded, and non-hydrogen molecules with extensive data sets. Make measurements of binary nucleation (ethanol-water).

352 **Industry/University Cooperative Research Activity: Flocculation of Clays;** Ponisseri Somasundaran; Columbia University, Henry Krumb School of Mines, New York, NY 10027; Award #80-11013 A02; $63,853 for 12 months beginning 01/01/83 (PMP); Split-funded with MPM for $30,000. Part of a total NSF award of $249,984.

Explore the application of flocculating agents in the processing of clay particles. Elucidate mechanisms of polymer adsorption and related kinetics; study the role of hydrodynamic forces at various stages of polymer adsorption and flocculation; develop techniques to characterize aggregate (floc) properties such as shear strength, density, compressibility, and filterability; and examine the effects of aging of polymer and particles on floc properties.

353 **Particle Diffusion in Aerosols by Photon Correlation Spectroscopy;** Christoph M. Sorensen; Kansas State University, Department of Physics, Manhattan, KS 66506; Award #82-18415; $56,167 for 12 months beginning 03/01/83 (PMP).

Use photon correlation spectroscopy to measure the diffusion of aerosol particles when the Knudsen number is either very small or very large. Develop photon correlation spectroscopy to probe aerosol systems and develop diagnostic capabilities including mean size and size distribution measurements, rotational diffusion and nonspherical shape measurements, and number density and *in situ* optical property measurements.

354 **Industry/University Cooperative Research Activity: Delay Cake and Radial Filtration;** Frank M. Tiller; Univer-

sity of Houston Central Campus, Chemical Engineering Department, Houston, TX 77004; Award #82-06774; $44,819 for 12 months beginning 02/01/83 (PMP). Part of a total NSF Award of $89,638.

Investigate a dynamic thin-cake filter thickener and radial filtration. Develop a theory of radial filtration and apply it to short-cycle, thin-cake, cylindrical element filters. Study clogging phenomena in delayed cake filtration, determine effect of shear stress on cake structure and resistance, and use high-speed rotating elements for thickening.

355 **Industry/University Cooperative Research Activity: Structure and Operating Characteristics of High Velocity Fluidized Beds;** Herbert Weinstein; City College of the City University of New York, Department of Chemical Engineering, New York, NY 10031; Award #81-03627 A01; $150,000 for 12 months beginning 03/01/83 (PMP).

Examine the behavior of high velocity fluidized beds. Determine the structure of a bed using x-ray absorption measurements; obtain radial profiles of solids density at several axial stations using a chordal absorption technique; correlate pressure fluctuations in the bed to develop a length scale for determining secondary flow patterns in the bed to complement the x-ray studies. Determine the operating characteristics of the bed with a mixture of two solids of different mean size and density with regard to stratification and/or classification.

Renewable Materials Engineering (RME)

356 **Development of Collagen-Resorcinol-Formaldehyde Graft Polymers;** Semih Erhan; Albert Einstein Medical Center, Department of Dental Medicine, Philadelphia, PA 19141; Award #82-11535; $76,880 for 12 months beginning 01/15/83 (RME).

Develop a new material from collagen by grafting resorcinol-formaldehyde resins onto a modified protein backbone. Suggest methods for the formation of grafts at the expense of unbound resin as well as for the characterization of the modified collagen and the protein-resin grafts. Evaluate the chemical and mechanical characteristics of the grafts and investigate the ability of the grafts to function as metal binding adhesives. Examine their thermal resistance.

357 **Engineering Research Needs: Chemicals from Renewable Resources, Conference to be Held at West Lafayette, IN, from June 21-23, 1983;** Norman B. Jansen; Purdue University, Laboratory of Renewable Resources Engineering, West Lafayette, IN 47907; Award #82-13483; $10,527 for 6 months beginning 03/01/83 (RME); Split-funded with CBP for $3,000; Split-funded with OIR for $3,000.

Discuss the development of processes for the conversion of renewable resources into chemicals, including the production of polymeric materials from renewable resources, application of new genetic techniques to produce valuable chemicals, engineering aspects of using immobilized cell or other unique reactor systems, and needs in personnel training.

358 **Modeling of Cellulose Hydrolysis by Pure and Mixed Component Cellulases;** Michael R. Ladisch; Purdue University, Laboratory of Renewable Resources, West Lafayette, IN 47907; Award #81-15356 A01; $62,501 for 12 months beginning 04/15/83 (RME).

Define the exact nature of the synergistic action of cellulases. Separate factors such as the crystalline structure of cellulose and pore and film diffusional effects from the true enzyme kinetics through experimental design by using pure component water-soluble cellulose segments (cellodextrins) as substrates. Develop mathematical models to quantitatively describe hydrolysis at high conversions as well as during the initial period of hydrolysis. Identify rate limiting steps to simplify the model for combined cellulase action. Extend the cellulase kinetics to include the other factors encountered when a solid substrate is used.

359 **Studies of Primary and Secondary Reaction Processes in the Thermal Conversion;** William A. Peters; Massachusetts Institute of Technology, Department of Chemical Engineering, Energy Laboratory, Cambridge, MA 02139; Award #82-12308; $81,577 for 12 months beginning 01/15/83 (RME).

Study the thermal decomposition of biomass. Determine the separate contributions to overall pyrolysis behavior (including stoichiometry and kinetics) of primary volatiles formation and secondary reactions of those volatiles. Measure independent effects of reaction conditions of practical interest including temperature, heating rate residence time, total pressure, partial pressure of reactive gases (such as H_2, CO and/or H_2/CO mixtures, and steam), and sample moisture content. Examine the effect of sample dimension on the yields, compositions, and generation kinetics of products from the primary decomposition of biomass, and the homogeneous (vapor phase) and heterogeneous (gas-char and gas-additive such as CaO) secondary reactions of freshly formed biomass pyrolysis volatives. Investigate loblolly pine, sweet gum hardwood, cellulose, hemicellulose, and lignin.

360 **Partial Support of the Fifth Symposium on Biotechnology for Fuels and Chemicals to be Held May 10-13, 1983 in Gatlinburg, TN;** Charles D. Scott; Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN 37830; Award #82-18145; $2,000 for 6 months beginning 03/15/83 (RME); Split-funded with CBP for $2,000; Split-funded with OIR for $2,000.

Support the travel of participants to a symposium in Gatlinburg, Tennessee, May 10-13, 1983. Bring together investigators from the various disciplines and institutions involved in developing biotechnology for converting biomass, including waste materials, to fuels and chemical feedstocks.

361 **Conversion of Cellulose and Xylan into Glycols;** George T. Tsao; Purdue University, Laboratory of Renewable Resources Engineering, West Lafayette, IN 47907; Award #82-18221; $75,000 for 12 months beginning 02/15/83 (RME).

Examine promising organic chemical reactions for converting renewable materials into useful chemicals which are currently derived from petroleum. Apply periodate and other oxidative agents like hypochlorite to starch and cellulose to produce polymeric dialdehyde glucans. Perform the oxidation of isolated xylan and amorphous cellulose, as well as the reductive hydrolysis of the resulting dialdehyde polysaccharides to industrial glycols. Investigate the reaction of the aldehydes with appropriate amino- and sulfur-containing reagents.

Separation Processes (SEP)

362 **Improvement and Application of Continuous Membrane Column;** Sun-Tak Hwang; University of Cincinnati, Department of Chemical and Nuclear Engineering, Cincinnati, OH 45221; Award #83-00912; $62,296 for 12 months beginning 02/01/83 (SEP).

Evaluate the feasibility and operating characteristics of a membrane reactor which performs the functions of reaction and separation in the same device. Identify membranes and catalyst composites and measure permeation and physical properties. Use these properties to design and construct a continuous membrane column reactor.

363 **Industry/University Cooperative Research Activity: Reduced Order Models for Separation Processes;** Babu Joseph; Washington University, Department of Chemical Engineering, St. Louis, MO 63130; Award #82-17179; $43,466 for 24 months beginning 04/01/83 (SEP). Part of a total NSF Award of $86,932.

Develop reduced order dynamic and steady state mathematical models for countercurrent separation processes such as distillation, absorption, and extraction in staged or continuous contact equipment to reduce computational time. Install the models on the computer system at the Monsanto Corporation and test them on realistic problems.

364 **Study in the Approximation of Quantities Involving Physical Properties Derivatives in Separations Calculations;** Angelo Lucia; Clarkson College of Technology, Department of Chemical Engineering, Potsdam, NY 13676; Award #82-16857; $54,936 for 24 months beginning 03/01/83 (SEP).

Evaluate the efficiency of a new method for calculating separations parameters such as liquid and vapor phase compositions. Assess the method first on a simple flash process, on a relatively simple multistage separations problem, and then on a more difficult multistage separations problem such as azeotropic or three-phase distillation, or gas absorption.

365 **New Class of Separating Agents;** Thomas W. Mix; Merix Corporation, Wellesley, MA 02181; Award #82-12870; For 24 months beginning 03/15/83 (SEP). Part of a total NSF Award of $205,810.

Extend a study of the merits of chlorofluorinated compounds as solvents for extractive and azeotropic distillation to include synthesis, testing, and design evaluation. Synthesize candidate chlorofluorinated compounds and evaluate candidate solvents via process design studies in which computer designs are generated based on experimentally determined physical property and thermodynamic data.

366 **Characterization of the Structure of Ionomeric Membrane Separator;** Charles E. Rogers; Case Western Reserve University, Department of Macromolecular Science, Cleveland, OH 44106; Award #81-15115 A01; $52,000 for 12 months beginning 03/01/83 (SEP).

Focus on the development of molecular theories and computer simulation of block copolymer microdomain structure formation. Establish relationships between membrane structure and the corresponding ion transport properties with applications to electrochemical separation processes. Investigate application of the current membrane model to a set of ionomers of varying chemical structures using different transport ions; examine computer simulation modeling of the molecular structure of a cluster within a membrane ionomer; and merge and extend current theories of microdomain formation in block copolymers to include membrane ionomeric materials.

367 **Adsorption of Poliovirus in Packed Beds of Sand and Clay;** Vincent L. Vilker; University of California, Department of Chemical, Nuclear, and Thermal Engineering, Los Angeles, CA 90024; Award #82-12227; $96,004 for 24 months beginning 02/01/83 (SEP).

Study the movement of poliovirus through packed sand and sand/clay beds under conditions of percolating flow. Extend a model based on the packed bed convective-diffusive equation; supply experimental data on poliovirus adsorption on sand and clay to include the effect of percolation rate and other potential environmental variables.

368 **Multi-Component Pressure Swing Adsorption;** Phillip C. Wankat; Purdue University, Department of Chemical Engineering, Lafayette, IN 47907; Award #82-11835; $32,117 for 12 months beginning 01/15/83 (SEP).

Study configurations of multicomponent pressure swing adsorption for both dilute and concentrated gas mixtures. Base theoretical models on extensions of two-component models. Consider temperature and combined temperature-pressure swing operating modes.

369 **Gordon Research Conference on Separation and Purification—1983, New London, NH, August 14-19, 1983;** Phillip C. Wankat; Perdue University, Department of Chemical Engineering, Lafayette, IN 47907; Award

#82-18928; $4,612 for 6 months beginning 01/15/83 (SEP).

Provide partial support for speakers invited to the Gordon Research Conference on Separation and Purification held at Colby-Sawyer College at the University of New Hampshire.

370 **Rapid Filtration of Non-Electrolytes by Electroosmosis;** Allen Zelman; Rensselaer Polytechnic Institute, Center for Biomedical Engineering, Troy, NY 12181; Award #81-15007 A01; $41,980 for 12 months beginning 03/25/83 (SEP).

Develop an experimental basis for the process of rapid filtration of non-electrolytes by electroosmosis. Use ionic polymer membranes specifically manufactured for electroosmosis to transport a range of non-electrolytes such as aldehydes, alcohols, ethers, ketones, phenols, esters, carboxylic acids, and aromatics. Build a test cell with an automatic data acquisition system to evaluate transport coefficients from a single non-steady state experiment. Use computer techniques to evaluate simultaneously the transport equations from non-equilibrium thermodynamics.

Thermodynamics and Transport Phenomena (TTP)

371 **Simultaneous Mixing and Chemical Reaction;** Robert J. Adler; Case Western Reserve University, Department of Chemical Engineering, Cleveland, OH 44106; Award #80-17868 A02; $47,375 for 12 months beginning 03/21/83 (TTP).

Use dilatometry to study the effects of mixing on chemical conversion in a liquid phase laboratory batch reactor. Obtain data for conversion as a function of time when chemical reaction and mixing are comparable in speed. Measure the small volume change of the liquid caused by chemical reaction and other secondary effects measured in a capillary tube attached to the reactor. Use extensional flow models as a general, predictive means of treating simultaneous mixing and chemical reaction in turbulent flows.

XX Berg, John C., see MEAM (FLM).

372 **Turbulent Mixing in Homogeneous and Non-homogeneous Dilute Polymer Solutions;** Neil S. Berman; Arizona State University, Chemical and Bioengineering Department, Tempe, AZ 85281; Award #80-22433 A02; $38,387 for 12 months beginning 02/01/83 (TTP).

Analyze reductions in turbulent mixing for cases of homogeneously mixed polymer solutions and non-homogeneous mixtures of solvent and threads of relatively concentrated polymer solution. Study the variables influencing the polymer conformation at entrances for homogeneous solutions and at the point of injection for non-homogeneous mixtures. Use two-component laser Doppler anemometry as well as pressure measurements and flow visualization to determine the turbulence structure.

373 **International Research Conference on Intermolecular Forces and the Transport Properties of Polyatomic Molecules, Madison, WI, June 22-24, 1983;** Phillip R. Certain; University of Wisconsin, Theoretical Chemistry Institute, Madison, WI 53706; Award #82-18160; $2,000 for 6 months beginning 04/01/83 (TTP). Part of a total NSF Award of $5,500.

Consider the impact of recent advances in molecular scattering theory on the analysis of experimental data concerning the influence of magnetic fields in gas transport properties. Use results to predict the behavior of gases and liquids under various temperature and pressure conditions.

XX Chato, John C., see MEAM (HET).

374 **Nonlinear Oscillations of Gas and Vapor Bubbles in a Liquid;** Lawrence A. Crum; University of Mississippi, Department of Physics and Astronomy, University, MS 38677; Award #82-11575; $38,000 for 12 months beginning 04/01/83 (TTP).

Study the nonlinear oscillations of gas and vapor bubbles moving in liquids. Use an acoustical levitation technique to isolate individual gas or vapor bubbles. Obtain the pulsation amplitude and the damping of these oscillating bubbles as they are driven through their first harmonic resonance. Compare measured and calculated values and consider the effect of raising the temperature of the host liquid.

375 **Microstructured Fluids: Vesicles, Liposomes, and Microemulsions;** H. Ted Davis; University of Minnesota, Department of Chemical Engineering and Materials Science and of Chemistry, Minneapolis, MN 55455; Award #82-15342; $75,000 for 12 months beginning 03/15/83 (TTP).

Identify and describe the equilibrium and nonequilibrium fluid microstructures of liquids in the presence of surface-active agents at molecular and supramolecular levels, with emphasis on vesicles and liposomes. Relate the molecular dynamics within microstructures to their formation, stability, mechanical properties, and convertibility. Determine the responsible molecular forces and discover how they affect structural responses to external changes. Suggest chemical formulations and material treatments to exploit equilibrium and long-lived disequilibrium fluid microstructures and composites. Emphasize vesicle structures and their size distribution, as well as liposome structure, rheology, and stability.

376 **Light Scattering from Liquid Interfaces: Visco-Elastic Response of Monomolecular Films to Thermal Fluctuations;** Robert V. Edwards; Case Western Reserve University, Department of Chemical Engineering, Cleveland, OH 44106; Award #82-13258; $65,000 for 12 months beginning 01/15/83 (TTP).

Study the viscoelastic response of monomolecular films to thermal fluctuations by light scattering at liquid interfaces. Design and build a light scattering spec-

trometer. Form and study monologues of various organic molecules at vapor-water or oil-water interfaces. Direct attention toward the frequency dependence of the response of an interfacial monolayer to strain and time-rate-of-strain. Determine the frequency spectra of a series of monomolecular films; characterize planar and bending motions; and test the constitutive equations that have been proposed to account for monolayer response to fluctuation. Study the phase transitions of various monolayer systems and special surface polymerization reactions.

377 **Understanding the Diffusion of Small Solutes;** D. Fennell Evans; University of Minnesota, Department of Chemical Engineering and Materials Science, Minneapolis, MN 55455; Award #80-14567 A02; $55,169 for 12 months beginning 04/01/83 (TTP).

Study diffusion in polar and non-polar liquids using a Taylor dispersion technique. Measure the dispersion of solutes having different molecular shapes and sizes at temperatures up to 230°C and at pressures up to 25,000 psi (175 mega pascals). Use these data to develop correlation and prediction methods based on molecular properties.

378 **Pressure Coefficient of Interfacial Tension and the Thickness of Interfacial Films;** Robert J. Good; State University of New York, Department of Chemical Engineering, Buffalo, NY 14260; Award #82-17971; $47,305 for 12 months beginning 03/15/83 (TTP).

Study the interfacial tension in water/oil/surfactant systems. Obtain measurements using composition, hydrostatic pressure, and temperature as the principal variables. Determine the effect of hydrostatic pressure on the vapor pressure of the water and of the hydrocarbons to establish these compositions. Investigate the effect of mass transfer phenomena.

379 **Experimental and Computer Simulation Studies of Fluid Mixtures;** James M. Haile; Clemson University, Department of Chemical Engineering, Clemson, SC 29631; Award #82-06858; $50,513 for 12 months beginning 12/01/82 (TTP).

Develop new methods for predicting thermodynamic properties and phase equilibria of fluid mixtures. Devise a method of performing molecular dynamics in the isothermal-isobaric ensemble in which neutron diffraction can be used. Use the intermolecular force laws obtained from these experiments in the new theories and in computer simulations to test the reliability of the measured interactions and the accuracy of the new theories.

380 **Transport Characteristics of Bone Membrane;** William J. Heideger; University of Washington, Department of Chemical Engineering, Seattle, WA 98195; Award #82-07148; $48,000 for 12 months beginning 01/01/83 (TTP).

Investigate the transport characteristics of the extracellular pathways of bone membrane *in situ.* Concentrate on the layer of cells lining the periosteal surface of the chick calvaria. Determine whether the electrical potential has a role in ion homeostasis or in bone mineralization, determine whether the potential is species specific, and identify the source of the potential. Calculate the potential by determining the final equilibrium levels of both charged and uncharged extracellular markers in the interior and exterior phases of the bone.

381 **Blood Flow and Macrovascular Transport in a Tumor Capillary Bed During Normo- and Hyperthermia;** Rakesh K. Jain; Carnegie-Mellon University, Department of Chemical Engineering, Pittsburgh, PA 15213; Award #81-11626 A01; $64,700 for 12 months beginning 02/01/83 (TTP).

Characterize the microcirculatory response to heat through direct measurement of the changes in capillary diameter, capillary blood flow and macromolecular transport in normal and neoplastic tissues during various degrees of hyperthermia. Use experimental methods involving continuous, *in vivo* monitoring of normal and neoplastic tissues grown in a transparent chamber implanted in a rabbit ear. Employ contact heating stage to induce hyperthermia locally; measure absolute and relative changes in vessel diameter during a preprogrammed heating cycle, make on-line determinations of red blood cell velocity using a dual-slit photometric set-up interfaced to a cross correlator; and conduct macromolecular transport studies. Extend single capillary analyses to capillary arrays.

382 **Quasielastic Light Scattering Studies of Macromolecular Transport in Entangled Polymer Solutions;** Alexander M. Jamieson; Case Western Reserve University, Department of Macromolecular Science, Cleveland, OH 44106; Award #80-17821 A02; $60,430 for 12 months beginning 01/01/83 (TTP).

Conduct experiments using the quasielastic light scattering spectroscopy method of studying various solutions, especially those in which chain stiffness and long-range electrostatic repulsions are complicating features. Develop and improve theoretical models for interpreting system behavior.

383 **Study of Phase Equilibrium in Fluid-Hydrate Systems;** Riki Kobayashi; Rice University, Chemical Engineering Department, Houston, TX 77001; Award #81-10853 A01; $65,000 for 12 months beginning 03/21/83 (TTP).

Determine the water composition of the liquid as well as the gaseous and hydrate former in equilibrium with the hydrate phase. Find the composition of the equilibrium hydrate phase and improve the theoretical model to predict the occupation number of the hydrate formers in the various cages as well as the proper phase compositions in the fluid phases.

384 **Solubility of Pure Gases and Gas Mixtures in Liquids at Pressures up to 30,000 psia;** Edward McLaughlin; Louisiana State University, Chemical Engineering Depart-

ment, Baton Rouge, LA 70803; Award #81-11287 A01; $48,767 for 12 months beginning 04/01/83 (TTP).

Determine the solubility of pure gases (argon, nitrogen, methane, carbon dioxide) and of binary gas mixtures (argon/nitrogen, nitrogen/methane, nitrogen/carbon dioxide, methane/carbon dioxide) in liquids (n-dodecane, water) at pressures up to 30,000 psia and temperatures up to 450°F. Examine the validity of various solubility theories to determine which one best matches the data.

385 **Fluorocarbon-Hydrocarbon Interactions at Interfaces and in Micelles;** Pasupati Mukerjee; University of Wisconsin, School of Pharmacy, Madison, WI 53706; Award #82-16450; $47,000 for 12 months beginning 03/01/83 (TTP).

Study fluorocarbon-hydrocarbon interactions at fluid interfaces, solid-liquid interfaces, and micellar systems. Perform experimental studies on surface chemical properties of fluoroalkyd alkanes combining aliphatic fluorocarbon (FC) and hydrocarbon (HC) moieties. Investigate the mutual interactions between FC and HC molecular chains in adsorbed layers at fluid interfaces and at various solid-water interfaces along with wetting properties of mixed surfactants.

386 **Engineering Foundation Conference on Fundamentals of Adsorption: Garmisch-Partenkirchen, West Germany, May 6-11, 1983;** Alan L. Myers; United Engineering Trustees, Inc., New York, NY 10017; Award #82-13953; $5,000 for 12 months beginning 03/15/83 (TTP); Split-funded with SEP for $1,500.

Provide partial support for the travel and registration expenses of approximately 50 participants at an international conference on the fundamentals of adsorption.

387 **Concentration Dependent Diffusion in Supersaturated Solutions;** Allan S. Myerson; Georgia Institute of Technology, Department of Chemical Engineering, Atlanta, GA 30332; Award #82-14246; $78,000 for 24 months beginning 02/01/83 (TTP).

Determine the diffusion coefficients of nonelectrolytes in concentrated, saturated, and supersaturated solutions employing GOUY interferometry. Compare results for supersaturated solutions to predictions of cluster diffusion theory. Calculate the location of the spinodal curve using various thermodynamic techniques. Modify the cluster diffusion approach of Cussler to develop predictive equations.

388 **Further Application of Statistical Mechanics to Thermodynamic Properties of Liquid Solutions;** John P. O'Connell; University of Florida, Department of Chemical Engineering, Gainesville, FL 32611; Award #80-07395 A02; $56,588 for 12 months beginning 03/11/83 (TTP).

Investigate applications of statistical mechanics for predicting the thermodynamic properties of solutions. Use a generalized two-parameter corresponding state correlation method.

389 **Nucleation and Stabilization of Cavitation Nuclei in Liquids;** James J. Reidy; University of Mississippi, Department of Physics and Astronomy, University, MS 38677; Award #80-22917 A03; $39,332 for 12 months beginning 02/01/83 (TTP).

Explore the mechanisms of the formation and stabilization of vapor nuclei in liquids. Induce nuclei by irradiating water containing a scintillating agent. Monitor the initiation of cavitation nuclei and their subsequent collapse by measuring the pulses of optical radiation which are emitted. Try radiation sources other than neutrons.

390 **Systematic Experimental Investigation of Heats of Transport and Heat-Mass Onsager Coefficients via the Diffusion Thermoeffect;** Richard L. Rowley; Rice University, Department of Chemical Engineering, Houston, TX 77001; Award #82-14579; $20,000 for 12 months beginning 02/15/83 (TTP).

Measure heats of transport in liquid mixtures via the diffusion thermoeffect (Dufour effect). Study binary mixtures over the composition range between 10 and 90 mole percent at 25°C, 35°C, and 50°C. Examine several ternary mixtures over a corresponding composition range. Use resultant heats of transport and Onsager coefficients to develop a liquid model for heats of transport incorporating observed temperature, composition, and thermodynamic effects. Investigate possible relationships between binary and ternary heats of transport. Test previously untested molecular theories.

391 **Kinetics of Micellar and Microemulsion Systems;** Dinesh O. Shah; University of Florida, Department of Chemical Engineering, Gainesville, FL 32611; Award #82-12346; $76,000 for 12 months beginning 01/01/83 (TTP).

Elucidate the kinetic aspects of micellar solutions and microemulsions using stopped-flow, temperature-jump, pressure-jump and ultrasonic absorption techniques, and correlate the results with the molecular packing of these systems. Study the effect of molecular structure (both polar head group and nonpolar chain) to determine the effect of adding of various alcohols or oils to the kinetic properties. Investigate the effect of adding Coulombic interactions on the kinetic properties of micelles by varying the valency of counterions. Measure kinetic properties of high concentration surfactant solutions and of microemulsions. Determine the rate of molecular exchange between bulk and the interface in microemulsions. Designate a correlation for the kinetic properties of micellar solutions and microemulsions.

392 **Mass Transfer and Reaction in Liquid-Liquid Dispersions;** Lawrence L. Tavlarides; Syracuse University, Department of Chemical Engineering and Materials Science, Syracuse, NY 13210; Award #82-09694 A01; $63,400 for 12 months beginning 03/11/83 (TTP).

Analyze mass transfer with reaction in agitated liquid-liquid dispersions from a fundamental basis. Consider droplet rate processes of coalescence and redispersion, microscopic interphase transport processes, and macroscopic flow patterns in reactors. Develop a simulation model capable of predicting overall mass transfer rates for a liquid-liquid extraction/reaction system and conduct experiments to determine the validity of the model. Perform mass transfer/reaction experiments with the iodine-carbontetrachloride/cyclohexane-water system. Measure drop size distributions, coalescence frequencies, and overall transport rates for comparisons with computed results. Apply these techniques to the scale-up problem. Extend the homogeneous simulation model to model spatially nonhomogeneous dispersions undergoing mass transfer/reaction.

393 **Experimental and Theoretical Study of the Condensation of Vapor Mixtures that React in the Liquid Phase;** Ross Taylor; Clarkson College of Technology, Department of Chemical Engineering, Potsdam, NY 13676; Award #82-13787; $73,417 for 24 months beginning 02/01/83 (TTP).

Study simultaneous condensation of multiple component vapors, with chemical reaction in the condensate and transfer of heat and momentum between the liquid and vapor phase. Use the ammonia carbon-dioxide water system to study the condensation process, and conduct experiments with SO_2-NaOH-H_2 and NH_3-H_2SO_4-H_20 to study the gas phase mass transfer coefficients. Develop a model and compare it with the experimental data.

394 **Continuation of Experimental and Theoretical Study of Homogeneous Nucleation of Simple Vapors;** Peter P. Wegener; Yale University, Engineering and Applied Science, New Haven, CT 06520; Award #79-09683 A02; $60,000 for 12 months beginning 01/17/83 (TTP).

Study homogeneous nucleation of simple atomic vapors. Perform experiments using a cryogenic (liquid nitrogen) shock tube to study the nucleation of argon and other monatomic vapors carried in helium. Use Rayleigh light scattering in conjunction with pressure measurements to compute the thermodynamic state at the onset of nucleation from known initial conditions. Merge the classical theory of nucleation with experimental results applied in conjunction with the equation of motion.

Division of Civil and Environmental Engineering (CEE)

Geotechnical Engineering (GEO)

395 **Nonlinear Consolidation Analyses Around Pile Shafts;** Mohsen M. Baligh; Massachusetts Institute of Technology, Department of Civil Engineering, Cambridge, MA 02139; Award #81-10003 A01; $58,850 for 12 months beginning 12/15/82 (GEO).

Relate the influence of naturally occurring and stress induced anisotropy in clays to engineering pile systems.

396 **Industry/University Cooperative Research: Theoretical and Laboratory Simulation of Underground Fracturing Operations;** Michael P. Cleary; Massachusetts Institute of Technology, Mechanical Engineering Department, Cambridge, MA 02139; Award #81-19364 A01; $63,470 for 12 months beginning 03/11/83 (GEO).

Study the mechanisms and growth laws dominating the evolution of underground fractures.

397 **Collaborative Research: Determination of Soil Properties with the Self-Boring Pressuremeter;** G. Wayne Clough; Virginia Polytechnic Institute, Department of Civil Engineering, Blacksburg, VA 24061; Award #83-00464; $54,233 for 12 months beginning 01/01/83 (GEO).

Develop finite element programs designed to allow a detailed study of the stress path and drainage conditions in soil around pressuremeters. Consider three-dimensional effects and model the influence of the probe advance, the waiting period, and the test itself. Perform parametric studies, field self-boring pressuremeter tests, and model tests of the self-boring pressuremeter loading. Interpret test results to formulate guidelines and to improve and develop methods to analyze pressuremeter results.

398 **Conference on Arctic Technology and Policy;** C. Chryssostomidis; Massachusetts Institute of Technology, Sea Grant College Program, Cambridge, MA 02139; Award #83-07853; $1,000 for 12 months beginning 03/03/83 (GEO). Part of a total NSF Award of $5,000.

Convene the 1983 conference called "Arctic Technology and Policy: An Assessment and Review for the Next Decade" at MIT on March 2-4, 1983. Present the 11th Annual MIT Sea Grant College Program Lecture and the 3rd Robert Bruce Wallace Lecture. Assess current knowledge of the Arctic focusing on our ability to work there and on the challenges ahead in science, engineering, and policy.

399 **Further Development of the Bounding Surface Soil Plasticity Model;** Yannis F. Dafalias; University of California, Department of Civil Engineering, Davis, CA 95616; Award #82-16995; $97,016 for 24 months beginning 03/01/83 (GEO).

Develop the bounding surface soil plasticity constitutive model. Include modifications and calibration methods within the framework of the present formulation; generalize the formulation to include new aspects of the response of cohesive soils; and extend the bounding surface plasticity model to cohesionless soils, particularly sands. Perform and evaluate model predictions with experimental data available in the literature. Make available the results of this investigation to the geotechnical engineering profession.

400 **Generalized Approach for Constitutive Laws of Geologic Materials;** C. S. Desai; University of Arizona, Department of Civil and Mechanical Engineering, Tucson, AZ 85721; Award #82-15344; $124,013 for 24 months beginning 02/01/83 (GEO).

Develop a general formulation for defining constitutive laws of complex geologic materials. Evaluate existing laws based on plasticity and hypo-elasticity and perform mathematical, laboratory, and numerical studies to improve the existing laws. Define yielding as affected by density and stress paths, nonassociative characteristics, and anisotropy. Conduct mathematical analysis, determine significant parameters from laboratory tests, and verify boundary value problems. Perform tests on geologic material (sand) by using a multiaxial testing device.

401 **Centrifuge Facility for Research in Geotechnical Engineering;** Angelo Giovannetti; NASA, Ames Research Center, Moffett Field, CA 94035; Award #78-26122 A07; $97,100 for 3 months beginning 03/01/83 (GEO).

Complete construction of a centrifuge facility for research in geotechnical engineering.

402 **Effect of Initial Stresses on the Safety of Underground Excavations Against Wedge Slides and Rock Falls;** Richard E. Goodman; University of California, Department of Civil Engineering, Berkeley, CA 94720; Award #81-13431 A01; $65,000 for 12 months beginning 04/01/83 (GEO).

Use a base friction (gravity simulator) mechanism and an interactive computer graphics system to study the deformation and stability of fractured rock masses.

403 **Support of the Fourth International Conference on Permafrost; University of Alaska, Fairbanks; July 18-23, 1983;** W. Timothy Hushen; National Academy of Sciences, National Research Council, Washington, DC 20418; Award #83-04802; $10,000 for 12 months beginning 04/01/83 (GEO). Part of a total NSF Award of $23,000.

Plan, organize, and oversee the organization of this meeting to study the permafrost, or perennially frozen ground, which underlies approximately twenty percent of the world's land area.

404 **Flood-Routing Analyses for Mine Tailings Impoundments;** Jey K. Jeyapalan; Texas A&M University, Department of Civil Engineering, College Station, TX 77843; Award #81-15160 A01; $24,000 for 12 months beginning 03/04/83 (GEO).

Use state-of-the-art hydrodynamics to test the validity of new material property formulations. Examine suitable constitutive relations for geological materials existing in a quasi-liquefied state.

405 **Acoustic Properties of Partially Saturated Geothermal and Petroleum Reservoirs;** James N. Lange; Oklahoma State University, Department of Physics, Stillwater, OK 74074; Award #80-19278 A02; $54,500 for 12 months beginning 03/04/83 (GEO).

Investigate the utilization of acoustic techniques to determine *in situ* mechanical properties of rock. Address associated micro-mechanisms, such as partial gas saturation of the pore liquids, to resolve discrepancies between predictions and actual measurements.

406 **Hydraulic Conductivity of Frozen Soil;** Robert D. Miller; Cornell University, Department of Agronomy, Ithaca, NY 14853; Award #80-17422 A02; $30,416 for 12 months beginning 03/25/83 (GEO).

Investigate a temperature gradient metamorphism that occurs in the freeze-thaw process of well graded natural soils. Study the discontinuity in the unfrozen water content function and examine the rebound effects on ice free domains near the threshold of ice intrusion.

407 **Feasibility Study of a Novel Rock Tunneling and Excavation Method;** Thomas A. O'Hanlon; Flow Industries, Inc., Kent, WA 98031; Award #82-12874; For 7 months beginning 01/15/83 (GEO). Part of a total NSF Award of $200,000.

Test equipment for, and prove the feasibility of, a novel nonexplosive rock excavation method. Develop specific hardware, such as a field adaptable packer and accumulator/charging system, and conduct extensive testing. Undertake analytical studies of the process to establish optimum geometries for the hole alterations. Integrate the analytical studies with selected laboratory and field tests to demonstrate the technical and economic soundness of the concept in a production mode.

408 **Finite Strain Consolidation of Thick Soil Deposits;** Robert L. Schiffman; University of Colorado, Department of Civil, Environmental and Architectural Engineering, Boulder, CO 80309; Award #82-00950 A01; $70,000 for 12 months beginning 10/15/82 (GEO).

Investigate finite strain consolidation in thick soil deposits.

409 **Rapid Shear Flow of Densely Packed Granular Solids;** Hayley H. Shen; Clarkson College of Technology, Department of Civil and Environmental Engineering, Potsdam, NY 13676; Award #82-16665; $49,593 for 18 months beginning 03/01/83 (GEO).

Incorporate the effects of lateral mass transfer into analyses developed by Shen (1982), and Shen and Ackermann (1982). Remove the numerous simplifying assumptions which restrict the applicability of the analysis by Shen and Ackermann and include the effects of lateral mass transfer, energy diffusion, and appropriate boundary conditions, to obtain an accurate theoretical description of rapidly sheared granular flows.

410 **Theoretical Investigation of Bifurcation Phenomena of Remoulded Lightly Overconsolidated Clay in Undrained Triaxial and Biaxial Tests;** Ioannis G. Vardoulakis; University of Minnesota, Department of Civil and Mineral Engineering, Minneapolis, MN 55455; Award #82-16418; $81,969 for 24 months beginning 06/15/83 (GEO).

Investigate the bifurcation phenomena in undrained triaxial and biaxial (plane strain) tests on clay specimens. Formulate adequate constitutive equations for the undrained clay behavior and perform the bifurcation analysis of plane and axisymmetric (rectilinear) deformations. Test four constitutive models: an isotropic-hardening critical-state model, a yield-vertex model, a model involving kinematic and isotropic hardening, and an incrementally non-linear model without yield surface. Perform studies on the basis of "modified" deformation theories of plasticity and also perform stability analysis of the pore-water pressure build-up.

411 **Travel to Attend the Executive Committee of International Society for Soil Mechanics and Foundation Engineering: Paris, France; May 17-18, 1983;** Harvey E. Wahls; North Carolina State University, Department of Civil Engineering, Raleigh, NC 27607; Award #83-06723; $1,600 for 6 months beginning 03/15/83 (GEO).

Provide travel support for an investigator to attend the meeting; visit major geotechnical institutes; collaborate with individual investigators working in the area of constitutive relations for clay soils; and participate in technical specialty meetings.

412 **Wave Induced Pressure and Stress Instabilities in Seabeds;** Tukuo Yamamoto; University of Miami, Ocean Engineering Department, Miami, FL 33124; Award #81-17454 A01; $64,946 for 12 months beginning 04/01/83 (GEO).

Simulate, in a wave tank, the development of large shear strains and associated soil mass transport within the bed as would be required to substantiate the thesis that large submarine land slides or fan developments are directly attributable to increased or intensified wave action.

413 **Efficient Optimal Design of Large Complex Structural Systems;** Jasbir S. Arora; University of Iowa, Division of Materials Engineering, Iowa City, IA 52242; Award #82-13851; $49,826 for 12 months beginning 02/01/83 (STM).

Explore methods to effectively and efficiently design large complex structural systems. Develop the concept of bounding optimum solution by using lower bound information. Incorporate second order information into algorithms; and develop transformation methods that collapse all constraints of the problem into one equivalent constraint.

414 **Participation in the Sixth International Conference on Wind Engineering, Australia, March 21-27, 1983;** Jack E. Cermak; Colorado State University, Ft. Collins, CO 80523; Award #83-09696; $2,073 for 6 months beginning 03/01/83 (STM).

Provide partial support for a participant to present a technical paper at the conference. Study wind loadings on structures, wind-induced motions, and wind-induced failures of structures. Collaborate with scientists from other countries on research activities in the field.

415 **Three-Dimensional Elastic-Plastic-Fracture Analysis for Concrete Structures;** Wai F. Chen; Purdue University, Department of Civil Engineering, Lafayette, IN 47907; Award #82-09626 A01; $47,704 for 12 months beginning 02/01/83 (STM).

Investigate the use of three-dimensional elastic-plastic-fracture analysis for concrete structures.

416 **Participation in the Sixth International Conference on Wind Engineering, Australia, March 21-27, 1983;** Arthur N. Chiu; University of Hawaii-Manoa, Honolulu, HI 96822; Award #83-08137; $2,084 for 6 months beginning 03/01/83 (STM).

Provide partial support for a participant to present a technical paper at the conference. Study wind loadings on structures, wind-induced motions, and wind-induced failures of structures. Collaborate with scientists from other countries on research activities in the field.

417 **Two-Point Approximation for Constraint Function in Structural Optimization;** Raphael T. Haftka; Virginia Polytechnic Institute, Aerospace and Ocean Engineering Department, Blacksburg, VA 24061; Award #82-12934; $86,818 for 24 months beginning 01/01/83 (STM).

Use information on constraints and their derivatives at previous design points to improve the accuracy of constraint approximations. Develop an approximation based on the value of the constraint function and its derivatives at two points.

418 **Participation in the International Conference on Corrosion of Reinforcement in Concrete Construction, London, July 13-15, 1983;** Robert H. Heidersbach; Oklahoma State University, School of Chemical Engineering, Stillwater, OK 74074; Award #83-05630; $7,000 for 6 months beginning 03/15/83 (STM).

Provide partial travel assistance to a group of researchers to present papers at the conference. Discuss the implications of construction loss due to the corrosion of metals in concrete. Convene with researchers from around the country to explore these issues.

419 **Biaxial Fatigue and the Discontinuity of Concrete;** Thomas T. Hsu; University of Houston, Department of Civil Engineering, Houston, TX 77004; Award #82-12782; $125,499 for 24 months beginning 01/01/83 (STM).

Use a new approach to define the discontinuity stress based on biaxial fatigue tests. Perform biaxial tests using uniaxial fatigue test machines to cover the whole range of biaxial stresses from compression-compression, compression-tension, to tension-tension. Perform additional tests to include high-strength concrete.

420 **Workshop on Wood Research: State-of-the-Art and Future Directions;** Rafik Y. Itani; Washington State University, Civil and Environmental Engineering Department, Pullman, WA 99163; Award #82-15266; $37,075 for 12 months beginning 03/01/83 (STM).

Discuss the state-of-the-art of wood research; identify where current research is being conducted and sources of available support for such activities; identify long-term research objectives and directions in wood research; generate proceedings; and provide for an exchange of views among various researchers.

421 **Participation in the Sixth International Conference on Wind Engineering, Australia, March 21-27, 1983;** Ahsan Kareem; University of Houston, Department of Civil Engineering, Houston, TX 77004; Award #83-02223; $1,900 for 6 months beginning 02/15/83 (STM).

Provide partial support for a participant to present a technical paper at the conference. Study wind loadings on structures, wind-induced motions, and wind-induced failures of structures. Collaborate with scientists from other countries on research activities in the field.

422 **Analysis and Computational Methods for Optimal Structural Design;** Noboru Kikuchi; University of Michigan, Mechanical Engineering Department, Ann Arbor, MI 48109; Award #81-18158 A01; $93,208 for 12 months beginning 04/15/83 (STM).

Investigate an upper-bound method for min-max problems in optimal design, shape remodeling and optimal design problems, and grid optimization for finite element methods. Apply results to optimize grids.

423 **Participation in the Sixth International Conference on Wind Engineering, Australia, March 21-27, 1983;** Kishor C. Mehta; Texas Tech University, Department

of Civil Engineering, Lubbock, TX 79409; Award #82-19356; $2,199 for 2 months beginning 02/15/83 (STM).

Provide partial support for a participant to present a technical paper at the conference. Study wind loadings on structures, wind-induced motions, and wind-induced failures of structures. Collaborate with scientists from other countries on research activities in the field.

424 **Analysis of Inelastic Deformation in Metals by the Boundary Element Method;** Subrata Mukherjee; Cornell University, Department of Theoretical and Applied Mechanics, Ithaca, NY 14853; Award #82-06344; $114,745 for 24 months beginning 02/15/83 (STM).

Examine the application of the boundary element method to problems of time-dependent inelastic determination and fracture of metallic media. Carry the boundary element method forward with applications to nonhomogeneous and large deformation viscoplasticity problems, as well as to problems of inelastic fracture and viscoplastic wave propagation. Investigate problems with geometrical nonlinearities and study the coupling of material nonlinearities and inertia. Compare solutions from finite element and other methods, as well as studies of convergence of the numerical solutions.

425 **Effects of Cyclic Fatigue Loading on Partially Prestressed Beams;** Antoine E. Naaman; University of Illinois, Department of Materials Engineering, Chicago, IL 60680; Award #82-11563; $74,811 for 12 months beginning 01/01/83 (STM).

Study the effects of cyclic fatigue loading on the behavior of partially prestressed beams. Investigate the fatigue life of the members, cracking, and crack width increases under fatigue, and deflection and deflection increases with the number of cycles of loading.

426 **Behavior of High Strength Concrete Beams;** Arthur H. Nilson; Cornell University, Department of Structural Engineering, Ithaca, NY 14853; Award #82-10875; $102,644 for 12 months beginning 01/15/83 (STM).

Extend studies which have shown that there are fundamental differences in the nature of high-strength concrete compared with normal strength concrete. Perform studies on flexural members subject to short-term and sustained loading and on shear-critical beams. Investigate the fundamental behavior of the material and members made of the material, and develop engineering information in a form useful to writers of design specifications and to practicing engineers.

427 **Participation in the Sixth International Conference on Wind Engineering, Australia, March 21-27, 1983;** Hans A. Panofsky; Pennsylvania State University, Department of Meteorology, University Park, PA 16802; Award #82-15310; $208 for 6 months beginning 02/15/83 (STM).

Provide partial support for a participant to present a technical paper at the conference. Study wind loadings on structures, wind-induced motions, and wind-induced failures of structures. Collaborate with scientists from other countries on research activities in the field.

428 **Participation in the Sixth International Conference on Wind Engineering, Australia, March 21-17, 1983;** Jon A. Peterka; Colorado State University, Department of Civil Engineering, Fort Collins, CO 80523; Award #83-00217; $2,073 for 6 months beginning 02/15/83 (STM).

Provide partial support for a participant to present a technical paper at the conference. Study wind loadings on structures, wind-induced motions, and wind-induced failures of structures. Collaborate with scientists from other countries on research activities in the field.

429 **Cyclic Behavior of Prestressed Concrete at Cryogenic Temperatures;** Milos Polivka; University of California, Department of Civil Engineering, Berkeley, CA 94720; Award #82-09474; $89,455 for 24 months beginning 01/01/83 (STM).

Examine different aspects of the cyclic behavior of prestressed structural lightweight concrete for the containment of cryogenic liquids (e.g., liquefied natural gas, and liquefied petroleum gas). Explore the design considerations of the percent of steel, level of prestressing, and stress concentration which can influence the performance of prestressed slabs.

430 **Participation in the Sixth International Conference on Wind Engineering, Australia, March 21-27, 1983;** Herbert S. Saffir; Herbert Saffir Consulting Engineers, Coral Gables, FL 33134; Award #83-03816; $1,125 for 2 months beginning 02/15/83 (STM).

Provide partial support for a participant to present a technical paper at the conference. Study wind loadings on structures, wind-induced motions, and wind-induced failures of structures. Collaborate with scientists from other countries on research activities in the field.

431 **Loads Due to Human Movements on Assembly Structures;** William E. Saul; University of Wisconsin, Department of Civil and Environmental Engineering, Madison, WI 53706; Award #82-13966; $58,390 for 12 months beginning 01/01/83 (STM).

Produce loading models due to human movement for the design of grandstands and other assembly structures for static, impulsive, dynamic random or random coherent movement. Conduct the project through stages of bibliographic search, model hypotheses, laboratory tests, controlled field tests, and field verification.

432 **Participation in the Sixth International Conference on Wind Engineering, Australia, March 21-27, 1983;** Robert H. Scanlan; Award #83-04297; $2,165 for 6 months beginning 02/15/83 (STM).

Provide partial support for a participant to present a technical paper at the conference. Study wind load-

ings on structures, wind-induced motions, and wind-induced failures of structures. Collaborate with scientists from other countries on research activities in the field.

433 **Fracture Process Zone and R-Curves for Cementitious Composites;** Surendra P. Shah; Northwestern University, Department of Civil Engineering, Evanston, IL 60201; Award #82-03100 A01; $63,464 for 12 months beginning 02/16/83 (STM).

Determine the fracture toughness of Portland Cement mortar, concrete and fiber reinforced concrete for use in design of structures. Evaluate the size of the nonlinear zone around the crack tip for various loading configurations. Develop theoretical models, predict the extent of the process zone, and assess the influence of the process zone on the commonly used test-specimens for evaluating fracture toughness.

434 **Participation in the Sixth International Conference on Wind Engineering, Australia, March 21-27, 1983;** Peter R. Sparks; Clemson University, Clemson, SC 29631; Award #83-08246; $2,495 for 6 months beginning 03/01/83 (STM).

Provide partial support for a participant to present a technical paper at the conference. Study wind loadings on structures, wind-induced motions, and wind-induced failures of structures. Collaborate with scientists from other countries on research activities in the field.

435 **Alkali-Silica Reaction in Concrete;** Leslie J. Struble; Martin Marietta Corporation, Cement Department, Baltimore, MD 21227; Award #82-10791; $81,992 for 24 months beginning 01/15/83 (STM).

Determine whether the expansion of concrete due to the alkali-silica reaction is affected by the alkali mineralogy of the cement. Obtain cements whose alkalies exist in several different minerals. Determine the mineralogy, especially the alkali mineralogy with various alkali and reactive aggregates, to show whether the cement affects expansion. Develop a mechanism for the expansion of concrete due to the alkali-silica reaction.

Hydrology, Hydraulics and Water Resources (HHW)

436 **Experimental Studies of Spillway Stilling Basins for Dams;** Charles E. Bowers; University of Minnesota, St. Anthony Falls Hydraulic Laboratory, Minneapolis, MN 55455; Award #82-08611; $68,706 for 12 months beginning 11/01/82 (HHW).

Investigate large pressure fluctuations in hydraulic jumps to providbetter understanding of flow phenomena. Apply to the design of stilling basins for large and small dams.

437 **Analysis and Stability of Oscillations in a Closed Surge Tank;** M. Hanif Chaudhry; Old Dominion University, Department of Civil Engineering, Norfolk, VA 23508; Award #81-19614 A01; $29,275 for 12 months beginning 02/15/83 (HHW).

Analyze oscillations in a large surge tank. Develop a non-linear stability criterion for both large and small variations in water level in the tank.

438 **Influence of Building Design and Other Factors on Indoor Air Quality;** Cliff I. Davidson; Carnegie-Mellon University, Departments of Civil Engineering and Architecture, Pittsburgh, PA 15213; Award #82-06619; $191,847 for 20 months beginning 11/15/82 (HHW).

Investigate indoor air pollutant concentrations in several types of single-family residences in Pittsburgh, Pennsylvania. Study the influence of building design, occupant behavior, and outdoor conditions; develop predictive models and evaluate them by collecting a sizeable data base of information during winter and summer months. Conduct short- and long-term measurements in several residences and incorporate these measurements into the modeling effort. Examine airborne particles, nitrogen oxides, carbon monoxide, and trace organics.

439 **Modern Stability and Numerical Concepts in Water Resource Management;** Lucien Duckstein; University of Arizona, Systems and Industrial Engineering, Tucson, AZ 85721; Award #81-10778 A01; $94,451 for 12 months beginning 01/01/83 (HHW).

Adapt analytical tools of modern systems theory to water resources engineering.

440 **Theoretical Dynamics of Buoyant Plumes in Coastal Waters;** Richard W. Garvine; University of Delaware, College of Marine Studies, Lewes, DE 19958; Award #81-10383 A01; $19,354 for 12 months beginning 02/01/83 (HHW). Part of a total NSF Award of $38,708.

Conduct modeling studies of buoyant plumes in coastal waters, such as those produced by outflow of rivers, estuaries, and power plants. Use an approach which treats plumes near fields by application of the nonlinear, long internal wave equations for an inviscid, rotating fluid. Use jump conditions at the frontal boundaries to account for turbulent exchange between buoyant and ambient water.

441 **Effects of the Wave-Induced Resultant Bottom Shear Stress on Wave Set-Up;** Franciscu Gerritsen; University of Hawaii-Manoa, Center for Engineering Research, Honolulu, HI 96822; Award #80-05690 A01; $14,106 for 3 months beginning 01/28/83 (HHW).

Determine how a wave attenuates on a shallow reef. Explore the magnitude of the resultant bottom shear stress of structures under varying conditions. Apply results to the design of coastal structures.

442 **Integration of the Hierarchical and Multiobjective Approaches: Phase II;** Yacov Y. Haimes; Case Western Reserve University, Center for Large Scale Systems and Policy Analysis, Cleveland, OH 44106; Award

#82-11606; $59,984 for 12 months beginning 12/01/82 (HHW).

Develop a theory and methodology for water resource modeling that is responsive to: the hierarchical decisionmaking process; the large scale and complexity of these water systems; the difficulties posed by goals and objectives that may be in conflict and competition; the presence of multiple decisionmakers; and the aspects of risk and uncertainty that influence these decisions.

443 **Resource Analysis Using Microcomputers;** Daniel W Halpin; Georgia Institute of Technology, Department of Civil Engineering, Atlanta, GA 30332; Award #82-08271; $57,255 for 12 months beginning 01/15/83 (HHW).

Assess the power of the microcomputer to provide an interactive environment for analysis of construction resource requirements on heavy construction projects. Address quantity development; resource definition; production analysis; cost analysis; time analysis; and resource optimization.

444 **Turbulent Mixing and Entrainment in Doubly-Diffusive Systems;** Donald R. Harleman; Massachusetts Institute of Technology, Civil Engineering Department, Cambridge, MA 02139; Award #81-19384; $98,395 for 12 months beginning 02/01/83 (HHW).

Examine salinity and temperature gradients which form a doubly-diffusive system in an estuary or solar pond. Investigate mixing and turbulent entrainment in the system.

445 **Fourth International Symposium on the Use of Computers for Environmental Engineering Related to Buildings; Tokyo, Japan; March 30 - April 2, 1983;** Ronald H. Howell; University of Missouri, Department of Mechanical Engineering, Rolla, MO 65401; Award #83-07909; $1,289 for 6 months beginning 03/01/83 (HHW).

Support travel for a participant to deliver three papers at the symposium.

446 **Economic Analysis and Computer-Aided Building Design;** Robert E. Johnson; University of Michigan, Architectural Research Laboratory, Ann Arbor, MI 48109; Award #82-04727; $47,996 for 24 months beginning 10/15/82 (HHW).

Investigate the hypothesis that the design of cost effective buildings would be greatly facilitated if architects and engineers could be immediately and unambiguously informed of both the initial and in-use economic consequences of their design decisions. Conduct experiments which explore how such a setting is established within the context of an existing geometric modeling relational database system (ARCH:MODEL). Explore how both existing and new economic analysis procedures research help to define and clarify the role of economic analysis during initial design within the context of computer-aided design.

447 **Fan and Drive for a Refrigerated Wind Tunnel for Basic Research in Environmental Dispersion, Fluid Mechanics, Wind Engineering, and Ice Engineering;** John F. Kennedy; University of Iowa, Institute of Hydraulic Research, Iowa City, IA 52242; Award #82-16298; $54,000 for 12 months beginning 01/15/83 (HHW).

Purchase a fan and drive for a refrigerated wind tunnel for basic research in environmental aerodynamics and wind engineering. Use the refrigerated wind tunnel to conduct research on turbulence and boundary layers, and to solve environmental and dispersion problems.

448 **Effect of Turbidity on the Emissivity and Thermal Infrared Mapping of Coastal Waters;** Vytautas Klemas; University of Delaware, Department of Marine Studies, Lewes, DE 19958; Award #82-10857; $83,278 for 24 months beginning 11/01/82 (HHW).

Study the thermal infrared emissivity of water as the suspended sediment concentration is varied from zero to extremely high loads. Investigate sands, silts, and clays separately under carefully controlled temperature, grain size, and mixing conditions. Use the results to develop a model for correcting thermal infrared maps of turbid coastal waters. Examine the feasibility of using thermal infrared imagery for mapping suspended sediment.

449 **Methodological Foundation for Performance and Accountability Evaluations of Water Resource Systems;** Roman Krzysztofowicz; University of Virginia, Department of Engineering Science and Systems, Charlottesville, VA 22906; Award #83-00928; $91,792 for 12 months beginning 12/15/82 (HHW).

Develop a methodological foundation for making performance and accountability evaluations of a class of engineering/societal systems. Apply this methodology to evaluate the performance and accountability of storage management systems of water resources.

450 **Establishment of Mathematical Modeling of Shoreline Evolution;** Bernard Le Mehaute; University of Miami, Ocean Engineering Department, Coral Gables, FL 33124; Award #79-11930 A04; $47,008 for 12 months beginning 01/01/83 (HHW).

Investigate sediment transport, shoreline hydrology, and water resources engineering. Study fluid-sediment interactions in the surf zone.

451 **Mechanics of Turbulent Buoyant Plumes;** E. John List; California Institute of Technology, Department of Environmental Engineering Science, Pasadena, CA 91104; Award #81-17272 A01; $129,878 for 12 months beginning 01/15/83 (HHW).

Examine the mixing and dispersion of plumes of wastewater discharged into coastal ocean waters.

452 **Resource Analysis Using Microcomputers;** Jose Lluch-Garcia; University of Puerto Rico, Department of Civil

Engineering, Mayaguez, PR 00708; Award #83-02298; $63,814 for 12 months beginning 02/15/83 (HHW).

Assess the power of the microcomputer to provide an interactive environment for analysis of constructionesource requirements on heavy construction projects. Address quantity development; resource definition; production analysis; cost analysis; time analysis; and resource optimization.

453 **Interactive Computer Graphical Models of the Conjunctive Use of Ground and Surface Waters;** Daniel P. Loucks; Cornell University, Department of Environmental Engineering, Ithaca, NY 14853; Award #82-11719; $50,000 for 12 months beginning 12/01/82 (HHW).

Develop and apply interactive models of the conjunctive use of surface and groundwater and their natural, economic, and social impacts in a policymaking context. Couple these mathematical models with color computer graphics to improve data base management and communication.

454 **Dynamic Modeling and Analysis of Traffic Stream Flow in Complex Transportation Networks;** Panos G. Michalopoulos; University of Minnesota, Department of Civil and Mineral Engineering, Minneapolis, MN 55455; Award #82-10189; $45,000 for 24 months beginning 12/15/82 (HHW); Split-funded with ECSE (STO) for $30,000.

Develop macroscopic dynamic models describing traffic flow in three dimensions (time, street width and length). Include elements such as lane changing, traffic friction due to parking, grades, environmental or pavement conditions, and geometric factors. Apply the new models and methods of analysis to situations that are frequently encountered, such as signalized intersections, arterials, and networks, and compare these models with available field data.

455 **Theoretical and Experimental Studies of the Effect of Air on Water Movement in Unsaturated Porous Media;** Hubert J. Morel-Seytoux; Colorado State University, Department of Civil Engineering, Fort Collins, CO 80523; Award #82-12668; $44,997 for 12 months beginning 03/01/83 (HHW).

Develop a better understanding of how movement of water in porous media is influenced by the presence of air and its resulting effects such as viscous resistance, compression, buoyancy, and counterflow. Conduct experiments in a laboratory flume designed to measure what happens both in the water and in the air. Deduce mathematical models from physical principles and compare results.

456 **Simulation of Multi-Phase Flow Phenomenon Via Catastrophe Theory;** George F. Pinder; Princeton University, Civil Engineering Department, Princeton, NJ 08544; Award #81-11240 A01; $63,360 for 12 months beginning 03/25/83 (HHW).

Study fluid flow phenomena exhibiting a complicated thermodynamic behavior. Combine the power of the collocation formulation with the advantages of catastrophe theory to simulate multiphase porous medium flow.

457 **Outflow Hydrographs During Earth Dam Breaches;** Victor M. Ponce; San Diego State University, Departments of Civil, Mechanical and Environmental Engineering, San Diego, CA 92182; Award #80-25155 A02; $49,932 for 12 months beginning 03/22/83 (HHW).

Examine phenomena associated with the breach of an earth dam: the outflow of water, the consequent sediment erosion, and transport and deposition. Improve prediction of the flood height and damage downstream of earth dams which fail.

458 **Stochastic Modeling of Geophysical Time Series;** Jose D. Salas; Colorado State University, Civil Engineering Department, Fort Collins, CO 80523; Award #81-10782 A01; $69,496 for 12 months beginning 02/15/83 (HHW).

Investigate the statistical characteristics of time series of geophysical processes which exhibit apparent changes. Find and study the properties of stochastic models which reproduce such apparent changes, and investigate the application of such models to actual geophysical series.

459 **Industry/University Cooperative Research Activity: Stochastic Modeling of Streamflow with a Physical Basis;** Donald M. Thomas; Dames and Moore, Civil Engineering Department, Los Angeles, CA 90071; Award #79-07793 A02; $58,524 for 12 months beginning 12/01/82 (HHW).

Develop reliable mathematical models to relate rainfall and runoff for problems of deterministic and stochastic components of potential stream flows. Apply models to water resources planning and design of storage reservoirs and hydraulic structures, land use planning, flood plain zoning, and management.

460 **Evaluating Scaling Criteria for Vortex Modeling;** Paul J. Tullis; Utah State University, Civil Engineering Department, Logan, UT 84322; Award #81-10786 A01; $53,953 for 12 months beginning 03/01/83 (HHW).

Investigate the scale-model similitude requirements needed for reliable full-scale predictions of vorticity in submerged intakes.

461 **Global Stability Analyses for Environmental Systems;** Eric F. Wood; Princeton University, Civil Engineering Department, Princeton, NJ 08544; Award #81-00491 A01; $89,072 for 12 months beginning 01/17/83 (HHW).

Study water resources engineering by using mathematical models of environmental systems. Examine the effects of non-linear dynamics in order to model, analyze, and control these systems. Use recent progress in differential topology to provide qualitative and quantitative methods for analyzing the non-linear systems.

462 **Optimization of Regional Water Supplies for Optimal Planning and Management;** William W. Yeh; University of California, Engineering Systems, Los Angeles, CA 90024; Award #81-13500 A01; $50,100 for 12 months beginning 03/30/83 (HHW).

Develop a systems approach to the conjunctive development and use of groundwater, surface water, and other sources of water. Optimize the approach and make it responsive to the inherent multiple purpose nature of problems in water resources management.

463 **Validity Range of New Free-Surface Unsteady Flow Equations with Bottom Curvatures;** Vujica M. Yevjevich; George Washington University, Departments of Civil, Mechanical and Environmental Engineering, Washington, DC 20052; Award #83-05578; $115,100 for 12 months beginning 02/15/83 (HHW). Part of a total NSF Award of $132,280.

Investigate the unsteady free surface flow of water in open channels with appreciable bottom curvature. Study Dressler equations, which represent a major theoretical generalization of St. Venant equations, and which contain additional terms to describe the effects of the bottom curvature and its derivative.

Environmental and Water Quality Engineering (EWQ)

464 **Wastewater Treatment With Immobilized Liquid Ion Exchanges;** Walter C. Babcock; Bend Research Inc., Thermochemical Institute, Bend, OR 97701; Award #81-15633 A01; For 12 months beginning 01/01/83 (EWQ). Part of a total NSF Award of $114,737.

Determine the feasibility of using synthetic fibers containing ion-exchange substances to extract metals from liquid wastes. Study research applications for removing contamination from ponds due to surface or groundwater overflow and seepage.

465 **Influence of Change in Drainage Basin Hydrology and Vegetation on Water Quality;** David L. Correll; Chesapeake Research Consortium, Inc., Chesapeake Bay Center, Annapolis, MD 21403; Award #82-19615; $105,059 for 24 months beginning 04/01/83 (EWQ).

Investigate the characteristics of nutrient transport over and through soils as affected by changes in soil, hydraulic properties, and vegetative cover. Study factors influencing water quality including nitrification, denitrification, soil erosion, sediment transport and deposition, phosphorus movement, and type of vegetative cover. Examine mechanisms responsible for the transport of nutrients by water to determine their relative significance and their potential for general applicability to characterization of nutrient transport on coastal-plain drainage basins.

466 **Rheology of Biological Wastewater Suspensions;** Richard I. Dick; Cornell University, Department of Environmental Engineering, Ithaca NY 14853; Award #81-11249 A01; $68,280 for 12 months beginning 01/17/83 (EWQ).

Determine the effect of basic design and operational variables in biological wastewater treatment processes on the rheological properties of the biological solids synthesized. Investigate the relationships between the rheological properties of biologically active suspensions and the performance of wastewater treatment processes based upon their use. Operate biological reactors under a broad range of conditions using both synthetic and actual wastewaters. Study variables including the concentration of macro- and micronutrients, dissolved oxygen concentration, mean cell residence time, hydraulic residence time, shear rate in the biological reactor, and duration of anaerobiosis during solids separation and recycling.

467 **Adsorption and Biodegradation of Organic Compounds on Activated Carbon;** Francis A. DiGiano; University of North Carolina at Chapel Hill, Department of Environmental Sciences and Engineering, Chapel Hill, NC 27514; Award #82-13418; $72,446 for 12 months beginning 02/15/83 (EWQ).

Characterize the fate of organic compounds removed from water during its treatment by use of activated carbon. Use radioisotope procedures to study adsorption of organic compounds on the carbon, biological degradation of these compounds and consequent regeneration of the carbon's adsorptive capacity. Study the effects of adsorbed-phase concentration on biofilm activity and competitive adsorption of organic compounds that vary in their biodegradability. Consider simultaneous availability of primary and secondary substrates at high and low concentrations, respectively, and the relative significance of bioregeneration of adsorption sites on the activated carbon particles. Adapt a biofilm model based on fundamental concepts of film-development on non-adsorbant surfaces under steady-state conditions.

468 **Workshop on Utilization of Municipal Wastewater and Sludges on Land;** Thomas L. Gleason; United States Environmental Protection Agency, Office of Research and Development, Washington, DC 20460; Award #83-03553; $7,000 for 12 months beginning 01/01/83 (EWQ); Split-funded with OIR for $2,000. Part of a total NSF Award of $10,000.

Convene a workshop in Denver, Colorado, on February 23-25, 1983 to assess research needs relating to management of sludges derived from the treatment of wastewater by placement on land. Conduct the project at the University of California, Riverside, under a cooperative agreement with the U.S. Environmental Protection Agency.

469 **Role of Uncertainty in Engineering Design for Systems for Land Application of Nitrogenous Wastes;** Douglas A. Haith; Cornell University, Department of Agricul-

tural Engineering, Ithaca, NY 14853; Award #82-19159; $31,163 for 12 months beginning 04/01/83 (EWQ).

Study the sources of uncertainty and investigate procedures for dealing with them in engineering design of land application systems for wastewater treatment. Investigate a deterministic model of the dynamic relationships of nitrogen-species to determine parameters for engineering design. Consider model parameters as random variables. Apply Monte Carlo simulation and first-order variance propagation techniques to evaluate waste application schedules, estimate relative importance of the sources of uncertainty, and develop design procedures that incorporate considerations of risk.

470 **Effects of Drainage Basin Characteristics on Water Quality;** George Hornberger; University of Virginia, Department of Environmental Sciences, Charlottesville, VA 22906; Award #82-15914; $50,911 for 12 months beginning 04/01/83 (EWQ).

Study how physical/chemical processes to which water is subjected on drainage basins affect its quality. Modify a hydrological model derived from earlier studies by Bevin and Kirby to predict effects dependent on basin characteristics, distribution of precipitation, antecedent conditions, litter-layer storage, evapotranspiration, infiltration, and soil properties.

471 **Structured Models of Biological Waste Treatment Systems;** Robert L. Irvine; University of Notre Dame, Civil Engineering Department, Notre Dame, IN 46556; Award #81-12530 A01; $147,102 for 12 months beginning 01/15/83 (EWQ).

Develop structured models for biological waste treatment systems.

472 **Use of Selective Toxicants for Control of Activated Sludge Bulking;** David Jenkins; University of California, Berkeley, CA 94720; Award #80-06295 A02; $108,194 for 12 months beginning 01/15/83 (EWQ).

Investigate the use of selective toxicants for control of activated sludge bulking.

473 **Soil/Fly-Ash Leachate Interactions: Release, Transport and Retention of Trace Elements;** James O. Leckie; Stanford University, Civil Engineering Department, Stanford, CA 94305; Award #80-09028 A02; $114,151 for 12 months beginning 01/17/83 (EWQ).

Investigate soil/fly-ash interactions. Focus on the transport and retention of trace elements.

474 **Energetic and Kinetic Effects on Anaerobic Wastewater Treatment Process Performance;** Perry L. McCarty; Stanford University, Department of Civil Engineering, Stanford, CA 94305; Award #82-15346; $86,700 for 12 months beginning 04/01/83 (EWQ).

Perform research on anaerobic processes used in the treatment of wastewater.

475 **Effect of Pollutants From Snow and Ice on Quality of Water From Urban Drainage Basins;** Vladimir Novotny; Marquette University, Civil Engineering Department, Milwaukee, WI 53233; Award #82-17150; $91,215 for 24 months beginning 08/01/83 (EWQ).

Characterize the associative relationship between the quality of stormwater draining from urban land and pollutants contributed from melting of snow and ice. Investigate factors affecting the quality of urban stormwater, including land use and atmospheric deposition associated with traffic, industrial, and commercial activities. Study water quality parameters including degree and amount of acidity, suspended and dissolved solids, chemical species including chlorides, organic matter, nitrogenous compounds, heavy metals, and coliform organisms.

476 **Effects of Activated Carbon on Reactions of Chlorine-Containing Disinfectants With Organic Compounds;** Vernon L. Snoeyink; University of Illinois, Department of Civil Engineering, Urbana, IL 61801; Award #81-10024 A01; $99,398 for 12 months beginning 02/04/83 (EWQ).

Characterize reactions between disinfectants containing chlorine and organic compounds that become adsorbed on activated carbon during treatment of water. Determine the extent of reactivity toward selected classes of organic compounds including substituted catechols, easily oxidized hydrocarbons, and heavily chlorinated organic substances in the presence of disinfectants. Emphasize the determination of reaction products; characterize the mechanisms of the reactions; and establish whether the products are likely to be more or less strongly bound to the carbon than when simply adsorbed from solution.

Earthquake Hazard Mitigation (EHM)

477 **International Conference on Earthquake Mitigation and Preparedness in Cities;** Hal Bernson; City of Los Angeles, City Council, Los Angeles, CA 90012; Award #82-13064; $38,800 for 9 months beginning 01/15/83 (EHM).

Hold a conference in Los Angeles, California, February 7-11, 1983, to develop a general understanding of governmental response to earthquake risk; to provide for an exchange of information on research findings, current practice, governmental constraints, and public policy problems related to the identification and mitigation of earthquake hazards by large metropolitan governments; and to exchange research findings, experiences, and methods for earthquake emergency response planning.

478 **Earthquake Response of Flexible Foundations;** Dimitrios E. Beskos; University of Minnesota, Department of Civil and Mineral Engineering, Minneapolis, MN 55455; Award #80-24725 A01; $3,000 for 5 months beginning 03/25/83 (EHM).

Complete analytical computations for work on earthquake response of flexible foundations. Study the earth-

quake response of three-dimensional foundations of arbitrary shapes using computers extensively.

479 **U.S.-China Cooperative Research: Recording and Analysis of Strong Ground Motion and Structural Effects;** Bruce A. Bolt; University of California, Seismographic Stations, Berkeley, CA 94720; Award #82-14326; $38,155 for 12 months beginning 01/01/83 (EHM).

Study earthquake strong ground motions recorded in China and in California. Analyze standardized data sets and develop mutually compatible processing algorithms and software for reduction of accelerograms such as filtering and integration for seismological and engineering applications. Use a shaking table for instrumented calibration and response of structures and compare results with related work. Determine the degree of similarity between ground motions from China and California by correlations between ground motion parameters and parameters characterizing the response of large structures such as bridges, dams, and off-shore structures.

480 **Workshop on the Need and Specifications for a Ground Motion Simulator for Use on the NASA/Ames Geotechnical Centrifuge;** James A. Cheney; University of California, Department of Civil Engineering, Davis, CA 95616; Award #83-10229; $48,290 for 12 months beginning 04/01/83 (EHM).

Conduct a workshop June 5-8, 1983. Bring together geotechnical experts closely associated with centrifuge testing for soil dynamics problems who will discuss and recommend approaches for upgrading the centrifuge facility at the National Aeronautics and Space Adminstration-Ames research facility for earthquake engineering investigations. Address the potential need to add a ground motion simulator to the centrifuge.

481 **Risk Analysis for Natural Hazards Damage Mitigation;** Arthur N. Chiu; University of Hawaii at Manoa, Department of Civil Engineering, Honolulu, HI 96822; Award #81-19124 A01; $89,505 for 12 months beginning 04/15/83 (EHM).

Collect data on local strong wind characteristics and on structural response and soil-structure interaction under dynamic loads. Study historical extreme wind data. Use the information collected to improve design procedures and guidelines for dynamic structural loadings.

482 **Interaction Effects in the Seismic Response of Arch Dams;** Ray W. Clough; University of California, Department of Civil Engineering, Berkeley, CA 94720; Award #82-14198; $66,792 for 12 months beginning 02/01/83 (EHM).

Measure the dynamic properties of an arch dam in China, using rotating mass shaking equipment. Perform analytical correlations; investigate the dynamic interaction mechanisms of the dam-reservoir and the dam-foundation relationships; and develop improved mathematical models for the complete system.

483 **Second North American Masonry Conference;** James Colville; University of Maryland, College Park, MD 20742; Award #81-20535 A01; $3,500 for 6 months beginning 03/01/83 (EHM).

Support the publication of the proceedings of the Second North American Masonry Conference at the University of Maryland.

484 **Residents' Acceptance of Hurricane Hazard Mitigation Measures;** John A. Cross; University of Wisconsin, Department of Geography and Urban Studies, Oshkosh, WI 54901; Award #82-11441; $31,764 for 18 months beginning 03/01/83 (EHM).

Study the attitudes of residents of the Lower Florida Keys toward the hurricane hazard and several hazard mitigating actions. Conduct three surveys: a mail questionnaire among long-term residents; a mail questionnaire among new residents; and a survey of area realtors. Indicate various strengths and weaknesses of current hazard mitigation strategies.

485 **Improvement and Expansion of Computer Facility for Earthquake Engineering Research;** C.S. Desai; University of Arizona, Department of Civil and Mechanics Engineering, Tucson, AZ 85721; Award #81-13207; $195,000 for 12 months beginning 03/01/83 (EHM).

Purchase a modern virtual memory computer and integrate it into the existing graphics facility. Use the system for complex time-dependent and multidimensional problems in earthquake engineering and in other disciplines of engineering.

486 **Maximizing Learning from Destructive Earthquakes;** C.M. Duke; Earthquake Engineering Research Institute, Berkeley, CA 94704; Award #79-02990 A03; $78,242 for 12 months beginning 08/01/83 (EHM).

Inspect damaged structures and ground effects resulting from an actual earthquake. Develop guidelines for post-earthquake inspections by experts, publish data from the field inspections, outline lessons learned from the various damaged structures, recommend changes to the building code committees, and disseminate the information to various professional decisionmakers.

487 **Conference on the 1886 Charleston Earthquake and Its Implications for Today;** Walter W. Hays; U.S. Geological Survey, Office of Earthquake Studies, Reston, VA 22092; Award #83-06491; $10,000 for 3 months beginning 04/01/83 (EHM).

Provide support for travel costs of selected participants and for the publication and dissemination of proceedings from the conference. Discuss the Charleston earthquake in the broad context of eastern seismicity and earthquake preparedness, emphasizing what has been learned during the past several years, identifying fundamental technical problems that are still unresolved, generating recommendations for solving them, and specifying ways to improve the state-of-preparedness in the Southeastern United States.

488 **Post-Event Investigations to Maximize Learning from Destructive Natural Disasters;** O. Allen Israelsen; National Academy of Sciences, Department of Engineering, Washington, DC 20418; Award #82-19358; $139,960 for 12 months beginning 04/01/83 (EHM).

Collect perishable information immediately after a natural disaster. Gain a better understanding of the particular phenomenon and of its effect upon constructed works.

489 **Operation of the Universities Council for Earthquake Engineering Research;** Wilfred D. Iwan; California Institute of Technology, Department of Civil Engineering, Pasadena, CA 91104; Award #82-16629; $15,802 for 12 months beginning 04/01/83 (EHM).

Support the activities of the Universities Council for Earthquake Engineering Research, which include exchanging information on earthquake engineering related university research plans, priorities and programs; assisting in the coordination of university research efforts; organizing meetings; and publishing proceedings of the meetings.

490 **Seismic Performance of Base-Isolated Bridges;** James M. Kelly; University of California, Earthquake Engineering Research Center, Berkeley, CA 94720; Award #82-13604; $122,860 for 12 months beginning 02/01/83 (EHM).

Study quarter-scale models of straight and skew bridge decks mounted on base isolation systems and correlate the observed behavior with the predictions of analytical models. Prepare design guidelines on the use of isolators and dissipators for bridge construction.

491 **Statistical Investigation of Engineering Seismology;** Leon Knopoff; University of California, Institute of Geophysical and Planetary Physics, Los Angeles, CA 90024; Award #82-14203; $84,402 for 12 months beginning 03/01/83 (EHM).

Simulate all the major features of seismicity that have been statistically verified to exist in nature and establish the relationships between model parameters based on real earthquake sequences. Estimate future earthquake hazards in a given site and specific uncertainties associated with such an estimate.

492 **United States-Japan Tsunami Workshop;** Harold G. Loomis; University of Hawaii at Manoa, Department of Ocean Engineering, Honolulu, HI 96822; Award #82-17875; $21,900 for 7 months beginning 02/01/83 (EHM).

Conduct the United States-Japan Bilateral Workshop on Tsunamis and Storm Surges in Tsukuba, Japan, May 1983. Formulate approaches to insure cooperation between the United States and Japan in tsunami and coastal hazard research. Focus on critical issues relating to numerical simulation and coastal effects of both tsunamis and storm surges. Prepare a report to provide guidance for future research activities in the field.

493 **Earthquake Engineering Research Facility Support;** Hugh D. McNiven; University of California, Electrical Engineering Research Center, Berkeley, CA 94720; Award #77-21787 A04; $58,500 for 12 months beginning 02/28/83 (EHM).

Provide partial support for specialized personnel to operate and maintain the earthquake simulator at Richmond Station, University of California, Berkeley.

494 **Seismic Reliability of Damaged Concrete Buildings;** Christian Meyer; Columbia University, Department of Civil and Mechanics Engineering, New York, NY 10027; Award #81-21359 A01; $58,860 for 12 months beginning 04/01/83 (EHM).

Study concrete buildings that have been damaged by earthquakes and determine their seismic reliability.

495 **Methods for Evaluating the Seismic Strength of Existing Buildings;** Richard V. Nutt; Applied Technology Council, Structural Engineering Department, Palo Alto, CA 94303; Award #82-09260; $126,888 for 12 months beginning 01/01/83 (EHM).

Develop comprehensive methods for evaluating the seismic strength of existing buildings, before and after strengthening. Select a team of nationally recognized experts consisting of private consultants, academicians, and government representatives to develop these methods.

496 **Eighth World Conference on Earthquake Engineering, San Francisco, July 21-28, 1984;** Joseph Penzien; Earthquake Engineering Research Institute, Berkeley, CA 94704; Award #82-11707 A01; $112,000 for 12 months beginning 03/25/83 (EHM).

Support pre-conference activities; printing, handling and mailing of announcements, call for papers, preliminary and final program; and expenses for committees: Steering, Program Information, Arrangements, Publications, Special Events, Liaison, and Finance; and staff and temporary salaries.

497 **Citizen Adoption of Mitigation Measures in Multiple Impact Disasters;** Ronald W. Perry; Battelle Memorial Institute, Social Change Study Center, Seattle, WA 98105; Award #81-20426 A01; $34,512 for 3 months beginning 01/15/83 (EHM).

Compare findings from research on the human response to the hazards posed by Mt. St. Helens (including ash fall, mudflows, floods, and earthquakes) to similar work on the response to the Mt. Usu volcano on Hokkaido, Japan. Collect data from officials and citizens in communities near the volcanoes in the United States and Japan. Develop a common questionnaire and mutual time table to coordinate the research effort.

498 **Reinforcing Existing Unreinforced Masonry Wall Buildings;** Joseph M. Plecnik; North Carolina State University, Department of Civil Engineering, Raleigh, NC 27607; Award #82-11240; $150,723 for 24 months beginning 01/01/83 (EHM).

Study a repair technique which strengthens unreinforced brick masonry walls by coring or drilling vertical holes through the center, placing an appropriate amount of reinforcement in the drilled hole, and filling the hole and adjoining voids with epoxy, epoxy foam, or cement grout. Improve the in-plane shear strength and the out-of-plane flexural strength of masonry walls.

499 **Earthquake Resistance of Composite Floor Diaphragms;** Max L. Porter; Iowa State University of Science and Technology, Civil Engineering Department, Ames, IA 50010; Award #82-09104; $77,710 for 12 months beginning 01/01/83 (EHM).

Investigate the response of steel-deck reinforced composite slabs acting as structural diaphragms. Determine the behavior and strength characteristics of composite steel deck slab diaphragms subjected to lateral loads on buildings from earthquakes and wind. Analyze studies of refined elemental tests, tests of other potential failure modes, variable key parameters of slab configuration affecting strength and failure mode, tests of a slab with flexible support beams, and tests of slabs subjected to combined gravity and in-plane loading. Provide recommendations related to the design of composite steel-deck floor slabs subjected to in-plane shear forces resulting from earthquakes.

500 **Emergent Citizen Groups in Disaster Preparedness and Recovery Activities;** Enrico L. Quarantelli; Ohio State University, Sociology Department, Columbus, OH 43210; Award #81-13191 A01; $168,920 for 12 months beginning 02/04/83 (EHM).

Study citizen groups involved in disaster preparedness and recovery. Gather data, including a survey and field studies, analyze data, and write research reports and papers.

501 **Investigation of Semi-Rigid Steel Beam-Column Connections Subjected to Static and Cyclic Loadings;** James B. Radziminski; University of South Carolina, Department of Civil Engineering, Columbia, SC 29208; Award #81-15014 A01; $72,868 for 12 months beginning 02/03/83 (EHM).

Investigate the dynamic behavior of beam-to-column connections, referred to as semi-rigid connections, for steel structures. Determine the limits of dynamic resistance of the various types of semi-rigid connections. Conduct experiments and correlate analysis methods.

502 **Stability of Earth Structures Under Seismic Loading;** Wolfgang H. Roth; Dames & Moore, Los Angeles, CA 90071; Award #79-26691 A02; $9,161 for 3 months beginning 10/31/83 (EHM).

Develop a nonlinear geotechnical model to predict the dynamic response of embankments and slopes and verify the validity of the predictive model with simulated tests in a centrifuge. Design, fabricate, and test an auxiliary shaking device to realistically test the model to scaled earthquake conditions in a centrifuge.

503 **Recovery from Natural Disasters: Case Studies in Local Public Planning and Management;** Claire B. Rubin; George Washington University, National Disaster Research Center, Washington, DC 20052; Award #82-14344; $147,308 for 18 months beginning 03/01/83 (EHM).

Document and analyze community recovery from earthquakes and other natural disasters, focusing on local public planning and management decisions during the recovery period. Build on earlier case studies, expanding not only the number and coverage of such studies but also the analytical framework for recovery research. Conduct ten case studies over an 18-month period and prepare an account of each area visited. Produce an analysis report and an analytical framework for future studies of the recovery process.

504 **Fault Movement: Its Potential Damage to Embankment Dams;** Chih-Kang Shen; University of California, Department of Civil Engineering, Davis, CA 95616; Award #82-11471; $83,686 for 24 months beginning 02/15/83 (EHM).

Analyze the conditions under which damage and failure of embankment dams occur due to a fault movement in their foundations by means of model tests in a centrifuge. Develop and test appropriate models that are compatible for testing in a large centrifuge. Perform shakedown tests of appropriate models in a small centrifuge.

505 **Implementation of Base Isolation for the West Valley Law and Justice Center, San Bernardino, California;** Alexander G. Tarics; Reid & Tarics Associates, Inc., San Francisco, CA 94102; Award #82-17584; $149,012 for 24 months beginning 01/01/83 (EHM).

Research and implement a base-isolated structural system for the West Valley Law and Justice Center in San Bernardino County. Obtain data from the instrumentation of the building in developing the science of earthquake-resistant design.

506 **Conference on Earthquake Research in Urban and Regional Planning;** Charles Thurow; American Planning Association, Chicago, IL 60637; Award #83-03554; $29,284 for 6 months beginning 02/15/83 (EHM).

Hold a conference April 16 and 17, 1983 in Seattle, Washington, to assess the state of current research and the results of past research on seismic hazards within the field of urban and regional planning. Bring together the leading scholars and researchers in this field.

507 **New Probabilistic Method for Response Spectrum Superposition;** Mihailo D. Trifunac; University of Southern California, Department of Civil Engineering, Los Angeles, CA 90007; Award #82-15655; $85,251 for 12 months beginning 04/01/83 (EHM).

Develop a model for a multi-degree-of-freedom system by the spectrum superposition method. Apply the model to evaluate the complete earthquake response characteristics, including distribution functions of peak

response amplitudes and probable values for the largest peak response. Use the results to up-grade existing procedures in earthquake engineering and to assess safety margins of structural systems subjected to earthquake induced ground motions.

508 **Seismic Response Characteristics of Meloland Road Overpass During 1979 Imperial Valley Earthquake;** Stuart D. Werner; Agbabian Associates, El Segundo, CA 90245; Award #82-11964 A01; $69,148 for 12 months beginning 04/15/83 (EHM).

Determine the dynamic (earthquake) response of the Meloland Road Overpass. Evaluate the analysis techniques by a systematic process of studying the recorded data and corroborating it with various analytical methods. Develop a general mathematical model for use in other bridge analyses for earthquake forces.

509 **Earthquake Damageability of Low-Rise Construction;** John H. Wiggins; J.H. Wiggins Company, Department of Engineering Mechanics, Redondo Beach, CA 90277; Award #81-09607 A01; $121,057 for 12 months beginning 04/01/83 (EHM).

Improve methods for making damageability predictions of various types of low-rise buildings (less than three stories) as a function of the Modified Mercalli Intensity and physical intensity factors. Develop modeling techniques for structural and non-structural damage, techniques to relate or subject these models to intensity factors, and performance indices for structural and non-structural damage.

510 **Earthquake Ground Motion Research;** Francis T. Wu; State University of New York, Department of Geological Science, Binghamton, NY 13901; Award #82-13972; $74,653 for 24 months beginning 04/15/83 (EHM).

Continue cooperative activities on earthquake induced ground motion with the Geophysical Institute of the State Seismological Bureau (SSB) of China. Establish and use an eight station mobile network to collect and analyze ground acceleration data from large and small earthquakes. Address the source effects of large earthquakes, the path effects, and prediction of strong ground motions from weak motions generated by small earthquakes in the magnitude range of two to four.

511 **Methodology for Damage Assessment of Existing Structures;** James T. Yao; Purdue University, Department of Civil Engineering, Lafayette, IN 47907; Award #81-17678 A01; $150,849 for 12 months beginning 02/03/83 (EHM).

Develop an evaluation procedure for predicting the hazard potential of existing structures subjected to disastrous natural hazard loadings. Base the approach on system-identification techniques and fuzzy set theory. Refine the mathematical formulation of the problem, develop a computer program for the method, and test and calibrate the approach by using information on documented cases of damage.

Division of Electrical, Computer, and Systems Engineering (ECSE)

Automation, Bioengineering, and Sensing Systems (ABS)

512 **Engineering Modeling of Neurological Control Mechanisms;** Gyan C. Agarwal; University of Illinois, Department of Systems Engineering, Chicago, IL 60680; Award #82-12067; $99,923 for 24 months beginning 02/01/83 (ABS).

Identify the dynamics of the human motor system, define and determine the parameters of its various components by means of mathematical modeling. Study movement around the ankle, the elbow and the wrist joints in normal human subjects. Use the stretch reflex as a test probe to study underlying neural mechanisms of posture and measure system changes during control of voluntary movements.

513 **Visuo-tactile Coordination for Robot Control;** Michael A. Arbib; University of Massachusetts, Computer and Information Science, Amherst, MA 01003; Award #81-08818 A01; $106,246 for 12 months beginning 02/15/83 (ABS).

Provide a theory for, and conduct experiments on, the integrated use of visual and tactile information in the control of robot arms and hands. Develop techniques for static visual and tactile recognition of objects. Explore and update the schemes embodying this recognition. Perform a series of increasingly sophisticated robotics tasks requiring the integration of active visual and tactile input.

514 **Adaptive Cephalic Imaging;** Ralph W. Barnes; Wake Forest University, Department of Neurology/Biomedical Research and Development, Winston Salem, NC 27103; Award #82-10738; $91,782 for 24 months beginning 04/01/83 (ABS).

Measure the geometry of the distorting medium using cepstrum analysis techniques. Develop mathematical models of the near and far boundaries of the distorting medium using cubic spline fits. Use this model to solve for the ray paths from each element of a transducer array to desired field points. Introduce time delays to maintain phase coherence at the field point in both transmit and receive modes of operation.

515 **Random Process Analysis of Beat-to-Beat Fluctuations in Electrocardiographic and Hemodynamic Parameters;** Richard J. Cohen; Massachusetts Institute of Technology, Department of Health Sciences and Technology, Cambridge, MA 02139; Award #81-21571 A01; $60,000 for 12 months beginning 04/15/83 (ABS).

Analyze beat-to-beat fluctuations in hemodynamic and electrocardiographic parameters using random process analysis methods. Determine the dynamic response of the cardiovascular system to naturally occurring extrinsic perturbations. Determine the intrinsic variability of the cardiovascular system itself. Undertake theoretical and experimental studies to apply random process analysis techniques to the functioning of the cardiovascular system. Develop the analytic and computational tools needed to perform stochastic analysis. Relate the analysis of beat-to-beat fluctuations to the cardiovascular state to assess changes and variations.

516 **Nonlinearity and Intermodulation in Microwave Acoustics;** C. Chapin Cutler; Stanford University, W. W. Hansen Laboratory of Physics, Stanford, CA 94305; Award #81-11100 A01; $68,611 for 12 months beginning 03/15/83 (ABS).

Study nonlinear interaction of acoustic waves in matter at frequencies around one GHz. Design instrumentation for the mixing of intense pulsed intersecting beams at an interface, and observe third order mixing products from objects and materials. Study the effect of excess attenuation and beam broadening and distortion caused by nonlinearity. Determine an optimum strategy of beam modulation and adjustment of intensity for both single frequency and multiple frequency excitation. Apply these phenomena to non-destructive testing on a microscopic scale.

517 **Finite Amplitude Acoustic Wave Propagation in Mammalian Tissues;** Floyd Dunn; University of Illinois, Department of Electrical Engineering, Urbana, IL 61801; Award #81-15206 A01; $76,000 for 12 months beginning 03/01/83 (ABS).

Study finite amplitude acoustic wave propagation in tissues. Take measurements in solutions of biological media, e.g., aqueous solutions of proteins at various concentrations and temperatures and in aqueous solutions of linear molecules as a function of molecular weight. Use both the finite amplitude and the thermodynamic methods of measurement.

518 **Research Initiation: Pyramid Algorithms and Machines for Image Processing;** Charles R. Dyer; University of Wisconsin, Department of Computer Science, Madison, WI 53706; Award #83-01521 A01; $48,220 for 24 months beginning 02/01/83 (ABS).

Explore a new hierarchical data structure in the form of an overlapped pyramid for use in parallel region-processing algorithms in image procession. Develop fast parallel algorithms by combining horizontal and vertical propagation operations for segmenting an image into regions and building the associated segmentation trees. Investigate various types of pyramid machines which are appropriate for VLSI implementation.

519 **Research Equipment for Robot Vision;** Donald R. Falkenburg; Oakland University, Department of Engineering, Rochester, MI 48063; Award #82-13465; $25,000 for 12 months beginning 02/01/83 (ABS).

Support the acquisition of an AUTOVISION II programmable vision system manufactured by AUTOMATIX. Use the system to support research on contouring techniques, CAM, statistical tolerancing, and quantized data systems.

520 **Cutaneous Communication Aids for the Deaf;** Moise H. Goldstein; Johns Hopkins University, Electrical Engineering Department, Baltimore, MD 21218; Award #81-09421 A01; $64,998 for 12 months beginning 02/01/83 (ABS).

Investigate transformations between acoustic signals of speech and spatiotemporal patterns of vibrotactile stimulation of the skin, including: vocodertype display (time-varying spectrum analyzer) with channel output represented spatially; flowed spectrographic representation; and display presenting information about the shape of the vocal tract. Use modern signal processing techniques to extract articulatory parameters from the acoustic signals of speech. Compare identification of words presented in isolation and in fluent strings.

521 **Complex Surface Recognition for Robot Vision;** Ernest L. Hall; University of Tennessee, Department of Electrical Engineering, Knoxville, TN 37996; Award #81-12074 A01; $99,805 for 24 months beginning 03/01/83 (ABS).

Develop techniques and algorithms for the three-dimensional recognition and location of complex curved objects and surfaces using a computer vision approach. Develop techniques for segmentation of a complex surface into simple surfaces which can be recognized and measured using existing techniques. Use relational table and model matching methods.

522 **Investigation for a Universal 2-D Holographic Scanner;** Charles S. Ih; University of Delaware, Department of Electrical Engineering, Newark, DE 19711; Award #82-09184; $73,310 for 12 months beginning 01/01/83 (ABS).

Investigate the incorporation of multiple-beam scanning and detection into 2-D holographic scanners. Examine visible optical wavelengths.

523 **Structure of Multidimensional Patterns;** Anil K. Jain; Michigan State University, Department of Computer Science, East Lansing, MI 48824; Award #80-07106 A03; For 12 months beginning 12/15/82 (ABS). Part of a total NSF Award of $27,000.

Study the meaning of "structure" for patterns in a multidimensional space under the general framework of exploratory data analysis. Focus on the manner in which the theory of spatial point processes will enhance understanding of intrinsic dimensionality, clustering tendency, cluster validity, and cluster stability. Extend the general problem of structure over previous work in cluster validity and comparative analysis by suggesting new approaches based on spatial point processes. Examine procedures for generating data with which competing algorithms can be objectively compared.

524 **Remote Sensing With Electromagnetic Waves;** Jin-Au Kong; Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, Cambridge, MA 02139; Award #82-03390 A01; $55,000 for 12 months beginning 04/15/83 (ABS).

Develop theoretical models that account for absorption, layering, scattering effects, and rough interfaces. Relate the radiative transfer theory to the wave theory and develop the modified radiative transfer theory that accounts for partial coherent wave phenomena. Use the quantum mechanical potential operator approach to investigate the multiple scattering phenomenon with the model of randomly distributed discrete scatterers. Investigate the rough surface effects for both periodic and random rough surfaces and incorporate the rough surface contribution with the random and discrete scatterer models. Develop the strong fluctuation random medium theory to study the scattering of vector electromagnetic waves in a random medium with large permittivity variations, and interpret all available active and passive data and carry out sensitivity studies. Apply the theoretical models to the study of clouds and rainfall, vegetation, soil moisture, snow-ice fields and desert areas, and general earth terrain.

525 **Focused Electromagnetic Hyperthermia Applicators;** Shung-Wu Lee; University of Illinois, Department of Electrical Engineering, Urbana, IL 61801; Award #81-20305 A01; $100,000 for 12 months beginning 04/15/83 (ABS).

Characterize and define the absolute limitations on the ability to focus electromagnetic energy into minimal tissue volumes at different frequencies, taking into account such trade-offs as minimum spot diameter with depth of penetration into tissue. Study specialized radiating systems (off-set parabolic reflector, parabolic-parabolic dual reflector, elliptical reflector) for the synthesis of focused spots which will be scanned to illuminated tumors of arbitrary shape. Examine alternative means of beam scanning, including mechanical movement of the feed or the reflector and electrical scanning by phase adjustment across the feed array. Develop applicators to couple electromagnetic power into the region of a deep-seated tumor.

526 **Adaptive Control, Learning and Cost Effective Sensor Systems for Robotic or Advanced Automation Systems;** James L. Nevins; Charles Stark Draper Laboratories Inc., Robotics and Assembly Systems, Cambridge, MA 02139; Award #82-14366; $98,952 for 12 months beginning 04/01/83 (ABS).

Address the modeling and control of assembly systems in the presence of noisy data and incomplete and time varying models. Explore multi-loop control sys-

tem hierarchies capable of a broad range of control actions, ranging in scope from direct process control to management-supervisory-diagnostics functions. Examine control interactions between sensors and the various requirements of multi-loop systems.

527 **Image Processing for Morphologic Cytology;** E.A. Parrish; University of Virginia, Department of Electrical Engineering, Charlottesville, VA 22906; Award #82-07185; $99,614 for 12 months beginning 01/01/83 (ABS).

Apply pictorial pattern recognition to automate tasks associated with morphological studies. Develop algorithms to locate, identify, and produce quantitative stereologic data on the intracellular components of liver cells in images of ultra-thin sections. Implement these algorithms on an experimental system and compare system performance to that of experienced technicians using currently available techniques.

528 **Research on Acoustic Microscopy With Superior Resolution;** Calvin F. Quate; Stanford University, Edward L. Ginzton Laboratory, Applied Physics and Electrical Engineering, Stanford, CA 94305; Award #80-10786 A02; $111,871 for 12 months beginning 02/01/83 (ABS); Split-funded with SSM for $25,000.

Improve the resolving power of the acoustic microscope. Develop an instrument that has a resolution superior to the optical microscope and four times better than the present acoustic microscope. Use the instrument to carry out research in microscience.

529 **Shape Analysis Using the Method of Moments;** Anthony P. Reeves; Cornell University, School of Electrical Engineering, Ithaca, NY 14853; Award #83-03583; $68,603 for 24 months beginning 02/01/83 (ABS).

Investigate image shape analysis techniques based on a moment set data representation. Study the shape information contained in a truncated moment set, develop advanced analysis algorithms, and design parallel VLSI hardware for real-time implementation of these analysis algorithms.

530 **Adaptive Control of Cardiovascular Dynamics;** Rob J. Roy; Rensselaer Polytechnic Institute, Department of Biomedical Engineering and Systems Engineering, Troy, NY 12181; Award #80-16225 A03; $89,985 for 12 months beginning 02/15/83 (ABS).

Focus on the problem of a microcomputer-based adaptive controller which is capable of regulating the infusion rates of multiple interacting drugs. Construct, identify, and validate a model. Implement algorithms on a microcomputer.

531 **Microwave Remote Sensing of Earth Terrain;** Leung Tsang; Texas A&M University, Department of Electrical Engineering, College Station, TX 77843; Award #80-14579 A02; $42,000 for 12 months beginning 01/15/83 (ABS).

Investigate theoretical models that interpret remote sensing data. Apply these models to the study of ice-snow fields, desert areas, soil moisture, vegetation, clouds, and rainfall. Account for the volume scattering effects of the terrain media: a random medium, and a homogeneous medium containing randomly distributed discrete scatterers.

Computer Engineering (COM)

532 **Group Travel For U.S. Participants in the 10th International Symposium on Computer Architecture;** Dharma P. Agrawal; Institute of Electrical and Electronics Engineers, Department of Electrical Engineering, New York, NY 10017; Award #83-03556; $6,000 for 12 months beginning 04/01/83 (COM). Part of a total NSF Award of $12,000.

Support group travel for U.S. participants to the symposium. Discuss state-of-the-art computer architecture among participants from Europe and the United States.

533 **Design and Layout of VLSI Circuits;** John P. Hayes; University of Michigan, Department of Electrical and Computer Engineering, Ann Arbor, MI 48109; Award #82-14709; $154,868 for 24 months beginning 01/01/83 (COM).

Develop analytic models and synthesis techniques for the logical and physical design of VLSI circuits. Use the connector-switch-attenuator theory. Develop a unified switching theory to determine the design tradeoffs among various classes of logical circuits. Examine the functional design and physical layout of CMOS chips by developing systematic VLSI design rules that integrate, at least partially, the logical and physical design steps. Emphasize the use of regular interconnection structures such as arrays and trees. Pursue a hierarchical approach to system modeling and fault simulation.

534 **Proposal for a Workshop on Multiprocessors for High Performance Parallel Computation at Carnegie-Mellon University;** Anita K. Jones; Carnegie-Mellon University, Computer Science Department, Pittsburgh, PA 15213; Award #82-15465; $24,130 for 12 months beginning 02/01/83 (COM).

Hold a small, specialized workshop in the Winter/Spring of academic year 1982-1983. Bring together research and development people involved in designing, building, and applying multiprocessors to solve problems, focusing on high performance applications.

535 **Proposal for Research on MISE: Machines for In-System Evaluation of Custom VLSI Chips;** H. T. Kung; Carnegie-Mellon University, Computer Science Department, Pittsburgh, PA 15213; Award #82-15387; $83,513 for 12 months beginning 03/01/83 (COM).

Study the feasibility of building general facilities and tools for in-system evaluation of different kinds of

custom chips. Perform a taxonomy study of custom chips and identify classes of custom chips that can benefit from the proposed approach. Specify a prototype MISE system and estimate its simulation speed for various custom chips. Conduct case studies of one or two application examples.

536 **Parallel Architectures for Speech Recognition;** Harvey F. Silverman; Brown University, Division of Engineering, Providence, RI 02912; Award #81-13494 A01; $134,244 for 12 months beginning 02/15/83 (COM).

Develop new approaches for economical implementation of new intelligent algorithms. Examine the design and implementation of multiprocessors computing systems, composed of microprocessors, for discrete utterance recognition, connected speech recognition, and digital signal processing algorithms.

537 **Quantitative Ion Microanalysis;** Peter Williams; Arizona State University, Department of Chemistry, Tempe, AZ 85287; Award #82-06028; $20,000 for 12 months beginning 03/01/83 (COM). Part of a total NSF Award of $245,000.

Purchase an ion microscope for quantitative analysis (5-10 percent accuracy) of dilute impurities and dopants, of monolayer levels of impurities at surfaces and interfaces, and of major elements in bulk and thin film samples.

Electrical and Optical Communications (EOC)

538 **Integrated Optical Silicon Devices for Applications to Optical Communications and Optical Signal Processing;** Joe T. Boyd; University of Cincinnati, Department of Electrical and Computer Engineering, Cincinnati, OH 45221; Award #82-16303; $81,169 for 24 months beginning 03/15/83 (EOC).

Investigate integrated optical devices utilizing silicon. Direct research towards achieving lower loss in integrated optical waveguides. Study laser annealing of optical waveguides where losses in two different planar waveguide materials have already been reduced by an order of magnitude compared to any reported planar waveguide. Study a variety of single mode channel waveguide structures. Use results to fabricate a simple integrated optical interferometer and parallel processing filter. Examine laser recrystallization of polycrystalline silicon deposited on lithium niobate and the coupling to photodetectors.

539 **Interleaved Coding for Atmospheric Optical Communication Channels;** Frederic M. Davidson; Johns Hopkins University, Department of Electrical Engineering and Computer Science, Baltimore, MD 21218; Award #82-14759; $52,884 for 15 months beginning 04/01/83 (EOC).

Investigate the improvement in performance of direct detection optical communication links using convolutional coding of a digital information source and Viterbi decoding of the received data to recover the original message. Measure the performance of short constraint length (eight bit or less shift register encoders); rate one-half and rate one-third convolutional codes using Viterbi decoding under a variety of turbulence conditions. Use binary pulse position modulation as the actual channel transmission signal format. Measure the performance advantage of using "soft decisions" as opposed to "hard decisions" in the Viterbi decoder with several appropriate path metrics.

540 **Rapidly Converging Computationally Efficient Algorithms for Adaptive Sensor Arrays;** William A. Gardner; University of California, Department of Electrical and Computer Engineering, Davis, CA 95616; Award #82-13402; $46,362 for 12 months beginning 04/01/83 (EOC)

Develop and evaluate algorithms that exhibit both rapid convergence and low computational complexity. Combine the recursive least squares approach and the deflected stochastic gradient approach.

541 **Mode-Locked Lasers for Optical Communication Systems;** Elsa Garmire; University of Southern California, Center for Laser Studies, Los Angeles, CA 90007; Award #82-11709; $50,000 for 12 months beginning 01/01/83 (EOC).

Explore mode-locking of semiconductor lasers by feedback control. Test and build feedback-controlled mode-locked lasers at 0.83um, 1.35um and 1.55um. Seek monolithic integration of the electronics and lasers. Verify the concept experimentally, and measure the effectiveness of feedback-controlled mode-locking.

542 **Scanning Optical Data Processing with Feedback;** Guy Indebetouw; Virginia Polytechnic Institute, Department of Physics, Blacksburg, VA 24061; Award #81-16337 A01; $36,355 for 12 months beginning 03/15/83 (EOC).

Determine the computational potential of a scanning optical data processor (SODP) with electronic feedback loops. Gather data on nonlinear and space variant operations. Evaluate the potential of the SODP in optical construction of coded aperture images and in analog optical bandwidth compression. Assess the performance characteristics and limitations by developing analytical techniques which combine system theory and optics.

543 **High Performance Metal-Oxide Semiconductor (MOS) Very Large Scale Integrated (VLSI) Analog Devices and Circuits;** Richard C. Jaeger; Auburn University, Department of Electrical Engineering, Auburn University, AL 36849; Award #82-11732; $38,142 for 12 months beginning 03/01/83 (EOC).

Explore technology and circuit techniques for improving the performance of MOS analog designs. Develop a low substrate sensitivity technology using deep level impurities in silicon. Develop device models for MOS transistors fabricated using this technology. Explore the basic limits on voltage, gain, power supply rejection (PSRR), and common mode rejection (CMRR)

in amplifiers. Characterize device studies and model the fundamental voltage gain limitations of the MOS transistor. Evaluate circuit and device techniques for improving voltage gain, CMRR and PSRR of MOS amplifier circuits. Fabricate high performance analog circuits using the technology and circuit techniques resulting from this research.

544 **Specialized Research Equipment: Computer Communication Network Laboratory;** William P. Osborne; University of Nebraska, Department of Electrical Engineering, Lincoln, NE 68508; Award #82-14453; $41,451 for 24 months beginning 03/01/83 (EOC).

Acquire equipment for research in computer communication networks. Build a radio frequency channel interface for a PDP 11/34 computer and seven LSI-11/2 computers. Study the performance of various network strategies.

545 **Travel to Attend: International Symposium on Optical Waveguide Sciences; Kweilin, China; June 20-23, 1983;** Harrison E. Rowe; Bell Laboratories, Crawford Hill Laboratory, Holmdel, NJ 07733; Award #83-00363; $1,400 for 12 months beginning 04/01/83 (EOC).

Support travel for a participant to the symposium. Study single-mode optical waveguides, nonlinear phenomena in optical waveguides, and integrated optics. Present technical papers on research, education, and applications of optical waveguides.

546 **Design of Integrated High-Frequency Analog Active Filters;** Rolf Schaumann; University of Minnesota, Department of Electrical Engineering, Minneapolis, MN 55455; Award #82-15001; $45,110 for 12 months beginning 01/01/83 (EOC).

Conduct research on high-frequency integrated filters. Explore the design of digitally controlled, monolithic, high-frequency multiple loop feedback filters and ladder simulation signal-flow-graph filters. Develop integrated programmable filter modules with variable pole frequency, bandwidth, and gain. Design integrated signal processing circuits where the signal is handled in a continuous time analog fashion for fast response and where the circuit parameters are digitally controlled for better accuracy. Emphasize stabilization against errors caused by power supply or temperature variations and fabrication tolerances.

547 **Parallel Processing Architecture for Real-Time Simulation of Communication Systems;** Donald L. Schilling; City College of the City University of New York, Department of Electrical Engineering, New York, NY 10031; Award #82-11433; $55,000 for 12 months beginning 02/15/83(EOC).

Investigate a microprocessor-based, real-time simulator for the study of communication systems. Separate a communication system into its basic components or modules. Design each module with the capability to process its local data units in an independent and parallel manner with respect to all other modules. Combine individual and appropriately programmed modules in a pipelined fashion.

548 **Specialized Research Equipment: Video Disc Recorder for Video Bandwidth Compression;** Donald L. Schilling; City College of the City University of New York, Department of Electrical Engineering, New York, NY 10031; Award #82-12060; $25,000 for 12 months beginning 04/01/83 (EOC).

Acquire an Oktel Corporation Video Disc Recorder Model DM3000 to enable the computer simulation of interframe video bandwidth compressors. Load the contents of a magnetic disc, frame by frame, into a large random access memory (RAM). Access the digital RAM memory by computer, one picture element at a time, and execute any bandwidth compression algorithm which is appropriately programmed. Read the compressed image out of the computer into the RAM memory and back into the magnetic disc. View the compressed video on a TV monitor for subjective evaluation.

549 **Nonlinear and Active Optical Devices;** C. L. Tang; Cornell University, School of Electrical Engineering, Ithaca, NY 14853; Award #81-16560 A01; $92,895 for 12 months beginning 03/15/83 (EOC).

Conduct research on lasers, optical detectors, and related devices for applications in optical communication systems. Investigate electronically tunable semiconductor lasers and FM optical communication systems, semiconductor laser dynamics, fast optical detectors, and metalorganic chemical vapor deposition growth of semiconductor optical devices.

Quantum Electronics, Waves, and Beams (QWB)

550 **Exact, Nonlinear Time-Dependent Vlasov-Maxwell Solutions for Plasmas;** Barbara Abraham-Shrauner; Washington University, Department of Electrical Engineering, St. Louis, MO 63130; Award #82-11546; $86,431 for 12 months beginning 02/01/83(QWB).

Study exact, time-dependent solutions of the nonlinear Vlasov-Maxwell equations for plasmas. Treat both one-dimensional plasmas and three-dimensional magnetized plasmas. Develop models for actual magnetically confined plasmas for time-dependent extensions of the Bernstein-Greene-Kruskal equilibria.

551 **On the Modeling and Experimentation of: I. Electromagnetically coupled (EMC) Printed Circuit Antennas (PCA's) for EHF and Millimeter Waves. II. Printed Circuit Antennas on Cylindrical Substrates Including Feeding Effects;** Nicolaos G. Alexopoulos; University of California, Department of Electrical Engineering, Los Angeles, CA 90024; Award #82-15408; $73,816 for 12 months beginning 03/15/83 (QWB).

Investigate the excitation of the microstrip transmission line by a coaxial feed and consider various types of printed circuit antennas such as dipoles, rectangu-

larly and circularly shaped patches, and other types of printed circuit antenna. Study electromagnetically coupled printed dipoles.

552 **Intensity Dependent Absorption Research;** Michael Bass; University of Southern California, Center for Laser Studies, Los Angeles, CA 90007; Award #81-13428 A01; $78,000 for 12 months beginning 02/01/83 (QWB).

Study intensity dependent absorption (IDA) in narrow band gap materials such as semiconductors. Clarify the properties of IDA in wide band gap materials such as alkali-halides and certain glasses, and develop techniques to measure IDA. Employ ultra pure samples of certain semiconductors as well as selectively doped samples to acquire experimental values against which to test the several theories of IDA. Study crystalline and glassy forms of the same material to evaluate the role of disorder in IDA.

553 **Generation of Coherent Electromagnetic Radiation Using Intense Relativistic Electron Beams;** George Bekefi; Massachusetts Institute of Technology, Department of Physics, Cambridge, MA 02139; Award #82-13485; $99,000 for 12 months beginning 01/15/83 (QWB).

Conduct studies to generate intense, coherent electromagnetic radiation in the millimeter and submillimeter wavelength range, by energy converson of the free electron laser (FEL) and two FEL hybrids, the Rippled Field Magnetron and the Lowbitron. Investigate the influence of finite radial geometry (i.e., beam diameter and waveguide walls) on the growth rate and efficiency of the aforementioned systems, together with the effects of beam quality (energy and momentum spread) on the emission characteristics.

554 **Waves and Stochasticity;** Abraham Bers; Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, Cambridge, MA 02139; Award #82-13430; $101,000 for 12 months beginning 02/01/83 (QWB).

Study the electrodynamics of waves and their interactions in a magnetized plasma. Conduct linear and nonlinear studies of coupling electromagnetic energy to a plasma; wave propagation and transformations in the plasma; and stochastic heating of the particles by the waves.

555 **Coherent VUV Generation by Multiwave Parametric Raman Scattering;** William K. Bischel; SRI International, Molecular Physics Laboratory, Menlo Park, CA 94025; Award #82-13373; $80,000 for 12 months beginning 03/15/83 (QWB).

Characterize the basic physics of multiwave parametric Raman scattering by measuring the anti-Stokes conversion efficiencies as a function of the temperature and density of the Raman medium. Use the data to determine the limits of the existing theory and to develop new theoretical approaches. Demonstrate good conversion of ArF laser radiation to the VUV using a prototype two-chamber low temperature Raman cell.

556 **Investigation of the Feasibility of the Electron Beam-Excited High Pressure Charge Transfer Laser;** Carl B. Collins; University of Texas-Dallas, Department of Physics, Richardson, TX 75080; Award #80-18730 A02; $67,515 for 12 months beginning 02/01/83 (QWB).

Investigate the feasibility of developing an electron beam-excited helium plasma into a collisionally-pumped laser emitting in the visible and near ultraviolet. Develop kinetic models and study charge transfer processes involving helium, neon, and argon dimer ions. Examine a laser transition operating between excited states of atomic fluorine. Measure rate coefficients of elementary reactions fundamental to laser pumping and construct small test laser devices.

557 **Electron Beam Pumping of Charge Transfer Lasers: Industry/University Cooperative Research Grants NSF 80-13;** George J. Collins; Research Institute of Colorado, Department of Electrical Engineering, Fort Collins, CO 80526; Award #82-15168; $81,302 for 12 months beginning 03/01/83 (QWB). Part of a total NSF Award of $162,604.

Explore continuously pumped electron beam plasmas, at a pressure between 0.1 and 5 Torr, as an active laser medium. Emphasize beam pumping of cw ion lasers to obtain an operating efficiency greater than 2×10^{-3} in the ultraviolet at an output power of 0.1 to 1W. Measure the fundamental plasma parameters and develop a model that calculates these parameters. Calculate excitation rates, laser gains, optimum laser conditions, output powers, and operating efficiencies.

558 **Contact Charge Transfer Lasers;** A. N. Dharamsi; Old Dominion University, Department of Electrical Engineering, Norfolk, VA 23508; Award #82-17801; $96,863 for 12 months beginning 03/15/83 (QWB).

Explore an optical pumping mechanism unique to contact charge transfer complexes. Demonstrate gain and lasing in contact charge transfer complexes. Study excited charge transfer state energies, kinetic rates and oscillator strengths relevant to the formation and decay of these states, and develop insight into the chemical physics of the processes involved.

559 **Investigation of New Experimental Techniques with Subpicosecond Pulses;** Jean-Clau Diels; North Texas State University, Department of Physics, Denton, TX 76203; Award #81-19568 A01; $61,502 for 12 months beginning 02/01/83 (QWB).

Explore physical processes associated with generation and propagation of subpicosecond optical pulses. Probe gain and loss kinetics in a subpicosecond dye laser medium using modelocked laser pulses. Examine application of nonlinear optical techniques to high-resolution range measurements and investigate frequency pulling and pulse dispersion effects relevant to picosecond pulse propagation. Conduct exploratory studies of pulse compression utilizing coherent optical interactions.

560 **Theory of Nonlinear Plasma Phenomena;** Thomas Dupree; Massachusetts Institute of Technology, Department of Nuclear Engineering and Physics, Cambridge, MA 02139; Award #82-12964; $55,000 for 12 months beginning 02/01/83 (QWB). Part of a total NSF Award of $85,000.

Study nonlinear and turbulent plasma phenomena by analytic methods and computer simulation. Develop a model consisting of a random collection of localized exact coherent equilibria (BGK modes) which take the form of phase space holes; test the model by computer simulation.

561 **Search for Optical Bistability in New Materials;** Elsa Garmire; University of Southern California, Center for Laser Studies, Los Angeles, CA 90007; Award #81-14829 A01; $89,632 for 12 months beginning 03/01/83 (QWB).

Conduct a search for bistability in organic dyes using a pulsed Nd:YAG laser. Study an InAs nonlinear Fabry-Perot using the HF laser whose wavelength matches the InAs bandgap. Demonstrate bistability in a new material and elucidate the mechanism of the nonlinear index near the bandgap; investigate bistable optical devices; and examine new approaches in optical bistability.

562 **Industry/University Cooperative Research Activity: Optical Bistability Experiments to Improve Solid-State Devices and Basic Understanding;** Hyatt M. Gibbs; University of Arizona, Optical Sciences Center, Tucson, AZ 85721; Award #80-20303 A02; $69,986 for 12 months beginning 04/01/83 (QWB). Part of a total NSF Award of $139,971.

Study bistable optical devices based on interferometers fabricated from semiconducting materials. Examine parameters affecting operating temperatures, holding intensity, and switch-off speed using optical techniques. Measure carrier lifetimes and nonlinear optical properties in GaAs and other semiconductors. Characterize new materials such as superlatties grown by molecular beam epitaxy. Develop compact, high-speed, low-power bistable devices.

563 **Distributed Feedback of Surface Acoustic Wave Structures;** Hermann A. Haus; Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, Cambridge, MA 02139; Award #82-11650; $41,000 for 12 months beginning 01/15/83 (QWB).

Develop and exploit a variational principle for the analysis of radiating acoustic structures. Determine the higher order transverse modes in surface acoustic resonators made with metallic reflectors. Determine the modes responsible for the spurious responses of interdigital transducers and develop designs for their suppression. Develop synthesis procedures for single-phase unidirectional transducers.

564 **Study of Nonlinear Wave Plasma Interaction;** Noah Hershkowitz; University of Wisconsin, Nuclear Engineering Department, Madison, WI 53706; Award #82-03965 A01; $25,500 for 12 months beginning 02/15/83 (QWB).

Explore four topics in nonlinear plasma wave interaction: excitation and interaction of two- and three-dimensional soliton waves in plasma media; self-similar behavior of various plasma phenomenon; radiation of linear and nonlinear plasma waves by probes and antenna structures; and characterization of sheaths in the neighborhood of a variety of probe configurations and of the interaction between these sheaths and linear and nonlinear plasma waves.

565 **Picosecond Opto-Electronic Device Studies;** Erich P. Ippen; Massachusetts Institute of Technology, Electrical Engineering and Computer Science, Cambridge, MA 20139; Award #80-20639 A02; $96,000 for 12 months beginning 02/15/83 (QWB).

Investigate picosecond pulse generation using semiconductor diode lasers. Evaluate optical cross-sections, dynamic properties, and nonlinear processes that govern short pulse interactions in semiconductor waveguides. Extend optical probing techniques to the 800nm and 1500nm wavelength regions and study devices of varying composition and structure. Emphasize GaAlAs and InGaAlAs laser materials.

566 **Nonlinear Acoustic Wave Effects Including Acousto-Optic Interactions;** Adrianus Korpel; University of Iowa, Department of Electrical and Computer Engineering, Iowa City, IA 52242; Award #81-21781 A01; $59,000 for 12 months beginning 04/15/83 (QWB).

Investigate nonlinear acoustic wave effects. Study strong acousto-optic interactions, analyzing the operation of certain acousto-optic devices for those cases where conventional theory breaks down and behavior cannot be predicted accurately. Investigate the possibility of analog signal storage (electronic holography) by a system of independent nonlinear resonators or modes. Emphasize engineering applications of the phenomenon of nonlinear echoes (polarization echoes, parametric echoes). Examine the relevance to engineering of solitons and soliton theory, specifically ultrasonic solitons.

567 **Study of Nonlinear Wave Plasma Interaction;** Karl E. Lonngren; University of Iowa, Department of Electrical and Computer Engineering, Iowa City, IA 52242; Award #80-19363 A03; $65,400 for 12 months beginning 02/15/83 (QWB).

Explore four topics in nonlinear plasma wave interaction: excitation and interaction of two-and three-dimensional soliton waves in plasma media; self-similar behavior of various plasma phenomenon; radiation of linear and nonlinear plasma waves by probes and antenna structures; and characterization of sheaths in the neighborhood of a variety of probe configurations

and of the interaction between these sheaths and linear and nonlinear plasma waves.

568 **Study of the Optimal Design of Electromagnetic Pulse Radiators;** Robert E. McIntosh; University of Massachusetts, Department of Electrical and Computer Engineering, Amherst, MA 01003; Award #81-16158 A01; $54,424 for 12 months beginning 04/01/83 (QWB).

Explore the possibility of synthesizing transient electromagnetic signal radiators according to specified performance criteria. Define the relationship between the synthesis of transient electromagnetic antennas and those synthesis techniques used in conventional CW antenna or array design. Compare the performance of existing antennas with the optimum achievable performance. Synthesize new antenna configurations to improve the transmission of short time-duration electromagnetic pulses.

569 **Tunable Far Infrared Lasers;** Richard J. Temkin; Massachusetts Institute of Technology, Plasma Fusion Center, Cambridge, MA 02139; Award #81-17229 A01; $86,159 for 12 months beginning 04/01/83 (QWB).

Study wide-range tuning of a far infrared (FIR), laser pumped molecular gas laser system. Test the physics of the tuning process, the nature of tuning steps, the threshold for high intensity, off-resonant laser pumping, the onset of various multiphoton processes, and the rates of molecular excitation and relaxation. Investigate tuning in a variety of gases and at both near and far infrared wavelengths. Develop a quantum mechanical theory that uses the density matrix approach to predict the saturated FIR laser output vs. pump laser power and frequency in various gases. Compare experimental and theoretical results.

570 **Picosecond Phenomena and Devices;** Amnon Yariv; California Institute of Technology, Department of Applied Physics, Pasadena, CA 91104; Award #82-15157; $51,018 for 12 months beginning 02/15/83 (QWB); Split-funded with SSM for $20,000.

Perform research in picosecond optoelectronics in semiconductors, emphasizing materials, devices, and phenomena with ultimate application in extreme high frequency modulation and switching of optical signals. Explore ultrafast carrier and lasing dynamics in InGaAsP semiconductor lasers and ultrafast response of GaAs-AlGaAs and InGaAsP lasers to short current pulses.

571 **High Voltage Conduction and Breakdown Phenomena in Dielectrics;** Markus Zahn; Massachusetts Institute of Technology, Department of Electrical Engineeering and Computer Science, Cambridge, MA 02139; Award #82-16436; $85,000 for 12 months beginning 03/01/83 (QWB).

Measure and analyze high voltage conduction and breakdown phenomena in liquid dielectrics. Use laser Schlieren photography to view electrical trees and streamers, and Kerr electro-optic measurements to map electric field distributions. Examine the small-signal stability of equilibrium charge distributions, and calculate the fastest growing unstable wavelength. Determine if this analysis can be related to the characteristic spacings observed in electrical trees.

Science and Technology to Aid the Handicapped (STH)

572 **Tactile Perception of Speech;** James C. Craig; Indiana University, Department of Psychology, Bloomington, IN 47405; Award #80-17178 A02; $82,462 for 12 months beginning 02/01/83 (STH).

Examine the feasibility of using the tactile sense as an alternate modality for the perception of speech and the understanding of spoken language. Study how distinctive elements of the acoustic speech signals should be transformed to provide recognizable tactile patterns and determine effective training procedures for both perceptual learning of tactile speech displays and evaluating tactile representations of speech. Test natural and synthetic speech tokens on the skin of the finger(s) using computer-controlled, spectral display, and Optacon transducers. Develop training procedures for the acquisition of tactually presented speech. Examine the close association between speech production and speech perception by allowing learners of tactile speech to produce, hear, and feel his or her own speech patterns in real-time. Apply results of these experiments to the development and improvement of speech aids for the deaf and aids for the perception and production of speech.

573 **Workshops and Bulletins on Science and Technology for the Handicapped;** Martha R. Redden; American Association for the Advancement of Science, Office of Opportunities in Science, Washington, DC 20005; Award #79-20290 A03; $12,000 for 6 months beginning 03/15/83 (STH).

Bring together handicapped persons, researchers, and industry representatives to stimulate communication and research of benefit to the handicapped. Organize and conduct, over the next three years, a series of nine regional workshops of handicapped scientists and engineers and other researchers, as well as representatives of consumer organizations interested in science and technology for the handicapped. Review current research issues, make recommendations, and suggest priorities for research. Provide a continuing update of the program priorities for the ongoing NSF program, Science and Technology for the Handicapped. Publish the conference and workshop proceedings and a quarterly bulletin to be distributed to the workshop participants, mission agencies, and the Congress.

Solid-State and Microstructures Engineering (SSM)

574 **Low Temperature Characterization of Silicon MOSFETs;** Richard L. Anderson; University of Vermont, Department of Electrical Engineering, Burlington, VT 05401;

Award #82-14650; $59,995 for 12 months beginning 01/15/83 (SSM).

Enhance the understanding of charge transport phenomena in metal-oxide-semiconductor field-effect-transistors (MOSFETs) as a function of temperature. Evaluate the basic capabilities and limitations of device operation at low temperature and develop design rules for optimizing performance at any specific low temperature. Measure quasi-static electrical characteristics of silicon MOSFETs from 4°K to 150°C. Model these characteristics using results obtained from test junctions and ring oscillators fabricated on the same wafer as the MOSFETs. Program the threshold voltage and evaluate retention time. Evaluate the dependence of free carrier trapping on implantation.

575 **High Transition Temperature Superconducting Electronic Devices and Circuits;** Malcolm R. Beasley; Stanford University, Hansen Laboratory, Stanford, CA 94305; Award #82-18083; $105,005 for 12 months beginning 03/15/83 (SSM).

Investigate the potential applications of superconducting materials to electronic system requirements. Focus on basic elements required for high transition temperature (Tc), superconducting integrated electronics. Emphasize the incorporation of A15 superconductors into devices, circuits and functional electronic building blocks required for superconducting integrated electronics. Address superconducting quantum interference devices (SQUIDS) using high Tc microbridges and thin film coupling coils. Emphasize the integration of crossovers, and investigate the use of SNS devices. Examine microbridge Josephson junction arrays for use as functional electronic building blocks.

576 **Mechanism of Liquid Metal Ion Source Operation;** Anthony E. Bell; Oregon Graduate Center, Applied Physics and Electrical Science, Beaverton, OR 97005; Award #82-06796 A01; $56,594 for 12 months beginning 01/15/83 (SSM). Part of a total NSF Award of $86,594.

Examine various aspects of neutral atom/droplet emission, measure angular distribution of neutrals and droplets, and determine the composition of neutral clusters. Measure neutral velocity and consider the possibility that neutral atoms may originate from field induced decomposition of polymeric ions. Perform experiments to explore shape, size, and magnitude of the electric field at the tip. Investigate the effect of alloy composition on emission characteristics.

577 **Device Related Studies of Localized State Charge Storage and Field Ionization in Semiconductors;** Darryl D. Coon; University of Pittsburgh, Department of Physics and Astronomy, Pittsburgh, PA 15260; Award #82-02473 A01; $52,000 for 12 months beginning 06/01/83 (SSM).

Conduct research on localized state charge storage and field ionization, emphasizing new device concepts and applications. Focus on basic physical processes which ultimately limit device performance and study research results to make comparisons with other devices.

578 **Structure of Submicron Magnetic Bubbles;** Edward DellaTorre; George Washington University, Department of Electrical Engineering and Computer Science, Washington, DC 20052; Award #83-01154; $40,000 for 12 months beginning 01/01/83 (SSM).

Develop a combined model of a numerical model for coercivity and of the Kersten model for low magnetic moments and high wall energy; explore ramifications of these models. Focus on the role of inclusions as nucleation centers for complex wall structures leading to hard bubbles.

579 **Plasma Etching of Aluminum for Integrated Circuit Applications;** Dennis W. Hess; University of California, Electronics Research Laboratory, Berkeley, CA 94720; Award #80-21508 A02; $55,005 for 12 months beginning 02/15/83 (SSM).

Explore the differences between BCl_3 and CCl_4 plasmas in aluminum etching. Use a parallel plate plasma reactor to carry out the experimental procedures.

580 **Study of Gallium Arsenide Transistor Related Structures Grown by Molecular Beam Epitaxy;** Arthur G. Milnes; Carnegie-Mellon University, Department of Electrical Engineering, Pittsburgh, PA 15213; Award #82-14859; $71,000 for 12 months beginning 02/15/83 (SSM).

Study the relationships between molecular beam epitaxy (MBE) growth conditions, material properties and defects, and bipolar device characteristics. Emphasize four areas: enhancing minority carrier performance in MBE layers; measuring growth and evaluation of tapered layers for novel device structures; comparing heterojunction and homojunction bipolar transistors; and fabricating and evaluating thyristor type gate-triggered structures.

581 **Numerical Modeling of Semiconductor Microdevices;** David H. Navon; University of Massachusetts, Department of Electrical and Computer Engineering, Amherst, MA 01003; Award #81-15008 A01; $65,786 for 12 months beginning 03/15/83 (SSM).

Focus on numerical modeling of two-and three-dimensional effects on short channel MOS devices. Evaluate the capabilities and limitations of two-dimensional modeling at submicron channel lengths. Solve the Boltzmann particle flow equation using Monte Carlo techniques. Evaluate minimum channel lengths for which the macroscopic equations are valid and explore the possibility of a pseudo-mobility for shorter channel length devices in computer-aided design models.

582 **Integrated Sensing Devices Based on the Charge-Flow Transistor;** Stephen D. Senturia; Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, Cambridge, MA 02139; Award

#81-14781 A01; $76,000 for 12 months beginning 02/01/83 (SSM).

Extend recent advances in charge-flow transistor (CFT) technology for moisture measurement, corrosion measurement, and metal-oxide gas sensors. Develop a Fourier transform analysis system to measure and evaluate device transients. Emphasize increased on-chip functionality and new techniques for sub-femto amp measurement of interelectrode corrosion currents beneath passivating layers. Explore a novel technique for correlating moisture uptake with interelectrode corrosion.

583 **Indium Phosphide Insulating Gate Field Effect Transistors;** Melvin P. Shaw; Wayne State University, Department of Electrical and Computer Science, Detroit, MI 48202; Award #82-11841; $50,000 for 12 months beginning 02/01/83 (SSM).

Investigate indium phosphide (InP) field-effect-transistors (FETs). Construct a novel flowing afterglow plasma deposition system for the growth of thin amorphous insulating films. Correlate the electrical characteristics of metal-insulator-semiconductor structures made from these films with ion-backscattering, x-ray fluorescence, and x-ray spectroscopy to determine the nature of vital interfaces and trapping and transport effects. Determine the effect of InP bulk and interface properties on charge transport in two and three terminal devices. Emphasize the dependence of current instabilities on geometry, boundary conditions, and circuit interactions.

584 **Thin Film Real Time Convolvers and Correlators;** Wen Chung Wang; Polytechnic Institute of New York, Department of Electrical Engineering, Brooklyn, NY 11201; Award #81-00456 A01; $59,900 for 12 months beginning 02/15/83 (SSM).

Develop a monolithic convolver and thin film real time correlator with low loss compared to a conventional separate medium convolver. Develop an improved ZnO film deposition system capable of device-quality films, and a flash evaporation technique to deposit InSb films. Emphasize controlled film deposition and characterization.

585 **Charge Transport and Storage in MNOS Memory Devices;** Marvin H. White; Lehigh University, Sherman Fairchild Laboratory, Department of Electrical and Computer Engineering, Bethlehem, PA 18015; Award #82-03096 A01; $57,000 for 12 months beginning 07/01/83 (SSM).

Study charge transport and storage in thin oxide, non-volatile, MNOS memory device structures. Incorporate a new MNOS structure to investigate tunneling of charge from silicon into insulator traps. Correlate electrical parameters such as distribution of charge in bulk and surface traps with fabrication parameters. Use photoemission and fast ramp techniques to examine tunneling properties.

Systems Theory and Operations Research (STO)

586 **Network Reliability;** Richard E. Barlow; University of California, Department of Industrial Engineering and Operations Research, Berkeley, CA 94720; Award #81-15000 A01; $51,886 for 12 months beginning 02/01/83 (STO).

Investigate computational and analytical methods for reliability evaluation of complex networks and for the design of highly reliable networks. Examine efficient reliability analysis techniques for large-scale networks; study the complexity of the exact network reliability problem; and develop methodologies for the analysis of time-dependent measures of network reliability.

587 **Generalized Convexity and Its Applications in Optimization, Economics, and Analysis;** Adi Ben-Israel; University of Delaware, Department of Mathematical Sciences, Newark, DE 19711; Award #82-14081; $39,973 for 24 months beginning 06/01/83 (STO). Part of a total NSF Award of $79,945.

Develop a unified, widely applicable theory of generalized convexity, based on general (nonaffine) supports. Solve the basic economic models of production, utility and consumption, under realistic assumptions (in particular, nonlinear economic functions). Develop the theory and methodology of generalized Lagrangians (based on F-convexity), applicable to general nonlinear (nonconvex) programming. Develop applications of F-convexity in numerical analysis.

588 **Computational Methods for Large-Scale Problems in Nonlinear Programming and Optimal Control;** Dimitri P. Bertsekas; Massachusetts Institute of Technology, Electrical Engineering and Computer Science, Cambridge, MA 02139; Award #82-17668; $60,000 for 12 months beginning 03/01/83 (STO).

Investigate four problem areas in large-scale optimization methods. Study computational problems of non-convex optimization in the presence of equality constraints; analyze and extend gradient projection algorithms; solve large-scale multicommodity network flow problems arising in data communication and transportation problems; and conduct research on distributed asynchronous algorithms for optimization.

589 **Constructive Procedures for Multi-Dimensional Systems;** Nirmal K. Bose; University of Pittsburgh, Department of Electrical Engineering, Pittsburgh, PA 15260; Award #78-23141 A02; $38,274 for 12 months beginning 01/15/83 (STO).

Investigate design procedures for multi-dimensional systems. Study a general problem of compensator design for dynamic multivariable bidimensional feedback systems. Direct attention to the choice of a controller which not only stabilizes the plant but also yields other desirable properties of the feedback system. Investigate the realization of lower order filters required in spatial filtering problems. Construct solutions to the

dynamic compensator design and other problems using the already available software.

590 **Optimization of Large-Scale Dynamic Systems with Special Reference to Energy and Water Resources;** George B. Dantzig; Stanford University, Systems Optimization Laboratory, Stanford, CA 94305; Award #80-12974 A02; $93,000 for 12 months beginning 11/15/82 (STO); Split-funded with CEE (HHW) for $93,000.

Examine the useful interaction between mathematical programming methods and energy modeling. Investigate methods for linking a large-scale, regionalized water-energy model with a dynamic, nationally aggregated energy-economic model. Develop numerical and computational nonlinear programming methods for solution of large-scale optimization problems with nonlinear constraints that arise in the energy and water resources modeling activity.

591 **Basic Research in System Theory;** Charles A. Desoer; University of California, Electronics Research Laboratory, Berkeley, CA 94720; Award #81-19763 A01; $53,000 for 12 months beginning 03/01/83 (STO).

Develop the theoretical base of design techniques using mathematical tools for engineering systems design. Consider research in frequency domain design methodology for feedback systems; the development of methods for the computer-aided design of linear multi-input, multi-output feedback systems; and the development of a general theory of tracking and disturbance rejection for nonlinear control systems.

592 **Optimal Design and Control of Queueing Systems;** Frederick S. Hillier; Stanford University, Department of Operations Research, Stanford, CA 94305; Award #80-17867 A02; $71,000 for 12 months beginning 01/01/83 (STO).

Develop an optimization theory for the design and control of queueing systems. Emphasize unifying and generalizing parts of the theory, and adapt the theory to specific important classes applicable to real queueing systems. Investigate networks of queues, systems of finite queues in series, and inventory systems. Focus on analysis and algorithmic development for more robust models of simple systems and for models of multi-dimensional systems. Develop exact methods and diffusion approximations for controlling the service mechanism at a single station with one or more servers. Direct attention to models for controlling synchronized queues and for scheduling distinguishable customers for service. Study the relationship between holding and waiting costs in queueing systems.

593 **Study and Development for New Square-Root Least Squares Algorithms for Estimation in Large-Scale Systems;** Thomas Kailath; Stanford University, Department of Electrical Engineering, Stanford, CA 94305; Award #82-00065 A01; $47,293 for 12 months beginning 04/01/83 (STO).

Investigate square-root ladder algorithms for estimation and identification in stochastic systems. Concentrate on the system-theoretic and structural aspects of these algorithms. Use the algorithms to obtain computationally useful solutions to basic linear systems problems such as controllability, observability, and stability properties. Consider the applicability of the algorithms to multichannel signal processing and to systems identification for adaptive and stochastic control.

594 **Computer-Aided Reconstructability Analysis of Multi-dimensional Systems;** George J. Klir; State University of New York at Binghampton, Department of Systems Science, Binghampton, NY 13901; Award #82-17103; $50,000 for 12 months beginning 07/01/83 (STO).

Investigate evaluation, computation, and simulation problems related to research on reconstructability analysis. Design alternative search and evaluation procedures for reconstruction subject to information constraints. Determine the computational complexity of reconstruction algorithms, and develop efficient algorithms. Evaluate reconstructability analysis by simulation experiments and integrate the analysis in an overall software package for systems modeling applicable to industrial engineering problems.

595 **Analysis and Design Techniques for Control Systems with a Distributive Structure;** E. Bruce Lee; University of Minnesota, Department of Electrical Engineering, Minneapolis, MN 55455; Award #82-17375; $50,036 for 12 months beginning 03/01/83 (STO).

Develop controller analysis and synthesis techniques for control systems with a distributive structure of pure time delay type and other generalized systems. Concentrate on optimal control techniques for sampled data hereditary systems, and on structural properties and simplified feedback controllers for generalized systems. Investigate large-scale systems theory, particularly the role of information transmission and processing delays in feedback structures.

596 **Applications of Stochastic Realization Theory;** Anders Lindquist; University of Kentucky, Department of Mathematics, Lexington, KY 40506; Award #82-15660; $40,000 for 24 months beginning 02/01/83 (STO).

Apply the geometric theory of stochastic realization to such topics as smoothing, interpolation, and model reduction. Consider the problem of modeling of stochastic systems from partial covariance data. Study the nonlinear stochastic realization problem and assess its possible use in nonlinear filtering.

597 **Minimax Approaches to Robust Control and Estimation for Dynamical Systems;** D. P. Looze; University of Illinois, Coordinated Science Laboratory, Urbana, IL 61801; Award #82-12080; $64,784 for 24 months beginning 04/01/83 (STO).

Investigate minimax estimation and control problems for stochastic systems driven by and observed in

noise with uncertain second-order statistics. Discover new techniques for designing systems which will perform well in uncertain statistical environments. Consider the design of robust state estimators and controllers for systems with spectral uncertainty, the development of practical implementation algorithms for such procedures, and the analysis of the sensitivity of these schemes to statistical uncertainty. Determine fundamental relationships between uncertainty models and the structural properties of the corresponding robust filters and controllers.

598 **Descriptor Variable Systems Theory with Applications to Control and Optimization of Technological /Economic Production Systems;** David G. Luenberger; Stanford University, Department of Engineering-Economic Systems, Stanford, CA 94305; Award #82-14254; $50,000 for 12 months beginning 02/01/83 (STO).

Investigate solution methods for descriptor variable systems and study structural issues arising in these models. Consider the relation of system structure to the consistency of given boundary conditions; and study inference or observability, and structural controllability of these systems.

XX Michalopoulis, Panos G., see CEE (HHW).

599 **Design of Multivariable Control Systems;** J. B. Pearson; Rice University, Department of Electrical Engineering, Houston, TX 77001; Award #81-02895 A02; $54,083 for 12 months beginning 06/01/83 (STO).

Investigate design methodology for linear multivariable control systems. Extend these frequency domain techniques to include the effects of modeling uncertainty and large parameter variations. Merge the notion of feedback realizability with comparison sensitivity so as to yield feedback systems which have both prescribed filter and robustness characteristics. Examine the use of controller parameterization to achieve general synthesis goals and use generalized polynomial representations of systems to determine an effective framework for compensator design for uncertain systems.

600 **Martingale Methods and Stochastic Decision Models in Operations Research;** Stanley R. Pliska; Northwestern University, Department of Industrial and Management Sciences, Evanston, IL 60201; Award #82-15640; $54,978 for 24 months beginning 03/01/83 (STO).

Expand the use of martingale methods and stochastic calculus in operations research by deriving a discrete-time, stochastic control model where the underlying process being controlled can be non-Markovian. Develop an alternative, efficient computational procedure that involves stochastic calculus and convex optimization. Investigate a duality theory, leading to the provocative result that the dual variables are martingales. Illustrate the usefulness of the model by examples from industrial engineering such as production-inventory control, queueing control, or maintenance scheduling.

601 **Design of Multivariable Control Systems;** Michael K. Sain; University of Notre Dame, Department of Electrical Engineering, Notre Dame, IN 46556; Award #81-02891 A02; $59,010 for 12 months beginning 06/01/83 (STO).

Investigate design methodology for linear multivariable control systems. Extend these frequency domain techniques to include the effects of modeling uncertainty and large parameter variations. Merge the notion of feedback realizability with comparison sensitivity so as to yield feedback systems which have both prescribed filter and robustness characteristics. Examine the use of controller parameterization to achieve general synthesis goals. Use generalized polynomial representations of systems to determine an effective framework for compensator design for uncertain systems.

602 **On-Line Tool Wear Estimation and Failure Detection in Metal-Cutting Operations;** Nils R. Sandell; Alphatech, Inc., Burlington, MA 01803; Award #82-12886; For 24 months beginning 03/01/83 (STO). Part of a total NSF Award of $199,994.

Investigate techniques for wear estimation and failure detection of metal-cutting tools during machining operations. Develop algorithms for a microprocessor-based system to diagnose the state of cutting tools based on cutting force and power measurements generated by sensors monitoring the cutting process in a factory environment. Validate algorithm performance using real metal-cutting industry data.

603 **Controllability and Avoidability Problems for Systems With and Without Disturbances;** William E. Schmitendorf; Northwestern University, Department of Mechanical and Nuclear Engineering, Evanston, IL 60201; Award #80-24300 A02; $44,993 for 12 months beginning 08/01/83 (STO).

Examine controllability and avoidability problems associated with the design of control systems. Develop criteria for determining if an admissible control exists which steers the system to the target set. Investigate global controllability and controllability from an initial point. Develop techniques for determining such a control. Consider systems with and without disturbances.

604 **Decentralized Control of Large-Scale Systems;** Dragoslav D. Siljak; University of Santa Clara, Department of Electrical Engineering and Computer Science, Santa Clara, CA 95053; Award #80-11210 A02; $58,959 for 12 months beginning 05/01/83 (STO).

Develop concepts and design methods for decentralized control of large-scale systems composed of interconnected subsystems, which have their own local computational capabilities for independent processing of information and control. Study and resolve the problem of formulating decentralized control strategies based upon overlapping information sets.

605 **Algorithms for Large-Scale Linear Programming and Nonlinear Equations;** Michael J. Todd; Cornell Uni-

versity, Department of Operations Research and Industrial Engineering, Ithaca, NY 14853; Award #82-15361; $17,463 for 12 months beginning 03/01/83 (STO). Part of a total NSF Award of $34,925.

Examine large-scale linear programming. Test a general technique that treats several types of specially-structured constraints in two applications (variable upper bounds and block-angular structure). Extend it to deal with other types of constraints. Develop simplicial or piecewise-linear homotopy methods for solving systems of nonlinear equations. Develop a new "semi-simplicial" algorithm using a piecewise bilinear homotopy. Test other accelerated algorithms for such problems.

606 **Solution and Approximation Techniques in Stochastic Optimization;** Roger J.B. Wets; University of Kentucky, Department of Mathematics, Lexington, KY 40506; Award #82-13852; $19,954 for 12 months beginning 02/01/83 (STO). Part of a total NSF Award of $39,907.

Study stochastic optimization models, emphasizing the directions that are most likely to lead to computationally implementable techniques. Concentrate on stochastic problems of the Bolza type and explore computational techniques that are applicable to the solution of the recourse problem. Investigate questions related to problems of the Bolza type that exhibit network-like structure. Address the mathematical theory underlying the approximation and convergence of algorithmic procedures. Investigate the theory of epi-convergence, emphasizing rates of convergence, epi/hypo-convergence, and stochastic functionals.

607 **Multiple Objective Linear Programming: Evaluation and Further Methodological Development;** Stanley Zionts; State University of New York at Buffalo, Department of Management Science and Systems, Buffalo, NY 14260; Award #82-19054; $38,497 for 12 months beginning 06/01/83 (STO).

Investigate the Zionts-Wallenius approach for solving multicriteria linear programming problems. Subject the method to comprehensive robustness tests using several different nonlinear utility functions as well as random decision-maker errors.

Division of Mechanical Engineering and Applied Mechanics (MEAM)

Fluid Mechanics (FLM)

608 **Spreading of Oil Films on Water in the Surface Tension Regime;** John C. Berg; University of Washington, Chemical Engineering Department, Seattle, WA 98195; Award #81-09226 A01; $40,981 for 12 months beginning 02/01/83 (FLM); Split-funded with CPE (TTP) for $20,000.

Study the relationship between velocity gradients, surface tension and thickness variations of the film, and surface fractionation of multicomponent oils during spreading on water.

609 **Industry/University Cooperative Research: Particle Motion in a Turbulent Boundary Layer;** Frederick K. Browand; University of Southern California, Aerospace Engineering, Los Angeles, CA 90007; Award #79-10730 A02; $36,876 for 12 months beginning 11/01/82 (FLM). Part of a total NSF Award of $73,752.

Investigate particle motion in a turbulent boundary layer.

610 **Industry-University Cooperative Research: Theoretical and Experimental Analysis of Interacting Flows Over Multielement Airfoils at High Reynolds Numbers;** Tuncer Cebeci; California State University, Mechanical Engineering Department, Long Beach, CA 90840; Award #80-18565 A02; $101,420 for 12 months beginning 11/01/82 (FLM). Part of a total NSF Award of $202,840.

Analyze interacting flows over multielement airfoils at high Reynolds numbers. Perform separation bubble studies using interactive boundary-layer theory. Conduct experiments on multi-element airfoils.

611 **Conference on Double-Diffusive Convection, March 13-18, 1983, Santa Barbara, CA;** Chuan F. Chen; United Engineering Trustees, Inc., Department of Aerospace and Mechanical Engineering, New York, NY 10017; Award #82-13910; $5,000 for 8 months beginning 02/15/83 (FLM); Split-funded with HET for $4,000; Split-funded with OIR for $4,000. Part of a total NSF Award of $21,000.

Study double-diffusive convection in fluid mixtures of two components having different molecular diffusivities. Foster interaction and cross-fertilization between fluid dynamicists working in this area and scientists and engineers studying systems where this phenomenon might be important.

612 **Computational Study of Shear Turbulence;** Sin-I Cheng; Princeton University, Department of Mechanical and Aerospace Engineering, Princeton, NJ 08544; Award #80-10876 A02; $37,280 for 12 months beginning 02/03/83 (FLM).

Perform a computational study of shear turbulence. Use a crude grid system to numerically generate a turbulent spot-like three-dimensional vortical structure by solving time-dependent Navier Stokes equations.

613 **Workshop on Taylor Vortex Flow, University of Oregon, June 1983;** Russell J. Donnelly; University of Oregon, Department of Physics, Eugene, OR 97403; Award #83-08928; $17,400 for 12 months beginning 03/15/83 (FLM).

Hold a workshop entitled "Sixtieth Anniversary of Taylor Vortex Flow" at the University of Oregon, June 13-15, 1983. Assess the state of knowledge of flow between concentric cylinders or Couette flow. Investigate the future direction of Couette flow as a controlled flow to study nonlinear stability, transition to turbulence, and approach to chaos.

614 **Experiments on Spectral Energy Redistribution Due to Nonlinear Interactions and Phase and Amplitude Modulations During Transition to Turbulence;** Richard W. Miksad; University of Texas, Department of Civil Engineering, Austin, TX 78712; Award #82-11205; $109,873 for 12 months beginning 02/15/83 (FLM).

Study the mechanisms by which nonlinear interactions, and amplitude and phase modulations influence the spectral broadening and energy redistribution process during transition to turbulence. Use digital spectral and bispectral analysis techniques to quantitatively identify nonlinearly coupled modes in the fluctuation spectrum. Measure the complex coupling coefficient describing the physics of the interaction. Use digital complex demodulation techniques to investigate and interpret the changing phase and amplitude modulation characteristics observed in the nonlinear stages of transition.

615 **Experimental Study of the Stability of an Oscillatory Boundary Layer Using Controlled Excitation;** Peter A. Monkewitz; University of California, Department of Mechanics and Structures, Los Angeles, CA 90024; Award #82-14719; $95,196 for 24 months beginning 02/15/83 (FLM).

Study the stability and transition of an unsteady boundary layer in a U-channel of rectangular cross section with water as working fluid. Explore the flow up to velocity amplitudes of 1 m/sec, corresponding to a Reynolds number of 1000 based on the Stokes length scale. Focus on the controlled excitation of instability waves by electrical strip heaters mounted flush with the wall and on the measurement of their subsequent

development characterized by temporal growth rates and mode shapes. Study the influence of unsteadiness of the basic flow on the instabilities. Follow the instabilities through transition and the formation of turbulent regions.

616 **Biomechanics of Diarthrodial Joints;** Van C. Mow; Rensselaer Polytechnic Institute, Department of Mechanical/Aeronautical Engineering and Mechanics, Troy, NY 12181; Award #82-11968; $120,000 for 12 months beginning 03/01/83 (FLM).

Study normal and pathological synovial joints. Examine linear and nonlinear phenomena in articular cartilage deformation; rheological characterizations of biomacromolecular solutions; and sub-problems towards development of a lubrication theory for synovial joints.

617 **Studies of Ship Hydrodynamics and Water Waves;** J. N. Newman; Massachusetts Institute of Technology, Department of Ocean Engineering, Cambridge, MA 02139; Award #82-10649; $210,000 for 12 months beginning 02/01/83 (FLM).

Investigate the hydrodynamics of ship motions and surface waves. Focus on the further development of the unified slender-body theory with forward speed, the nonlinear behavior of the free surface near a moving body, the nonlinear interaction of short and long waves with and without the presence of a surface body or a shoal, the two-dimensional wave instability (with special emphases on damping higher order nonlinearity and the downward shift of the carrier wave frequency), and the modulation of capillary-gravity waves.

618 **Numerical Simulation of Transition to Chaos in Finite Containers;** Steven A. Orszag; Massachusetts Institute of Technology, Department of Mathematics, Cambridge, MA 02139; Award #82-15695; $76,000 for 12 months beginning 03/01/83 (FLM).

Develop and apply two- and three-dimensional pseudo-spectral methods to study the transition and subsequent chaos in flows within finite containers. Study the transition and turbulence in cylindrical Couette flow. Use time-dependent three-dimensional codes as well as steady-state nonlinear solvers to examine the equilibrium states, their linear and nonlinear instabilities, and various transitions to turbulent flows. Analyze the transitions in spherical Couette flow that take place between two concentric, differentially rotating spheres. Consider thermal convection in a rigid no-slip rectangular box and study transitional and turbulent convecting flows.

619 **Study of End Effects in Couette Flow;** Kwangjai Park; University of Oregon, Department of Physics, Eugene, OR 97403; Award #82-08804; $79,941 for 24 months beginning 03/01/83 (FLM).

Study end effects in Couette Flow using global flow pattern analysis. Obtain a clear experimental picture of the effects of ends on the evolution of Couette Flow and examine the quantization problem at the onset of Taylor flow; the onset of wavy mode; turbator dynamics at in-mode transition points; and the effects of external perturbations on stability boundaries.

620 **Microcirculatory Flow: A Study of Fluid Movement in Complex Porous Structures;** Eric P. Salathe; Lehigh University, Center for Applied Mathematics, Bethlehem, PA 18015; Award #80-06782 A03; $53,500 for 12 months beginning 02/01/83 (FLM).

Describe quantitatively microcirculatory phenomena of an entire organ through the use of a comprehensive analytical model that couples both fluid and particle movements in microcirculation.

621 **Pressure Velocity Correlation in Reacting Turbulent Flows;** Warren C. Strahle; Georgia Institute of Technology, Department of Aerospace Engineering, Atlanta, GA 30332; Award #80-22366 A02; $75,858 for 12 months beginning 01/20/83 (FLM).

Determine velocity-pressure gradient correlations in three-dimensional reacting turbulent flows.

622 **Propagation of Shock Waves in Random Media;** Bradford Sturtevant; California Institute of Technology, Aeronautics Department, Pasadena, CA 91104; Award #81-20092 A01; $70,110 for 12 months beginning 02/01/83 (FLM).

Examine the propagation of shock waves in random media. Study the refraction of shock waves at curved interfaces between fluids of different sound speeds. Use an analogy between sharp-fronted acoustic waves in liquids and optical waves.

623 **Dynamical Instabilities and Turbulence in Flow Between Independent Rotating Cylinders;** Harry L. Swinney; University of Texas, Department of Physics, Austin, TX 78712; Award #82-06889; $85,000 for 12 months beginning 02/01/83 (FLM). Part of a total NSF Award of $120,000.

Study instabilities and the onset of turbulence in flow between independently rotating concentric cylinders (the Couette-Taylor system). Determine spatial and temporal correlations by scattering intensity and laser Doppler velocimetry techniques. Investigate the different dynamical regimes and the transitions between them. Test solutions of the Navier-Stokes equation obtained numerically in a parallel collaborative study. Determine the dimensionality of phase space attractors.

624 **Experimental Studies of Transition in Plane Poiseuille Flow;** Sheila E. Widnall; Massachusetts Institute of Technology, Aeronautics/Astronautics Departments, Cambridge, MA 02139; Award #82-11478; $85,016 for 12 months beginning 03/15/83 (FLM).

Study transition to turbulence in plane Poiseuille flow, conducting experiments in a water channel with supporting theoretical efforts. Use a flow visualization technique using titanium dioxide-coated mica particles to obtain a global picture of various processes involved in the transition to turbulence. Make LDV measure-

ments of the mean and the transient flows. Study the response of flow to both transient point-like and wave-like disturbances.

625 **Biophysical Fluid Mechanics;** Theodore Y. Wu; California Institute of Technology, Department of Engineering Science, Pasadena, CA 91104; Award #81-18429 A01; $94,892 for 12 months beginning 03/11/83 (FLM).

Address hydrodynamic problems related to biophysical phenomena. Develop a hybrid theory by combining the singularity method and the boundary integral equation method. Conduct experiments to measure, by using fluorescent tracing particles, the velocity distribution within the mucus and serous fluid to derive the rate of strain in nearly *in vivo* condition. Assess the current theoretical models and provide a sound basis for biorheological studies of mucus. Perform research on wall effects in low Reynolds number flows. Extend unsteady slender-body theory to consider a general swimming form (such as anguilliform) noted by dorso-ventral fins executing distally progressive waves independent of body motion.

Heat Transfer (HET)

626 **Natural Convection in a Porous, Eccentric, Annular Gap and from a Pipe Buried in Permeable Medium;** Haim H. Bau; University of Pennsylvania, Department of Mechanical Engineering, Philadelphia, PA 19104; Award #82-17565; $86,583 for 15 months beginning 06/01/83 (HET).

Study convective heat transfer in a porous eccentric annulus and from a pipe buried in semi-infinite permeable medium. Obtain the flow and temperature fields in the porous medium, the Nusselt (Nu) versus Rayleigh (Ra) number correlations for various geometries and the eccentricity values which minimize/maximize the heat transfer rates. Formulate two-dimensional, steady governing equations in bicylindrical coordinates.

627 **Turbulent Heat Transport Downstream of an Abrupt Expansion in a Circular Tube;** James W. Baughn; University of California, Mechanical Engineering Department, Davis, CA 95616; Award #81-03657 A01; $56,723 for 12 months beginning 01/01/83 (HET).

Investigate local heat transfer in the vicinity of an abrupt axisymmetric pipe expansion with turbulent flow. Measure the local heat transfer coefficients by fixing a constant wall heat flux and measuring the local temperatures. Develop a calculation method for determining convective heat transfer rates in axisymmetric pipe expansion and similar flows for arbitrary Reynolds and Prandtl numbers with both developing and fully developed inlet conditions. Use air fluid and hot wire anemometry to study the turbulent flow.

628 **Industry/University Cooperative Research: Thermal Convection in Cavities with Applications to Crystal Growth and Other Problems;** Philip A. Blythe; Lehigh University, Center for the Application of Mathematics, Bethlehem, PA 18015; Award #81-15333 A01; $20,345 for 12 months beginning 03/11/83 (HET). Part of a total NSF Award of $40,690.

Study cavity flows which are driven by horizontal temperature gradients in the limit when the Rayleigh number is large. Analyze the L-dependence of such cavity flows, paying particular attention to the velocity profiles and to the heat transfer characteristics.

629 **Workshop on Macro- and Microscopic Modeling of Heat and Mass Transfer in Biological Systems, April 26-29, 1983—Urbana, Illinois;** John C. Chato; University of Illinois, Bioengineering Faculty, Urbana, IL 61801; Award #82-19725; $7,500 for 6 months beginning 04/01/83 (HET); Split-funded with CPE(TTP) for $4,000.

Explore and evaluate current methods of modeling biological thermal systems and mass transfer processes, both on a macroscopic (whole organ) and on a microscopic (microcirculatory) scale.

630 **Collaborative Research: Theoretical Studies of Laser-Induced Buoyant and Thermophoretic Motions in Aerosols;** John W. Cipolla; Northeastern University, Department of Mechanical Engineering, Boston, MA 02115; Award #83-02315; $49,712 for 12 months beginning 03/01/83 (HET).

Study thermophoretic and buoyant motions induced by laser irradiation of an absorbing aerosol-gas mixture. Focus attention on two important test problems: laminar flow in horizontal tubes and channels experiencing axial laser irradiation and thermophoretic aerosol motions, and natural convection in isothermal vertical enclosures caused by axial laser irradiation.

631 **Cryogenic Approach to Convective Heat Transfer Research;** Arthur M. Clausing; University of Illinois, Department of Mechanical and Industrial Engineering, Urbana, IL 61801; Award #82-11280; $62,094 for 12 months beginning 02/01/82 (HET).

Investigate basic convective heat transfer phenomena using a cryogenic approach. Improve the cryogenic facilities on convective heat transfer research. Extend research already conducted emphasizing high Grashof number regimes and combined convection regimes where large Reynolds numbers must be simultaneously generated. Focus on variable fluid property influences.

632 **Computation of the Windward Region Boundary Layer on a Heated Circular Cylinder;** M. E. Crawford; University of Texas, Department of Mechanical Engineering, Austin, TX 78712; Award #83-04389; $23,690 for 12 months beginning 06/01/83 (HET).

Examine the influence of cylinder surface temperature on the fluid dynamic and heat transfer characteristics of a circular cylinder in high Reynolds number cross-flows. Evaluate the ability of state-of-the-art numerical boundary layer methods to predict the influence of the surface temperature on boundary layer development

and local heat transfer rates. Improve deficiencies in numerical models based on experimental results obtained in a coordinated investigation.

633 **Heat Transfer Properties of Rotating and Convecting Liquid Cryogens;** Russell J. Donnelly; University of Oregon, Department of Physics, Eugene, OR 97403; Award #82-12102; $44,867 for 12 months beginning 03/01/83 (HET).

Construct a cryogenic Benard cell to exploit the properties of liquid ^{4}He and mixtures of liquid ^{3}He and ^{4}He. Vary properties by adjusting the concentration of ^{3}He and the mean temperature of the fluid cell. Mount the cell on a 42-inch rotating table. Observe the onset of both steady and overstable convection in Helium I.

634 **Combined Heat and Mass Transfer with Phase Change in Porous Media;** Ernest R. Eckert; University of Minnesota, Department of Mechanical Engineering, Minneapolis, MN 55455; Award #82-09107; $106,624 for 24 months beginning 01/01/83 (HET).

Study combined heat and mass transfer with phase change. Examine the unsteady transport processes which occur and consider differences between experimental results and those of a similarity analysis. Carry out experiments to determine if some porous materials fulfill the similarity requirement. Measure the local moisture content.

635 **Improved Method for Engineering Analysis of Radiative Transfer in Industrial Furnaces;** John R. Howell; University of Texas, Energy Studies and Mechanical Engineering, Austin, TX 78712; Award #82-10246; $51,696 for 12 months beginning 06/01/83 (HET).

Investigate a method of furnace heat transfer analysis that retains the computational ease and speed of the Hottel zoning approach, but allows easier determination of the geometric effect of complex geometries. Develop the experimental method, determine the errors involved in its application, and apply it to solve sample problems in geometries typical of industrial process furnaces.

636 **Multidimensional Heat Transfer Studies of Phase Changing Material with Embedded Fluid Carrying Pipes;** Latif M. Jiji; City College of the City University of New York, Department of Mechanical Engineering, New York, NY 10031; Award #82-09034; $61,135 for 12 months beginning 02/01/83 (HET).

Consider steady and transient multi-dimensional heat transfer problems with phase changes outside a fluid carrying tube with an unknown axial thermal interaction. Obtain approximate analytical solutions using a theoretical model which accounts for the combined effects of axial variations in the fluid/PCM coupled domain and the presence of the planar free surface near the tube.

637 **Mixed Convection from Spheres;** Arthur T. Johnson; University of Maryland, Department of Agricultural Engineering, College Park, MD 20742; Award #82-11576; $35,692 for 12 months beginning 01/01/83 (HET).

Model forced and natural convection processes around a spherical object, obtain results from the model which may be subjected to experimental verification, find experimental data to verify model results, and use the model to generate data leading to a simplified method for calculating mixed convective heat transfer from a sphere. Use both finite difference and finite element approaches.

638 **Drag and Heat Transfer Behavior of a Heated Circular Cylinder;** J. Michael Macha; Texas A&M University, Department of Aerospace Engineering, College Station, TX 77843; Award #83-03846; $37,765 for 12 months beginning 06/01/83 (HET).

Study the influence of cylinder surface temperature on the fluid dynamic and heat transfer characteristics of a circular cylinder in high Reynolds number crossflow. Quantify the effects of T_S/T_r on surface pressure distribution, locations of boundary layer transition and/or separation, local heat transfer rates, overall cylinder drag and heat transfer, structure of the velocity and thermal wakes, and the frequency of vortex shedding. Test the heated cylinders in a wind tunnel facility for a range of $1.0 < T_S/T_r < 2.4$ at both subcritical and supercritical values of Reynolds number. Evaluate the ability of state-of-the-art numerical boundary layer methods to predict the influence of T_S/T_r on boundary layer development and local heat transfer rates.

639 **Collaborative Research: Strong Radiative Interaction With an Aerosol-Gas Mixture: Thermophoresis and Convection;** Theodore F. Morse; Brown University, Division of Engineering, Providence, RI 02912; Award #82-15127; $70,000 for 12 months beginning 02/15/83 (HET).

Study the strong non-linear coupling of radiation induced convection and thermophoresis. Use a 275 Watt (CW) Coherent Radiation Model 41 Laser that interacts with an SO aerosol in a variety of configurations. Modify deposition efficiencies in an internal Modified Chemical Vapor Deposition process, and conduct experiments to examine the influence of focused laser radiation in modifying particle deposition in an external boundary-layer type flow.

640 **Analysis of Turbulent Flows;** Richard H. Pletcher; Iowa State University, Department of Mechanical Engineering, Ames, IA 50010; Award #82-11713; $57,780 for 12 months beginning 03/01/83 (HET).

Develop accurate turbulence modeling and numerical procedures to predict heat transfer parameters in two-dimensional and axisymmetric flows containing separated regions. Complete experiments on buoyant jets in cross flow. Develop calculation schemes and turbulence modeling for complex jet flows characteristic

of engine component cooling applications and thermal discharges into waterways and from stacks and cooling towers. Resolve basic questions on turbulence modeling for wake flows. Develop prediction methods, including turbulence modeling, for three-dimensional wall shear flows which may contain regions of separation.

641 **Radiative Properties and Heat Transfer Analysis of Fibrous Insulations;** Jeffrey A. Roux; University of Mississippi, Department of Mechanical Engineering, University, MS 38677; Award #82-17974; $42,943 for 12 months beginning 07/01/83 (HET).

Determine the monochromatic absorption coefficient, k, and scattering coefficient, x, of fibrous insulation in the 2 micron to 40 micron wavelength region. Obtain experimental reflectance data by use of a gold-coated integrated sphere interfaced with a Fourier Transform Spectrometer, a long wavelength mercury cadmium teluride detector, and a grating spectrometer. Make measurements on ten samples in thicknesses ranging from 0.10 to 0.50 inches. Use radiative properties to make non-gray predictions of the coupled conduction and radiation transport through the fibrous insulation.

642 **Fourth Symposium on Turbulent Shear Flows—September 12-14, 1983—Karlsruhe, West Germany;** Frank W. Schmidt; Pennsylvania State University, Department of Mechanical Engineering, University Park, PA 16802; Award #82-17962; $3,000 for 12 months beginning 03/15/83 (HET). Split-funded with FLM for $3,000.

Advance the understanding of the physical phenomena associated with turbulent flows and the capabilities for calculating processes such as the transport of heat and mass. Present technical papers and debate and discuss issues in this field.

643 **Evaporative Heat Transfer Characteristics of the Contact Line Region of a Mixture;** Peter C. Wayner; Rensselaer Polytechnic Institute, Department of Chemical and Environmental Engineering, Troy, NY 12181; Award #82-13690; $63,391 for 12 months beginning 01/15/83 (HET).

Study heat, mass, and momentum transport processes in the leading edge region of a two-component evaporating stationary thin film. Obtain experimental data in the leading edge region where the liquid film thickness is less than 10^{-5}m. Determine integral heat flow rates, contact line stability, "burn-out" heat flux and temperature, and apparent contact angles. Evaluate the effect of bulk composition on both the microscopic and macroscopic heat transfer characteristics. Record significant visual observations using either a video cassette recorder and/or cinemicrography.

Mechanical Systems (MES)

644 **Three-Dimensional Effects in Fluid Film Lubrication;** Christopher M. Ettles; Rensselaer Polytechnic Institute, Department of Mechanical, Aeronautical Engineering and Mechanics, Troy, NY 12181; Award #82-12511; $62,869 for 12 months beginning 01/15/83 (MES).

Focus on that branch of two-dimensional thermohydrodynamic (THD) theory that views the fluid lubrication film in elevation. Concentrate on truncation error, stability, and rate of convergence issues. Apply the research results to thrust bearings to investigate the size effect and to find the appropriate amount and location of cooling. Investigate the generation of heat and of film waviness and stability.

645 **Investigation of a Novel Robot Arm;** Eugene F. Fichter; Oregon State University, Department of Industrial and General Engineering, Corvallis, OR 97331; Award #81-21403 A01; $64,657 for 12 months beginning 01/28/83 (MES).

Investigate the mechanics, controllability, and industrial application of an alternative robot arm. Study the arm using the methods of kinematics as well as the theory of screws. Use a computer simulation with graphical output to find the most practical design for the arm. Design and test a microprocessor-based control system using a model of the mechanical system. Build and test a prototype robot.

646 **Development of Methods of Global Analysis Based Upon the Cell State Space Concept;** Chieh S. Hsu; University of California, Department of Mechanical Engineering, Berkeley, CA 94720; Award #82-17471; $75,552 for 12 months beginning 03/01/83 (MES).

Explore the implications of using a cellularly structured state space in the theory of dynamical systems. Refine and improve simple cell mapping and generalized cell mapping methods. Study mathematical aspects of cell-to-cell mappings to develop a coherent cell mapping theory for dynamical systems. Explore the possibility of using cell mapping in the study of random oscillations of nonlinear systems. Apply cell mapping methods to nonlinear mechanical systems under parametric and forcing excitation.

647 **Vehicular Energy Losses Associated with the Traversal of a Nonuniform Road Profile;** Leonard Segel; University of Michigan, Department of Mechanical Engineering and Applied Mechanics, Ann Arbor, MI 48109; Award #82-14559; $54,668 for 12 months beginning 03/01/83 (MES).

Investigate the effect of tire/suspension losses for unsteady rolling of pneumatic viscoelastic tires. Model the tire as a multitude of radial hysteretic springs and assume a random profile as a model for an uneven road. Compare the predictions of this model in the frequency and the time domains with measured values of rolling resistance obtained with a laboratory dynamometer which exposes a tire wheel suspension system to a fabricated nonuniform road surface.

648 **New Theoretical Basis for Methods Engineering in Process Control;** James R. Buck; University of Iowa, Systems Division/College of Engineering, Iowa City, IA 52242; Award #82-10606; $100,521 for 12 months beginning 02/01/83 (PRR).

Provide a theoretical foundation for methods engineering in computer-aided manufacturing and production. Focus on task management and execution performed by humans in the supervisory control of production processes. Describe field studies, empirical laboratory experiments and computer modeling and simulations as procedures to examine issues. Develop a theory of human operator behavior and performance in process control jobs in contemporary and future industry.

649 **Laser Machining and Welding of Amorphous Alloys;** Russell J. Churchill; American Research Corporation of Virginia, Radford, VA 24143; Award #83-10478; For 6 months beginning 03/01/83 (PRR). Part of a total NSF Award of $28,970.

Examine laser machining and welding of amorphous alloys. Study laser-solid interactions, measure material removal rates, establish particular geometrical conditions for cutting and welding of toroidal core laminations, evaluate alloy properties before and after laser processing, and refine operating parameters to the point where valid conclusions can be reached.

650 **Investigation of Metal Cutting and Forming Process Fundamentals and Control Using Acoustic Emission;** David Dornfeld; University of California, Department of Mechanical Engineering, Berkeley, CA 94720; Award #81-12843 A01; $164,173 for 12 months beginning 11/01/82 (PRR).

Improve the efficiency of metal cutting processes through the use of adaptive control. Examine the cutting process and process conditions. Explore metal deformation processes. Purchase a torque sensor with signal conditioning electronics and acoustic emission source location instrumentation. Use the latter to locate the sources of acoustic emissions by triangulation.

651 **Experimental and Theoretical Investigation of Metals Cutting by Abrasive Jets, Phase II;** Mohamed Hashish; Flow Industries, Inc., Kent, WA 98031; Award #82-12878; For 20 months beginning 02/15/83 (PRR). Part of a total NSF Award of $203,377.

Study metal cutting by means of a high-velocity (over 2,000 fps) abrasive jet. Examine the phenomena of abrasive jet cutting and the internal structure of an abrasive jet. Acquire data for the formation of a cutting model and confirm the predictions made using it.

652 **Recognition of Parts and Their Orientation for Automatic Handling and Inspection, Phase II;** Barbara A. Lambird; LNK Corporation, Silver Spring, MD 20904; Award #80-18124 A02; For 12 months beginning 02/01/83 (PRR). Part of a total NSF Award of $110,000.

Perform research to devise an automated inspection machine. Develop a machine that comprises a solid-state camera with an array of 512 x 512 elements to scan objects to be inspected. Evaluate various mixes of software and hardware and demonstrate the feasibility of the concepts in a real-time environment. Specify a fast algorithm, a computer system architecture, and special purpose hardware capable of inspecting piece parts in production at a rate of at least one part every three seconds.

653 **Tenth Conference on Production Research and Technology at Cobo Hall, Detroit, Michigan, February 28-March 2, 1983;** Raymond A. Morris; Society of Automotive Engineers, Inc., Engineering Activity Division, Warrendale, PA 15096; Award #83-03837; $31,372 for 6 months beginning 02/15/83 (PRR).

Invite speakers, obtain manuscripts suitable for printing, and publish the proceedings of the Conference. Make reservations for the participants and provide luncheons, lodging, and tours.

654 **Investigation of the Dynamic Effects on Follower Motion of Variations in Cam Manufacturing Technique;** Robert L. Norton; Worcester Polytechnic Institute, Department of Mechanical Engineering, Worcester, MA 01609; Award #82-10865; $71,852 for 24 months beginning 03/01/83 (PRR); Split-funded with MES for $7,783.

Investigate the differences among several cam manufacturing methods. Test cams made to the same mathematical function by different methods. Make test cams including cams duplicated from hand dressed masters, cams cut point to point with CNC, and cams made using CNC and circular interpolation, using state-of-the-art equipment and technology. Use geometrically generated cams to qualify the test fixture and serve as a control. Design and build a special dynamic test fixture. Measure accelerometer data on the follower train for each test cam and analyze the data in the frequency domain with a digital signal analyzer.

655 **Collaborative Research: Computer-Aided Design for Castings;** Robert D. Pehlke; University of Michigan, Department of Materials and Metallurgical Engineering, Ann Arbor, MI 48109; Award #82-11084; $148,536 for 12 months beginning 02/01/83 (PRR).

Investigate problems associated with the computer-aided design of castings: geometric modeling/physical simulation; providing thermal transport data; filling transients associated with pouring of castings; modeling of interfacial phenomena, describing the interaction of the modeling-medium and solidifying casting; and determining the total economics of the computation system.

656 **Fracture of Metal Cutting Tools;** Milton C. Shaw; Arizona State University, Department of Aerospace

and Engineering Science, Tempe, AZ 85287; Award #82-04640; $80,069 for 24 months beginning 02/15/83 (PRR).

Gain a better understanding of tool fracture. Explore cutting tool fracture characteristics and make recommendations to decrease tool fracture in production.

657 **Modeling and Planning of NC Machining Processes;** Herbert B. Voelcker; University of Rochester, Department of Electrical Engineering, Rochester, NY 14627; Award #82-11424; $111,450 for 24 months beginning 03/01/83 (PRR).

Focus on automatic machining-operation planning and process planning, and associated object- and process-modeling problems. Develop algorithms for producing wholly automatically positioning specifications for workpiece setups on specific machine tools, tool lists and associated process parameters, and NC codes.

658 **Extension and Evaluation of a Methodology for Managing Assembly Systems;** Wilbert E. Wilhelm; Ohio State University, Department of Industrial and Systems Engineering, Columbus, OH 43210; Award #82-13196; $77,760 for 23 months beginning 02/01/83 (PRR).

Develop a methodology that can be applied by U.S. industry to design and manage assembly systems. Develop a model and investigate techniques for manipulating the model. Use test cases taken from actual industrial settings to guide model development and to evaluate its practical utility.

Solid Mechanics (SOM)

659 **Mechanical Sciences: Nonlinear Elasticity and Stability of Reinforced Materials;** Millard F. Beatty; University of Kentucky, Department of Engineering Mechanics, Lexington, KY 40506; Award #82-13741; $71,417 for 12 months beginning 03/01/83 (SOM).

Study the mechanical behavior of constrained, reinforced or natural fiber structured materials. Determine the arrangement of reinforcing fibers, cords or wires needed to control either the deformation or the loading, and potentially undesirable buckling and warping effects that such reinforcement may produce. Investigate problems involving inflation, bending, twisting, stretching, and eversion deformations of reinforced rubber-like structural elements, such as rods, slabs, tubes and shells, and any inherent instability phenomena associated with these deformations. Examine the elastic properties of rubberlike materials, both with and without reinforcement, using frequency measurements. Compare results with predicted responses for known models of elastic behavior. Pursue specific applications to rubber suspension or structural support systems and inflatable structures.

660 **Examination of the Anterior and Posterior Cruciate Ligaments in the Human Knee;** David L. Butler; University of Cincinnati, Department of Orthopaedic Surgery, Cincinnati, OH 45221; Award #81-18140 A01; $88,877 for 12 months beginning 02/15/83 (SOM).

Develop a mathematical model for the mechanical response of the anterior and posterior cruciate ligaments of the human knee. Model the mechanical response of the ligament fascicles and derive the response of each ligament using the measured geometry of its fascicle system. Develop the geometrical properties of the system, measure the mechanical response of the fiber bundles, and verify the predicted response of the model at the ligament level. Use a state variable constitutive representation for the fiber bundle response to account for subfailure and failure characteristics.

661 **Mechanical Sciences: Theoretical and Computational Studies in Finite Plastic Deformation of Metals;** Kerry S. Havner; North Carolina State University, Department of Civil Engineering, Raleigh, NC 27607; Award #82-18034; $96,750 for 24 months beginning 04/15/83 (SOM).

Obtain a better understanding and predictive capability for the finite plastic deformation of metals. Conduct parallel and interrelated investigations at both the individual crystal and macroscopic polycrystalline levels. Examine the stability of a tensile loading axis in the six-fold symmetry position of f.c.c. crystals through a second-order analysis of minimum plastic work. Analyze the channel die-compression test for various crystal orientations and hardening rules of practical value, develop general constitutive theories for elastoplastic crystals, and search for improved macroscopic constitutive equations that will adequately represent experimental behavior of metals at a large strain.

662 **Mechanical Behavior of Fibrous Materials;** Richard W. Perkins; Syracuse University, Department of Mechanical and Aerospace Engineering, Syracuse, NY 13210; Award #82-15389; $119,239 for 12 months beginning 03/01/83 (SOM).

Study the mechanics of paper materials, extending the elasticity work to incorporate time, moisture, and temperature dependent phenomena and failure. Extend the in-plane theories to take into account the thickness direction (or Z-direction) response. Characterize the internal structure of paper both before and after the elastic limit and develop improved accuracy in the measurement of paper deformation.

663 **Mathematical Sciences: Phenomenological Thermodynamics;** James B. Serrin; University of Minnesota, School of Mathematics, Minneapolis, MN 55455; Award #79-03535 A05; $12,925 for 12 months beginning 05/15/83 (SOM). Part of a total NSF Award of $25,850.

Investigate mathematical problems arising from continuum mechanics and classical thermodynamics.

664 **Industry/University Cooperative Research Program: Large-Strain Plastic Deformation Processes with Applica-**

tion to Metal Strip Drawing; Paul K. Wright; Carnegie-Mellon University, Department of Mechanical Engineering and Mechanical Science, Pittsburgh, PA 15213; Award #80-11582 A01; $109,962 for 12 months beginning 03/01/83 (SOM).

Utilize experimental and computational analyses to investigate metal forming processes such as plane-strain strip drawing, and emphasize the effects of friction. Use a transparent sapphire die to observe the interface between the die and the plastic deformation zone of the strip. Employ a finite-element code to predict working loads, residual stress distributions, and redundant work factors; compare these predictions with slip-line solutions and experiments.

Office of Interdisciplinary Research (OIR)

XX Chen, Chuan F., see MEAM (FLM).
XX Gleason, Thomas L., see CEE (EWQ).
XX Jansen, Norman B., see CRE (RME).
XX Karim, M. Nazmul, see CPE (CBP).

665 **Hill Land Symposium "Foothills for Food and Forests," Corvallis, OR, April 1983;** J.E. Oldfield; Oregon State University, Animal Science Department, Corvallis, OR 97331; Award #82-19808; $3,000 for 12 months beginning 03/01/83 (OIR); Split-funded with BBS/BSR for $3,000.

Focus attention on the development of hill land areas; survey current practices from areas of advanced technology, including Australia, New Zealand, and the United Kingdom; identify problem areas in adapting this technology to the United States; and bring research resources to bear on them. Study the interdisciplinary nature of the research on agriculture and forestry, including implications for botany, chemistry, computer science, microbiology, plant pathology, and veterinary medicine. Publish a proceedings including all prepared papers from the symposium.

666 **Workshop on Chemical Instabilities: Applications in Chemistry, Engineering, Geology, and Materials Science;** Ilya Prigogine; University of Texas, Physics Department, Austin, TX 78712; Award #82-16177; $10,000 for 12 months beginning 03/01/83 (OIR).

Hold an interdisciplinary workshop sponsored by the Center for Studies in Statistical Mechanics in collaboration with the Department of Petroleum Engineering, at the University of Texas, Austin, March 14-18, 1983. Study the problem of instabilities and pattern formation in non-linear, non-equilibrium chemical systems by using new mathematical and numerical techniques. Bring together researchers in chemistry, chemical engineering, geology, petroleum engineering, and applied mathematics to discuss applications in these fields using these new methods.

XX Scott, Charles D., see CPE (RME).

PRINCIPAL INVESTIGATOR INDEX

*References Denote Entry Numbers

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