RECENT AWARDS IN ENGINEERING

NATIONAL SCIENCE FOUNDATION WASHINGTON, D.C. 20550

FIRST QUARTER FISCAL YEAR 1983

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 (1-275) 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 2 5 4

1 53. Particle Analysis by Mass Spectrometry;
3 Sheldon K. Friedlander; University of California, Department of Chemical, Nuclear and Thermal Engineering, Los Angeles, CA 6
7 90024; Award #80-08686 A02; $53,000 for 12 months beginning 11/01/82 (PMP). Part 8
11 of a total NSF award of $113,000. 9

10 Apply the techniques of particle beam generation and focal plane mass spectrometry to study and measure the chemical composition of single aerosol particles on a continuous, real-time basis. Study different methods of volatilization and ionization, including laser ionization. Stress the efficiency of introduction of particles into the source region and ionization as a function of particle size and composition. Characterize the particle beam and the generation of beams composed of biological particles.

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 → 97. 2 → <u>Formation and Mechanical Properties of Naturally Occurring Ice Systems Within the Context of Civil Engineering Interests</u>; ← 4
3 → John F. Kennedy; University of Iowa;
5 → Institute of Hydraulic Research, Iowa City, ← 6
IA 52242; 7 → Award #81-09252 A01; $72,891 ← 8
for 12 months beginning 12/15/82 (GEO); ← 9
11 → Split-funded with MEAM (SOM) for $10,000.
10 → Study the formation and mechanical properties of naturally occurring ice systems, emphasizing issues of solid mechanics.

12 → xxKennedy, John F., see CEE (GEO).

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.

610. University/Industry Cooperative Research Center in Robotics; John Birk; University of Rhode Island, Electrical Engineering Department, Kingston, RI 02881; Award #82-03570; $80,000 for 12 months beginning 04/01/82 (MES). Split-funded with OIR/ENG for $22,000; with ECSE/ENG for $15,000; with ISTI/STIA for $98,000; and with MCS/MPS for $5,000.

Study integrated robot systems to develop a data base for industrial applications such as vision systems for robot control and inspection, integration of robotics into production systems, and articulated robotic hands with sensors.

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)

DIVISION OF CHEMICAL AND PROCESS ENGINEERING (CPE)

Chemical and Biochemical Processes (CBP)

1. Conversion of Lignin to High-Value Chemical Intermediates; Robert W. Coughlin; University of Connecticut, Department of Chemical Engineering, Storrs, CT 06268; Award #80-14523 A02; $2,995 for 12 months beginning 10/01/82 (CBP).

   Consider processes for large-scale conversion of lignin to high-value liquid chemicals to achieve optimum and most economical total use of woody biomass. Perform catalytic hydrocracking, shape-selective catalysis, flash hydropyrolysis and hydrogenation by hydrogen-donor solvents for the production of high-value chemical intermediates from lignocellulosic materials.

2. Advanced Control Strategies for Distillation Columns; Thomas F. Edgar; University of Texas, Department of Chemical Engineering, Austin, TX 78712; Award #81-11613 A01; $51,030 for 12 months beginning 12/15/82 (CBP).

   Conduct a fundamental engineering study of advanced control strategies for high purity, interactive distillation columns. Use the dynamic relative gain array to develop methods for screening a proposed design for control difficulties. Investigate multivariable interaction analysis, multivariable control, and adaptive control for highly nonlinear and interactive high purity columns by both experimental and computer simulation.

3. Input Multiplicity as a Cause of Sudden Destabilization of Chemical Process Control Systems; Lowell B. Koppel; Purdue University, Department of Chemical Engineering, Lafayette, IN 47907; Award #82-09653; $48,531 for 12 months beginning 10/25/82 (CBP).

   Develop techniques to eliminate input multiplicities or mitigate their effects. Discover the structural properties most likely to lead to input multiplicity in chemical processes; detect input multiplicity from process steady-state models and from plant operating data; identify the smallest residual group of operating variables responsible for the multiplicity; and guide the designer in choice of pairings which eliminate or minimize the effects of input multiplicities.

4. Use of Reactors with Immobilized Plant Cells for Biosynthesis and Biotransformation Reactions; Henrik Pedersen; Rutgers University, College of Engineering--Busch Campus, Piscataway, NJ 08854; Award #82-12670; $74,527 for 12 months beginning 01/15/83 (CBP).

   Study the use of hollow fiber reactors for immobilized plant cell cultures for biosynthesis and biotransformation reactions. Study nutrient composition, temperature, and pH to optimize the reaction conditions for a reactor operated in either the batch recycle or continuous flow modes. Perform experiments with strains of Daucus carota for biotransformation reactions such as the 12 β-hydroxylation of digitoxigenin, gitoxigenin, and oleandrigenin.

5. Dynamic Behavior of Continuous Polymerization Reactors; W. Harmon Ray; University of Wisconsin, Department of Chemical Engineering, Madison, WI 53706; Award #82-10726; $91,526 for 12 months beginning 11/15/82 (CBP).

   Develop and use detailed models for both homogenous and heterogeneous catalytic polymerization reactors to analyze and explain observed experimental measurements of molecular weight distribution, copolymer composition, chain branching, tacticity and other properties. Study bulk and solution polymerization in continuous stirred tank and tubular reactors, emulsion polymerization in continuous stirred tank reactors, and olefin polymerization in semi-batch and continuous catalytic reactors. Produce new reactor types and control systems which will lead to more uniform and high quality polymer.

6. Neutron Scattering from Latex Particles; L. H. Sperling; Lehigh University, Materials Research Center, Bethlehem, PA 18015; Award #82-06720; $63,000 for 12 months beginning 11/15/82 (CBP).

   Apply small-angle neutron scattering to latexes containing a delta fraction of deuterated polymer to obtain new evidence concerning the core-shell model, and determine the actual polymer chain conformation when the latex particles are smaller than the chain dimensions in the relaxed state, and when one or both ends are in the ionic state. Compare nonionic initiators with ionic types; characterize polymers and delta fractions of deuterated polymer via gel permeation chromatography and intrinsic viscosity; and determine the latex particle diameters by electron microscopy.

7. Study of the Transition Between Solid-State and Submerged Cultures in Aerated Baker's Yeast Fermentations; Robert D. Tanner; Vanderbilt University, Department of Chemical Engineering, Nashville, TN 37240; Award #82-09945; $74,809 for 12 months beginning 01/15/83 (CBP).

   Study the gelled Baker's yeast system to determine the effect of oxygen on acetaldehyde production and the effect of aeration on lysine production as a function of salt content of the cell. Develop mathematical models for the semi-solid state gelatin culture, relating ethanol production to sodium chloride and acetaldehyde concentrations; develop experimental techniques for monitoring the oxygen and carbon dioxide concentration and methods to separate and purify products resulting from solid substrate fermentations.

8. Solving and Optimizing of Process Models Described by General Functions; Arthur W. Westerberg; Carnegie-Mellon University, Department of Chemical Engineering, Pittsburgh, PA 15213; Award #82-10971; $65,940 for 12 months beginning 11/15/82 (CBP).

Investigate design techniques for large chemical processes, especially unit models appearing in current flowsheeting systems which change behavior and modeling equations depending on the operating conditions. Study a multicomponent flash unit operating near the critical region; optimize a flowsheet containing a potential three-phase flash, solving it as an embedded optimization using a single-level Newton-based algorithm.

Engineering Energetics (ENE)

9. Theoretical Studies of the Dynamics of Dense Fluids; Ziya Akcasu; University of Michigan, Department of Nuclear Engineering, Ann Arbor, MI 48109; Award #82-07308; $70,652 for 24 months beginning 10/15/82 (ENE).

Study the dynamics of random disturbances on controlled thermonuclear plasmas in both magnetic and inertial confinement systems, emphasizing polyelectrolyte solutions. Coordinate theoretical research with experimental programs; connect these efforts with a common theoretical bond.

10. Investigation of Downstream Nozzle Effects and Arc Interruption; David M. Benenson; State University of New York, Department of Electrical and Computer Engineering, Buffalo, NY 14260; Award #82-07593; $71,000 for 12 months beginning 10/01/82 (ENE).

Study the processes impacting thermal recovery in a gas blast high pressure interrupter through experiments with a transparent orifice and converging-diverging (shock free) nozzle configurations in a dual flow interrupter arrangement. Use spectroscopic techniques with high speed synchronized data acquisition methods to characterize the radial distribution of temperature at various axial stations within the interrupter and at various times within the arc core, the size of the thermal boundary layer, and the radial distribution of temperature within this layer.

11. Pulsations, Bifurcations, and Related Phenomena Important in Flame Stability; John D. Buckmaster; University of Illinois, Department of Theoretical and Applied Mechanics, Urbana, IL 61801; Award #82-09625; $31,998 for 12 months beginning 11/15/82 (ENE).

Study linear stability of anchored flames using activation energy asympotics and by anchoring a premixed flame to a linear condensate; seek bifurcations for such conditions corresponding to pulsating flames and cellular flames. Explore model for polyhedral flame tips and investigate pulsations of diffusion flames.

12. Gas Phase Reaction in a Turbulent Jet; Rene Chevray; Columbia University, Department of Mechanical Engineering, New York, NY 10027; Award #82-19349; $75,235 for 12 months beginning 11/01/82 (ENE).

Study the interactions of turbulence and chemical reactions in combustion, especially the fully developed region of a jet of ozone in a co-flowing stream of nitric oxide, and make joint measurements of velocity and concentration. Use absorption spectroscopy for simultaneous detection of two-species concentration fluctuations. Measure the velocity fluctuation by laser doppler velocimetry. Analyze the experimental data by the Monte Carlo method using the probability density function approach.

13. Modeling the Combustion of Premixed Gaseous Fuels in a Refractory Tube; Stuart W. Churchill; University of Pennsylvania, Department of Chemical Engineering, Philadelphia, PA 19104; Award #82-03967; $71,000 for 12 months beginning 10/15/82 (ENE).

Study radiantly stabilized combustion in a refractory tube by determining the longitudinal wall-temperature profile and the exit gas temperature and composition as a function of flame-front location for a wide range of fuel compositions, fuel-to-air ratios, flow rates, and inlet temperatures. Solve the coupled differential energy and species balances for the gas stream, using the appropriate experimental wall temperature profile as a boundary condition. Subject the rate constants in the overall model to a sensitivity analysis and identify the constants whose values are required with particular precision.

14. Plasma Jet Ignition of Lean Fuel-Air Mixtures; Eli K. Dabora; University of Connecticut, Department of Mechanical Engineering, Storrs, CT 06268; Award #82-01955; $69,043 for 12 months beginning 11/01/82 (ENE).

Study ignition of lean fuel-air mixtures, primarily methane, in a combustion bomb, using a plasma jet as the ignition source. Detect the hydroxyl and hydrogen radicals, their formation by the plasma, their diffusion into the fuel-air mixture, and their influence on the flame velocity when combustion occurs. Use a conventional method to detect hydroxyl and a new method to detect hydrogen; detect depletion of methane by an infra-red absorption technique. Apply to a single cylinder engine using a homogeneous charge to assess the potential of plasma ignition in fuel savings and emission reduction.

15. Response of the In-Core Neutron Detectors of a Nuclear Reactor to Moving Core Components; Richard A. Danofsky; Iowa State University, Department of Nuclear Engineering, Ames, IA 50010; Award #82-10254; $61,130 for 12 months beginning 11/01/82 (ENE).

Study, both theoretically and experimentally, the fundamental characteristics of the signals generated by a moving neutron absorber. Investigate the response of neutron detectors as a function of detector and perturbation locations; compare it with the results of the theoretical models. Continue to work on one-dimensional motion and extend it to the two-dimensional case.

16. Study of Photodissociation and Photoionization in the Rare Gases: Diagnostic Tools for the Study of Excimer Molecule Formation; J. G. Eden; University of Illinois, Department of Electrical Engineering, Urbana, IL 61801; Award #82-07868; $71,000 for 12 months beginning 10/15/82 (ENE).

Study excimer molecule formation in rare gas dimer ion absorption spectra and photodissociation of xenon dimers. Exploit rare gas dimer molecular photodissociation and multiphoton ionization of rare gases to better understand rare gas ion recombination processes and chemical reactions occuring between xenon dimers and a halogen ion or molecule.

17. Investigation of Inflow Magnetohydrodynamic Disk Generator; Robert H. Eustis; Stanford University, Department of Mechanical Engineering, Stanford, CA 94305; Award #81-07271 A01; $80,000 for 12 months beginning 02/01/83 (ENE).

Investigate critical phenomena for the accurate design and evaluation of disk generators for magnetohydrodynamic power production. Develop diagnostic apparatus; investigate the effects of inlet fluid mechanics on the performance of the inflow disk generator, the stability of the current discharge phenomena and the slag-electrode interaction effects in the disk, and current leakage phenomena in the disk generator. Develop theoretical models and apply experimental results to large-scale inflow disk generators.

18. Pyrosynthesis of Aromatic Compounds from Acetylene and Vinylacetylene; Julian Heicklen; Pennsylvania State University, Department of Chemistry, University Park, PA 16802; Award #82-12324; $66,969 for 12 months beginning 12/15/82 (ENE).

Study pyrosynthesis of aromatic compounds from acetylene and vinylacetylene and the products of their pyrolysis at 300-800° C. Freeze the reaction after a fixed time, and analyze it by gas chromatography to separate isomers. Experiment with added inactive gases to check for chaperone effects, with packed vessels and coated walls to check for heterogeneous effects, with radical scavengers to check for free radicals, and with methyl-substituted compounds to elucidate mechanisms of the reactions.

19. Picosecond Time-Resolved Double Resonance Spectroscopy of Polyatomic Molecules; Hoi-Sing Kwok; State University of New York, Department of Electrical and Computer Engineering, Buffalo, NY 14260; Award #82-11651; $52,251 for 12 months beginning 11/01/82 (ENE).

Measure the mode-mode collisionless intramolecular vibrational energy transfer time in a polyatomic molecule during the process of multiphoton excitation, making a unique two-frequency picosecond laser pulse system to perform a time-resolved double resonance experiment. Identify vibrational modes of the molecule where intra-group energy randomization is fast but inter-group energy transfer occurs more slowly. Measure the collisional energy transfer rate as a function of vibrational excitation in the hot molecule.

20. Nonuniformities in MHD Flows; Jean F. Louis; Massachusetts Institute of Technology, Department of Aeronautics and Astronautics, Cambridge, MA 02139; Award #81-02902 A01; $79,900 for 12 months beginning 10/15/82 (ENE).

Study the effects of isotropic nonuniformities on equilibrium and nonequilibrium plasmas; characterize the nature of the nonuniformities driven by the electrothermal ionization instabilities. Determine the effective Hall coefficient and the level of fluctuations in the electron/ion density; measure positive ion concentration/fluctuations using the electric Langmuir probe. Develop theoretical models and compare these for validation.

21. Theoretical Study on Stability of Diffusion Flames; Moshe Matalon; Northwestern University, Department of Engineering Sciences and Applied Mathematics, Evanston, IL 60201; Award #82-12082; $35,873 for 12 months beginning 12/15/82 (ENE).

Analyze the structure of the reaction zone; formulate general models for flames. Study the spherical diffusion flame related to burning fuel drops. Examine multiplicity of solutions arising from the reaction zone structure; stability boundaries in terms of Lewis numbers; effect of the fluid flow; instability consequences; and extension to include radiative losses, acceleration fields, and more complex chemical reactions.

22. Inverse Transport Methods for Optically-Thick Media; Norman J. McCormick; University of Washington, Department of Nuclear Engineering, Seattle, WA 98195; Award #82-09908; $35,000 for 12 months beginning 11/01/82 (ENE).

Modify existing inverse transport methods to calculate the relative concentrations of particles from the backscattered and transmitted angular intensities and cross section data for several optical-thick environments. Change the scattering model to identify the particles with fewer coefficients and when measurements are made at a fewer number of angular directions. Study the limitations of an approximate inverse method that requires many fewer measurements and inverse methods for determining multigroup neutron cross sections from multiple-scattering experiments.

23. Kinetics and Gas Dynamics of Free-Jet Expansions; David R. Miller; University of California at San Diego, Department of Applied Mechanics and Engineering Sciences, La Jolla, CA 92093; Award #80-17871 A02; $38,491 for 12 weeks beginning 01/01/83 (ENE).

    Study nozzle beam sources using flux gauge measurements of beam intensity; time-of-flight measurements with mass spectrometric detection to determine velocity distributions of species; and laser-induced and electron beam-induced fluorescence and infra-red emissions detection to identify internal states of the expansions. Correlate results with rigorous theoretical modeling of the free-jet expansion by the method of characteristics and by moment solutions of the Boltzmann equation. Examine the terminal states of sulfur dioxide, iodine, nitric oxide, nitrogen, carbon monoxide, carbon dioxide, methane, and methanal by laser-induced and electron beam-induced fluorescence.

24. Study of Jet Ignition in Lean Gas Mixtures; Antoni K. Oppenheim; University of California, Department of Mechanical Engineering, Berkeley, CA 94720; Award #81-15163 A01; $80,000 for 12 months beginning 02/01/83 (ENE).

    Study the initiation of the combustion process in lean premixed combustible gases using jets of active radicals generated either by electric discharge or by combustion. Perform experiments using a cylindrical cell fitted with windows for Schelieren and interferometric photography and equipped with instruments for time resolved measurements of pressure, temperature, and the electrical properties of the discharge used to produce the jets. Analyze the fluid mechanical and chemical kinetic processes of the distributed ignition system provided by the jets.

25. Linear Transport in Non-Homogeneous Media; G. C. Pomraning; University of California, Department of Chemical, Nuclear and Thermal Engineering, Los Angeles, CA 90024; Award #81-16450 A01; $51,500 for 12 months beginning 02/01/83 (ENE).

    Study the theory and application of the singular eigenfunction technique for the linear neutron transport in media with continuously varying spatial properties. Find a unifying principle for a given spatial dependence of the media; detail a periodic medium for its practical importance in the theory of homogenization of reactor cells; improve the collocation-numerial-solution method for its use in reactor analysis. Use variational techniques to construct a set of self-consistent trail and weight functions.

26. Experimental and Theoretical Investigation of Turbulent, Backmixed, Gaseous Combustion; G. Scott Samuelsen; University of California, Department of Mechanical Engineering, Irvine, CA 92664; Award #80-13742 A02; $78,705 for 12 months beginning 02/01/83 (ENE).

    Study the physical and chemical mechanisms of fuel consumption and heat release in complex nonpremixed and premixed combustion flows; measure the Reynolds stresses and temperature fluctuations in non-premixed and premixed backmixed flowfields representative of practical devices; and establish an experimental data base for complex flows that can be utilized in the testing and development of mathematical models. Apply state-of-the-art mathematical modeling to establish a reference base and direction for the development of improved models of turbulence and turbulent-chemistry interaction.

27. Analytical and Computational Methods in Particle Transport Theory; Charles E. Siewert; North Carolina State University, Department of Mathematics and Nuclear Engineering, Raleigh, NC 27650; Award #82-03550; $35,000 for 12 months beginning 10/15/82 (ENE).

    Solve basic problems in the area of particle transport theory, using the F_N method as the basis of the numerical studies and the theories of complex variables and of singular integral equations for the analysis. Establish the complete solution in the theory of multiple light scattering including the full effects of polarization; investigate the transport of neutral hydrogen atoms in a hydrogen plasma for the case of a non-constant ion temperature; study complications following the expansion of forwardly peaked scattering laws; and deduce partial indices for basic problems in particle transport theory.

28. Sulfur Catalyzed Radical Recombination In Flames; Owen I. Smith; University of California, Department of Chemical, Nuclear and Thermal Engineering, Los Angeles, CA 90024; Award #82-09837; $61,993 for 12 months beginning 10/15/82 (ENE).

    Investigate flame inhibition by sulfur catalyzed recombination of chain carriers to characterize the high temperature kinetics of reactions responsible for inhibition of hydrocarbon flames by sulfur dioxide. Investigate the mechanism and kinetics of the process in one-dimensional, low-pressure, premixed hydrogen/oxygen argon flames; perform sampling and chemical analysis by a molecular-beam-mass-spectrometer system; measure ambient temperature in an isothermal fast-flow reactor to characterize molecular properties of sulfur radicals.

Kinetics, Catalysis, and Reaction Engineering (KCR)

29. Engineering Studies on Electrolytic Cells and Processes Porous Electrodes, Shape Change, and Optimization; Richard C. Alkire; University of Illinois, Department of Chemical Engineering, Urbana, IL 61801; Award #80-08947 A02; $60,800 for 12 months beginning 10/14/82 (KCR).

    Develop optimization techniques for electrochemical processes and develop and test mathematical models for electrode shape change. Study mass transfer in the presence of a two-phase feedstock and complete and verify models for electrode shape change.

30. Process Dynamic Models for Heterogeneous Catalysts; James E. Bailey; California Institute of Technology, Department of Chemical Engineering, Pasadena, CA 91104; Award #81-11607 A01; $67,987 for 12 months beginning 10/15/82 (KCR).

    Explore a novel identification strategy for dynamic and mechanistic models of catalytic kinetics. Reconsider all of the important dynamic characteristics of catalytic reactors. Devise a systematic procedure for identification of useful process models for the dynamics of interactions between the fluid phase and the catalyst surface, and of chemical reactions on the catalyst surface. Consider the fluid-phase measurements and the input variables used to drive the dynamic transients.

31. New X-Ray Methods for Heterogeneous Multi-Phase Catalysts; Harry Brumberger; Syracuse University, Department of Chemistry, Syracuse, NY 13210; Award #79-13779 A02; $115,056 for 24 months beginning 01/01/83 (KCR).

    Study the small-angle scattering of supported metal catalysts and develop theoretical scattering models based on irregular, space-filling polyhedral cells (Voronoi cells) filled with the phases of the catalyst. Perform static x-ray scattering experiments with systems showing strong metal-support interactions and with catalysts that show "raft-like" metal formations. In dynamic scattering experiments, use platinum on alumina and nickel on silica to investigate the effects on sintering and redispersion of the metal. Consider such factors as atmospheric composition, additives, and metal loading, and determine the kinetics of these processes. Extend the dynamic scattering measurements to high pressures.

32. Studies of Zeolite Catalysts for Control of Emissions; Redox Reaction and Hydrocarbon Oxidation; W. Keith Hall; University of Wisconsin, Department of Chemistry and Chemical Engineering, Milwaukee, WI 53201; Award #82-07077; $125,007 for 24 months beginning 12/01/82 (KCR).

    Investigate redox catalysis over a variety of zeolite systems containing altervalent base-exchange cations. Study the oxygen-carrying process, the function of the altervalent cation, and the role of poisons. Examine the chemisorption of reactant molecules and its effect on the location of the cation using redox studies and inrared, electron paramagnetic resonance, and Mossbauer spectroscopies. Consider such systems as iron in Y-zeolite, mordenite, ferrierite, ZSM-5, and erionite, and the corresponding cobalt systems. Study the reactions of carbon monoxide with oxygen, nitric oxide, nitrous oxide, and the decomposition of nitrous oxide.

33. Dynamics and Structure of Chemisorption and Reaction on Surfaces Investigated By Transient Infrared Spectroscopy; Gary L. Haller; Yale University, Department of Chemical Engineering, New Haven, CT 06520; Award #82-10869; $69,126 for 12 months beginning 12/01/82 (KCR).

    Investigate the feasibility of using infrared emission spectroscopy to observe the distribution of internal (rotational and vibrational) energy in the products of a surface reaction. Expose a surface of platinum covered with oxygen to a pulsed molecular beam of carbon monoxide and measure the infrared emission using a Fourier-transform infrared spectrometer and a time-delay algorithm to adjust the time between the beginning of the beam pulse and the collection of the interferograms.

34. Nitrogen Oxide Reduction Properties of Chromia-Doped Tin Oxide and Platinized, Chromia-Doped Tin Oxide; Gar B. Hoflund; University of Florida, Department of Chemical Engineering, Gainesville, FL 32611; Award #82-10776; $93,000 for 24 months beginning 01/01/83 (KCR).

    Elucidate the properties of chromia-doped tin oxide before and after platinization by probing electronic structure, composition, and geometrical structure using x-ray photoelectron spectroscopy, Auger electron spectroscopy, electron stimulated desorption, and ultraviolet photoelectron spectroscopy. Determine the catalytic activity of the sample toward nitrogen-oxide reduction in both reducing and oxidizing atmospheres in situ by reactive molecular-beam scattering. Examine the influences of metal-support interaction, oxidation states of the surface atoms, promotors, poisons, and sintering.

35. Electrogenerative Process Studies; Stanley H. Langer; University of Wisconsin, Department of Chemical Engineering, Madison, WI 53706; Award #81-19232 A01; $52,500 for 12 months beginning 02/01/83 (KCR).

Explore aspects of kinetics, electrocatalysis, and cell construction for certain systems that show promise of being operable in the electrogenerative mode at substantial currents. Study the electrogenerative reductions of nitric oxide and nitroaromatic compounds and the electrogenerative oxidation of sulfur dioxide. Determine feasibility using actual cells, and use potential sweep and rotating disc studies to define the limits and effects of operating parameters.

36. Characterization of Catalyst Particles in Reactive Atmosphere; Lanny D. Schmidt; University of Minnesota, Department of Chemical Engineering and Materials Science, Minneapolis, MN 55455; Award #82-14048; $77,949 for 12 months beginning 01/01/83 (KCR).

Study the structures and transformations of 1- to 10-nanometer diameter particles in situations of interest in heterogeneous catalysis. Characterize the chemical and morphological microstructures of noble metals and compound particles on various supports; and use transmission electron microscopy, x-ray photoelectron spectroscopy, adsorption, and reaction methods in configurations which permit application of several techniques simultaneously and allow examination of the same surfaces and particles repeatedly. Characterize microstructures produced by chemical reaction cycling and sequencing, and describe catalyst structures in systems used for petroleum processing, pollution abatement, and production of new energy sources.

37. Industry/University Cooperative Research Activity: The Preparation, Sintering, and Catalytic Behavior of Supported Silver Catalysts; M. Albert Vanice; Pennsylvania State University, Department of Chemical Engineering, University Park, PA 16802; Award #80-19968 A02; $36,864 for 12 months beginning 01/15/82 (KCR). Part of a total NSF award of $73,727.

Measure the rates of agglomeration of silver supported on alumina, silica, or titania in the presence of gases such as oxygen, ethylene, carbon dioxide, and water. Prepare and characterize new supported silver and silver-mixed metal cluster catalysts; compare sintering rates under reaction conditions with the agglomeration studies. Determine the catalytic properties of silver-containing clusters and the particle-size effect for turnover frequencies on silver crystallites. Characterize the catalysts by oxygen and nitrous oxide chemisorption, x-ray line broadening, electron microscopy, infrared, ultraviolet, nuclear magnetic resonance, mass, Auger, and photoelectron spectroscopies, and extended x-ray absorption fine structure.

Minerals and Primary Materials Processing (MPM)

38. Physical Chemistry of Metallurgical Slags; David R. Gaskell; Purdue University, Department of Materials Engineering, Lafayette, IN 47907; Award #82-15459; $64,015 for 12 months beginning 10/15/82 (MPM).

Investigate the physico-chemical properties of metallurgical slags pertinent to the pyrometallurgical extraction and refining of metals. Study the kinetics of gas-slag reactions. Examine measurement of the apparent rate constant as a function of composition, oxygen potential, and temperature in the system FeO-CaO-SiO and obtain information on the constitutions of the melt surfaces by measuring the surface tensions on the melts.

39. Sequestration of Calcium Ion in Selective Desliming; Iwao Iwasaki; University of Minnesota, Mineral Resources Research Center, St. Paul, MN 55114; Award #82-10584; $46,790 for 12 months beginning 10/15/82 (MPM).

Investigate the conditions and mechanisms by which surface precipitation of calcium salts may be prevented through the use of a proper combination of reagents. Control the adverse effects of calcium ions in selective flocculation without using EDTA or NTA.

40. Industry/University Cooperative Research Activity: Electrochemical Kinetics of Hydrometallurgical Processes; Denny A. Jones; University of Nevada, Department of Chemical and Metallurgical Engineering, Reno, NV 89507; Award #81-10020 A01; $51,034 for 12 months beginning 01/01/83 (MPM).

Establish a galvanic series of mixed potentials of a representative selection of oxide and sulfide mineral compounds in aerated and deaerated sulfuric acid. Develop potentiostatic polarization curves for mineral compounds and measure the rate of galvanic interaction between two compounds; conduct a polarization study of chalcopyrite ($CuFeS_2$) in deaerated acid solutions to determine kinetics and mechanisms of leaching reactions and the utility of anodic polarization as a substitute for more conventional oxidizers. Demonstrate the feasibility of an electrolytic leach process for chalcopyrite in a laboratory electrochemical cell and in a rotating-drum laboratory reactor.

41. Refining of Liquid Metals by Injection of Gas-Particle Jets; Michael McNallan; University of Illinois, Department of Materials, Civil and Mechanics Engineering, Chicago, IL 60680; Award #81-15342 A01; $33,785 for 12 months beginning 12/15/82 (MPM).

Investigate the hydrodynamics of gas-particle jets by using high-speed chromatography of jets in water models and in a high temperature liquid model system. Study a range of gas, liquid, and particle properties to develop a general model of flow transitions in submerged gas-particle jet behavior. Examine the effects of hydrodynamic variables on mass transfer by measuring the rate of deoxidation of liquid copper by gas-particle injection using a stabilized zirconia probe. Use both gaseous and particulate reducing agents and define optimal process conditions for injection.

42. Industry/University Cooperative Research Activity: Enhanced Sulfide Mineral Leaching By Alteration of Reaction Product Layers Via Particle Additions; Jan D. Miller; University of Utah, Department of Metallurgy and Metallurgical Engineering, Salt Lake City, UT 84112; Award #81-07763 A02; $77,221 for 12 months beginning 01/01/83 (MPM).

Study the dissociation of sulfide minerals that form adherent, rate-limiting reaction product layers in the presence of intentionally added electron-conducting particles; and conduct leaching experiments with chalcopyrite, sphalerite (ZnS) and galena (PbS). Measure electronic conductivity on solid sulfur, carbon and α-Fe_2O_3 with various dispersed particles. Perform scanning electron microscopy and electron microprobe studies to determine the distributions and sizes of the dispersed phase particles; x-ray studies to identify reaction products; and Auger studies to locate the migration paths utilized by the various metals.

43. Hydration Reaction Mechanisms and Their Effects Upon Properties of Cements with Mineral Waste Substituents; Della M. Roy; Pennsylvania State University, Materials Research Laboratory, University Park, PA 16802; Award #81-12821 A02; $48,245 for 12 months beginning 12/01/82 (MPM).

Study the hydration mechanisms operating in hydraulic cements containing different pozzolanic additives. Investigate hydration mechanisms, rates, and the characteristics and properties of the hydration products of Portland cements with industrial by-product substituents and other modifiers. Carry out systematic variations of the types and amounts of well characterized by-product mineral additives, cements, and of other additives and mixtures. Examine early hydration behavior, microstructural changes, phase characterization, and other properties as a function of various experimental parameters.

44. Testing Burton's Method for Synthesizing Diamonds; Felix Sebba; Virginia Polytechnic Institute, Departments of Chemistry and Chemical Engineering, Blacksburg, VA 24061; Award #82-10614; $19,863 for 12 months beginning 10/15/82 (MPM).

Synthesize diamond from a solution of carbon in a lead-calcium alloy by creating supersaturation at about 500°C in a region where graphite is stable and diamond metastable. Create the supersaturation by passing steam over the lead-calcium hydroxide. Pass steam over the alloy at temperatures from 500°C and 700°C at 25°C intervals and quickly cool the alloy. Dissolve the residual alloy in nitric acid and analyze the insoluble solid for diamond using chemical and physical methods.

45. Beneficiation of Minerals Using Selective Flocculation; Ponisseri Somasundaran; Columbia University, Henry Krumb School of Mines, New York, NY 10027; Award #79-09295 A03; $7,000 for 5 months beginning 02/01/83 (MPM).

Determine selective flocculation and flotation and investigate adsorption, surface tension, zeta potential and viscosity of selected mineral-polymer-surfactant systems under relevant conditions of pH, ionic strength, temperature, water hardness and agitation. Analyze results to elucidate the role of physico-chemical parameters dictated by polymer chemistry, water chemistry, hydrodynamic forces, and variations in ambient temperature. Emphasize the effect of mineral aging under various conditions on the selectivity of polymer adsorption and study the effect of polymers on downstream processes of flotation and filtration under relevant experimental conditions.

46. Turbulence Phenomena in Metals Processing; Julian Szekely; Massachusetts Institute of Technology, Department of Materials Science and Engineering, Cambridge, MA 02139; Award #82-10849; $60,194 for 12 months beginning 10/15/82 (MPM).

Study turbulence phenomena in metals processing. Measure the fluid velocities and turbulence levels in gas bubble or buoyancy driven flows in transparent aqueous systems using laser velocimetry. Measure fluid velocities in molten Woods Metal using hot film anemometry and experiments conducted in Sweden aimed at the measurement of melt velocities and dissolution rates in a 4-ton ladel holding molten steel. Interpret the measurements using suitable turbulence models.

47. Kinetics of Flash Reaction of Metal Sulfides in Oxygen Streams; Nicholas J. Themelis; Columbia University, Henry Krumb School of Mines, New York, NY 10027; Award #81-10526 A01; $74,053 for 12 months beginning 11/01/82 (MPM).

Study the chemical kinetics and heat and mass transfer phenomena encountered in the oxidation of metal sulphide particles which are dispersed in an air stream. Record in a single-particle reaction system the weight and temperature of a sulphide particle suspended in an air stream against the time of reaction. Measure chemical reaction and heat and mass transfer rates in a small-scale flash reactor through which flows a dispersion of copper and iron sulphides in oxygen-enriched air. Determine the temperature of the reacting particles by a two-wavelength pyrometer which eliminates emissivity and surface area considerations.

48. New Refining Process for Molten Iron and Iron Alloys--Soda-Ash Treatment Combined with Slagless BOP Blowing; Harue Wada; University of Michigan, Department of Materials and Metallurgical Engineering, Ann Arbor, MI 48109; Award #81-17084 A01; $53,529 for 12 months beginning 01/01/83 (MPM).

Clarify the mechanisms of simultaneous desulfurization and dephosphorization reactions as well as the behavior of nitrogen during the soda-ash treatment and the reaction mechanisms of soda-ash slag involved in the treatment. Measure reaction kinetics and equilibrium of desulfurization and dephosphorization of molten iron and iron alloys; measure the removal of nitrogen in carbon saturated iron and iron alloy as well as in lower carbon alloy steels containing Cr, Mn, Si, and other minor elements; and examine decomposition mechanisms and kinetics of Na_2CO_3 and Na_2O with or without carbon at high basicities.

Particulate and Multiphase Processes (PMP)

49. Condensational Growth of Small Aerosol Particles; Barton E. Dahneke; University of Rochester, Department of Chemical Engineering, Rochester, NY 14627; Award #80-19543 A01; $99,454 for 12 months beginning 10/14/82 (PMP).

Develop a new instrument for the measurement of the number concentration of an aerosol--a condensation nucleus counter combined with an aerosol beam detection system. Demonstrate the instrument by expanding the aerosol sample adiabetically into a droplet growth chamber and accelerating them into an aerosol beam to be counted and sized by scattered light or electronic detection techniques.

50. Industry/University Cooperative Research Activity: Wave Structure in Two Phase Annular Film Flow and Entrainment Generation; Abraham E. Dukler; University of Houston, Department of Mathematics, Houston, TX 77004; Award #81-13568 A01; $54,114 for 12 months beginning 01/01/83 (PMP).

Measure wall shear stress and wave amplitude for rising and falling films to permit a test of the physical premises of the analytical models and to revise and complete the models. Explore the condition for the initiation of drop entrainment and take simultaneous measurements of droplet size, velocity (including direction), and wave structure to develop insights into the models and scale-up procedures on pilot plant and full scale equipment.

51. Semifluidized Bed Filtration of Potable and Waste Water; Liang-Tse Fan; Kansas State University, Department of Chemical Engineering, Manhattan, KS 66506; Award #82-09086; $41,717 for 12 months beginning 10/01/82 (PMP).

Use bench scale and pilot scale semifluidized bed filters to determine the feasible and/or optimal regions of operation of the semifluidized bed filter. Measure the throughput of the filter, the increase in pressure gradient, and the concentration of the effluent under a variety of operating conditions. Develop models and design equations for semifluidized bed filters based on the experimentally measured concentrations of the slurry suspension and increase in pressure gradients; test, screen and modify the most adequate one for use in scale-up of granular filters.

52. Industry/University Cooperative Research Activity: Water Sensitivity of Sandstone; Hugh S. Fogler; University of Michigan, Department of Chemical Engineering, Ann Arbor, MI 48109; Award #81-08197 A01; $70,000 for 12 months beginning 10/01/82 (PMP).

Elucidate the chemical and colloidal phenomena involved in sandstone water sensitivity. Explain the different degrees of damage produced by different salts and solvents and investigate additives. Develop a comprehensive chemical and physical model to predict the permeability decrease resulting from the water sensitivity of sandstone.

53. Particle Analysis by Mass Spectrometry; Sheldon K. Friedlander; University of California, Department of Chemical, Nuclear and Thermal Engineering, Los Angeles, CA 90024; Award #80-08686 A02; $53,000 for 12 months beginning 11/01/82 (PMP). Part of a total NSF award of $113,000.

Apply the techniques of particle beam generation and focal plane mass spectrometry to study and measure the chemical composition of single aerosol particles on a continuous, real-time basis. Study different methods of volatilization and ionization, including laser ionization. Stress the efficiency of introduction of particles into the source region and ionization as a function of particle size and composition. Characterize the particle beam and the generation of beams composed of biological particles.

54. Industry/University Cooperative Research Activity: Soot Formation and Burnout in Flames; Jack B. Howard; Massachusetts Institute of Technology, Department of Chemical Engineering, Cambridge, MA 02139; Award #80-08071 A02; $22,080 for 12 months beginning 12/01/82 (PMP). Part of a total NSF award of $48,785.

Measure the quantity, size, specific surface area, and composition of the soot entering the burnout stage, determining soot particle size and concentration profiles by optical techniques involving light scattering and extinction methods. Carry out surface area measurements and spectroscopic methods for determining radical concentration. Investigate particle breakup during burnout, determine the effects on the burnout kinetics of the thermal and oxidative history of the soot entering the burnout stage, and study the effects of fuel type on the burnout behavior of the soot.

55. Group Travel for U.S. Participants in the Fourth International Conference on Fluidization; Kashikojima, Japan; May 29-June 3, 1983; Dale L. Keairns; United Engineering Trustees, Inc., Department of Chemical Engineering, New York, NY 10017; Award #82-12334; $10,000 for 12 months beginning 01/01/83 (PMP); Split-funded with MEAM (HET) for $2,000.

    Provide funds for a number of U.S. researchers to attend and participate in the Fourth International Fluidization Conference and workshop in Kashikojima, Japan, May 29-June 3, 1983.

56. Relationships Between Cyclone Performance and Dimensions; David Leith; Harvard University, Department of Environmental Health Sciences, Boston, MA 02115; Award #80-12968 A02; $40,826 for 12 months beginning 01/01/83 (PMP).

    Develop a theory for dimensioning and sizing cyclone equipment through the rigorous application of engineering principles. Conduct tests to find inadequacies in efficiency or pressure drop theories at the limits of their applicability; demonstrate the usefulness of cyclone design procedures using the theory to optimize cyclone performance; and provide a base against which future improvements in cyclone performance can be measured.

57. Behavior of Capsules in Turbulent Pipe Flow; Henry Liu; University of Missouri, Department of Civil Engineering, Columbia, MO 65201; Award #82-11256; $57,526 for 12 months beginning 04/01/83 (PMP).

    Conduct experiments to verify a theory that takes into account the role of the lift force in capsule motion in hydraulic capsule pipeline and study capsule flow behavior. Test capsules of several geometries and densities. Measure quantities including capsule pressure gradient, capsule-pipe clearance, lift-off velocity, and pressure gradient generated along the pipe. Take photographs and motion pictures of the capsules moving in the pipe.

58. Interactions in Multiple Colloidal Systems; Egon Matijevic; Clarkson College of Technology, Department of Chemistry, Potsdam, NY 13676; Award #81-11612 A01; $52,377 for 12 months beginning 11/01/82 (PMP).

    Analyze solids of different geometries. Investigate adhesion and interactions of particles of different morphologies; particle removal from an uneven surface; and detachment of colloidal particles from surfaces exposed to turbulent hydraulic shear.

59. Industry/University Cooperative Research Activity: Scaling Concept for High Gradient Magnetic Separation; Emanuel Maxwell; Massachusetts Institute of Technology, Francis Bitter National Magnet Laboratory, Cambridge, MA 02139; Award #81-15218 A01; $55,000 for 12 months beginning 01/01/83 (PMP).

    Develop a scaling concept to predict the performance of a high gradient separator under arbitrary operating parameters once a set of characteristic curves has been established for the machine. Devise methods to determine the characteristic curves.

60. Fluid Flow Behavior in an Air Sparged Hydrocyclone; Jan D. Miller; University of Utah, Department of Metallurgy and Metallurgical Engineering, Salt Lake City, UT 84112; Award #82-13963; $46,215 for 12 months beginning 01/01/83 (PMP).

    Study the fluid flow characteristics of air-sparged hydrocyclones with water-only and multiphase flow to determine flow behavior profiles as a function of design and operating variables. Make flow measurements with an advanced laser doppler velocimeter and analyze data in the context of certain mathematical models. Correlate the results with flotation response. Evaluate design modifications and operating variables.

61. Sedimentation: Data Analysis, Quantitative Theory, and Simulation; David K. Pickard; Harvard University, Department of Statistics, Cambridge, MA 02138; Award #81-17673 A01; $49,929 for 12 months beginning 02/01/83 (PMP).

    Devise a quantitative theory of sedimentation, and develop efficient and useful simulations. Use a parameterized Markov model to combine the advantages of global parameters with the description of individual trajectories and to predict the performance of both small- and large-scale systems via simulations involving a modest number of particles.

62. New Model of Lamella Settlers; Ronald F. Probstein; Massachusetts Institute of Technology, Department of Mechanical Engineering, Cambridge, MA 02139; Award #80-08068 A02; $71,098 for 12 months beginning 10/15/82 (PMP).

    Investigate the operation, performance, and design of lamella and tube settlers as a function of feed location, settler angle, and suspension type. Study the stability and transition to turbulence of lamella and tube type sedimenting flows. Determine the most stably operating configurations as a function of geometry, suspension properties, and operating conditions and see if instabilities can be suppressed by design changes or fluid additives. Apply the stratified flow methodology to analyze general suspension flows. Obtain solutions which might be too complex to obtain by standard methods of two-phase flow theory.

63. Flocculation Processes in Particulate Systems; William B. Russel; Princeton University, Department of Chemical Engineering, Princeton, NJ 08544; Award #82-12327; $63,821 for 12 months beginning 11/01/82 (PMP).

Address three aspects of the flocculation process: flocculation rates in flowing systems, the steady-state floc size, and the effect of floc structure on the rheology at high rates of shear. Predict the collision rate, the breakup of flocs, or the stress generated by the presence of a floc in a shearing flow. Apply low angle light scattering, quantify the floc size and structure unambiguously, and study well-characterized suspensions of monodisperse particles.

64. Industry/University Cooperative Research Activity: Sedimentation and Diffusion in Concentrated Colloidal Suspensions; William B. Russel; Princeton University, Department of Chemical Engineering, Princeton, NJ 08544; Award #81-16339 A01; $36,769 for 12 months beginning 02/01/83 (PMP).

Investigate diffusion and sedimentation in concentrated aqueous suspensions; and develop a predictive theory for the sensitive concentration dependence of both properties accounting for hydrodynamic interactions and interparticle potentials, particularly of electrostatic origin. Calculate diffusion and sedimentation coefficients for both hard-sphere and electrostatically stabilized suspensions. Conduct experiments with model microemulsion systems, both nonionic and ionic, to measure independently the osmotic compressibility, sedimentation velocity, and diffusion coefficient.

65. Agglomeration of Particulate Systems in Fluidized Beds; Gabriel I. Tardos; City University of New York, Department of Chemical Engineering, New York, NY 10031; Award #82-13062; $33,064 for 12 months beginning 10/15/82 (PMP).

Examine the agglomeration phenomenon which causes the destabilization of low- and high-temperature fluidized beds of fine granules. Study low temperature beds in which defluidization occurs either because of the presence of sticky fluids or the presence of solutions. Investigate high-temperature agglomeration due to sintering of coal and/or ash particles in fluidized beds. Define the conditions under which stable-size agglomerates form in the fluidized bed, taking into account such bonding mechanisms between particles as solid-liquid bridges, viscoelastic flattening, and high temperature sintering.

66. Industry/University Cooperative Research Activity: Kinetics of Deep Bed Filtration; Chi Tien; Syracuse University, Department of Chemical Engineering and Materials Science, Syracuse, NY 13210; Award #81-10760 A01; $116,412 for 12 months beginning 10/15/82 (PMP).

Study the removal of particles from liquid suspensions flowing through granular media. Refine a simulation model which describes the dynamics of deposits in its entirety; gather experimental data on the transient behavior of deep bed filters; and make particle adhesion and attachment measurements to account for the effect of adhesion force and surface roughness on deposition.

67. Basic Studies on the Flow of Settling Slurries; Raffi M. Turian; University of Illinois, Department of Energy Engineering, Chicago, IL 60680; Award #81-11258 A01; $46,710 for 12 months beginning 11/01/82 (PMP).

Study slurry system characteristics and transport behavior, and establish the relationships between these and the constitutive nature of the slurry. Refine and extend available slurry flow correlations and flow regime delineation methods; examine the influence of particle size distribution on slurry behavior using known formulations of well defined particle sizes; and investigate the role of particle shape. Determine the influence and function of the fines in the slurry mix; measure and correlate data to provide effective methods for prediction of the critical velocity.

Renewable Materials Engineering (RME)

68. Biological and Synthetic Systems for Production of Hydrogen from Water; Alvin I. Krasna; Columbia University, Department of Biochemistry, New York, NY 10032; Award #82-15821; $74,978 for 12 months beginning 01/01/83 (RME).

Develop biological systems for the catalytic photolysis of water by visible light to hydrogen and oxygen. Present methods for reversible absorption and desorption of oxygen in a dynamic experimental design with a variety of reagents which combine reversibly with oxygen. Incorporate the means for removal of oxygen from these reagents so that they can be used catalytically.

69. Kinetic and Process Investigation on Acid Catalyzed Hemicellulose Hydrolysis; Yoon Y. Lee; Auburn University, Department of Chemical Engineering, Auburn, AL 36849; Award #82-11654; $58,127 for 12 months beginning 11/01/82 (RME).

Improve heat efficiency in the process of hydrolyzing hemicellulose. Investigate the reaction kinetics under low water conditions, develop a continuous plug-flow reactor to be operated under such conditions, and explore the use of a countercurrent extractor in separating sugars.

Separation Processes (SEP)

70. Counter-Current Staged-Feed Crystallizer; James R. Beckman; Arizona State University, Department of Chemical and Bio Engineering, Tempe, AZ 85281; Award #82-11671; $43,742 for 12 months beginning 11/01/82 (SEP).

    Prepare and evaluate a mathematical model for counter-current staged-feed (CCSF) crystallization with chemical reaction. Establish the kinetic parameters in batch crystallization experiments. Run six-stage laboratory CCSF crystallization with varying operating parameters to determine their effects and the ability of the model to predict these effects.

71. Stability Analysis of a Proposed Continuous Flow Electrophoresis Device (PCFE); Cornelius F. Ivory; University of Notre Dame, Department of Chemical Engineering, Notre Dame, IN 46556; Award #82-11483; $27,033 for 12 months beginning 10/15/82 (SEP); Split-funded with CBP for $8,000.

    Evaluate a modified continuous flow electrophoresis device, which will reduce instabilities due to buoyancy effects caused by unfavorable thermal gradients. Perform a theoretical analysis of the solute behavior and experiments to validate the subsequent experimental methodology. Complete the theoretical analysis, including the optimization of electrophoresis cell orientation, and the analysis used to design a prototype experimental cell.

Thermodynamic and Transport Phenomena (TTP)

72. Thermodynamics of Polar Fluids; Kwang-Chu Chao; Purdue University, Department of Chemical Engineering, Lafayette, IN 47907; Award #82-09624; $55,472 for 12 months beginning 12/01/82 (TTP).

    Investigate thermodynamic properties and fluid phase equilibria of polar fluids. Obtain a new equation of state by adding a polar interaction perturbation to a chain-of-rotators equation. Develop a reduced states correlation and extend a group contribution method to the entire fluid states. Include both gas and liquid for a greater number of chain molecules and polymers of common interest. Examine the concentration model activity coefficient equation for miscible and partially miscible systems. Determine vapor pressures and liquid densities of some common polar substances over a wide temperature range.

73. Dissolution and Precipitation of Minerals like Those in Teeth and Marble; Edward L. Cussler; University of Minnesota, Department of Chemical Engineering and Materials Science, Minneapolis, MN 55455; Award #82-07917; $47,620 for 12 months beginning 01/15/83 (TTP).

    Determine how porous solids dissolve and reprecipitate in the presence of acid. Compare dissolution theories for prediction of the concentration profiles of ions and reprecipitated solids with experimental results to develop improved theoretical relations. Conduct experiments with dilute suspensions of the appropriate solids that are stabilized in gels and use the results to explore the implications for corrosion of marble and tooth enamel; study the phenomena of periodic precipitation of solids which may be similar to that producing Liesegang rings.

74. Diffusion and Relaxation in Polymer Solutions; John L. Duda; Pennsylvania State University, Department of Chemical Engineering, University Park, PA 16802; Award #82-07401; $64,887 for 12 months beginning 12/01/82 (TTP).

    Develop analytical techniques to extract diffusivity data from transient measurements obtained from an oscillatory pressure sorption experiment and study the coupling of diffusion and molecular relaxation in concentrated polymer solutions. Develop a new sorption technique which can determine diffusion coefficients in dilute polymer solutions; use experimental data to evaluate existing theories for the transition region between the free-volume theory region of applicability and the statistical mechanical formulations for the high-solvent limit. Extend the free-volume theory to describe diffusion in ternary solutions consisting of a polymer and two solvents; analyze the enhancement of polymer devolatilization by the addition of a second solvent.

75. Transpiration: A Theoretical-Experimental Analysis of Mass Transfer Using a Plant Model System; R. Igor Gamow; University of Colorado, Department of Chemical Engineering, Boulder, CO 80309; Award #82-11861; $28,558 for 12 months beginning 01/01/83 (TTP). Part of a total NSF award of $48,558.

    Investigate a proposed mechanism for predicting the direction of plant movement during growth in response to atmospheric and specific environmental stimuli other than sunlight. Develop and test a numerical simulation of mass transfer between a simple plant and its surroundings. Examine the avoidance behavior and transpiration rate of a single plant in a wind tunnel as functions of differing humidities, wind speed, wind direction, and motion of wind barriers; compare the experimental behavior with the theoretical model of mass transport in the vicinity of the plant surface.

76. Properties of Nonideal Liquid Mixtures from Computer Simulation and Theory; Keith E. Gubbins; Cornell University, Department of Chemical Engineering, Ithaca, NY 14853; Award #82-09187; $69,013 for 12 months beginning 12/01/82 (TTP).

Perform computer simulation and theoretical studies of pure and mixed fluids and study dense fluid mixtures by means of perturbation methods based on statistical mechanics and intermolecular potential theory; focus on nonideal mixtures, in which the molecules differ significantly in size, energy of interaction, and polarity. Develop theories and investigate semiempirical equations based on perturbation theory with particular attention to obtaining better mixing and combining rules. Study applications to supercritical fluid mixtures, liquid-liquid equilibria, multicomponent mixtures, dilute solutions and mixtures with chemical reaction; develop reliable methods for correlating, extrapolating, and predicting physical and thermodynamic properties of dense fluids.

77. Spectroscopic Investigations of Structure, Transport, and Thermodynamic Properties of Nonideal Liquid Solutions; Erdogan Gulari; University of Michigan, Chemical Engineering Department, Ann Arbor, MI 48109; Award #81-07724 A01; $65,000 for 12 months beginning 02/01/83 (TTP).

Determine the structure and transport properties of nonideal solutions of associating solutes by the nonintrusive spectroscopic techniques of Quasielastic Light Scattering (QLS), Fourier Transform Infrared Spectroscopy (FTIR), and Small Angle X-ray Scattering (SAXS). Use QLS to measure mutual diffusion coefficients, apparent molecular weights, and hydrodynamic sizes and shapes of the aggregates formed by hydrogen bonding. Use FTIR to determine the types and amounts of hydrogen-bonded aggregates, bond strengths, equilibrium constants, and activity coefficients for the various aggregates. Employ SAXS to determine the sizes and shapes of small hydrogen bonded and micellar aggregates in solution. Test existing theories of solutions and transport in the liquid state and formulate correlations for predicting the mutual diffusion coefficients.

78. Multiphase Equilibria from Total Pressure Measurements; David B. Manley; University of Missouri at Rolla, Department of Chemical Engineering, Columbia, MO 65211; Award #82-05782; $48,752 for 12 months beginning 10/15/82 (TTP).

Conduct an experimental program to measure multiphase-multicomponent vapor-liquid equilibria data in systems that simulate carbon dioxide, water, and crude oil mixtures. Extend the total pressure method to multiphase-multicomponent equilibria. Develop a technique for measuring saturated vapor densities, along with a suitable theoretical framework to describe the observed behavior.

79. Studies of Mixing Effects on Chemical Reaction; Gary K. Patterson; University of Missouri at Rolla, Department of Chemical Engineering, Columbia, MO 65211; Award #82-07293; $38,000 for 12 months beginning 12/01/82 (TTP).

Develop a method for measuring the local concentration of reactants and/or products of chemical reactions in mixing vessels. Measure, in a continuous feed-mixing tank with a flat-bladed impeller, velocity, turbulence, concentration, and segregation distributions in reactors of interest.

80. Mechanisms of Solute Diffusion in Swelling Hydrophilic Polymer Systems; Nikolaos A. Peppas; Purdue University, Department of Chemical Engineering, Lafayette, IN 47907; Award #82-07381; $44,000 for 12 months beginning 12/01/82 (TTP).

Investigate mechanisms of water-soluble solute diffusion and penetrant diffusion through initially glassy, continuously swelling hydrophilic polymer systems. Perform the experimental studies with non-porous and macroporous systems which are crosslinked PVA and PHEMA polymers and PHEMA/PMMA and EVA copolymers; use several solutes of low or high molecular weight. Study the effects of the degree of crosslinking and dynamic swelling behavior of the polymer on solute diffusion. Analyze the results with a new physical theory based on a Peclet-like dimensionless number, and by mathematical modeling analysis of moving boundary problems.

81. Linear and Nonlinear Viscoelastic Properties of Polymeric Fluids and Suspensions in Polymeric Fluids; Robert L. Powell; Washington University, Department of Chemical Engineering, St. Louis, MO 63130; Award #82-09891; $49,966 for 12 months beginning 12/01/82 (TTP).

Investigate the rheology of filled polymeric fluids and transient flow viscometry. Consider model particles in polymer solutions and particulate fillers in thermoplastics, and examine the effect of interfacial bonding on the rheological and mechanical properties. Develop theoretical models to describe the observed behavior of the linear viscoelastic properties. Establish the material nature of the properties measured in transient flows. Derive a theoretical relation between material properties and the torque measured in a transient flow. Measure the transient shear stress functions using the parallel and cone-and-plate geometries with a modified and computerized Weissenberg Rheogoniometer and verify that the two are the same.

82. Industry/University Cooperative Research Activity: Computer-Aided Design and Analysis of Multiproduct Batch/Semicontinuous Processes; Gintaras V. Reklaitis; Purdue University, School of Chemical and Agricultural Engineering, Lafayette, IN 47907; Award #79-24565 A04; $73,412 for 12 months beginning 11/15/82 (TTP). Part of a total NSF award of $174,500.

Develop and implement computer-aided procedures for improving multiproduct processes, both of the batch and semicontinuous type. Evaluate these techniques in four industrial food processing plants in the Midwest.

83. Coalescence in Near-Critical Systems; Robert S. Schechter; University of Texas, Department of Chemical Engineering, Austin, TX 78712-1186; Award #82-08952; $54,000 for 12 months beginning 01/01/83 (TTP).

Investigate the coalescence of droplets when the dispersed and continuous phases are near a thermodynamic critical point. Explore surfactant-oil-water mixtures over a wide range of variables about a critical point. Study several anionic and nonionic surfactant systems. Use near critical temperatures and compositions which are commonly observed to possess ultralow interfacial tensions. Measure the amplitudes of the interfacial capillary waves by light scattering in carefully controlled isothermal systems with vibration suppression. Measure droplet collision efficiency and the rate of film thinning and critical rupture thickness. Study self-diffusion in surfactant sytems.

84. Nonisothermal Moisture Movement in Wood; John F. Siau; State University of New York, College of Environmental Science and Forestry, Wood Products Engineering Department, Syracuse, NY 13210; Award #82-03274; $53,000 for 12 months beginning 10/15/82 (TTP).

Investigate the movement of moisture in wood as it is influenced by temperature gradients in the wood. Conduct experiments to test a diffusion model which can relate the effect of opposing thermal and moisture gradients, the effect of thermal diffusion with no moisture gradient, and the effect of moisture and temperature gradients with no partial pressure gradient. Use the results to assess the thermal insulating and vapor barrier properties of wood. Examine the difference between nonisothermal and isothermal transport of moisture in wood.

85. Coalescence: Drainage and Stability of Thin Films; John C. Slattery; Northwestern University, Department of Chemical Engineering, Evanston, IL 60201; Award #82-05567; $60,420 for 12 months beginning 10/15/82 (TTP).

Study the effects of interfacial viscosities upon coalescence at fluid-fluid interfaces. Propose a hydrodynamic theory for the drainage of thin liquid film. Conduct numerical experiments to determine the stability of the draining film between a droplet and fluid-fluid interface. Perform a systematic experimental study of the coalescence times of single bubbles at fluid-fluid interfaces.

86. Structural Mixing and Three Dimensional Temperature Distributions in Agitated Vessels; Gary B. Tatterson; Texas A&M University, Department of Chemical Engineering, College Station, TX 77843; Award #82-04741; $69,619 for 12 months beginning 10/15/82 (TTP).

Measure three-dimensional velocity and temperature fields in a turbulent liquid during heat transfer processes by the method of high speed stereoscopic photography. Use a continuous flow mixing tank apparatus and temperature-sensitive particles (neutrally buoyant liquid crystals) to make simultaneous temperature and velocity measurements. Identify the influence of flow on heat transfer at the mixing tank wall and in the vessel interior in the vicinity of an entering stream of liquid. Increase the particle concentration presently being used in such tracer studies by several orders of magnitude through the use of automated film digitization.

87. Transport of Macromolecules Across Arterial Wall and Low Reynolds Number Flow Applications to Biological Systems; Sheldon S. Weinbaum; City College of the City University of New York, Department of Mechanical Engineering, New York, NY 10031; Award #82-00301; $76,146 for 12 months beginning 10/15/82 (TTP); Split-funded with PMP for $30,000. Part of a total NSF award of $136,146.

Study the transport of macromolecules across arterial walls and low Reynolds number flow transport in biomedical systems. Explore the basic mechanisms by which lipoproteins first cross the arterial endothelium and subsequently diffuse into the underlying tissue. Develop theoretical models and conduct supporting laboratory experiments to analyze the three-dimensional hydrodynamic interaction of finite spherical particles at the entrance to biological pores and filters. Use the results to examine the fine structure of osmosis at the entrance to the membrane pores and entrance effects in nuclepore filters. Develop models to explain the fluid draining behavior of cellular matrices at different porosities, and the time-dependent deformation of membrane-bound fluid cells moving in close proximity to solid boundaries.

DIVISION OF CIVIL AND ENVIRONMENTAL ENGINEERING (CEE)

Geotechnical Engineering (GEO)

88. International Symposium on Mechanics of Geomaterials; Zdenek P. Bazant; Northwestern University, Department of Civil Engineering, Evanston, IL 60201; Award #82-08208; $10,806 for 18 months beginning 11/01/82 (GEO); Split-funded with STM for $10,806.

Hold a IUTAM symposium in Evanston, Illinois, September, 1983 to provide a forum for an in-depth discussion of the frontiers of research in field of geomaterials. Address the following subjects: constitutive modeling of nonlinear triaxial behavior; behavior of solids with a system of cracks; shear localization, faulting and frictional slip; fracture propagation and fracture energy; fluid-infiltrated geomaterials; creep, shrinkage, and chemical aging; numerical modeling; and modern trends and directions.

89. Model of Characteristic Planes for Creep of Anisotrophic Clays; Zdenek P. Bazant; Northwestern University, Department of Civil Engineering, Evanston, IL 60201; Award #82-11642; $48,298 for 12 months beginning 12/01/82 (GEO).

Advance the present understanding of and modeling capability for anisotropic behavior of clays. Develop computer program calculating material response to given stress histories. Compare theoretical predictions with previously obtained test data on the measured creep of various anisotropically and isotropically consolidated clays, coupled with data on particle orientation distributions based on x-rays microscopy.

90. Isolation of Structures from Ground-Transmitted Vibrations by Use of Wave Barriers; Dimitrios E. Beskos; University of Minnesota, Department of Civil and Mineral Engineering, Minneapolis, MN 55455; Award #81-09723 A01; $64,014 for 12 months beginning 12/15/82 (GEO).

Perform mathematical modeling and numerical calculations to adapt the boundary integral approach to dynamic engineering geomechanics problems.

91. Sampling Strategies for Determination of the In-Situ State of Stress in Rock; Barry H. G. Brady; University of Minnesota, Department of Civil and Mineral Engineering, Minneapolis, MN 55455; Award #82-12674; $46,343 for 11 months beginning 12/01/82 (GEO).

Examine, using the techniques of computational mechanics, the stress distribution in the rock units which constitute a jointed or fractured rock mass. Simulate complex load paths applied to the blocky system and establish the way in which representative values of the ambient stress components can be determined in the presence of penetrative and persistent structural features. From these observations, methodologies for sampling the state of stress in various generic types of jointed and fractured media.

92. Statistical Characteristics of Granular Materials; Colin B. Brown; University of Washington, Department of Civil Engineering, Seattle, WA 98195; Award #82-11600; $58,208 for 12 months beginning 12/01/82 (GEO).

Predict the kinematics (packing, porosity, volume and relative approach statistics) and dynamics (contact forces, constitutive relation statistics) for granular materials made up of spheres of different properties and radii. Conduct experiments to examine the validity of the theoretical results.

93. Stress Waves in Wet Snow; Robert L. Brown; Montana State University, Department of Civil Engineering/Engineering Mechanics, Bozeman, MT 59715; Award #82-09594; $7,742 for 3 months beginning 10/15/82 (GEO).

Develop a two-phase model consisting of a viscoplastic skeletal structure and a liquid filled pore space. Conduct field tests using piezoresistive pressure transducers and air-burst explosions. Develop more general constitutive equations.

94. Workshop on Experimental Research Developments in Soil Engineering, August 1983, Blacksburg, VA; G. Wayne Clough; Virginia Polytechnic Institute, Department of Civil Engineering, Blacksburg, VA 24061; Award #82-16272; $49,995 for 12 months beginning 12/15/82 (GEO).

Hold a workshop to address the interrelationships among theoretical, laboratory, and field research on soils, in Blacksburg, Virginia, in August 1983.

95. Rock Mechanics of Excavation Tools and Behavior of Fluid-Filled Rocks Under Impact Loading; Werner Goldsmith; University of California, Department of Mechanical Engineering, Berkeley, CA 94720; Award #81-04715 A01; $47,128 for 12 months beginning 01/15/83 (GEO).

Perform research on the penetration and fracture of rock by direct mechanical contact loading, as opposed to explosive fragmentation.

96. Fundamental Thermal and Electrochemical Phenomena Associated with Drilling Processes in Rock; Stuart A. Hoenig; University of Arizona, Department of Electrical Engineering, Tucson, AZ 85721; Award #82-09912; $78,826 for 12 months beginning 11/01/82 (GEO).

Observe acoustical and electrical signals to develop correlations for drill wear.

Pursue techniques for applying the system in an in-situ field mode, including the use of other coolants, such as air and water-based foam, and sacrificial anodes to reduce the normal corrosion wear process.

97. Formation and Mechanical Properties of Naturally Occurring Ice Systems Within the Context of Civil Engineering Interests; John F. Kennedy; University of Iowa, Institute of Hydraulic Research, Iowa City, IA 52242; Award #81-09252 A01; $72,891 for 12 months beginning 12/15/82 (GEO); Split-funded with MEAM (SOM) for $10,000.
Study the formation and mechanical properties of naturally occurring ice systems, emphasizing issues of solid mechanics.

98. Continuum Theory of Rock Damage and Fracture; Dusan Krajcinovic; University of Illinois, Department of Materials Engineering, Chicago, IL 60680; Award #81-05270 A01; $47,492 for 12 months beginning 12/15/82 (GEO).
Use a microstructure approach to investigate rock damage and fracture.

99. Behavior and Modeling of Natural, Anisotropic, Normally Consolidated Clay; Paul Lade; University of California, Department of Mechanics and Structures, Los Angeles, CA 90024; Award #82-11159; $66,956 for 12 months beginning 11/15/82 (GEO).
Study the stress-strain, pore pressure and strength characteristics of natural, intact, anisotropic, normally consolidated clay under three-dimensional undrained stress conditions with and without rotation of the principal axes of stress using a torsion shear apparatus and a cubical triaxial apparatus. Examine the effect of rotation on the observed behavior by comparing results from the two types of equipment and results of triaxial compression tests performed on specimens cut at different angles to the direction of deposition of the natural clay. Evaluate the procedures used for characterization of soil stress-strain and strength behavior, and develop improved procedures for this characterization.

100. Consolidation, Swelling, Deterioration, and Creep of Clays and Shales; Gholamrez Mesri; University of Illinois, Department of Civil Engineering, Urbana, IL 61801; Award #82-12064; $66,720 for 12 months beginning 12/15/82 (GEO).
Study consolidation problems, including: the relationship of the end-of-primary void ratio-effective stress and the secondary compression index to the duration of the primary consolidation stage; the relationship of excess pore water pressure and effective stress path during consolidation to time and effective stress compressibility parameters; the theory of consolidation, including vertical drains, for field settlement and pore pressure behavior; and the state of the art of surcharging, with or without drains. Test undisturbed samples of eight natural clay deposits and samples of two dozen natural shale formations with different degrees of diagenetic bonding.

101. Collaborative Research: Micromechanical Modeling of Granular Soil Behavior; S. Nemat-Nasser; Northwestern University, Department of Civil Engineering, Evanston, IL 60201; Award #80-07764 A02; $49,994 for 12 months beginning 11/01/82 (GEO).
Develop micro-mechanics based constitutive relations incorporating rate effects for granular soils.

102. Static and Dynamic Behavior of Anisotropic Cohesionless Soil Under Combined Stresses; Adel S. Saada; Case Western Reserve University, Department of Civil Engineering, Cleveland, OH 44106; Award #81-12070 A01; $64,971 for 12 months beginning 01/01/83 (GEO).
Investigate the static and dynamic behavior of anistiopic cohesionless soil under combined stresses.

103. Experimental and Analytical Validation of Constitutive Models for Soils; Stein Sture; University of Colorado, Department of Civil, Environmental, and Architectural Engineering, Boulder, CO 80309; Award #80-25806 A02; $74,320 for 12 months beginning 10/14/82 (GEO).
Investigate the behavior of cohesive and cohesionless soils subjected to proportional, nonproportional, and cyclic as well as monotonic loading in conjunction with a rotating principal stress field. Demonstrate the influence of these features on the stress-strain-strength behavior of soil and identify the extent to which stress induced anisotropy modifies the response behavior of soils and the extent to which existing constitutive laws and testing methodology require modification to account for such effects. Conduct laboratory study by means of a new directional shear apparatus and existing multiaxial cubical test cells.

104. Investigation Into the Use of Seismic Tomography for Site Characterization; Firdaus E. Udwadia; University of Southern California, Department of Civil Engineering, Los Angeles CA 90007; Award #81-10774 A01; $60,580 for 12 months beginning 01/01/83 (GEO).
Develop a seismic tomographic system for application in solid engineering geomechanics.

105. Endochronic Theory for the Mechanical Behavior of Sand; Han-Chin Wu; University of Iowa, Department of Materials Engineering, Iowa City, IA 52242; Award #82-13569; $50,000 for 18 months beginning 01/15/83 (GEO).
Test constitutive equations developed and correlated with static loading tests against laboratory test results with different stress paths. Investigate the pore water pressure change in the undrained

test and study the dynamic response of sand by means of constant amplitude cyclic shear loading.

106. Effect of Vegetation Roots on Slope Stability; T. H. Wu; Ohio State University, Department of Civil Engineering, Columbus, OH 43210; Award #81-13253 A01; $30,407 for 12 months beginning 01/15/83 (GEO).

Extend the development of classical soil mechanics modeling to incorporate botanical considerations.

Structural Mechanics (STM)

107. Statistical Duration-Intensity Model of Structural Floor Loads; Ross B. Corotis; Johns Hopkins University, Department of Civil Engineering and Materials Science/Engineering, Baltimore, MD 21218; Award #82-05384 A01; $69,397 for 12 months beginning 10/26/82 (STM).

Develop a statistical duration-intensity model of structural floor loads.

108. Strength Behavior Model for Wood - An Anisotropic, Inhomogeneous, Discontinuous Material; James R. Goodman; Colorado State University, Department of Forest and Wood Sciences, Fort Collins, CO 80523; Award #82-10362; $79,160 for 12 months beginning 01/01/83 (STM).

Develop mathematical models for the strength behavior of wood in tension containing knots, associated cross grain, checks and global cross grain and develop failure criteria for wood containing cracks at various grain angles. Define the failure mechanism, especially at small grain angles, and incorporate it into a refined finite element stress analysis model. Modify an existing finite element procedure to incorporate fracture mechanics representations at the crack tips.

109. Synthesis of Prestressed Axisymmetric 3-Nets; Edward N. Kuznetsov; University of Illinois, Department of General Engineering, Urbana, IL 61801; Award #82-12099; $21,489 for 12 months beginning 11/15/82 (STM).

Synthesize the entire class of immobile (static) axisymmetric 3-nets where the first array is meridional and the other two arrays are inclined to meridian at equal but opposite angles. Determine the number and the role of arbitrary parameters governing the interrelated geometry and state of prestress; obtain analytical relations characterizing static-geometric interdependence and establish pertinent regularities; and perform computer-aided parametric studies for a variety of profiles (meridians) of static 3-nets with reference to their states of prestress.

110. Optimal Forms of Shallow Shells; Raymond H. Plaut; Virginia Polytechnic Institute, Department of Civil Engineering, Blacksburg, VA 24061; Award #82-10222; $94,641 for 24 months beginning 12/01/82 (STM).

Examine the problem of optimal design of shells, considering shallow shells of revolution with arbitrary meridional shape, and shells with rectangular planform, all with uniform thickness. Determine the optimal forms of these shells with respect to vibration, buckling, and dynamic instability. Maximize the fundamental frequency of free vibration and determine the form of the shell that will maximize the critical or buckling load. Study dynamic instability considering a cylindrical panel subjected to airflow at a constant velocity and shallow spherical shells subjected to stop, pulse, and loading.

111. Studies of Nonlinear Theory of Shear Deformable Elastic Shells; Eric Reissner; University of California at San Diego, Department of Applied Mechanics and Engineering Science, La Jolla, CA 92093; Award #82-13256; $50,754 for 24 months beginning 12/01/82 (STM).

Formulate consistent constitutive relations for shear deformability and geometric nonlinearity and apply the results to certain test cases including shallow shells of revolution and helicoidal shells.

112. Active Control in Structural Engineering; Tsu T. Soong; State University of New York, Department of Civil Engineering, Buffalo, NY 14260; Award #80-10891 A02; $54,825 for 12 months beginning 10/15/82 (STM).

Investigate active control in structural engineering.

Hydraulics, Hydrology, and Water Resources (HHW)

113. Real-Time Control of Irrigation Systems; Rafael L. Bras; Massachusetts Institute of Technology, Department of Civil Engineering, Cambridge, MA 02139; Award #82-11469; $62,990 for 12 months beginning 11/15/82 (HHW).

Utilize recent and advanced concepts of random point processes to model rainfall occurrence using the physically observed cluster behavior. Formulate a saturated-unsaturated flow model to account for salt mass balance, acknowledging the influence of groundwater elevation in crop yield, and obtain water demand curves as a function of climate, soil, and farming activity.

114\. Developments in Synthetic Streamflow Modeling; Stephen J. Burges; University of Washington, Department of Civil Engineering, Seattle, WA 98195; Award #82-11730; $55,776 for 12 months beginning 11/15/82 (HHW).

Address some of the operational difficulties in current stochastic techniques, and perform the following tasks: develop operational multi-site models which are flexible enough to model the long-term annual-scale persistence at the individual sites; refine a simplified synthetic flow disaggregation model that can be readily used with annual scale models; evaluate data requirements for implementing stochastic methods; and develop a method of incorporating uncertainty in total seasonal runoff forecasts into operational decision-making for reservoir systems.

115\. Mathematical Model for Erodible Channels with Width Variation; Howard H. Chang; San Diego State University, Department of Civil Engineering, San Diego, CA 92182; Award #82-09029; $31,310 for 12 months beginning 11/15/82 (HHW).

Develop and calibrate mathematical model, using it along with a case history data base, to provide a basic understanding of the formation and adjustment of channel width in alluvial streams.

116\. Mixing in Stratified Flow Over Topography; Hugo B. Fischer; University of California, Department of Civil Engineering, Berkeley, CA 94720; Award #82-12073; $77,285 for 12 months beginning 11/01/82 (HHW).

Investigate the flow of two-layer and continuously stratified fluids over an obstacle. Conduct towed obstacle experiments for comparison with past results and to define the contrast with the fixed obstacle experiments. Specify the conditions necessary for the formation of internal hydraulic jumps and regions of flow separations and quantify their effect on vertical mixing.

117\. Development and Application of a Freshwater Hydrodynamic-Biogeochemical Model Using in Situ Experimental Enclosures; Donald R. Harleman; Massachusetts Institute of Technology, Department of Civil Engineering, Cambridge, MA 02139; Award #82-11525; $121,190 for 12 months beginning 11/15/82 (HHW).

Develop linked hydrodynamic-biogeochemical models capable of simulating the effects of nutrient cycling (e.g., algal blooms) in lakes and predicting the response of the lake to external controls. Examine the role of turbulence and sediment re-suspension on phytoplankton growth, either with or without lake bottom sediments in the enclosure. Address improved methods of measuring biological available inorganic phosphorus, and of separating and identifying living and non-living particulates.

118\. 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).

Study the implications of immediately and unambiguously informing architects and engineers 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 data base system (ARCH:MODEL) currently under development at the Architectural Research Laboratory, University of Michigan. Explore how existing and new economic analysis research procedures help to define and clarify the role of economic analysis during initial design within the context of computer-aided design.

119\. Applications of Stochastic Optimal Control Theory to the Real-Time Operation of Multireservoir Systems; Peter K. Kitanidis; University of Iowa, Institute of Hydraulic Research, Iowa City, IA 52242; Award #82-12066; $87,031 for 24 months beginning 04/01/83 (HHW).

Investigate application of stochastic optimal control theory to the problems of real time operation of multi-reservoir systems. Examine various types of control, such as deterministic optimal, Linear-Quadratic-Gaussian, and approximate closed-loop dual, and develop guidelines to determine when it is appropriate to separate the estimation problem from the optimization problem. Consider the problem of real-time forecasting of river flows from a stochastic optimal central viewpoint. Derive methods that use optimally short- and long-term forecasts, generated in real time through various hydrological models, to operate multi-reservoir systems.

120\. Alluvial Bed Form Resistance and Sediment Movements; Hsieh W. Shen; Colorado State University, Department of Civil Engineering, Fort Collins, CO 80523; Award #78-25054 A03; $163,000 for 24 months beginning 11/01/82 (HHW).

Study the sheltering effect of large particles on smaller particles; develop a sediment bed load mathematical model for non-uniform materials; develop a mathematical model for the degradation process and determine the best method to integrate the bed load into the total sediment load.

121\. Two-Dimensional Turbulent Jets with Time Varying Discharge Velocity and Flow Rates; Ben L. Sill; Clemson University, Department of Civil Engineering, Clemson, SC 29631; Award #82-13187; $45,271 for 12 months beginning 11/15/82 (HHW).

Investigate the fluid mechanics of an established two dimensional turbulent jet subject to relatively slow changes in discharge rate or velocity. Study the unsteady velocity field, jet size, eddy formation, and entrainment resulting from the time-varying discharge. Conduct the experimental work in a 9 inch by 12 inch basin, measuring streamlines, velocity fields, mixing rates, and some basic turbulence parameters.

122. Theoretical and Experimental Investigation of Transient Mixed-Flows, Open Channel Flow-Closed Conduit Flow; Charles C. Song; University of Minnesota, St. Anthony Falls Hydraulic Laboratory, Minneapolis, MN 55455; Award #80-25160 A01; $65,000 for 12 months, beginning 12/01/82 (HHW).

Study the simultaneous existence of transient open channel flow and transient closed conduit flow in a water conveyance system. Consider the problem of air entrainment and its effect on transient flows in general, and the movement of the interface in particular.

Environmental and Water Quality Engineering (EWQ)

123. Wastewater Treatment for Temperate Regions Using Aquatic Macrophytes and their Epifloral Biofilms; Paul L. Bishop; University of New Hampshire, Department of Civil Engineering, Durham, NH 03824; Award #82-09851; $58,853 for 12 months beginning 11/15/82 (EWQ).

Investigate the feasibility of treating domestic wastewater in temperate regions by use of psychrophilic macrophytes to exploit the mutualistic symbiosis between the phototroph and its heterotrophic biofilm. Study organisms including the submersed, unattached macrophytes Elodea canadensis (freshwater), Ulva lactuca (marine) and their biofilms. Culture Lemna sp. (freshwater) for comparative purposes and biofilms by use of scanning and transmission electron photomicroscopy. Assess process performance by determining changes in concentration of total organic carbon, suspended solids, ammonia - nitrite and nitrate forms of nitrogen, and phosphate. Use results of experimental work to develop a model for predicting performance of the combined system.

124. Mathematical Models of Trace Contaminants in Natural Waters; Donald J. O'Connor; Manhattan College, Civil Engineering Department, Bronx, NY 10417; Award #82-07319; $79,519 for 12 months beginning 12/01/82 (EWQ).

Develop fundamental bases for construction of mathematical models that characterize the movement of conservative substances, which are potential contaminants of water, in natural bodies of water. Study difference in behavior of substances, such as halogenated hydrocarbons and heavy metals, and other substances usually present in natural water, such as oxygen and plant nutrients. Describe the net effects of settling, scour, and burial of solids to which organic substances and heavy metals have been adsorbed; evaluate the effects of evaporation and vaporization on presence and concentration of volatile organic substances; and correlate mathematical models with prototype determinations in streams, estuaries and lakes.

Earthquake Hazards Mitigation (EHM)

125. Seismic Hazard and Structural Damage Prediction; A. H. Ang; University of Illinois, Department of Civil Engineering, Urbana, IL 61801; Award #82-13729; $159,210 for 12 months beginning 12/15/82 (EHM).

Develop damage models based on the concept of hysteretic energy and maximum structural distortion and develop associated seismic hazard models in terms of ground motion amplitude, frequency, and duration. Formulate the damage prediction models within the context of nonlinear random vibration. Use these models for evaluating reliability against severe seismic damage and develop methods for formulating probability-based criteria to insure a reliability against specified tolerable damage, including the determination of appropriate earthquake load factors within the LRFD (load and resistance factor design) format.

126. Travel to Attend: IUTAM Symposium on Random Vibrations and Reliability; Frankfurt (Oder), East Germany; October 31-November 6, 1982; A. H. Ang; University of Illinois, Department of Civil Engineering, Urbana, IL 61801; Award #82-16834; $1,007 for 2 months beginning 10/28/82 (EHM).

Provide travel support for a participant in the IUTAM Symposium on Random Vibrations and Reliability, Frankfurt (Oder), East Germany, October 31-November 6, 1982.

127. Earthquake Simulator Tests of a Replica Model Reinforced Concrete Building; Vitelmo Bertero; University of California, Department of Civil Engineering, Berkeley, CA 94720; Award #80-09478 A03; $125,880 for 12 months beginning 10/01/82 (EHM).

Study the correlation of a scale model subjected to earthquake forces on a shake table with the reinforced concrete building which was tested in Japan. Develop mathematical models to predict the dynamic response of the concrete building to verify construction practices. Evaluate construction practices to develop design criteria and code provisions.

128. Maximum Amplitude Nondestructive Dynamic Testing of a Highway Bridge Implications for Seismic Design; Bruce M. Douglas; University of Nevada, Department of Civil Engineering, Reno, NV 89507; Award #81-08124 A01; $64,619 for 12 months beginning 12/01/82 (EHM).

Study the dynamic behavior of various types of bridges subjected to seismic forces. Shake full size bridges by external devices and record the lateral movement and motion of the bridge. Evaluate the dynamic response of pile groups and correlate results with the dynamic response of the tested bridge. Develop a mathematical algorithm for dynamic response for the dynamic loads on a bridge.

129. Methodology for Reducing Non-Structural Damage and Operational Loss in Office Buildings During Earthquakes; Michael E. Durkin; Michael E. Durkin and Associates, Woodland Hills, CA 91364; Award #82-06508; $57,489 for 12 months beginning 12/15/82 (EHM).

Examine the relationship of non-structural damage to operational loss. Analyze data from recent California earthquakes and develop a conceptual framework for relating the performance of non-structural elements and operational aspects to engineering, architectural, and organizational variables. Develop alternative earthquake hazard reduction strategies tailored to physical characteristics of buildings and organizational characteristics of building occupants.

130. Guidelines for Mitigation of Seismic Hazards in Tilt-Up-Wall Structures: Phase II; Robert D. Ewing; Agbabian Associates, El Segundo, CA 90245; Award #81-14457 A01; $249,910 for 12 months beginning 10/15/82 (EHM).

Determine the seismic response of tilt-up-wall panels by experimental tests and develop a mathematical model for evaluation of existing structures and design of new buildings. Construct a test facility to conduct the test program. Evaluate and modify the nonlinear dynamic correlations with the mathematical models.

131. Acquisition of Structural Dynamics Analyzer for Earthquake Engineering and Structural Dynamics Research; James M. Gere; Stanford University, Department of Civil Engineering, Stanford CA 94305; Award #82-11574; $54,086 for 6 months beginning 11/15/82 (EHM).

Purchase a structural dynamics analyzer or Fourier analyzer and related equipment for use in structural dynamics research.

132. Seismic Evaluation of Low Rise Buildings in Zones of Moderate Seismicity; Barry J. Goodno; Georgia Institute of Technology, Department of Civil Engineering, Atlanta, GA 30332; Award #82-13803; $68,891 for 18 months beginning 12/01/82 (EHM).

Study one-to-four story office structures composed of a lightweight steel frame, bar joist roof, and lightweight panel or brick masonry exterior facade. Conduct a limited survey to define the variety of construction within the class and a design review of two similar buildings for code-level lateral forces. Model one low rise structure on the computer and study it in the field using ambient level vibration measurements. Examine the results of the research program in light of existing seismic design criteria for larger structures.

133. Full Scale Testing of a Rehabilitated Multistory Building; Gary C. Hart; University of California, Department of Civil Engineering, Los Angeles, CA 90024; Award #80-07792 A01; $46,652 for 12 months beginning 11/23/82 (EHM).

Investigate the seismic safety of a three-story building which was retrofitted by adding additional shear walls to resist earthquake forces. Analyze data from forced vibration tests and compare the dynamic response with data obtained from an actual earthquake. Verify the current analysis method.

134. Transportation Actions to Reduce Highway Evacuation Times Under Natural Disasters; Antoine G. Hobeika; Virginia Polytechnic Institute, Department of Civil Engineering, Blacksburg, VA 24061; Award #82-11748; $181,133 for 24 months beginning 12/15/82 (EHM).

Develop, test, and evaluate various highway-related measures that would reduce the highway network clearance time in a community threatened by a natural disaster. Publish document on the state-of-the-art in network evacuation planning under emergency conditions; develop a model capable of evaluating transportation actions aimed at reducing network evacuation time that can be used by state, local, and other agencies concerned with evacuation planning. Determine the social, economic, and political feasibility of recommendations, as well as their implementation requirements.

135. Generalized Approach to Risk and Damage Analysis Associated with Seismically Induced Pore Water Pressure Build Up; Edward Kavazanjian; Stanford University, Department of Civil Engineering, Stanford CA 94305; Award #82-10616; $230,900 for 24 months beginning 11/15/82 (EHM).

Provide a tool to allow for a probabilistic prediction of expected levels of pore pressure and ground strains considering uncertainties in soil parameters as well as seismic loading. Perform a case history study of the April, 1981, Westmoreland, California, earthquake where numerous liquefaction phenomena developed in a low magnitude event (M_L = 5.6)

136. Development of Guidelines for Earthquake Engineering Gas and Liquid Fuel Lifelines; Edward A. Kippel; American Society of Civil Engineers, Department of Civil, Mechanical and Environmental Engineering, New York, NY 10001; Award #79-23559 A01; $153,892 for 12 months beginning 11/15/82 (EHM).

Develop guidelines for the earthquake engineering design of gas and liquid fuel lifelines, including gas and liquid fuel pipelines, pump and compressor stations, storage facilities, tanker loading and unloading facilities, and other associated facilities.

137. Analytical and Experimental Studies of Mechanical Equipment Under Earthquake Loads; Sami F. Masri; University of Southern California, Department of Civil Engineering, Los Angeles, CA 90007; Award #82-09767; $93,240 for 12 months beginning 12/01/82 (EHM).

Study the problem of determining the reliability of a mechanical system under a dynamic environment. Develop a practical nonparametric identification technique suitable for use with experimental measurements derived from realistic equipment and structural systems; devise a simple physical model to represent the essential features of the component behavior. Conduct analytical and experimental studies on the response of generic nonlinear equipment models subjected to a variety of dynamic environments.

138. Equipment for the Replacement of the Data Acquisition and Data Analysis Systems for the Earthquake Simulator at the Earthquake Engineering Research Center; Hugh D. McNiven; University of California, Earthquake Engineering Research Center, Berkeley, CA 94720; Award #82-08500; $179,985 for 12 months beginning 10/15/82 (EHM).

Replace the earthquake simulator's data acquisition and data analysis systems.

139. Research on Window Glass Subjected to Dynamic Loads; Joseph E. Minor; Texas Tech University, Department of Civil Engineering, Lubbock, TX 79409; Award #81-18214 A01; $158,270 for 12 months beginning 01/01/82 (EHM).

Study the behavior and failure of window glass under dynamic loading and investigate the behavior of multiple pane units, investigating the mechanics of panes of glass edge bonded with sealants and dynamic behavior of multiple pane units.

140. Hysteretic Behavior of Precast Panel Walls; Peter Mueller; Lehigh University, Department of Civil Engineering, Bethlehem, PA 18015; Award #82-06674, $178,928 for 12 months beginning 11/01/82 (EHM).

Investigate the effect of horizontal connections on the strength and inelastic rotation capacity of the base of precast walls subjected to cyclic, lateral, and constant axial load. Develop an analytical model for the description of the strength and hysteretic behavior of the potential plastic hinge region of precast walls and formulate preliminary design recommendations for earthquake-resistant precast panel walls.

141. Development of Seismic Hazard Awareness and Policy: A Regional Approach in the Central States; Alvin H. Mushkatel; Arizona State University, Center for Public Affairs, Tempe, AZ 85281; Award #82-12799; $284,442 for 24 months beginning 12/15/82 (EHM).

Examine seismic mitigation policy in the five-state New Madrid fault region. Suggest a model that links individual and community attitudes to the development of mitigation policy with the media and other factors acting as mediating influences. Investigate governmental mandates and the influence of seismic program funds upon activities and attitudes of key actors and the public. Make comparisons within and between states in the New Madrid region.

142. Lateral Stiffness of Pile Groups for Seismic Analysis of Highway Bridges; Gary M. Norris; Clarkson College of Technology, Department of Civil and Environmental Engineering, Potsdam, NY 13676; Award #82-06224; $30,559 for 12 months beginning 11/15/82 (EHM).

Develop a simple straightforward method for evaluating the lateral foundation stiffness of both interior pile groups and groups in abutment fills for application relative to the structural analysis of highway bridges undergoing seismic loading. Validate the developed method by inputting recorded free field motions at Meloland Overcrossing to a finite element model of the bridge having foundation springs of lateral stiffness calculated according to the method and comparing predicted and recorded strong motions at various stations on the bridge.

143. Policy, Economic, and Social Effects of an Earthquake Prediction: The Lima-Callao Area of Peru, 1980-1984; Richard S. Olson; Arizona State University, Center for Public Affairs, Tempe, AZ 85281; Award #82-14245; $297,870 for 24 months beginning 12/15/82 (EHM).

Reconstruct the short-term and monitor the middle- to long-term effects of the prediction for at least two great earthquakes for the area offshore of Lima-Callao, Peru on the following: public policy and governmental organization in the areas of hazard mitigation and disaster preparedness; the economic system, focusing on business-firm behavior, especially that of the U.S. subsidiaries and the markets for housing, labor, and capital; and the social system, especially information-seeking by the public and both diffuse and organized collective behavior. Explore questions and propositions about the effects of, and the responses to, earthquake prediction.

144. Dynamics of Multistory Rigid Prism Structures Under Earthquake Loadings; Irving J. Oppenheim; Carnegie-Mellon University, Department of Civil Engineering, Pittsburgh, PA 15213; Award #82-09468; $93,368 for 24 months beginning 12/01/82 (EHM).

Study the dynamics of multistory rigid prism structures. Verify and extend the existing equations; obtain the piecewise linear analytical solution for the general N-story model; examine the mathematical stability of the nonlinear equations; devise a convergent numerical integration scheme for the general nonlinear N-story model; conduct parametric studies; compare sample response with results from bounding techniques and/or probabilistic methods; and determine reasonable failure and design criteria for rigid prism structures and related structural types.

145. Repair of Seismic Damage to Steel Structures; Charles W. Roeder; University of Washington, Department of Civil Engineering, Seattle, WA 98195; Award #82-05260; $111,570 for 24 months beginning 12/01/82 (EHM).

Investigate the use of thermal straightening to repair seismic damage. Determine deformation and strain distributions obtained through thermal repair; study the effect of redundancy and restraint on the straightening process; and apply these results to steel structures to determine when and how straightening can be applied to seismic damage. Consider braced frames, moment frames and other structural systems and evaluate and compare previous experimental work to project results.

146. Cooperative Studies with Researchers in the Balkan Region on Building Construction Under Seismic Conditions; Theodore G. Toridis; George Washington University, Department of Civil, Mechanical and Environmental Engineering, Washington, D.C. 20052; Award #82-19357; $50,000 for 12 months beginning 11/15/82 (EHM).

Develop a set of manuals which will synthesize current research and construction knowledge to provide assessment of existing or damaged structures, for repair and retrofit, for construction of new structures, and for consideration of special problems of historical and cultural structures. Identify an appropriate group of U.S. researchers to participate in the Balkan program; coordinate the overall U.S. activities; arrange for travel for these experts to the different committee sessions; and make certain that the results from the Balkan project are made available to U.S. researchers.

147. Measurement and Interpretation of Full Scale Building Response During and After Construction Period; Morteza A. Torkamani; University of Pittsburgh, Department of Civil Engineering, Pittsburgh, PA 15260; Award #82-06909; $112,389 for 24 months beginning 11/15/82 (EHM).

Conduct a series of low level vibration tests during and after the construction period of a steel framed high rise building in Pittsburgh. Process data collected from the tests identify natural frequencies, mode shapes, and damping coefficients. Perform sensitivity analyses to study the contribution of each component to the mathematical model for the building. Define the model and use it to calculate the response of the building to the measured wind velocity. Compare calculated and measured responses at selected building coordinates and illustrate the accuracy of the parameters and data processing.

148. Active Control of Structures Under Earthquake and Other Dynamic Loads; J. N. Yang; George Washington University, Department of Civil, Mechanical and Environmental Engineering, Washington, D.C. 20052; Award #81-05307 A01; $74,568 for 12 months beginning 11/08/82 (EHM).

Perform analytical and computer simulation studies of the control by active devices of tall buildings and bridge structures under earthquakes and/or wind excitation.

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

Automation, Bioengineering, and Sensing Systems (ABS)

149. Interaction of Electromagnetic Fields With Biological Tissue; Kun-Mu Chen; Michigan State University, Department of Electrical Engineering and Systems Sciences, East Lansing, MI 48824; Award #80-01772 A01; $98,060 for 24 months beginning 11/01/82 (ABS).
Support the ongoing program on "Interaction of Near-Zone EM Fields with the Human Body." Cover the following topics: interaction of near-zone fields of EM sources with human bodies; EM local heating for hyperthermia cancer therapy; EM probing of biological parameters and bioelectric phenomena; and improvement and extension of the tensor integral equation method.

150. Electrokinetic Effects in Bone; Solomon R. Pollack; University of Pennsylvania, Department of Bioengineering, Philadelphia, PA 19104; Award #80-17856 A02; $10,000 for 12 months beginning 10/15/82 (ABS).
Determine the influence of electrokinetic effects on stress generated potentials in bone. Measure stress generated potential on human and bovine cortical bone and selectively modify the Haversian Canal and canalicular fluid properties by steeping and by ultrasonic agitation. Perform both macroscopic and microelectrode measurements in four-point bending and for step function stresses; analyze the amplitude and sign of the measured potentials and compare the results to electrokinetic theory, linear piezoelectric theory, and gradient piezoelectric theory.

151. Digital Image Processing of High Resolution Electron Microscope Images; Benjamin M. Siegel; Cornell University, School of Applied and Engineering Physics, Ithaca, NY 14853; Award #82-05894; $79,344 for 12 months beginning 11/15/82 (ABS).
Apply computer image processing methods to electron micrographs of unknown structures. Take the electron micrographs on the Kyoto EM and pursue heavy/light atom discrimination by studying the possibilities of observing single heavy atoms, e.g., Hg, intercalated in DNA and heavy atoms in organometallic polymers. Extend the nonlinear image processing methods to the Maximum A Posterior (MAP) and Maximum Entropy Methods (MEM); adapt them to processing defocus series of conventional transmission bright-field phase contrast electron micrographs that are complex images (real and imaginary parts) and test them on actual high resolution images.

Computer Engineering (COM)

152. New Efficient Feedforward Adaptive Signal Processing Algorithm and its Real-Time Microcomputer Configuration; Gerald G. Cano; Perinatronics Company, Crofton, MD 21114; Award #82-60708; Part of a total NSF award of $30,000 for 6 months beginning 11/01/82 (COM).
Examine the relationship between a feedforward adaptive algorithm and its real-time computer configuration. Obtain a real-time feedforward adaptive processor by combining a new mathematical algorithm with an appropriate hardware architecture and software system foundation. Show the feasibility to cancel adaptively, in real-time, a strong interfering source and background noise from a weak desired signal, all received from a distributed array of sensors.

153. Decoupled Access/Execute Computer Architectures; James E. Smith; University of Wisconsin, Department of Electrical and Computer Engineering, Madison, WI 53706; Award #82-07277; $93,200 for 24 months beginning 11/15/82 (COM).
Study a new type of processor architecture that should lead to high performance Very Large Scale Integrated (VLSI) circuit implementations. Investigate performance evaluations for a variety of workloads and implementations; implementation and architectural variations; software issues related primarily to code compilation; and deadlock detection and prevention.

Electrical and Optical Communications (EOC)

154. Digital Filter Structures; Casper W. Barnes; University of California, Department of Electrical Engineering, Irvine, CA 92717; Award #81-09239 A01; $37,791 for 12 months beginning 12/15/82 (EOC).
Develop fundamental approaches to discover new digital filter structures that provide optimal tradeoffs between filter complexity and finite word effects, taking full account of the possible implementation in very large scale integrated (VLSI) circuits. Emphasize the investigation of finite word effects in multi-input, multi-output digital filters. Study problems associated with scaling, roundoff error, coefficient sensitivity, and limit cycles. Examine normal form digital filter sections as fundamental building blocks for general filter implementations, and non-minimal realizations of digital filters by introducing additional degrees of freedom in a filter structure.

155. Multiple User Channels and Information Theory; Thomas M. Cover; Stanford University, Information Systems Laboratory, Stanford, CA 94305; Award #82-11568; $97,711 for 12 months beginning 10/15/82 (EOC).

Study multiple-user communication theory. Consider the capacity of the broadcast channel for correlated sources and the capacity region for multiple access channels with feedback. Investigate the duality between data compression and channel transmission and examine the relay channel and interference channels. Study the relationships between Kolmogorow complexity and interference, and Hadamard's inequality using information theory.

156. Multilevel Computer-Aided Design of VLSI Digital Systems; S.W. Director; Carnegie-Mellon University, Department of Electrical Engineering, Pittsburgh, PA 15213; Award #82-07709; $92,373 for 12 months beginning 10/15/82 (EOC). Part of a total NSF award of $184,746.

Take a hierarchical approach to the design of digital systems, beginning with a behavioral specification of the system. Support the hierarchical design with a comprehensive set of computer-aided design (CAD) methods which takes into account the important characteristics of integrated circuit technology. Consider synthesis of digital VLSI systems, multilevel representations for digital system design space exploration, man-machine environment for CAD of digital VLSI systems, and special hardware for VLSI CAD.

157. Information Theory and Data Compression; Robert M. Gray; Stanford University, Department of Electrical Engineering, Stanford, CA 94305; Award #80-16714 A02; $48,000 for 12 months beginning 01/15/82 (EOC).

Study problems in information theory and its implications for data compression. Emphasize the further development of the theoretical convergence and optimality properties of the Linde-Buzo-Gray and the k-means algorithms for the design of vector quantization systems and the extension of these algorithms to quantization within a feedback loop, e.g., the design of locally optimal predictive quantizers; and the continuation of previous work on Shannon performance bounds for asymptotically-mean stationary sources and channels.

158. Acquisition of Specialized Equipment for Microfabrication Research; David A. Hodges; University of California, Electronics Research Laboratory, Berkeley, CA 94720; Award #81-20447 A02; $111,650 for 12 months beginning 12/01/82 (EOC); Split-funded with SSM for $111,650.

Acquire dry etching systems for oxide, metal, and polysilicon and organic dielectrics, and for thin film deposition; acquire a multi-source evaporation system for mixed alloys of metal silicides (shallow contacts and thin layers); acquire a sputtering system for inorganic resist such as Ge_xSe_y; and acquire a plasma-enhanced chemical vapor deposition (CVD) system for ultra-thin Sin_xOy.

159. Research in Two-and-Multidimensional Digital Filters; Eliahu I. Jury; University of Miami, Department of Electrical Engineering, Coral Gables, FL 33124; Award #81-16847 A01; $32,396 for 12 months beginning 03/01/83 (EOC).

Investigate some of the problems associated with higher dimensional systems, whether discrete or continuous, and produce useful algorithms for the analysis and synthesis of such systems. Emphasize two-and-multidimensional digital filters. Study problems related to sufficient conditions for stability, verification of the modified Shanks' conjecture, margins of stability, quantization error, limit cycles study, approximation problems and rational modeling, optimum choice of sampling rate and quantization fineness, and stability of multivariable, multidimensional digital filters.

160. Quantization of Line Drawings; Jack Koplowitz; Clarkson College of Technology, Department of Electrical and Computer Engineering, Potsdam, NY 13676; Award #82-06609; $81,172 for 24 months beginning 12/01/82 (EOC).

Investigate quantization methods for line drawn images. Analyze the performance of commonly used quantization methods and the properties of the encoding errors; study the information content of line drawings with models of random curves and the investigation data compression algorithms; and examine the application of filtering and tree encoding techniques for achieving highly accurate quantization.

161. Optimization and Control of Large-Scale Networks; James S. Meditch; University of Washington, Department of Electrical Engineering, Seattle, WA 98195; Award #80-11262 A02; $20,910 for 12 months beginning 10/15/82 (EOC); Split-funded with STO for $20,910.

Study the stability, control and performance optimization of large-scale networks in which there is contention for limited resources by many users, control is distributed, and network state information is generally distributed, delayed and incomplete. Develop a basic theoretical understanding of the structure and operation of such networks, and provide algorithms for the practical realization of optimal performance.

162. Research on Signal Processing by Multiple Programmable Chips; David G. Messerschmitt; University of California, Electronics Research Laboratory, Berkeley, CA 94720; Award #82-11071; $60,000 for 12 months beginning 12/15/82 (EOC).

Study the implementation of real-time signal processing systems using multiple programmable chips interconnected by multiple store-and-forward switching chips. Design the hardware-level interconnect protocols very flexibly to accommodate almost any interconnect topology. Address several aspects of an integrated automated design system in which the designer uses a code generator to write the application software and the design of the appropriate topology and routing, as well as the generation of code to handle the interprocessor communications are performed automatically. Test this design approach using benchmark applications and a simulator of a multiprocessor system.

163. Feedback Techniques in Data Communication Networks; John J. Metzner; Oakland University, School of Engineering, Rochester, MI 48063; Award #81-12818 A01; $38,972 for 12 months beginning 12/15/82 (EOC).

Study the use of feedback techniques to improve the data rate efficiency and reliability of large scale computer communication networks which use noisy communication links. Investigate new and improved strategies for optimum acknowledgment retransmission use in the broadcast of identical data to multiple sites, communication needs for updating, checking, and locating discrepancies in multicopy remote files, and the development of various compatible feedback techniques. Determine the possibility of incorporating into the circuit switching relay node a more active role in the error control process.

164. Research in Source Channel Coding and Communication Networks; Jim K. Omura; University of California, System Science Department, Los Angeles, CA 90024; Award #80-12568 A02; $70,000 for 12 months beginning 01/01/83 (EOC).

Examine the relationship between information theory and queuing/network theory in the analysis and design of digital communication networks that are accessed by a large number of different users. Develop procedures for the efficient utilization of multi-access communication channels and networks; seek techniques for evaluating the delay-throughput stability and operating point characteristics of Markovian multi-user data communication channels and analyze the delay-throughput performance characteristic of store-and-forward and real-time demand assignment access-control schemes. Investigate delay-throughput performance of automatic repeat request strategies employed over a multi-access communication channel.

165. Problems in Integrated Digital Networks; Mischa Schwartz; Columbia University, Department of Electrical Engineering, New York, NY 10027; Award #81-08776 A01; $89,718 for 12 months beginning 11/01/82 (EOC).

Address the efficient multiplexing of different types of digital traffic such as voice, data, and image traffic, over a common integrated digital network. Group the questions into those relating primarily to the link level (both terrestrial and satellite), and those involving network-wide considerations. Consider problems of appropriately modeling the interaction between circuit-type and packet-type traffic and of designing resource allocation strategies that provide jointly optimum performance for these two examples of traffic types. Study the routing problem for diverse traffic types.

166. 2-D Image Restoration: Adaptive and Recursive Approaches; Leonard M. Silverman; University of Southern California, Department of Electrical Engineering, Los Angeles, CA 90007; Award #80-11911 A02; $45,000 for 12 months beginning 12/01/82 (EOC).

Conduct a research program in nonlinear image restoration. Use a new procedure for nonlinear restoration of images degraded by additive noise to emphasize the visual quality of the restored image. Optimize the choice of various parameters. Blur degradation and consider color images, as well as recursive implementation.

167. InGaAsP Avalanche Photodiodes for Optical Communications; Gregory E. Stillman; University of Illinois, Department of Electrical Engineering, Urbana, IL 61801; Award #82-09090; $77,691 for 12 months beginning 11/01/82 (EOC).

Group high purity InGaAsP/InP lattice matched heterostructures by liquid phase epitaxy (LPE) and vapor phase epitaxy (VPE) techniques on different InP substrate orientations. Examine such problems as epitaxial growth techniques, defects and/or traps at interfaces, new devices structures, variation of impact ionization coefficients with crystal orientation, and excess noise factors.

168. Short-Pulse Optical and Opto-Electronics Devices; John R. Whinnery; University of California, Electronics Research Laboratory, Berkeley, CA 94720; Award #81-14526 A01; $99,426 for 12 months beginning 10/15/82 (EOC).

Conduct research on a double mode-locked dye laser in the picosecond and subpicosecond range, stressing correlations among the pulses of one pulse train, and between two trains of different frequency. Compare with correlation for commercial synchronously-pumped systems, and with other mode-locked configurations. Continue work on opto-electronic switches for producing short electrical pulses. Study degenerate four-wave mixing in dyes in relation to a four-level model, test the model, and investigate additional extensions of this model.

169. Two-Dimensional Recursive Digital Filtering; John W. Woods; Rensselaer Polytechnic Institute, Department of Electrical, Computer, and Systems Engineering, Troy, NY 12181; Award #81-08806 A01; $48,000 for 12 months beginning 11/01/82 (EOC).

Solve problems of two-dimensional (2-D) recursive digital filtering; increase the efficiency of the spectral factorization based magnitude and phase design algorithm developed under the present program. Compare the quality of approximation afforded by various factored forms for classes of filter specifications. Develop a general 2-D linear shift-invariant operator factorization to design two-pass (forward and back) recursive filters; examine necessary and sufficient conditions for 2-D recursive filter stability and investigate two-dimensional, hybrid, infinite impulse response (IIR) and finite impulse response (FIR) filters.

170. Two-Dimensional Recursive Estimation with Application to Real-Time Filtering of Images; John W. Woods; Rensselaer Polytechnic Institute, Department of Electrical and Systems Engineering, Troy, NY 12181; Award #80-12569 A02; $55,500 for 12 months beginning 12/01/82 (EOC); Split-funded with STO for $14,000.

Develop efficient methods for the two-dimensional (2-D), recursive filtering of image data corrupted by distortion and noise. Use efficient Kalman recursive estimation techniques for near optimal recursive estimation and restoration of noisy images. Examine more comprehensive models, optimal estimation algorithms for the 2-D field, offline model identification procedures, online model tuning, and the feasibility of implementation with integrated electronic circuits.

Quantum Electronics, Waves and Beams (QWB)

171. Characterization of Self-Pulsing Instabilities In High-Gain Lasers; Neal B. Abraham; Bryn Mawr College, Department of Physics, Bryn Mawr, PA 19010; Award #82-10263; $61,601 for 12 months beginning 11/15/82 (QWB).

Study the threshold conditions for pulsations and their characteristics for Fabry-Perot lasers and traveling-wave ring lasers using two high gain infrared transitions, 3.51 um in xenon and 3.39 um in neon. Determine the effects of gain, cavity loss, and homogeneous broadening on the instabilities. Examine the appearance of complicated structure in the intensity power spectrum.

172. Engineering Aspects of Plasma Waves; Igor Alexeff; University of Tennessee, Department of Electrical Engineering, Knoxville, TN 37996; Award #82-16621; $37,530 for 12 months beginning 12/15/82 (QWB).

Investigate the state-of-the-art free-electron maser and study the dynamics of trapped electron clouds. Examine geometric mean plasma frequency. Consider stabilization of the flute instability in hot-electron and toroidal plasmas, demonstrating two new MHD stabilization mechanisms; study related plasma wave discoveries as they occur.

173. Continuation of Lower Hybrid Wave Research on the Encore Tokamak; Paul M. Bellan; California Institute of Technology, Department of Engineering and Applied Science, Pasadena, CA 91104; Award #81-13533 A01; $101,632 for 12 months beginning 11/15/82 (QWB).

Conduct experimental lower hybrid wave research on a small tokamak with emphasis given to rf generation of dc currents, wave propagation, and plasma heating. Use high pulse repetition rate to permit high-resolution spatial profile measurements of plasma and wave parameters. Excite lower hybrid waves using a high-power rf source and collect data by electrostatic and magnetic probes using a mini-computer for analysis.

174. Fifth International Conference on Lasers and Applications, New Orleans, Louisiana, December 13-17, 1982: Lasers, 1982; Vincent J. Corcoran; Society for Optical and Quantum Electronics, McLean, VA 22101; Award #82-13585; $2,800 for 12 months beginning 12/01/82 (QWB). Part of a total NSF award of $5,600.

Hold the Fifth International Conference on Lasers and Applications, LASERS 1982, in New Orleans, Louisiana, December 13-17, 1982. Bring together diverse interests in the laser field, extending from the basic sciences to a variety of laser applications.

175. Image Processing Using Nonlinear Optical Effects; Robert W. Hellwarth; University of Southern California, Department of Electrical Engineering and Electrophysics, Los Angeles, CA 90007; Award #82-11754; $77,680 for 12 months beginning 11/15/82 (QWB).

Develop and expand the application of nonlinear optics to image processing. Study new materials and novel physical mechanisms in old and new beam geometries. Determine the limits in speed, efficiency, memory capability and image complexity to which these materials, and the best of previously-used materials, can be pushed in image-processing applications.

176. Passive Mode-Locking of a Near Infrared Dye Laser With Semiconductors and Dyes Equipment; Ping-Tong Ho; University of Maryland, Department of Electrical Engineering, College Park, MD 20742; Award #82-09411; $41,000 for 12 months beginning 12/01/82 (QWB).

Purchase equipment consisting of a krypton ion laser and dye laser accessories; a stable optical table; and a lock-in amplifier for passive mode-locking of a cw near infra-red dye laser with a slow saturable absorber, to generate subpicosecond pulses.

177. Incoherent Optical Processing Using Grating Imaging; Emmett N. Leith; University of Michigan, Department of Electrical and Computer Engineering, Ann Arbor, MI 48109; Award #82-12472; $28,873 for 12 months beginning 11/01/82 (QWB); Split-funded with ABS for $20,000; Split-funded with EOC for $20,000.

Study both theoretical investigations and applications of achromatic interferometry, grating imaging, and grating imaging interaction.

178. Nonlinear Interaction of Light at Optical Surfaces; Gail A. Massey; San Diego State University, Department of Electrical and Computer Engineering, San Diego, CA 92182; Award #81-19737 A01; $63,664 for 12 months beginning 12/02/82 (QWB).

Construct an electron microscope utilizing multiphoton photoemission. Use the device to examine optical waveguide surfaces and investigate optical damage mechanisms.

179. Picosecond Nonlinear Raman Spectroscopy of Surfaces; Richard B. Miles; Princeton University, Department of Mechanical and Aerospace Engineering, Princeton, NJ 08544; Award #80-17655 A02; $71,964 for 12 months beginning 12/01/82 (QWB).

Investigate the application of a nonlinear optical technique, Coherent Anti-Stokes Raman Spectroscopy, to the study of molecular monolayers in contact with solid surfaces. Use picosecond laser pulses to achieve maximum intensities with minimum surface damage and move the sample between pulses.

180. Interaction of Strong Electromagnetic Waves with Plasmas; Z. A. Pietrzyk; University of Washington, Department of Nuclear Engineering, Seattle, WA 98195; Award #80-12997 A02; $98,000 for 12 months beginning 11/15/82 (QWB).

Investigate stimulated scattering and anomalous absorption of a CO_2 laser beam by a stationary plasma. Carry on basic studies of the collision of two radiation driven plasma wavefronts and study stimulated Raman and Brillouin scattering processes at visible wavelengths. Use a novel "double ended" solenoid configuration to generate a well defined target plasma which allows laser/plasma interactions to be studied in a carefully controlled manner.

181. Investigation of Recent Developments in the Modal Representation of Electromagnetic Fields; David M. Pozar; University of Massachusetts, Department of Electrical and Computer Engineering, Amherst, MA 01003; Award #82-06420; $37,197 for 12 months beginning 11/01/82 (QWB).

Study characteristic modes and the so-called Inaguki modes from a fundamental viewpoint, in regard to their relation to each other and to the classical eigenmodes, and in regard to their efficient calculation and their advantages/disadvantages relative to specific applications in electromagnetic radiation and scattering.

182. Ion and Electron Cyclotron Harmonic Heating Studies; John E. Scharer; University of Wisconsin, Department of Electrical and Computer Engineering, Madison, WI 53706; Award #82-12173; $81,190 for 12 months beginning 11/15/82 (QWB).

Conduct theoretical and experimental studies of wave coupling, propagation and heating in the ion and electron cyclotron range of frequencies (ICRF) in a plasma. Use a one-dimensional full wave solution obtained from a discrete slab model to examine antenna coupling and surface effects for large tokamaks in the ion cyclotron frequency range. Derive a differential operator for ICRF wave fields incorporating shear, two-dimensional and nonlocal plasma gradient effects to examine wave field solutions and plasma heating for a tokamak, start-up and heating. Formulate the wave propagation and heating models so that they can be readily adapted to waves in the electron cyclotron frequency range.

183. Trapped Particle Instabilities and Plasma Transport; Amiya K. Sen; Columbia University, Department of Electrical Engineering, New York, NY 10027; Award #81-13183 A01; $127,700 for 12 months beginning 12/01/82 (QWB).

Use a specially designed linear machine for plasma confinement to undertake experimental and theoretical studies of trapped particle instabilities in plasmas and plasma transport phenomena. Investigate linear wave properties of the trapped ion mode, effects of magnetic field gradients on the mode, and feedback control of the trapped ion instability. Explore nonlinear saturation of the trapped ion mode and wave-induced transport of particles and energy in the plasma.

184. Detailed Studies of Elementary Gas Phase Processes; Curt Wittig; University of Southern California, Department of Electrical Engineering and Electrophysics, Los Angeles CA 90007; Award #82-12827; $86,619 for 12 months beginning 11/15/82 (QWB). Part of a total NSF award of $116,619.

Use a time-of-flight mass spectrometer with tandem mass filters to fragment molecular ions via IR MPD to determine unambiguously the low energy pathways, and study solvated ions by constructing the ion cage one molecule at a time. Use photodetachment of electrons from negative ions to prepare beams of neutral molecules with precisely determined velocities.

Solid State and Microstructures Engineering (SSM)

185. Enhanced Photoyield from Small Metal Particles Suspended in a Matrix Studied by X-ray and Ultraviolet Photoelectron Spectroscopies; Clayton W. Bates; Stanford University, Department of Electrical Engineering and Materials Science/Engineering, Stanford CA 94305; Award #82-08053; $63,000 for 12 months beginning 11/15/82 (SSM).

Emphasize the effect of particle size, shape and composition on the properties of infrared photodetectors composed of small metal particles in a suitable matrix. Use silver and gold spherical particles ranging in diameter from 2 to 10 nanometers as well as pyramids approximately 100 nanometers; characterize the spectral features by measuring both the transmittance and reflectance with a spectrophotometer. Use particles deposited on metallic substrates for core level and valence band spectroscopy; obtain quantum yield information both in as-fabricated, metallic particle planar configurations and in completed matrices.

186. Investigation of Excess (1/F) Noise and Dielectric Response of Non-Crystalline Structures Preceding First Nucleation In Thin Film Systems; Robert W. Bene; University of Texas, Department of Electrical Engineering, Austin, TX 78712; Award #81-11616 A01; $45,129 for 12 months beginning 11/15/82 (SSM).

Use electrical characterization techniques to complement conventional material techniques in developing a better understanding of the nucleation of thin metal films. Investigate structural fluctuations in thin metal films reacting at low temperatures, studying the reaction path leading to first compound nucleation. Use low frequency noise and frequency dependent dielectric permittivity as main electrical probes and correlate the results with transmission electron diffraction measurements; analyze, predict, and control initial nucleation of metal films on silicon substrates.

187. Electrical Properties of Annealed and Implanted Gallium Arsenide; P. K. Bhattacharya; Oregon State University, Department of Electrical and Computer Engineering, Corvallis, OR 97331; Award #80-11917 A03; $50,751 for 12 months beginning 11/01/82 (SSM).

Identify the origin of dominant traps in vapor phase epitaxial (VPE) and ion implanted gallium arsenide (GaAs) by studying laser annealing characteristics of the traps; investigate the effects on the electrical transport properties of GaAs bulk and thin film samples. Fabricate field effect transistors from the layers under investigation and obtain a quantitative correlation between device performance in annealed material and in as-grown VPE material. Determine characteristics of the material and trap levels by photoluminescence, Hall effect, Deep Level Transient Spectroscopy, Double Source Differentiated Photocapacitance, and transient capacitance and photocapacitance measurement techniques.

188. Study of a Real Space Transfer Electron Device Oscillator - A New Solid-State Candidate for the 0-1,000 GHZ Frequency Range; Paul D. Coleman; University of Illinois, Department of Electrical Engineering, Urbana, IL 61801; Award #82-13052; $61,621 for 12 months beginning 11/15/82 (SSM).

Explore a new solid state oscillator based upon a real space transfer of electrons from a high mobility GaAs layer to a low mobility A1GaAs layer in a GaAs/A1GaAs heterostructure. Demonstrate real space transfer induced oscillations, evaluate oscillator characteristics, and quantify the power-frequency capabilities of this source.

189. Tunneling in Mis Structures; Walter E. Dahlke; Lehigh University, Department of Electrical and Computer Engineering, Bethlehem, PA 18015; Award #81-12537 A01; $55,000 for 12 months beginning 01/01/83 (SSM).

Explore tunneling phenomena in metal-insulator-semiconductor (MIS) structures. Continue research on the photoexcitation technique using thin MIS Schottky diodes.

190. Process Modeling and Characterization of Laser Recrystallization of Polysilicon; Dae Mann Kim; Rice University, Department of Electrical Engineering, Houston, TX 77001; Award #82-10779; $45,000 for 12 months beginning 12/01/82 (SSM).

Compare experimentally annealing characteristics with CW and pulsed lasers for polysilicon deposited both on single crystal silicon and insulators such as SiO_2. Correlate the dynamics of the heating and subsequent cooling of the lattice with the beam parameters of the various lasers. Extend the recently developed analytical perturbation technique for single pulse, nanosecond laser heating to include longer time constant effects; consider the mechanism of grain growth and its dependence upon substrate and film thickness.

191. Group Travel Grant For Second International Conference on Solid State Transducers; Wen H. Ko; Case Western Reserve Univeristy, Electronics Design Center, Cleveland OH 44106; Award #82-13110; $5,000 for 12 months beginning 11/15/82 (SSM).

Support travel for United States speakers and research participants in the Second International Conference on Solid State Transducers, Delft University, The Netherlands, May 31 - June 3, 1983.

192. Direct Writing of High Resolution, Modulated Doping Profiles Using Laser Photochemical Reactions; Richard K. Osgood; Columbia University, Department of Electrical Engineering, New York, NY 10027; Award #82-09218; $70,001 for 12 months beginning 11/01/82 (SSM).

Investigate direct writing of modulated doping profiles in silicon, emphasizing experimental characterization of the direct doping process, the doped silicon regions and the relevant laser chemistry. Use a cw argon laser with a doubling crystal as the source and employ photolysis of $TMA1_3$ and $BC1_3$. Study formation of silicide using various carbonyls as the metallic donors. Characterize the resulting doped silicon regions in terms of electrical and compositional properties, and use photoresponse measurements to determine spatial uniformity, deep level spectroscopy for trap characterization, and conventional bulk and junction electrical characterization for microscopic parameters of interest. Use mass spectroscopy, secondary ion mass spectroscopy, and auger techniques.

193. Industry/University Cooperative Research Activity: Electrophysical Aspects of Monolithic Saw Structures; Robert F. Pierret; Purdue University, Department of Electrical Engineering, W. Lafayette, IN 47907; Award #80-09793 A02; $66,781 for 12 months beginning 10/15/82 (SSM).

Examine and enhance the physical and electronic properties of the metal-zinc oxide-silicon dioxide-silicon surface acoustic wave structure projected for use in nonlinear signal processing, diagnostic, and possibly imaging applications. Compare probing techniques and theoretical views with surface acoustic wave propagation experiments and material evaluation studies to achieve problem solutions. Investigate ZnO film deposition and annealing studies; ZnO film quality/film degradation work; thermal and RF (radio frequency) annealing experiments; and fundamental studies probing the biasing, thermal, and photo response of completed monolithic test structures.

194. Electrical Effects of Oxygen in Silicon; Dieter K. Schroder; Arizona State University, Department of Electrical and Computer Engineering, Tempe, AZ 85281; Award #82-12336; $55,000 for 12 months beginnning 12/15/82 (SSM).

Study electrical effects of oxygen in silicon material and devices, emphasizing the properties of denuded zones formed at the wafer surfaces as a result of oxygen outdiffusion, precipitate formation in the interior of the wafers and their role as gettering sites, and donor formation and annihilation as a function of thermal wafer history. For electrical characterization, use metal-oxide-semiconductor capacitors, focusing on capacitance-voltage and capacitance-time techniques, pn and Schottky barrier junctions, and deep level transient spectroscopy.

195. Investigation of Interface Reactions of Transition-Metal/Silicon Structures Induced by Ion Implantation; Kang L. Wang; University of California, School of Engineering and Applied Science, Los Angeles, CA 90024; Award #80-11037 A02; $40,720 for 12 months beginning 10/15/82 (SSM).

Study reaction mechanisms and explore the applications of transition-metal silicides formed with ion implantation, followed by laser annealing. Implant various ion species at different ion energies and fluences, and at different substrate temperatures into deposited metal/silicon structures, formulating reaction kinetics from the experimental result. Investigate the film and interface stability after annealing and oxidation; characterize the resulting films chemically and electrically with various techniques. Explore potential applications to contacts for shallow junctions of submicron devices and use of the films as interconnection lines.

196. Submicron Silicon Inversion Layers; Robert G. Wheeler; Yale University, Section of Applied Physics, New Haven, CT 06520; Award #82-13080; $10,000 for 12 months beginning 11/15/82 (SSM).

Continue research on submicron silicon field effect transistors, extending the research from the quasi one-dimensional to the fully one-dimensional transport regime. Investigate the silicon system.

197. National Research and Resource Facility for Submicron Structures; Edward D. Wolf; Cornell University, Knight Laboratory, Ithaca, NY 14853; Award #82-00312 A02; $700,000 for 6 months beginning 01/01/83 (SSM).

Develop capabilities for lithography below 100 nm, emphasizing the 10 to 100 nm feature size. Support national user program including facilities for lithography, pattern transfer, and material deposition and characterization.

Systems Theory and Operations Research (STO)

198. Robust Stochastic Adaptive Control; Michael Athans; Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Sciences, Cambridge, MA 02139; Award #82-10960; $75,000 for 12 months beginning 01/01/83 (STO).

Study fundamental issues of adaptive control in the presence of unmodeled high-frequency dynamics and stochastic disturbances and sensor noise; develop new classes of robust adaptive schemes for use in engineering designs. Investigate the fundamental limitations of adaptive control for systems with unstructured uncertainties (represented in the frequency domain). Develop and analyze algorithms based on the final approach method and on modified LQG-like compensators.

199. Parameter Estimation and Adaptive Control of Large Scale and Distributed Parameter Systems; Mark J. Balas; Rensselaer Polytechnic Institute, Department of Electrical and Systems Engineering, Troy, NY 12181; Award #80-16173 A02; $68,792 for 12 months beginning 02/01/83 (STO).

Investigate the control of large-scale and distributed parameter systems (LSDS) whose dynamical behavior is modeled by a large number of ordinary differential equations or a set of partial differential equations. Develop a methodology to synthesize implementable, online parameter estimation and adaptive feedback control algorithms for LSDS whose parameters are poorly known, and to analyze the convergence and closed-loop stability of the resulting algorithms.

200. Feedback Theory of Two-Degree-of-Freedom Optimal Controller Design; Joseph J. Bongiorno; Polytechnic Institute of New York, Department of Electrical Engineering and Computer Science, Brooklyn, NY 11201; Award #82-09748; $140,670 for 24 months beginning 11/01/82 (STO).

Study the theory of optimal controller design with two degrees of freedom. Evolve the necessary optimization procedure which allows the controller to process these variables independently. Investigate the computational aspects of the design procedure as well as the sensitivity and robustness properties of the design.

201. Computational Methods for Identification and Optimal Control of Hereditary Systems; John A. Burns; Virginia Polytechnic Institute, Department of Mathematics, Blacksburg, VA 24061; Award #81-09245 A01; $20,230 for 12 months beginning 10/15/82 (STO).

Study approximation and numerical techniques for identification and optimal control of three classes of distributed parameter systems. Use the approximation schemes to develop computational methods for parameter estimation and optimal control of dynamical systems governed by such equations.

202. Research on Optimal Stochastic Control and Related Topics in Applied Probability; Wendell H. Fleming; Brown University, Division of Applied Mathematics, Providence, RI 02912; Award #81-21940 A01; $21,250 for 12 months beginning 07/01/83 (STO). Part of a total NSF award of $42,500.

Investigate the following topics: optimal control of Markov processes under partial observations of the states of the process being controlled; stochastic control under complete observations; large deviations problems; connections between stochastic control theory and stochastic mechanics; nonlinear filtering; measure-valued diffusion processes; stochastic evolution equations; and quantitative characters in population genetics theory.

203. Linear Shift-Variant Signal Processing; Eric W. Hansen; Dartmouth College, Department of Electrical Engineering, Hanover, NH 03755; Award #82-10412; $32,448 for 24 months beginning 11/15/82 (STO); Split-funded with EOC for $32,447.

Extend the theory of linear shift-variant systems to other shift-variant systems such as the computation of the Hankel transform. Generalize the theory to two-dimensional systems, recursive estimation using Kalman filters, and tomographic image reconstruction.

204. Discrete Event Large-Scale Systems and Many Person Optimization; Yu-Chi Ho; Harvard University, Division of Applied Sciences, Cambridge, MA 02138; Award #82-13680; $48,000 for 12 months beginning 02/01/83 (STO).

Investigate two problems in large-scale systems analysis and optimization: the first concerns a new approach to the analysis of discrete event dynamic systems and the second concerns incentive optimization within the topic of many person optimization.

205. Production-Investment-Location Problems Under Uncertainty: Model Formulation, Analysis, and Solution Algorithms; Arthur P. Hurter; Northwestern University, Department of Industrial Engineering and Management Sciences, Evanston, IL 60201; Award #81-02896 A01; $47,413 for 12 months beginning 10/15/82 (STO).

Develop methodologies for the design of facility location systems, to facilitate evaluation of alternative designs, and to portray the sensitivity of the design to changing important parameters, including the level of risk, the degree of risk aversion and prices and interest rates.

Formulate and analyze the model in terms of solution characteristics, sensitivity of the solution to changes in key parameters, and development of solution algorithms.

206. Analysis, Approximations, and Control of Nonlinear Stochastic Dynamic Systems; Harold J. Kushner; Brown University, Division of Applied Mathematics, Providence, RI 02912; Award #82-11476; $32,500 for 12 months beginning 02/01/83 (STO).

Develop analytical techniques for the approximate analysis and control of stochastic nonlinear dynamic systems. Consider the following topics: diffusion approximations and applications; asymptotic properties of stochastic approximations and stochastic difference equations, with and without constraints; applications and computational methods for the theory of large deviations--applications to approximation and robustness of escape times and similar quantities for systems with small noise effects; and decentralized detection and control.

207. Guaranteed Performance of Systems with Bounded Uncertainties; George Leitmann; University of California, Department of Mechanical Engineering, Berkeley, CA 94720; Award #82-10324; $70,372 for 24 months beginning 11/15/82 (STO).

Examine the control (as a function of state or measured state or measured output) of a dynamical system in the presence of uncertainty (in the model, input, and state or output) utilizing a non-stochastic approach. Include uncertain as well as delayed state or output variables. Study output feedback controllers for uncertain state and control matrices; stabilizing controllers for systems with uncertain delays; and control parameters turning to increase the robustness of guaranteed performance controllers.

208. Identifiability and Identification of Systems; William L. Root; University of Michigan, Aerospace Engineering Department, Ann Arbor, MI 48109; Award #80-05960 A01; $84,981 for 24 months beginning 01/01/83 (STO).

Investigate general problems in the theory of the identifiability and the identification of physical dynamical systems. Examine problem complexity, time required for identification, comparative kinds of identification, and approximation. Consider applications to realistic physical systems.

209. Open and Closed Loop Approximation of Linear Systems; Leonard M. Silverman; University of Southern California, Department of Electrical Engineering Systems, Los Angeles, CA 90007; Award #82-12479; $94,009 for 12 months beginning 01/01/83 (STO).

Address issues in the control and analysis of high-dimensional linear systems. Focus on improved methods that are required to discriminate the principal component from the perturbational component in linear processes; to reduce the order by deleting the perturbational component; to measure the size of the difference between the full and the reduced systems; and to assess the effect of the approximation error in both open-loop and closed-loop applications. Consider partial realization methods, SVD, and noise space approximation for open-loop systems analysis (estimation and signal processing), and closed-loop approximation (feedback control).

210. Non-Gaussian Self-Similar Processes; Murad S. Taqqu; Cornell University, School of Operations Research and Industrial Engineering, Ithaca, NY 14853; Award #80-15585 A02; $40,201 for 12 months beginning 11/01/82 (STO).

Extend the class of non-Gaussian self-similar processes to processes, with infinite variance, thereby providing models for random phenomena that at the same time exhibit long-range dependence and high variability. Study of asymptotically self-similar processes, their connection with collision processes, and their relevance to ARIMA (p,d,q) modeling when d assumes a fractional value. Investigate the robustness of statistics associated with long-range dependence and the development of algorithms for generating non-Gaussian self-similar sequences.

211. Investigations in Discrete Optimization; Leslie E. Trotter; Cornell University, Department of Operations Research and Industrial Engineering, Ithaca, NY 14853; Award #81-13534 A01; $42,237 for 12 months beginning 12/15/82 (STO).

Study discrete optimization models which arise naturally in modern applications of engineering problems. Classify combinatorial optimization problems by the strength of their linear programming counterparts, thereby allowing the study of tractable combinatorial algorithms which are derived for simple models, but have more general implications. Consider models including integral packing and covering models, integer rounding models, and matching-type models. Derive algorithms that are applicable to more general models.

212. Self-Organization in Dissipative Systems: A Perturbed Optimization Model; Robert E. Ulanowicz; Chesapeake Research Consortium, Inc., Chesapeake Biological Laboratory, Annapolis, MD 21403; Award #81-10035 A01; $72,297 for 12 months beginning 10/15/82 (STO).

Study an optimization oriented generic model for self-organizing dissipative systems, based on network flows.

213. Estimation and Statistical Analysis of Spatially-Distributed Random Processes; Alan S. Willsky; Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Sciences, Cambridge, MA 02139; Award #80-12668 A02; $39,000 for 12 months beginning 11/01/82 (STO); Split-funded with EOC for $26,000; Split-funded with ABS for $21,447.

Develop algorithms for efficient combination and processing of spatially-distributed data. Investigate the updating of a random field given additional measurements over some portion of the field, the estimation of the field and the state of a dynamic system moving over and driven by the field, and the use of the structure of ARMA and state space models to obtain efficient multi-dimensional data processing algorithms. Examine the geometry of random objects and contours, studying their detection in two-dimensional fields given measurements of the integral of the fields along certain lines; study the mapping of contours in random fields; and analyze level crossing problems for these contours.

214. Development of the Linguistic Approach to Systems Analysis and Control; Lotfi A. Zadeh; University of California, Electronics Research Laboratory, Berkeley, CA 94720; Award #82-09679; $50,000 for 12 months beginning 11/01/82 (STO).

Address problems related to the analysis, characterization and control of systems in which the sources of uncertainty are predominantly nonstatistical in nature. Develop basic concepts underlying the linguistic approach, in which words rather than numbers are employed to describe ill-defined variables and their interrelations. Explore the application of techniques in which uncertainty is treated by a combination of probabilistic and possibilistic methods, and investigate the application of fuzzy logic and approximate reasoning to process control and model validation.

DIVISION OF MECHANICAL ENGINEERING AND APPLIED MECHANICS (MEAM)

Fluid Mechanics (FLM)

215. Investigation of Mixing Mechanisms in Turbulent Boundary Layers Using Drag Reducing Liquids; Frederick H. Abernathy; Harvard University, Division of Applied Sciences, Cambridge, MA 02138; Award #81-21067; $101,500 for 12 months beginning 10/15/82 (FLM).

Use a free surface water table to investigate mixing in a turbulent shear layer, by introducing parts per million concentrations of drag reducing polymer solutions. Vary the dimensionless thickness of the layers to determine the influence of the outer flow on flow near the wall. Measure higher order moments of the velocity fluctuations and their spectra to determine the bursting rate. Study polymer flows in rigid tubes to verify the existence of the coherent polymer fluctuations in flows without a free surface and to connect the fluctuations with variations in intrinsic viscosity predicted from a model of polymer dynamics.

216. Transport Phenomena Within Regions of Closed Streamline Flows; Andreas Acrivos; Stanford University, Department of Chemical Engineering, Stanford, CA 94305; Award #81-21713; $66,407 for 12 months beginning 11/01/82 (FLM).

Investigate the conjecture that for the classical problem of flow past a bluff body, the branch of the steady solution of the equations of motion which originates at R=O does not extend beyond a large but finite value of R. Focus on two-phase systems with deformable boundaries, extending the earlier results concerning the deformation and break-up of single drops in shear flows.

217. Unsteady Aerodynamics; Hsien K. Cheng; University of Southern California, Department of Aerospace Engineering, Los Angeles, CA 90007; Award #79-26003 A03; $115,975 for 12 months beginning 10/15/82 (FLM).

Study fluid dynamics of animal swimming, flying, and hovering, emphasizing the lunate-tail swimming propulsion and the lift generation mechanism of the hovering flight of insects.

218. Large Eddies in Turbulent Shear Flow; Donald Coles; California Institute of Technology, Guggenheim Aeronautics Laboratory, Pasadena, CA 91104; Award #77-23541 A06; $103,366 for 12 months beginning 10/15/82 (FLM).

Study the nature and role of the large coherent vortex structures (large eddies) which are believed to control the development of turbulent shear flows. Measure and describe the shape, evolution, and transport properties of large eddies in synthetic and natural turbulent boundary layers; study the formation and interaction of vortex rings and their relationship to structure in axisymmetric jets; investigate the transition process in a free-convection boundary layer on a vertical wall, especially the equivalent of the turbulent spot; and study the flow processes which control interference effects for flow past two or more bluff bodies in close proximity. Perform systematic probes of the structure of turbulent spots and turbulent boundary layers.

219. Vorticity Measurements in Turbulent Shear Flow; Paul E. Dimotakis; California Institute of Technology, Department of Aeronautics, Pasadena, CA 91104; Award #80-22945 A01; $63,124 for 12 months beginning 10/15/82 (FLM).

Use laser doppler velocimetry to simultaneously measure two components of the velocity vector, deriving one component of the vorticity vector. Determine time resolved measurements of this quantity in a plane mixing layer of moderate Reynolds numbers and correlate these measurements with image records of particle streaks and other flow field quantities.

220. Experimental and Theoretical Research in Fluid Dynamics; Russell J. Donnelly; University of Oregon, Department of Physics, Eugene, OR 97403; Award #81-17569 A01; $67,726 for 12 months beginning 11/01/82 (FLM).

Conduct studies of stability and transition in Couette flow with special attention to the role of dislocations and boundary effects on the various transitions. Consider time dependent effects induced by modulation of the rotation speed. Investigate rigorous two fluid equations of motion for Helium II with special attention to describing quantized turbulent flow. Construct a Benard convection cell for visual studies of cells and dislocation motion.

221. Cardio-Pulmonary Dynamics; Y. C. Fung; University of California at San Diego, Department of AMES-Bioengineering, La Jolla, CA 92093; Award #79-10560 A02; $91,277 for 12 months beginning 10/26/82 (FLM).

Develop continuum mechanics of living systems, emphasizing cardio-pulmonary dynamics. Derive the basic mathematical description of the mechanical properties of the tissues (the constructive equations) from experimental results. Establish the constitutive equation of the heart muscle and develop the mechanics of the heart, including the stress and strain distribution, the coupling of heart muscle contraction and blood flow, and the coupling of the heart and lung; formulate a theory of blood flow in the lung. Determine the anatomical structure and the boundary conditions of pertinent problems; compare analytical results with in vivo experiments to test the adequacy of all hypotheses.

222. Primary and Secondary Instabilities in Inflexional Shear Flows; Patrick Huerre; University of Southern California, Department of Aerospace Engineering, Los Angeles, CA 90007; Award #81-20904; $90,746 for 24 months beginning 10/15/82 (FLM).

Investigate a model consisting of an inflexional velocity profile bounded by parallel walls. Perform analytical and numerical studies of partial differential equations to investigate successive two-dimensional subharmonic instabilities, effects of shear layer spreading rate on nonlinear regimes, three-dimensional instabilities and interactions with their two-dimensional counterparts, and feedback phenomena due to the presence of a trailing edge.

223. Some Basic Investigations in Turbulent Shear Flows; A. K. M. Fazle Hussain; University of Houston, Department of Mechanical Engineering, Houston, TX 77004; Award #81-11676 A01; $100,513 for 12 months beginning 11/15/82 (FLM).

Study large-scale coherent structures in the incompressible, axisymmetric jet. Emphasize the eduction of naturally occurring large-scale structures in the near field, the existence of structures in the self-preserving region of the jet, education of structure properties, and determination of the relative strengths of dominant azimuthal modes in the self-preserving region. Investigate structures in a high aspect-ratio plane jet, covering near-field structures under symmetric sinusoidal excitation and under antisymmetric sinusoidal excitation, and organized motions in the near-field and self-preserving regions of an unexcited plane jet via flow-visualization and a rake of hot wires.

224. Studies in Thermal Convection; Robert E. Kelly; University of California, Department of Mechanics and Structures, Los Angeles, CA 90024; Award #82-04944; $130,000 for 24 months beginning 11/15/82 (FLM).

Investigate instability of liquid flow down a heated inclined plane with evaporation or condensation at the interface. Consider coupling between the momentum and energy equations via buoyancy. Extend a complete linear stability analysis of doubly-diffusive convection in fluid layers with a large variable salinity gradient to take into account nonlinear effects. Examine chemical and hydrodynamic instabilities in a fluid layer undergoing an exothermic reaction; examine a heterogeneous reaction at a horizontal catalytic wall and study a case of homogeneous reaction. Study thermal convection when both vertical and horizontal temperature gradients exist or when the layer has variable depth, paying special attention to the mechanism by which finite amplitude longitudinal rolls adjust their wavelength.

225. Unsteady Behavior Radiation Characteristics of Turbulent Jets; John Laufer; University of Southern California, Department of Aerospace Engineering, Los Angeles, CA 90007; Award #81-18019; $94,754 for 12 months beginning 10/15/82 (FLM).

Conduct experiments on possible feedback mechanism and time dependent behavior of the unstable air column motion to clarify, modify or reformulate current ideas on acoustic sources in turbulent jets.

226. Second Sound Acoustic Imaging in Super-fluid Helium II; Hans W. Liepmann; California Institute of Technology, Department of Aeronautics, Pasadena, CA 91104; Award #82-00027; $49,580 for 12 months beginning 11/01/82 (FLM).

Apply acoustic imaging techniques to visualize flow structures in superfluid helium II: observe the spatial distribution of the quantized vortex lines, and measure simultaneously the amplitude and phase of the scattered waves by means of an array of superconducting thin film detectors. Use the stored wave forms in an image processing algorithm capable of reconstructing the positions of the scatterers. Design a precursor experiment to determine the basic scattering behavior of thin wire targets and quantized vortex lines, and store the information in a computer for signal recovery and enhancement.

227. Theoretical Research on Turbulent Diffusion with Rapid Chemical Reactions; Thomas S. Lundgren; University of Minnesota, Department of Aerospace Engineering and Mechanics, Minneapolis, MN 55455; Award #82-10341; $82,998 for 24 months beginning 10/15/82 (FLM).

Develop two methods for computing the concentration fields of two rapidly reacting molecular species which are being mixed by an incompressible homogeneous turbulent velocity field. In the first method, calculate the means and variances by using part of the concentration spectra of the zero molecular diffusivity problem. In the second method, utilize simplifications resulting from using the Lagrangian diffusion equation to calculate the concentration distribution functions.

228. Symposium on Waves on Fluid Interfaces; Madison, Wisconsin; October 18-20, 1982; Richard E. Meyer; University of Wisconsin; Mathematics Research Center, Madison, WI 53706; Award #82-12157; $10,000 for 12 months beginning 10/15/82 (FLM).

Conduct a symposium on Waves on Fluid Interfaces at the University of Wisconsin-Madison, October 18-20, 1982. Compare a wide range of physical views of fluid interfaces at the macroscopic level and promote their interaction. Publish the papers presented at the symposium.

229. Interaction Between Mantle Convection and Lithospheric Plates; Stephen Morris; University of California, Department of Mechanical Engineering, Berkeley, CA 94720; Award #82-08657; $95,081 for 24 months beginning 10/15/82 (FLM).

Develop a boundary layer model for thermal convection including viscosity variation due to temperature convection and lithospheric plates. Develop an asymptotic method for the cold plume and incorporate the existing hot plume model into a finite amplitude convection cell. Examine a limiting case of the Benard problem.

230. Experimental Investigation of Stokes Flow and Interfacial Instability Phenomena; Bruce R. Munson; Iowa State University, Department of Engineering Science and Mechanics, Ames, IA 50010; Award #82-04148; $75,000 for 12 months beginning 10/15/82 (FLM).

Investigate various Stokes flow (viscosity dominated flow) and interfacial stability phenomena utilizing a circular cylinder apparatus. Address Stokes flow phenomena, flow blocking, existence of free eddies, and properties of isolated stagnation points. Consider interfacial instability in an oscillating Stokes boundary-layer system of two or more fluid layers utilizing standing waves at the oscillating interface to measure flow instabilities.

231. Nonlinear Stability of Time-Dependent Couette Flow; G. Paul Neitzel; Arizona State University, Department of Mechanical and Energy Systems Engineering, Temple, AZ 85281; Award #82-09923; $63,139 for 12 months beginning 10/15/82 (FLM).

Study the nonlinear stability of time-dependent circular Couette flow, particularly the case where the inner cylinder angular velocity varies linearly with time. Use an extension of the Stuart-Watson method; perform numerical experiments employing a finite difference code to integrate the Navier-Stokes equations numerically; and conduct laboratory experiments using an existing wide gap, high aspect ratio apparatus with laser Doppler velocimetry.

232. Coronary Fluid Dynamics; Robert M. Nerem; University of Houston, Department of Mechanical Engineering, Houston, TX 77004; Award #82-00344; $79,481 for 12 months beginning 10/15/82 (FLM).

Investigate the fluid dynamic characteristics of the coronary system, considering the overall development of pressure and flow waveforms as well as velocity patterns, secondary flows, and wall shear stress. Extend a one-dimensional, unsteady flow, finite-branching model of the coronary circulation and perform supporting animal experiments. Study the detailed flow characteristics through a combination of in vivo measurements using a 20 MHz pulsed ultrasonic Doppler velocimeter, computer calculations, and studies of the coronary vascular endothelium.

233. Convection in Containers; Simon Rosenblat; Illinois Institute of Technology, Department of Mathematics, Chicago, IL 60616; Award #80-26808 A01; $51,942 for 12 months beginning 11/01/82 (FLM).
Examine nonlinear buoyancy-driven flows in closed containers. Address how the preferred wave number of convection is selected when the motion is weakly nonlinear and how the convection develops as the Rayleigh number is increased into the strongly nonlinear regime. Use an eigenfunction expansion technique to reduce nonlinear equations to a manageable system of nonlinear evolution equations. Determine whether model equations such as those of Lorenz have any physical meaning for the convection process.

234. Flow Through Heart Valves and Large Vessels; Lawrence Talbot; University of California, Department of Mechanical Engineering, Berkeley, CA 94720; Award #81-16360 A01; $104,564 for 12 months beginning 11/01/82 (FLM).
Study entry flow in curved vessels as typified by the aortic arch, extending the steady laminar flow experiment to the case of pulsatile flow. Investigate the nature of the entry region boundary-layer interaction for turbulent flow. Examine flow through heart valves, evaluating the relationship between heart murmurs and blood turbulence produced by stenotic valves.

235. Periodic Flow in Curved Tubes; John M. Tarbell; Pennsylvania State University, Department of Chemical Engineering, University Park, PA 16802; Award #80-10878 A02; $49,999 for 12 months beginning 10/26/82 (FLM).
Investigate the laminar periodic flow in a curved tube both numerically and experimentally with emphasis on heat and mass transfer. Integrate the fluid viscous periodic flow equations using the Method of Weighted Residuals. Obtain the range of significant parameters by experiments in a periodic flow loop, including curvature ration, flow reversal, flow development length, pulse shape, and tube wall elasticity on the flow-pressure drop frequency response of the curved tube.

236. Experimental Studies of Coherent Structure and Spectral Dynamics of Scalar and Velocity Fields in Turbulent Flows; Charles W. Van Atta; University of California at San Diego, Department of Applied Mechanics and Engineering Sciences, La Jolla, CA 92093; Award #81-00431 A01; $104,329 for 12 months beginning 11/01/82 (FLM).
Study the role of identifiable large-scale coherent flow regions in diffusion and entrainment of scalar and vector fields in turbulent transition spots generated in laminar boundary-layers and in fully turbulent shear flows. Investigate the development of objective criteria and techniques for isolating the effects of coherent structure of the flow fields on measured statistical properties.

237. Investigation of the Vorticity Structure of Turbulent Shear Flows; James M. Wallace; University of Maryland, Department of Mechanical Engineering, College Park, MD 20742; Award #82-14078; $81,605 for 12 months beginning 10/15/82 (FLM).
Develop a multi-element hot wire system to measure directly the vorticity distribution in a turbulent boundary layer.

Heat Transfer (HET)

238. Nonlinear Taylor Instability with Variable Acceleration and Droplet Entrainment; S. George Bankoff; Northwestern University, Department of Chemical Engineering, Evanston, IL 60201; Award #82-12483; $116,267 for 24 months beginning 11/01/82 (HET).
Solve a series of problems to permit the extension of the nonlinear Taylor instability theory to variable-acceleration systems, with entrainment and condensationm for two fluids contained in a vertical cylinder. Make comparisons with data obtained elsewhere in a vertical steam-water shock tube, and make appropriate modifications to the theory.

239. Transient Surface Element Method -- Further Development; James V. Beck; Michigan State University, Department of Mechanical Engineering, East Lansing, MI 48824; Award #81-21499; $130,676 for 24 months beginning 03/15/83 (HET).
Use the transient surface element method to obtain exact solutions for two-dimensional problems and to compile and develop some related table of inverse Laplace transforms and influence functions for various basic geometries. Develop approximate solutions for a single interface node and conduct the multimode numerical analysis for two- and three-dimensional interfaces. Analyze problems that come from fields involving errors in temperature measurement, flow in porous media and convection.

240. Unsteady Natural Convection in a Porous Layer Heated from the Side; Adrian Bejan; University of Colorado, Department of Mechanical Engineering, Boulder, CO 80309; Award #82-07779; $91,041 for 24 months beginning 12/01/82 (HET).
Study the fundamentals of the mechanism of transient natural convection in a two-dimensional porous medium confined between isothermal vertical and insulated

horizontal walls. Determine the relevant internal time-scales governing the transient evolution of the fluid-saturated porous layer to verify the validity of the scale analysis; describe all the possible steady state types suggested by the scale analysis; perform numerical experiments to calculate the heat transfer rate in those steady states not documented in the literature; and update all the engineering heat transfer correlations.

241. Double Diffusive Convection; Chuan F. Chen; University of Arizona, Department of Aerospace and Mechanical Engineering, Tuscon, AZ 85721; Award #82-06087; $58,589 for 12 months beginning 11/15/82 (HET).

Study double-diffusive phenomena in a porous medium. Investigate the onset of double-diffusive instabilities in a vertical porous medium saturated with stratified fluid subjected to lateral heating; the onset of instabilities when such a layer is inclined; and successive layer generation in a deep layer of porous medium saturated with stratified fluid both in the "diffusive" and "fingers" mode.

242. Hydrodynamic and Thermal Conditions in Irradiated Liquid Suspensions; Frank P. Incropera; Purdue University, School of Mechanical Engineering, Lafayette, IN 47907; Award #80-09034 A02; $72,615 for 12 months beginning 10/14/82 (HET).

Study the effects of radiative transfer and buoyancy forces on hydrodynamic and thermal conditions in quiescent and moving liquid layers. Determine the radiation field in irradiated liquid suspensions; ascertain conditions which enhance the deposition of radiation in the liquid; and study the effect of radiation absorption and stabilizing salt concentration gradients on buoyancy induced mixing in quiescent liquids which are heated from below and/or cooled from above. Determine the effect of radiative processes on thermal and hydrodynamic conditions in moving liquid layers which are heated from below; perform supporting analyses to model conditions associated with the experiments.

xxKeairns, Dale L., see CPE (PMP).

243. Numerical Simulation of Two-phase Temperature Evolution in a Porous Slab/Shell with Flow-dependent Heat-transfer Coefficients; Paul-Chang Lu; University of Nebraska, Department of Mechanical Engineering, Lincoln, NE 68508; Award #81-00443 A01; $27,233 for 12 months beginning 10/01/82 (HET).

Establish and test an unrestricted numerical scheme to simulate the transient temperature responses of both the solid and the fluid phases of a transpiration-cooled wall in the shape of a flat slab or a cylindrical-spherical shell to a general variation in the rate of cooling fluid flowing through.

244. Heat Transfer Enhancement Due to Oscillatory Flow Over Furrowed Walls; Borivoje B. Mikic; Massachusetts Institute of Technology, Department of Mechanical Engineering, Cambridge, MA 02139; Award #82-12469; $221,050 for 24 months beginning 12/01/82 (HET).

Study the physical processes responsible for heat transfer enhancement in furrowed-wall, oscillatory flow systems, both laminar and turbulent. Calculate the heat transfer coefficient in a periodically-furrowed, planar channel by numerical (direct spectral simulation), experimental, and analytical (vortex interaction) methods. Study the basic phenomena present (e.g. vortex shedding, vortex ejection, Prandtl-number dependence) and the development of efficient prediction and optimization techniques.

245. Radiative Properties of Coal Ash at High Temperatures; Morton Mitchner; Stanford University; Mechanical Engineering Department, Stanford, CA 94305; Award #82-12075; $95,509 for 12 months beginning 01/01/83 (HET).

Obtain experimental data on the optical properties of high temperature coal ash, and compare measurements of radiative emission from a dispersion of fly ash with values calculated using measured optical properties. Determine bulk value of the complex refractive index of the ash at infrared wavelengths (1 um - 6 um) by measuring the transmittance through thin slag samples prepared from the ash. Compare measurements of the emission from fly ash introduced into a heated argon stream with calculations to assess the adequacy of Mie theory (with measured optical properties) for predicting absorption and scattering cross sections. Investigate modifications of Mie theory to obtain satisfactory agreement between measurements and theory.

246. Post Critical Heat Flux Heat Transfer; Warren M. Rohsenow; Massachusetts Institute of Technology, Department of Mechanical Engineering, Cambridge, MA 02139; Award #82-04840; $83,458 for 12 months beginning 11/15/82 (HET).

Verify the droplet boundary layer analysis; establish how far beyond dryout this boundary layer analysis is applicable; simplify the prediction of drop diameter and slip ratio at the dryout point; and compare the analyses with world data. Complete an experiment to verify a model of heat transfer just beyond the dryout point.

247. Heat Transfer in Fluidized Beds; Satish C. Saxena; University of Illinois, Department of Chemical Engineering, Chicago, IL 60680; Award #80-22097 A02; $57,262 for 12 months beginning 06/15/83 (HET).

Conduct theoretical and experimental investigations of the heat transfer between fluidized beds of large particles and immersed surfaces. Examine single tubes and tube bundles in horizontal and vertical configurations, carrying out experiments in a 12-in. square fluidized bed at ambient conditions. Investigate single and bundles of vertical tubes in a cylindrical 10-in. fluidized bed at temperatures up to 1000° F. Develop suitable correlations for design and scale-up purposes.

248. Heat Transfer Through Porous Insulation; Chang-Lin Tien; University of California, Department of Mechanical Engineering, Berkeley, CA 94720; Award #81-20939 A01; $70,000 for 12 months beginning 01/15/83 (HET).
Investigate fundamental heat transfer mechanisms in porous thermal insulation to improve thermal insulation effectiveness. Consider the unevacuated insulations (fibers, powders and foams) with applications in the room and high temperature ranges. Examine radiation properties and radiative transfer, moisture and convection transport, and transient thermal performance.

249. Diffusion Flame Spread; James S. T'ien; Case Western Reserve University, Department of Mechanical and Aerospace Engineering, Cleveland, OH 44106; Award #81-15339 A01; $47,200 for 12 months beginning 12/15/82 (HET).
Analyze a diffusion flame spread over condensed-phase fuels in opposed flow. Formulate and develop an efficient solution procedure for a detailed flame spreading model which can be quantitatively compared with experiments; study heat and mass transfer and chemical activities, as well as the interactive effect of the flame with the pressure field. Apply the theoretical model to a number of different situations where the dominant forward heat transfer modes, the transition between diffusion and premixed flame spreads, and the flame front pulsation mechanism can be studied.

250. Stabilization of Superconducting Magnets in HE II - Heat Transfer Aspects; Steven W. Van Scriver; University of Wisconsin, Department of Nuclear Engineering, Madison, WI 53706; Award #80-11583 A02; $60,600 for 12 months beginning 10/14/82 (HET).
Study the fundamentals of the He II heat transfer in geometries which closely model actual engineering applications and examine the dynamics of the interaction between a superconducting composite and the He II. Consider steady state and transient heat transfer characteristics of the test section consisting of a composite superconductor in a geometry which can be treated analytically. Evaluate transport current characteristics from the standpoint of heat transfer and conductor stability to analyze the effects of various parameters on stability as well as to generalize the results for broader application.

251. Buoyancy Effects on Heat Transfer During Melting and Solidification; Raymond Viskanta; Purdue University, School of Mechanical Engineering, Lafayette, IN 47907; Award #80-14061 A02; $57,670 for 12 months beginning 01/01/82 (HET).
Perform experiments to determine heat transfer during inward melting and solidification in the presence of natural convection in the liquid and to study the effects of bidirectional heat additions to and removal from a test cell filled with a material in which phase change is occurring while buoyancy forces cause recirculation of the liquid. Study melting of semitransparent materials by direct deposition of radiation into the solid and liquid and measure the solid-liquid interface position and heat transfer. Perform supporting analyses to model the interface motion and heat transfer observed during the experiments.

252. Mixed Convection in Parallel Plate Systems with Arbitrary Surface Heat Flux and Surface Topology; Richard A. Wirtz; Clarkson College of Technology, Department of Mechanical and Industrial Engineering, Potsdam, NY 13676; Award #82-14988; $78,970 for 12 months beginning 11/01/82 (HET).
Study mixed convection from parallel plate systems such as those found in electronic packages. Perform experiments based on Mach-Zehnder interferometry to measure the heat transfer characteristics in the parallel plate channels. Examine the effects of variable plate surface heat flux, plate thermal conductivity, and surface topology, and develop design-oriented heat transfer correlations.

253. Experimental Study of Vapor Film Instability; Larry C. Witte; University of Houston, Department of Mechanical Engineering, Houston, TX 77004; Award #80-08036 A03; $60,809 for 12 months beginning 11/01/82 (HET).
Investigate the fundamental nature of the dynamic behavior of thin vapor films during forced convection film boiling heat transfer from spherical bodies. Identify the mode of instability for these very thin films and the precise conditions under which instability occurs. Determine why the materials contact liquid and what conditions control the contact.

254. Kinematics and Dynamics of High-Speed Mechanical Components; Ferdinand Freudenstein; Columbia University, Department of Mechanical Engineering, New York, NY 10027; Award #82-06175; $54,338 for 12 months beginning 11/15/82 (MES).

Investigate cam-follower systems, universal joints, and silent roller-chain drives, with special emphasis on stiffness and its relation to system damping, including both Coulomb and mixed (Coulomb/viscous) damping. Perform experiments to determine the internal reactions in high-speed universal joints of the Hooke type and the internal force/torque reactions in high-speed spherical four-bar linkages of general proportions. Examine the kinematics of the tooth forms used in silent roller chains.

255. High Performance Air-Gap Winding Permanent Magnet Motors; Joseph Gerstmann; Advanced Mechanical Technology, Inc., Newton, MA 02158; Award #82-60353; $29,723 for 6 months beginning 10/15/82 (MES).

Investigate rare earth magnet motor technology to produce motors with high torque and precise speed capability. Examine air gap armature winding techniques and advanced cooling techniques to establish a motor design having higher torque capability than currently available. Establish overall feasibility of the concept and identify design limits and approaches for utilizing air-gap armature windings.

256. Travel to Attend: Second Cairo University Conference on Mechanical Design and Production; Cairo, Egypt; December 27-29, 1982; Thomas R. Kane; Stanford University, Department of Mechanical Engineering, Stanford, CA 94305; Award #82-17588; $1,124 for 6 months beginning 11/01/82 (MES).

Provide partial travel support to allow a participant in the Second Cairo University Conference on Mechanical Design and Production, Cairo, Egypt, December 27-29, 1982 to present a paper disseminating some basic results regarding the formulation of dynamical equations of motion.

257. Lubrication in Steel Cold Rolling; William R. Wilson; Northwestern University, Department of Mechanical and Nuclear Engineering, Evanston, IL 60201; Award #81-22106 A01; $47,141 for 12 months beginning 12/15/82 (MES).

Investigate the mechanics of lubrication by liquid lubricants in cold rolling. Study film thickness and friction levels and examine changes in workpiece surface roughness during rolling. Develop experimentally validated mathematical models of rolling lubrication.

258. Automatic Visual Inspection of Printed Circuit Boards; Stephen Barnard; SRI International, Computer Science and Technology Division, Menlo Park, CA 94025; Award #81-14761 A01; $150,018 for 12 months beginning 11/01/82 (PRR).

Perform an automated visual inspection of printed circuit boards. Determine whether all components are present, positioned correctly, identifiable, and undamaged; make sure that trace and insulation widths are within design limits; check for potential open and short circuits; and detect and classify defects such as cold solder joints, pinholes, and droplets. Design procedures to classify and grade the information into a quantitative quality assessment.

259. Rapid, Non-Destructive Measurement of the Glass Content of Reinforced Plastic Composites; Gerald Entine; Radiation Monitoring Devices, Inc., Watertown, MA 02172; Award #82-60630; $30,000 for 6 months beginning 10/15/82 (PRR).

Conduct a proof-of-concept study to determine the potential and limitations of using a nuclear instrument approach to produce the rapid assaying of the glass content in fiberglass-reinforced plastic composites. Study the interaction of the absorption and scattering of the nuclear rays and the impact of the extremely wide variety of additives which might interfere with the measurement.

260. Electronics Manufacturing Research Workshops; William A. Smith; North Carolina State University, Industrial Engineering Department, Raleigh, NC 27607; Award #82-16463; $39,080 for 12 months beginning 10/01/82 (PRR).

Conduct two research workshops to define electronics manufacturing research needs, to identify mechanisms to improve coordination of research, and to recommend a priority agenda for action. Disseminate reports on workshop findings and establish dialogues among interested parties. Hold the Manufacturer Workshop, December 2-3, 1982, and the Research Provider Workshop, March or April 1983, in Research Triangle Park, North Carolina.

261. U.S.A.-Sweden Workshop on CAD/CAM for Tooling and Forging Technology; K. K. Wang; Cornell University, Sibley School of Mechanical and Aerospace Engineering, Ithaca, NY 14853; Award #82-17107; $11,900 for 6 months beginning 10/01/82 (PRR).

Hold the second U.S.A.-Sweden Workshop on CAD/CAM for Tooling and Forging Technology at Cornell University, Ithaca, New York, November 2-4, 1982. Present papers on geometric modeling, CAD/CAM applications to tooling, and forging technology. Conduct two panel sessions and provide a tour through Cornell's Computer-Aided Design Instructional Facilities.

Solid Mechanics (SOM)

262. Crack Detection by Ultrasonic Methods: Theory and Experiment; Jan D. Achenbach; Northwestern University, Department of Civil Engineering, Evanston, IL 60201; Award #82-08972; $86,118 for 24 months beginning 10/15/82 (SOM).

Analyze the direct and inverse problems of scattering of time harmonic waves in the high-frequency range on the basis of linearized theory for homogeneous isotropic solids. Calculate the angle dependence of the scattering at fixed frequency and the frequency dependence at fixed angles, using either pulse echo technique (single transducer) or pitch-catch technique (two transducers). Analyze the processed data (amplitude and phase spectra) as a function of scattering angle on the basis of theoretical calculations; construct the orientation and the edge of the crack by appropriate analytical inversion integrals applied to experimental data.

263. Crack Detection by Ultrasonic Methods: Theory and Experiment; Laszlo Adler; Ohio State University, Department of Welding Engineering, Columbus, OH 43210; Award #82-08076; $80,000 for 24 months beginning 10/15/82 (SOM).

Analyze the direct and inverse problems of scattering of time harmonic waves in the high-frequency range on the basis of linearized theory for homogeneous isotropic solids. Calculate the angle dependence of the scattering at fixed frequency and the frequency dependence at fixed angles, using either pulse echo technique (single transducer) or pitch-catch technique (two transducers). Analyze the processed data (amplitude and phase spectra) as a function of scattering angle on the basis of theoretical calculations; construct the orientation and the edge of the crack by appropriate analytical inversion integrals applied to experimental data.

264. Mechanical Sciences: Long Bone Remodeling; Stephen C. Cowin; Tulane University, Department of Biomedical Engineering, New Orleans, LA 70118; Award #82-13568; $209,303 for 24 months beginning 01/01/83 (SOM).

Develop a combined analytical and computational model for the stress adaptation process in human and animal long bones subjected to altered loadings. Perform analytical modeling, determine the elastic properties of bone, and study bone remodeling induced by hyperphysiological force levels in the diaphysis of the canine femur.

265. Development of Constitutive Relations for Porous, Ductile Metals; Donald R. Curran; SRI International, Department of Shock Physics and Geophysics, Menlo Park, CA 94025; Award #81-08186 A01; $69,954 for 12 months beginning 01/01/83 (SOM).

Investigate the nucleation, growth, and coalescence of microstructural voids governing the ductile failure of metals, focusing on the construction of improved computational models. Survey the currently available experimental data for void growth and collapse in porous copper; conduct experiments as needed to fill in gaps in the data, as well as to resolve questions on data interpretation. Develop and test a constitutive model that combines high temperature diffusion processes with plastic flow processes that occur at lower temperatures.

266. Fracture Problems in Pressure Vessels and Reinforced Pipes; Fazil Erdogan; Lehigh University, Department of Mechanical Engineering and Mechanics, Bethlehem, PA 18015; Award #82-09083; $139,990 for 24 months beginning 12/01/82 (SOM).

Study a group of problems associated with the fracture of solids which have potentially important practical applications: the basic reinforcement problem in pipes and containers having an axial crack; the effect of the end conditions on the stress intensity factors in cylinders; cylinders containing a crack and subjected to transient thermal stresses or residual stresses; and the part-through crack problems for shell and thick plates.

267. Plasticity Effects in Dynamic Crack Propagation; Lambert B. Freund; Brown University, Division of Engineering, Providence, RI 02912; Award #82-10931; $138,279 for 24 months beginning 10/15/82 (SOM).

Analyze rapid crack propagation in solid materials which exhibit some amount of ductility, principally structural metals, from the fundamental engineering fracture mechanics point of view. Study crack growth in elastic-plastic and elastic-viscoplastic materials by means of both analytical and numerical methods to determine the inelastic stress and deformation fields which prevail during the process. Use these results in conjunction with ductile crack growth criteria to generate theoretical fracture toughness versus crack speed relationships for materials which fail in a locally ductile mode.

268. Mechanical Sciences: Studies in Fracture and Materials-Mechanics of Solids; John W. Hutchinson; Harvard University, Division of Applied Sciences, Cambridge, MA 02138; Award #82-13925; $150,000 for 24 months beginning 01/01/83 (SOM).

Consider a stress analysis of particles in plastically deforming materials, with emphasis on void nucleation. Study the growth of an isolated void in a strain hardening material under general applied stress conditions and void interaction and coalescence or localization for voids in strain hardening, rate-dependent materials. Investigate surface instability of the Taylor-type in a plastic material subject to high acceleration normal to its free surface, and diffuse bifurcation in solids with non-associated flow laws, with emphasis on developing a method for determining the lowest bifurcation load.

269. Thermomechanics of First Order Phase Transformations in Solids; Richard D. James; Brown University, Division of Engineering, Providence, RI 02912; Award #82-09303; $106,887 for 24 months beginning 11/01/82 (SOM).
Consider first order phase transformations in solids. Use idealizations and methods from continuum mechanical theory, as well as certain assumptions connected with symmetry and stability that are based upon molecular calculations.

xxKennedy, John F., see CEE (GEO).

270. Mechanical Sciences: Fundamental Experiments in the Dynamic Fracture of Solids; Wolfgang G. Knauss; California Institute of Technology, Aeronautics and Applied Mechanics Department, Pasadena, CA 91104; Award #82-15438; $188,139 for 12 months beginning 01/01/83 (SOM).
Study the physical phenomena that control the dynamic fracture of solids. Examine all phases of dynamic crack propagation in brittle plastics: initiation, arrest, steady and non-steady propagation, and crack branching. Emphasize those phenomena that are necessary for the dissipative processes that limit crack speeds to less than the theoretically predicted values.

271. Damage Mechanics for Mechanical Components; F. A. Leckie; University of Illinois, Department of Mechanical and Industrial Engineering, Urbana, IL 61801; Award #82-10620; $96,174 for 12 months beginning 12/15/82 (SOM).
Investigate mechanical components which are loaded so severely that, due to material deterioration, the components can perform their required load bearing function for a finite life only. Establish better procedures for life prediction methods which can be related to mechanics principles, metallurgical phenomena, and practical engineering design. Consider bulk damage due to creep; surface damage resulting from fatigue in cast iron and stainless steel; interaction between bulk and surface damage due to creep-fatigue damage; and high temperature fracture.

272. Mechanics of Ductile Rupture and Plasticity in Solids; Robert M. McMeeking; University of Illinois, Department of Theoretical and Applied Mechanics, Urbana, IL 61801; Award #82-11018; $119,822 for 24 months beginning 10/15/82 (SOM).
Investigate finite elements of ellipsoidal holes in rectangular arrays to determine the macroscopic behavior of large samples when the volume fraction of holes is large and ellipsoidal holes growing near blunting crack tips to determine their role in ductile fracture at crack tips. Calculate necking and deformation for plastically dilatant materials; study crack growth in fully plastic plane strain specimens using very fine finite element meshes. Develop a new algorithm for finding the steady state flow field in metal forming problems.

273. Computer Simulation Studies of Plastic Instability Phenomena in Solids; Alan Needleman; Brown University, Divison of Engineering, Providence, RI 02912; Award #81-01948 A01; $121,021 for 24 months beginning 11/01/82 (SOM).
Conduct computer simulation studies of plastic instability phenomena in solid materials. Study the development of regions of intense flow localizations in nonhomogeneous deformation fields and the role of flow localization in precipitating ductile rupture. Analyze the transition from a periodic buckling pattern to the highly localized one often observed in practice.

274. Digital Processing of Wave Characteristics in Experimental Mechanics; William F. Ranson; University of South Carolina, College of Engineering, Columbia, SC 29208; Award #82-14040; $63,848 for 12 months beginning 11/01/82 (SOM).
Consider two important non-destructive evaluation techniques, ultrasonics and coherent optics. Develop the theory of data analysis for the non-integer and deformation gradient correlation for characteristic wave surfaces; include ultrasonic and optical measurements of slow crack growth in standard fracture mechanics specimens. Apply the theory of deformation gradient correlation procedures to structural problems, and determine the strain and crack opening displacement near the tip of a crack in standard fracture mechanics specimens.

Office of Interdisciplinary Research
(OIR)

275. Travel Support for U.S. Scientists to Attend XV Pacific Science Congress; Edward C. Creutz; Bernice P. Bishop Museum, Honolulu, HI 96819; Award #82-17026; $3,000 for 6 months beginning 12/15/82 (OIR); Split-funded with BNS/BBS for $5,000; with DEB/BBS for $7,000; with OCE/AAEO for $5,000; and with EAR/AHEO for $10,000.

Provide travel funds for American scientists to attend the XV Pacific Science Congress of the Pacific Science Association (PSA) in Dunedin, New Zealand, February 1-11, 1983. Hold symposia and/or present papers on the following topics: environmental biology, earth sciences, information science, and social and economic sciences.

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