NSF/RA-790707

Recent Awards: July-September 1979

NATIONAL SCIENCE FOUNDATION
Division of Problem-Focused Research
Directorate for Engineering and Applied Science
Washington, D.C. 20550

PLEASE READ THIS

THIS IS THE LAST ISSUE OF *RECENT AWARDS* YOU WILL RECEIVE unless you either returned the post card in the April-June issue or return the post card on page 28 of this issue.

TERMINATION OF THE CHEMICAL THREATS TO MAN AND THE ENVIRONMENT AND COMMUNITY WATER MANAGEMENT PROGRAMS

As of October 1, 1979, both the Chemical Threats to Man and the Environment Program and the Community Water Management Program were terminated. No funds were requested for continuation of these programs in NSF's FY 1980 *Budget to the Congress.*

NEW BIOSALINE RESOURCES RESEARCH IN THE ALTERNATIVE BIOLOGICAL SOURCES OF MATERIALS PROGRAM

Oceans, saline estuaries, and arid lands having high salt concentrations can possibly be used to grow plants and microbes which can serve as sources of chemicals and other useful materials. The ABSM Program will support research on assessing the feasibility of using biosaline resources to produce chemicals and materials. Specific research areas are:

- Identify and characterize photosynthetic biosaline plants and microbes for useful constituents.
- Examine biochemical pathways and physiological control points involved in salt and heat tolerance.
- Establish effective large-scale production practices for promising organisms.
- Identify and characterize thermophilic and halotolerant enzymes.
- Examine the utility of biosaline microbes for industrial processing.

Anyone wishing additional information on the Biosaline Resources component of this program should contact Dr. Oskar Zaborsky, Room 1140D, NSF, Washington, DC 20550 (202) 632-7398.

INTRODUCTION

Recent Awards keeps researchers, research users and policy makers informed about projects being supported by NSF's Division of Problem-Focused Research (PFR).

This brochure describes the awards made by PFR during the period July 1 through September 30, 1979, (fourth quarter, Fiscal Year 1979). The data have been reconciled with the NSF's Management Information System. Questions on PFR program objectives, procedures for application, or general information should be addressed to the Professional Assistant for PFR, Room 1134A, National Science Foundation, Washington, D.C. 20550.

HOW TO OBTAIN PFR RESEARCH FINDINGS AND RESULTS

One of the most important objectives of PFR is the timely and widespread dissemination of the results of PFR-sponsored research to potential users. The name and mailing address of the Principal Investigator and Grantee Institution is contained in each project description in this brochure. Persons wishing to obtain information on project findings including project reports, monographs, journal articles, technical reports, and other such relevant materials should write to the Principal Investigator at the Grantee Institution to determine what information is available and at what, if any, cost it may be obtained. The Grantee Institution may charge a nominal amount for the duplication and mailing of such materials to cover costs. The Principal Investigator may furnish information on how interested persons may acquire reports and other materials as appropriate from the National Technical Information Service (NTIS) of the Department of Commerce in lieu of furnishing the report or other material directly. NTIS is the central point in the United States for the public sale of Government-funded research and develop-

ment reports and other analyses prepared by Federal agencies, their contractors, and grantees. The Principal Investigator may also cite journals or other publications where project information may be found instead of furnishing a copy of the article.

DEFINITIONS AND EXPLANATION OF FORMAT

Formulation and Expression of Seismic Design Provisions;[1] Steven J. Fenves;[2] Carnegie-Mellon University, Department of Civil Engineering, Pittsburgh, PA 15213;[3] **Award #76-19033 A04**[4]

1. **Title of the Specific Grant**
2. **Principal Investigator:** the chief scientist or administrator who is responsible for the research plan and fiscal expenditures as an NSF awardee. Co-Principal Investigators will also be listed.
3. **Institution Conducting the Research:** any college, university, laboraoty, industry, or other organization, whether operating on a profit or nonprofit basis, as well as State governments and Federal organizations.
4. **Award Number:** the award number and amendment number, if applicable.

Note To Readers: The designation (SB S) after the award number indicates that the award was made as the result of Program Solicitation NSF 78-69, *Small Business Research Innovation.* Awards were made to support applied research on important scientific or technical problems or opportunities that could have significant public benefit if the research is successful.

Alternative Biological Sources of Materials

The Alternative Biological Sources of Materials program deals with selected aspects of the problem of meeting the Nation's future needs for raw materials. This program is directed toward alleviating national dependence on selected scarce resources by making alternative biological sources of materials available in the United States. Four particular topics have been selected for investigation in Fiscal Year 1979: Biological conversion of lignocellulosic materials to useful chemicals; biological nitrogen fixation; production of speciality chemicals from arid land plants (specifically, production of rubber from the guayule plant); and biosaline resources.

1. The Regulation of Rubber Formation in Guayule (*Parthenium argentatum*) Plants; Chauncey R. Benedict; Texas A&M University, Department of Plant Sciences, College Station, TX 77843; **Award #79-04650**

   Development of guayule (*Parthenium argentatum* Gray) as a domestic source of natural rubber is currently of considerable interest to the government. One of the characteristics of rubber accumulation in guayule is its cyclic nature. Rubber is not produced under the optimal growth conditions of summer, but is induced by exposure to low night temperatures of the fall and winter. The primary aim of this research is to identify the metabolic block to rubber synthesis and to characterize the biochemical control system operable in the cyclic synthesis of rubber. Success in this research will fill the gaps in our understanding of the regulation of rubber synthesis in non-lacticiferous rubber producing plants. Knowledge gained concerning the physiology and biochemistry of rubber synthesis in guayule will provide new leads to the enhancement of rubber yield under agronimic conditions.

2. Polysaccharide Production by Microalgae; John R. Benemann: Ecoenergetics Inc., 5619 Van Fleet Avenue, Berkeley, CA 94702; **Award #79-17646 (SB S)**

   The mass cultivation of microalgae for production of fuels, protein, and wastewater treatment has received substantial attention. The technologies developed should have applications in the production of chemicals and polymers of industrial-commercial value.

   This research addresses the production of polysaccharides from microalgal biomass produced on brackish waters. Microalgal polysaccharides of potential commercial interest will be identified, and their presence in sufficient quantities to allow commercial extraction will be demonstrated.

   This research should lead to a process for developing microalgal polysaccharides as a new source of flocculants and emulsifiers of use in many practical applications, including tertiary oil recovery.

3. Bacterial Transformations of Lignin; Ronald L. Crawford; University of Minnesota, College of Biological Sciences, Minneapolis, MN 55455;**Award # 79-06772**

   Lignin and cellulose are the two most abundant naturally-occurring organic materials on earth and represent potentially important industrial raw materials. In addition, disposal of lignocellulosic materials is becoming a major waste disposal problem. The objective of this project is to assess the effectiveness of bacteria for converting lignin in agricultural and forest-derived lignocellulosic materials to useful products. Specific objectives are to genetically modify lignin-degrading bacteria to produce catabolically blocked mutants, use the blocked mutants to map the catabolic pathways and produce novel lignin-containing compounds.

4. Water Use and Production Practices for Guayule; Delmar D. Fangmeier; University of Arizona, Department of Soils, Water and Engineering Tucson, AZ 85721; **Award #79-11721**

   This project involves three phases of guayule culture: establishment, growth and harvest; and evaluates the effectiveness of improved agronomic practices on the cultivation of guayule. Research concentrates on water requirement, stand establishment, herbicides usage, and harvest procedures.

   Two field plots will be established in Arizona using both direct-seeding and transplantation. Direct-seeding studies will include various seed treatments and methods of seedbed preparation. Water will be delivered in measured quantities based on soil moisture content and plant needs. Both dryland and irrigated trials are included. Rubber yields will be monitored in plants from all treatments.

5. Enzymatic Transformations of Lignin; Wolfgang G. Glasser; Virginia Polytechnic Institute, Department of Chemistry, Blacksburg, VA 24061; **Award #79-13135**

   Lignin constitutes a vast potential renewable resource base for producing chemicals and organic polymers, but its structural and chemical complexity has prevented effective utilization. Biotransformation of wood, including the lignin component, is accomplished naturally by microbes, and in this manner carbon is recycled. An alternative approach to conventional chemical processing of lignocellulosic materials is the use of enzymes or intact microorganisms.

   The overall goal of this project is the development of enzymatic or microbial processes for the conversion of lignin to commercially valuable materials. Specifically, the objectives of this three-year project are to refine determinations of the chemical changes brought about in lignin by microorganisms in laboratory cultures or by cell-free lignin-transforming enzymes; to investigate the effect on lignin of enzymatically-generated reactive oxygen species; to explore alternatives to classical fermentation systems for lignin transformation; and to pursue actual utilization schemes for the microbially and enzymatically transformed lignins.

6. An Integrated Approach to the Conversion of Lignocellulose From Wood Into Useful Chemicals; Irving S. Goldstein; North Carolina State University at Raleigh, Wood and Paper Science, Raleigh, NC 27607; **Award #77-12243 A02**

   This project studies the conversion of the wood components hemicellulose, cellulose, and lignin from low-quality southern hardwoods to useful chemicals in a systematic and integrated manner. Specific objectives include prehydrolysis of the hemicelluloses for optimum conversion to sugars, hydrolysis of cellulose to glucose with strong hydrochloric acid, conversion of lignin residues to low molecular weight phenoloc compounds, and preliminary process design of an integrated wood chemicals plant. Research focuses on the hydrogenation of lignin and a preliminary process design for the integrated system.

7. Insecticidal Activity of *Beauveria bassiana;* Edward A. Grula; Oklahoma State University, Department of Cell, Molecular and Developmental Biology, Stillwater, OK 74074; **Award #79-10369**

   Experiments are being conducted to elucidate the mechanisms of infection of insect pests by the fungus *Beauveria bassiana.* This entomopathogenic fungus is used on crops in the USSR and in the People's Republic of China. Through the US/USSR Microbiology Program, a culture of *B. bassiana* has been brought to the US for study.

   The specific objectives of this research are to elucidate the mechanism of penetration of the larval integument by growing hyphae, to determine the conditions for germination of fungal conidia, and to determine the growth requirements for the emergent hyphae on the surface of larvae.

8. Low Temperature Thermoconversion of Biomass To Useful Chemicals By Lewis Acid Catalysts; Victor R. Koch; EIC Corporation, 55 Chapel Street, Newton, MA; **Award #79-17513 (SB S)**

   The high price and uncertain availability of hydrocarbon feedstocks makes biomass attractive as a source of useful organic chemicals. Biomass may be converted to alcohols, ketones and acids with high selectivity but at low rates; thermoconversion of biomass proceeds at high rates but with no selectivity. The goal of this project is to convert biomass into useful organic chemicals at reasonable cost. Specific objectives are to confirm the presence of pyrone by spectroscopic teniques and elemental analysis; identify the threshold temperature for pyrone formation with $AlCl_3$, determine useful temperature range for pyrone generation; and assess pyrone yield as a function of temperature and amount of $AlCl_3$ catalyst.

9. Enhancing Biological Production of Ammonia from Atmospheric Nitrogen and Soil Nitrate; James M. Lyons; University of California-Davis, College of Agricultural and Environmental Sciences, Davis, CA 95616; **Award #77-07301 A02**

   The four major objectives of this multidisciplinary project are to: (1) enhance nitrogen fixation in bacteria by genetic manipulation; (2) increase the efficiency of symbiotic nitrogen fixation in legumes; (3) evaluate the potential for supplying nitrogen to rice crops through the *Azolla/Anabaena* symbiotic system; and (4) increase the efficiency of conversion of nitrate to ammonia in soil bacteria and in crop plants.

   During this, the project's second year, research will include: (1) the recognition that hydrogen uptake in *Rhizobia* is genetically controlled by a plasmid, (2) the identification of cyclic mononucleotides as regulators

of nitrogen fixation by root nodule bacteria, (3) the demonstration that superior mutants of *Rhizobia* can increase total productivity of soy plants, (4) continued optimization of Azolla propagation as a source of nitrogen for rice plants, and (5) the isolation of bacteria which convert nitrate to ammonia under anaerobic conditions. These studies will be continued, expanded and extended to field experiments where appropriate during the third year of the project.

10. Experimental Macro-Algal Mariculture; Michael Neushul; Neushul Mariculture Inc., 244 Vereda Galeria, Goleta, CA 93017; **Award #79-11715**

    Organic chemicals and polymers are presently derived largely from petroleum. As fossil resources become scarcer, alternative organic resources and end-use products derived from these raw materials need to be examined. One possibility is to use marine plants for the production of essential chemicals, intermediates, and polymers.

    The goal of this project is to cultivate selected species of marine algae suitable for deriving useful algal gums. In particular, the research will establish small-scale, near-shore, mariculture systems for the marine plants *Gelidium, Eucheuma* and *Macrocystis,* which produce agar, carrageenan, and algin. The research consists of preparing mariculture sites with anchored substrates, producing algal seed stock, propagating selected algae, seeding the substrates, applying required fertilizers, and obtaining essential growth and yield data. The optimum growth conditions for near-shore, marine plant farms capable of producing polymeric chemicals are to be determined.

11. Natural Rubber From Guayule: Genetics, Cytogenetics and Breeding; David D. Rubis; University of Arizona, Department of Plant Sciences, Tucson, AZ 85721; **Award #79-11723**

    This project involves research in genetics, cytogenetics and plant breeding of guayule (*Parthenium argentatum*) as a domestic source of natural rubber. The germplasm collection includes *P. incanum, P. confertum, P. hysterophorus, P. fruticosum, P. tomentosum* and *P. stromonium* as well as *P. argentatum.* Interspecific crosses will be made between guayule and each of the other species. Important characteristics such as cold tolerance and vigorous growth obtained from these crosses will be transferred to guayule by backcrossing.

    The basic breeding behavior of guayule and related species will be studied in order to develop techniques of breeding for variety improvement. Polyhaploids (36 chromosomes) will be used in crosses to develop true breeding F_1 tetraploids. Effects of temperature, daylength and light intensity will be studied in order to make crosses all seasons of the year.

12. Chemicals From Western Hardwoods and Agricultural Residues; Kyosti V. Sarkanen; University of Washington, Department of Chemical Engineering, Seattle, WA 98195; **Award #77-08979 A03**

    This research assesses the potential use of hardwoods and agricultural residues for the production of chemicals. Specific objectives are to: (a) characterize the essential properties of cellulose, hemicellulose, lignin and extractive components of red alder wood and wheat straw; (b) examine novel methods for converting red alder wood and wheat straw to fibrous products in combination with by-product recovery; and (c) convert the lignin and carbohydrate by-products to chemicals using microwave degradation. Research for this award period focuses on organic solvent separations of hardwood components and the characterizations of derived lignins.

13. Capturing the Sun Through Bioconversion—Conference II; Peter Schauffler; Bio-Energy Council, Suite 204, 1337 Connecticut Ave., N.W., Washington, DC 20036; **Award #77-17117 A02**

    This award provides additional support for the Bio-Energy '80 Conference to be held in Atlanta, Georgia, on April 21-24, 1980. Both the Department of Agriculture and the Department of Commerce (National Oceanic and Atmospheric Administration) are contributing supplemental support for the conduct of this conference. The conference focuses on biomass sources, conversion processes and products.

14. Investigation of Sagebrush as a Major Biological Source of Materials; Fred Shafizadeh; University of Montana, Department of Chemistry, Missoula, Mt 59801; **Award #78-26314**

    Sagebrush is a group of shrubby plants endemic to the semi-arid regions of the western United States. Sagebrush covers millions of acres of land in eleven states and produces several tons of biomass per acre per year. However, sagebrush is considered a weed, since it competes with grasses and other forage plants in its natural habitat.

    The objective of this research is to investigate means for producing useful chemicals, industrial feedstocks, animal feed and other materials from sagebrush, and to determine the potential market for these products.

15. Herbicides for Weed Control in Guayule Plantations and Their Influence on Rubber Yields; J. W. Whitworth; New Mexico State University, Department of Agronomy, Las Cruces, NM 88003; **Award #79-13024**

    Weed control is one of the most expensive operations in the growing of guayule. Stove oil and naptha substances effectively controlled small seedling grasses and susceptible broadleaved weeds, but the margin of selectivity on guayule was very narrow, and many weeds were resistant at any stage. Tentative solutions to these problems were indicated in preliminary testing of some newer herbicides. With increased availability of more plant material and guayule seeds, many of the

more than 156 newer type herbicides, alone and in combination, will be investigated for season-long control of weeds. Preliminary screening in the greenhouse will establish the influence of various herbicides on growth and development of roots and foliage of guayule as well as on survival. The more promising herbicides will be field tested on both direct seeded and transplanted guayule. Since many of the herbicides have growth regulator activity, their positive or negative effect on the deposition and yield of rubber will be investigated along with total yield of shrub.

16. Development of Superior Cultivars of Jojoba; Demetrios M. Yermanos; University of California-Riverside, Department of Plant Sciences, Riverside, CA 92521; **Award #78-12709 A01**

    The objective of this project is to develop superior cultivars of jojoba, a potential crop for the arid lands of Southwestern U.S. and northern Mexico.

    During the first year of this project, seeds with high oil content were selected through a non-destructive nuclear magnetic resonance procedure, planted in breeding nurseries, cytological studies initiated, and whole plants regenerated from stem terminal explants. In the second year these studies will be continued to develop and identify new cultivars with agronomically superior qualities.

17. Biological Systems for Lignocellulose Conversion; J. G. Zeikus; University of Wisconsin-Madison, Department of Bacteriology, Madison, WI 53706; **Award #79-10084**

    Cellulose and lignin are abundant renewable resources. Biological conversion of these substrates to chemicals and materials is attractive because of low conventional energy requirements, high efficiency, and environmental acceptability.

    The objective of this project is to convert cellulose and lignin to useful materials by biological means and to define the rate limiting steps. The organisms to be used are *Phanerochaete chrysosporium* and *Clostridium thermocellum*. Specifically, *P. chrysosporium* is to be used to optimize delignification of wood and the production of useful low molecular weight aromatic chemicals. *C. thermocellum* cellulase is to be used to optimize saccharification of delignified wood to readily utilizable sugars such as glucose. Conversion of cellulosic matter to high yields of ethanol or acetic acid is to be evaluated in mono- and co-culture fermentations with *C. thermocellum*.

Chemical Threats to Man and the Environment

The Chemical Threats to Man and the Environment program supported research on the prediction, identification, characterization, and control of hazards resulting from chemical compounds in the environment. The program emphasized research on techniques and methods that could be applied to a wide range of problems. The program was closely coordinated with the research programs of EPA and NIH.

As of October 1, 1979, the Chemical Threats to Man and the Environment program was terminated. No funds were requested for its continuation in the FY 1980 *Budget to the Congress* submitted by NSF.

1. Research on a Rapid and Simple Detection Method for Asbestos; Fred R. Albright; Lancaster Laboratories, Inc., 2425 New Holland Pike, Lancaster, PA 17601; **Award #79-17183 (SB S)**

    Occupationally related diseases are of great concern in our industrial society. Data on cancer and respiratory diseases suggest asbestos as a causative agent. This project addresses the need for a reliable, simple method of detecting asbestos fibers in the environment.

    Current analytical methods for asbestos possess inherent limitations, including lengthy analysis time, sophisticated and expensive instrumentation, inability to resolve or confirm the identity of fibers, and deficient analytical sensitivity. This research project studies the surface-chemical reactivity to fluorescent binding agents of several types of asbestos. Goals are to achieve a novel means of enhancing the detection of asbestos through greater specificity in identifying fibrils among non-asbestiform residues, and to reduce analysis time and expense.

2. Microbial Biodegradation of Synthetic Environmental Pollutants; Ananda M. Chakrabarity; University of Illinois at the Medical Center, Chicago, Department of Microbiology and Immunology, Chicago, IL 60680; **Award #79-05499**

    The release of synthetic halogenated hydrocarbons in the form of refrigerants, dielectric fluids, flame retardants, herbicides and pesticides to the environment has resulted in death and disability to many biological organisms. It appears that the ability of microorganisms to detoxify pollutants is restricted because of the absence of appropriate genetic compentence for their complete biodegradation in a single culture. Yet, characterization of facultative anaerobes from the Hudson River sediments points to the evolution of PCB bioconversion competence in the form of plasmids in members of the family *Enterobacteriaceae*. Similarly, examination of soil microflora has demonstrated the occurence of a 2,4-D plasmid in *Alcaligenes paradoxus*.

    This project seeks to isolate and characterize various microorganisms, from soil and river sediments as aerobic and facultative anaerobic cultures, and to examine the evolution of degradative competence against synthetic chlorinated hydrocarbons and various herbicides and pesticides. The evolution of a 2,4-D plasmid in a

soil bacterium species makes it likely that similar pathways for the partial or complete biodegradation of other chlorinated hydrocarbons may be evolving in various microorganisms. A study of the molecular mechanisms involved in the emergence of such biodegrative functions should be extremely useful in constructing multiplasmis strains that may develop capabilities for rapid and complete degradation of hazardous environmental pollutants.

3. Soils as a Source or Sink of Atmospheric Nitrous Oxide; John M. Duxbury; Cornell University, Department of Agronomy, Ithaca, NY 14850; **Award #78-11639 A01**

   Nirtous oxide has a role in the stratospheric ozone cycle. Nitrous oxide is produced in soil during the normal nitrogen cycle, and it may be that modern agricultural methods sharply increase nitrous oxide production, thereby upsetting the natural balance. This project is designed to test this hypothesis by measuring nitrous oxide fluxes across the soil-atmosphere interface and the fluxes of nitrous oxide and nitrate nitrogen in drainage water at selected agricultural and non-agricultural sites, and by determining the conditions under which soils act as a source or a sink of atmospheric nitrous oxide. The sites to be studied include mineral soils in central New York State and organic soils in western New York State and southern Florida. Both fallow and cropped land with various fertilization treatments will be studied. Field work will be supplemented by laboratory studies to characterize the phenomena observed.

4. The Chemistry of N-Nitroso Compounds and Their Occurrence In the Environment; David H. Fine; New England Institute for Life Sciences Inc., Department of Chemistry Research, Waltham, MA 02154; **Award #79-09443**

   Over the last three years new findings of nitrosamine occurrences have indicated that human exposure to these carcinogens may be far more widespread than was suspected. Earlier inquiries into the possible formation of nitrosamines from pesticidal chemicals in soils led to the discovery that some amine-containing herbicide fofmulations were contaminated with nitrosamines. Further research showed that nitrosamines occur in other products formulated with amines, such as industrial cutting fluids and cosmetics. We need a better knowledge of the general chemistry of nitrosamine formation in the total human environment, including industrial and consumer products to which humans are exposed.

   Awareness of widespread occurrences of nitrosamines may have been delayed because of earlier misconceptions about nitrosamine chemistry (e.g., that only secondary amines are readily nitrosated, that nitrosation can be expected only in acid media, or that a nitrite is a necessary precursor). This project will determine the conditions under which nitrosamines can form, identify nitrosating agents, and determine the detailed chemical pathways and mechanisms of nitrosamine formation. Particular emphasis will be given to formation mechanisms in neutral and alkaline solutions, to the nitrosation susceptibility of different amine substrates, to organic nitro and nitroso compounds as nitrosating agents, and to the role of nitrogen oxide gases.

5. Mycotoxins: A Potential Human Health Hazard; Anil C. Ghosh; SISA Incorporated, 767B Concord Avenue, Cambridge, MA 02138;**Award # 78-17841**

   This research on problems in the field of mycotoxins includes: development of rapid methods for the detection and estimation of toxins elaborated by the mold *Penicillium islandicum* Sopp; detailed studies on microbial production, structural elucidation, and biological activity of simatoxin and lumiluteoskyrin, two new metabolites of *P. islandicum;* and microbial production, identification, and biological studies of toxins produced by selected species of penicillia.

   All the fungi selected for these studies are common contaminants of various foodstuffs. The availability of practical detection methods for the toxins elaborated by these molds will facilitate an assessment of the overall extent of the hazard of these mycotoxins to human health.

6. Vapor Deposited Silver Halides for Thin Layer Chromatography; Gershon M. Goldberg; Ionomet Company, Inc., 1660 Soldiers Field Road, Brighton, MA 02135; **Award #79-17476 (SB S)**

   This project relates to improvements in the technique of thin-layer chromatography, (TLC); specifically, the preparation of a thin-film medium that will provide a rapid, economical, sensitive means to separate (from air, water, and soil samples) and quantitate chemical species having possible health or environmental consequences. The approach is to prepare, by vapor deposition continuous thin films of silver halides; to determine the optimum surface structure required for maximum separating effectiveness; and to tabulate the types of chemical structures that can be separated by them. The unique properties of these films may allow the preparation of a reverse phase system and offer the amplification factor of photographic development as a potential means for increased sensitivity of detection. It is anticipated that the complexing ability of silver ton combined with the faster and more complete separations claimed for other thin-film (as opposed to thin-layer) media will provide a high-performance TLC material competitive with the more equipment-intensive high-performance liquid chromatography and gas chromatography techniques.

7. Separation of Radium-226 and Thorium-230 From Uranium Ore; John E. Hawley; Hazen Research Inc., 4601 Indiana Street, Golden, CO 80401; **Award #79-17408 (SB S)**

The purpose of this research is to test the possibility of separating radium-226 and thorium-230 from uranium mill tailings at the time of leaching the uranium ore with sulfuric acid. The approach is to determine experimentally whether radium-226 and thorium-230 can be complexed to such a degree that precipitation of the sulfates can be prevented during uranium leaching. The complexing agents suggested for testing include orthophosphates and condensed phosphates such as pyrophasphate, trimetaphosphate, and hexametaphosphate.

8. Annual Conferences on Trace Substances in Environmental Health; Delbert D. Hemphill; University of Missouri Columbia, Department of Horticulture, Columbia, MO 65201; **Award #78-05696 A01**

   The purpose of the Thirteenth Annual Conference on Trace Substances in Environmental Health is to explore the biological, ecological and health significance of organic and inorganic substances that may be present in "trace" amounts in the environment.

   These conferences form part of an overall interdisciplinary approach necessary to understand the complexity of environmental and ecological problems and methods for their control. Areas of emphasis for the Thirteenth Conference include: Epidemiology of Trace Substances, Environmental Pollution, Environmental Geochemistry and Health, Analytical Methodology, and Metabolic and Health Effects of Chemical Substances.

9. Analysis of Organic, Elemental and Carbonate Carbon in Atmospheric Aerosols; James J. Huntzicker; Oregon Graduate Center, Environmental Technology, 19600 N.W.Walker Road, Beaverton, OR 97005; **Award #78-24554**

   This is a detailed investigation of the ability of the Oregon Graduate Center carbon analyzer to separate and measure the organic, elemental, and carbonate fractions of carbonaceous aerosols. The sample, collected on a glass or quartz fiber filter, is heated to 850° to volatilize organic carbon. The volatile carbon is swept through a bed of an oxidizing agent, after which carbon dioxide is catalytically converted to methane and measured in a flame ionization detector. Following removal of the volatilizable carbon, any remaining carbon is oxidized to carbon dioxide and the analysis completed as before. Provision is made for an acid treatment step to measure carbonate carbon.

   The objective of this project is to optimize the discrimination between elemental carbon and organic carbon. Interferences by non-carbonaceous materials will be assessed. The method will be compared with solvent extraction methods and with a wet chemical-thermogravimetric method.

10. Characterization and Transformations of Aquatic Organics and Complexes; Walter J. Maier; University of Minnesota, Department of Civil and Mineral Engineering, Minneapolis, MN 55455; **Award #79-15312**

    This research will provide information on the relationship between natural (background) constituents and trace pollutants in water. Such information is needed to formulate realistic pollution abatement strategies. An effort to identify and characterize the physical-chemical properties of natural constituents in the upper Mississippi River has been undertaken. Previous studies focused on the development of analytical methodologies including techniques for isolating, concentrating, and identifying specific compounds; characterizing functional groups; and measuring physical-chemical parameters of isolates for both organic material and trace metals in river water.

    This project extends and applies these techniques. Natural organics will be fractionated by polarity on macroreticular resins, characterized, and correlated with seasonal changes and variations in sources of organic matter in the river. Specific organic compounds in the aquatic organic pool of river water will be characterized; these include hydrocarbon and organic compounds containing nitrogen, sulfur, and chlorine. Organometallic complexes from aquatic systems will be isolated and characterized and their stability constants measured.

11. Improved Sensitivity of Laser Absorption Techniques for Atmospheric Pollutant Monitoring; Arlan Mantz; Laser Analytics Inc., 25 Wiggins Avenue, Lexington, MA 02173; **Award #77-02124 A03**

    The objective of this research is to improve the sensitivity of remotely monitoring atmospheric pollutant gases by absorption from a laser beam. The goals are to minimize laser source noise and the effects of atmospheric turbulence, both of which diminish the sensitivity of long-path monitoring by laser absorption techniques. The main emphasis of the work will be to complete the development and evaluation of a prototype environmental monitor system suitable for industrial plant site applications. This will include the refinement of a digital ratioing technique for eliminating atmospheric turbulence effects.

12. Evaluation of Effects of Acid Mine Drainage on Microbial Community Structure and Function in a Freshwater Lake; Aaron L. Mills; University of Virginia, Department of Environmental Sciences, Charlottesville, VA 22903; **Award #79-06298**

    This project will investigate the effects of drainage from pyrite mines into Lake Anna, Virginia. Emphasis will be placed on the effects of low pH, high heavy-metal concentration runoff on the structure and function of microbial communities in the most contamined arm of the lake. The hypothesis is that both the microbial communities and the processes they control have been severely altered.

Functional parameters such as heterotrophic potential, substrate decomposition, carbon dioxide uptake by phytoplankton, nitrification, denitrification, and sulfur oxidation will be measured. Stations for sampling have been selected to investigate the extent of the effects of contaminated drainage into the reservoir. A series of experiments involving metal uptake by bacteria, phytoplankton, and detritus is planned to determine the amount of metal made available for passage into higher trophic levels of aquatic food chains.

13. SO_2 Oxidation Rate on Well-Characterized Surfaces—A Laboratory Study; Volker A. Mohnen; SUNY State University at Albany, Atmospheric Sciences Research Center, Albany, NY 12222; **Award #76-81817 A01**

    The first phase of the research will study the oxidation rates of SO_2 on two well-characterized surfaces that can serve as paradigms for the wide range of surface types on typical stack particles. These surfaces are polycrystalline V_2O_5 (representing the metal oxides) and carbon on pyrolytic graphite (representing carbonaceous particles). Oxidation on V_2O_5 is hypothesized to occur in two stages: oxygen adsorption at reduced vanadium sites, and then oxidation of SO_2 by an Eley-Rideal mechanism. Oxidation on carbon surfaces is hypothesized to occur in two similar phases. This research will determine whether the proposed reaction schemes are valid, and will deduce the rate-controlling step. Methods of analysis include mass spectrometry, molecular beam and auger spectroscopy.

    The second phase of the research will involve the study of sulfate concentrations from in-stack coal and oil flyash samples. Measurements will be made of total sulfate per unit weight, surface vanadium content, and surface areas per unit weight for each type of ash. Determinations will be made of the degree to which sulfate concentration from SO_2 oxidation is related to the total surface area and to the vanadium concentration of the ash. These studies will elucidate the relative importance of vanadium and the carbonaceous surfaces of flyash as oxidizing agents for SO_2. Analysis will include use of $BaCl_2$ precipitating agent, ion liquid chromatography, BET surface analysis, and electron microscopy and energy dispersive X-ray microanalysis.

14. A Field Study of Biogenic Sulfur Gas Releases From Inland Surface Waters; David F. Natusch; Colorado State University, Department of Chemistry, Fort Collins, CO 80523; **Award #79-08967**

    This project will determine whether marshes and other surface waters contribute to local atmospheric loads of particulate sulfate. This study will determine the atmospheric concentration and stable sulfur isotope ratios of sulfides, sulfur dioxide, and particulate sulfur species at several sites to aid in determining how much of the sulfate in the atmosphere at these sites is derived from upwind anthropogenic SO_2 sources and how much is derived from local biogenic S sources. Local meteorological data, backwards air mass trajectories, trace metal concentrations and ammonium and nitrate concentrations in the particulate fraction will also be analyzed.

15. Personal Dosimeter for Anesthetic Gases; Eugene P. Scheide; Environmetrics-St Louis, 2833 Lawton Promenade, St. Louis, MO 63103; **Award #79-17110 (SB S)**

    Epidemiologic studies of medical personnel assigned to operating rooms have shown that women employees and wives of male employees are subject to increased spontaneous abortions, birth defects in their children, and cancer compared to medical personnel who do not work in operating rooms. An estimated 214,000 medical and dental workers are chronically exposed to these gases. Exposure to toxic gases in the work environment must be monitored in order to protect employee health. The objective of this research is to develop a simple and inexpensive method of measuring time-weighted average concentrations of breathing zone samples of waste anesthetic gases in hospital operating rooms. Researchers envision a personal dosimeter similar to a radiation film badge that can be worn on the coat lapel. The air contaminants being smpled diffuse into the dosimeter and are absorbed onto a collection element. Later analysis of this substrate gives the time-weighted average concentration of the contaminant being monitored. This research program will address all of the parameters that affect the performance of this personal dosimeter.

16. The Detection of Pyrrolizidine Alkaloids and Their Metabolites; Henry J. Segall; University of California Davis, Department of Physiological Sciences, Davis, CA 95616; **Award #78-06924 A01**

    Pyrrolizidine alkaloids are toxic compounds found in plants worldwide. These toxins may contaminate human and animal food sources. Analytical methodologies are being developed to identify these alkaloids and their metabolites in plants and in the milk of cows which consume the plants. Analytical tools being employed include high pressure liquid chromatography and gas chromatography/mass spectroscopy. Plants to be examined include *Senecio vulgaris, Senecio jacobaea, Seneca longilobus* and *Amsinckia intermedia.*

17. Pollutant Flow Through the Marine Food Web; David R. Young; Southern California Coastal Water Research, Division of Biology, El Segunda, CA 90245; **Award #77-15376 A01**

    Apprehension about pollutants in sea food is based on the assumption that food-chain concentrations of pollutants which have been demonstrated in terrestrial and freshwater systems also apply to open coastal marine ecosystems. Recent studies cast doubt on these assumptions. This research will determine whether coastal marine ecosystems are structured with respect

to pollutants by carefully analyzing concentrations of pollutants and pollutant analogues in marine organisms and comparing these data with trophic level assignments determined from food habits studies. Food webs from a diversity of ocean environments will be sampled at sites adjacent to well documented sources of pollutants. Concentrations of volatile and non-volatile trace elements, chlorinated hydrocarbons and the pollutant-analogue, cesium, will be determined. If the results confirm a lack of structure in marine food webs with respect to pollutants, a major change in thinking for biologists and concern about pollutants will have to be addressed individually.

Community Water Management

The Community Water Management (CWM) program originated in the former Regional Environmental Systems (1971-75) and Regional Environmental Management (1976-78) programs that dealt with water-related issues of land use, urban water resources, residuals and risk management. CWM's goal was to support research focused on management of threats to community water to achieve and maintain acceptable levels of health, safety, and environmental quality at reasonable cost. The CWM program was designed to meet that goal by supporting research to identify and assess alternative and innovative concepts for dealing with community water/wastewater-related problems.

As of October 1, 1979, the Community Water Management program was terminated. No funds were requested for its continuation in the FY 1980 *Budget to the Congress* submitted by NSF.

1. Chromium Recovery from Tannery Industry Wastes; Francis C. Brown; EIC Corporation, 55 Chapel Street, Newton, MA 12158; **Award #79-17104 (SB S)**

   The objective of this project is to determine whether there is a technically feasible and economically attractive process for recovering chromium from tannery industry solid wastes. A survey of the industry is being conducted to identify representative plants and waste disposal sites. Samples of currently produced and historically deposited wastes are being collected from these sites and analyzed to determine their chemical composition and their response to chemical and physical methods for processing to recover chromium. The chemical and physical properties of sludge residues following chromium removal and disposal methods for these residues are being evaluated. The data from these tasks will be used to produce a preliminary technical and financial assessment of commercial scale chromium recovery from tannery wastes.

2. Utilization of Wetlands for Wastewater Management; Ronald Capalaces; Forum Inc., 6512 Jay Miller Drive, Falls Church, VA 22041; **Award #79-23303**

   The objective of this project is to produce a concept for a documentary film presentation of results of research currently underway on utilization of wetlands for management of community wastewater. This film is planned to provide information and guidance to communities considering the potential utilization of wetlands as an alternative to conventional methods for advanced treatment of their wastewater. The treatment concept draws upon NSF-supported research in progress at the University of Michigan, Williams and Works, Inc. (Grand Rapids, MI), the University of Florida, Boyle Engineering Corporation (Orlando, FL), and the State of Florida.

3. Removal of Silica from Cooling Water by Activated Alumina; D. B. Clayton; D. B. Clayton and Associates, 10919 Braes Forest, Houston, TX 77071; **Award #79-17072 (SB S)**

   The objective of this research is to characterize the adsorptive ability of activated alumina for silica as it may be applied to removal for potential reuse of silica from industrial cooling tower water blowdown. Bench-scale experiments will be conducted to identify and evaluate the engineering design parameters necessary to indicate the feasibility of the concept and to provide information for the next phase, which is expected to involve pilot plant experimentation.

4. The Entrapment Concentration and Recovery of Heavy Metals From High-Yield Exhausts By Use of Stabilized Soil Adsorption Beds; Richard R. Dedolph; Gravi-Mechanics Company, 22 W510 71st Street, Naperville, IL 60540; **Award #79-17036 (SB S)**

   The objective of this project is to assess the potential for using the adsorptive and ion-exchange capacity of minerals, soils, peat and sludge for the concentration and recovery of heavy metals from industrial exhaust streams. After dispersal of the absorbing medium on a suitable substrate, the absorbant/exchange capacity of the medium is being determined by subjecting it to the exhaust fumes containing lead and zinc. The effects on metal entrapment efficiency of flow-rate, temperature, heavy-metal concentration and moisture-content of the absorbing medium are being evaluated.

5. Process Integration for Optimum Management of Municipal Wastewater Treatment Sludges; Richard I. Dick; Cornell University, Department of Environmental Engineering, Ithaca, NY 14850; **Award #77-22947 A01**

   This research will determine the influence of design and operating variables in wastewater and sludge processing on physical properties of municipal wastewater treatment plant sludges with emphasis on thickening and dewatering. Studies include determination of the effects of sludge residence time in treatment processes on settling and dewatering properties and changes in these physical properties as a consequence of both aerobic and anaerobic stabilization. The role of disinfection with emphasis on its potential integration into

systems for appropriate management of sludges is being investigated. The determination of the effects of using energized electrons for disinfection of sludges on their physical characteristics is being conducted in cooperation with research in progress at the Massachusetts Institute of Technology.

6. Utilization of Wetlands for Wastewater Management; Clayton Edwards; Image Associates, 1611 Connecticut Avenue, N.W., Washington, D.C. 20009; **Award #79-19066**

   The objective of this project is to produce a treatment concept for a documentary film presentation of results of research currently underway on utilization of wetlands for management of community wastewater. This film is planned to provide information and guidance to communities considering the potential utilization of wetlands as an alternative to conventional methods for advanced treatment of their wastewater. The treatment concept draws upon NSF-supported research at the University of Michigan; at Williams and Works, Inc. (Grand Rapids, MI); the University of Florida; Boyle Engineering Corporation (Orlando, FL); and the State of Florida.

7. Water Management in New England: A Method for Investigating Short-Run Operational and Long-Range Investment Strategies; Harris Gold; Water Purification Associates, 238 Main Street, Cambridge, MA 02142; **Award #77-25966**

   This project is developing and evaluating a method for optimizing operational and long-range investment strategies for water management in New England. A stochastic, dynamic programming method for anlayzing potential water shortages is being designed which will be linked to a formulation for optimizing the expansion of water system capacity with respect to size and time. The intent is to combine both short- and long-term considerations to reconcile demand for and supply of water.

   The integrated method being developed is being evaluated in New England at the local, regional and river-basin levels in comparison with current strategies. Specific tasks include delineation of technological and institutional mechanisms for matching supply with demand, formulation and testing of an optimization method for choosing the levels of demand-reduction and supply-increase in light of uncertain future supplies, tests of the use of developed methods on specific cases, and comparisons with policies that would result from standard water resource planning methods. Direct transfer of methodologies developed in this study will occur as a consequence of specific case studies conducted in this project, workshop seminars and a manual of practice which is planned as a final product.

8. Benefits and Problems of Refuse-Sludge Composting; Clarence G. Golueke; CAL Recovery Systems Inc., 160 Broadway, Suite 200, Richmond, CA 94804; **Award #79-17407 (SB S)**

   The objective of this project is to determine whether the light fraction of mixed municipal solid waste can be utilized as a bulking agent in composting of sludges produced during treatment of community wastewater. A standard rototiller and high-speed shredder are being adapted for development of a prototype mixer for the sludge and solid waste. The design principles for equipment to process these mixtures and the dilution effect of this concept on heavy metal content of sludges are being investigated.

9. Agricultural Utilization of Sludges From Treatment of Community Wastewater; Roger Haag; Rickel Manufacturing Corp., Box 626, Salina, KS 67401; **Award #79-17739 (SB S)**

   The objective of this project is to evaluate the technical and economic feasibility, of a method for placement of ammonia and phosphoric acid into agricultural soil simultaneously with sludges derived from the treatment of community wastewater. This concept is being evaluated in field-plot scale tests on a 10-acre site near Salina, Kansas using sludges obtained from the Salina municipal wastewater treatment plant.

10. Application of Ultrasonics and Electrostatics in Wastewater Treatment and Disinfection; Paul S. Kernion; Sonic-Clean Inc., 24 27th Street, New Orleans, LA 70184; **Award #79-17740 (SB S)**

    This research will investigate the potential use of an ultrasonic, electrostatic process for the advanced treatment of wastewater to permit its reuse for industrial and agricultural purposes. The work involves assessment of physical and chemical factors such as solids concentration, pH, and frequency of vibration on the efficiency of treatment. The capability to provide disinfection with regard to bacteria and parasites is also being investigated.

11. Disinfection of Community Wastewater Sludges By Use of High Energy Electrons; John G. Trump; Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, Cambridge, MA 02139; **Award #78-24092**

    This award supports the completion of studies to evaluate the technical and economic feasibilities of using high-energy electrons to disinfect sludges produced furing treatment of municipal wastewater. The objective of this study is to analyze results obtained from operation of the 50 kilowatt, 850,000 volt electron accelerator at the Deer Island Wastewater Treatment Plant of the Metropolitan District Commission (Boston) to complete codification of the design, operational, and maintenance characteristics of the electron-beam disinfection system.

    Microbiological studies include further characterization of an inhibitory effect on regrowth of *Salmonella* and *Shigella* species in disinfected sludges which has

been observed and tentatively attributed to competitive growth of gram positive bacteria. Potential control of regrowth by deliberate use of lactic acid bacteria is being investigated. A conference planned for Spring of 1980 will concentrate on the design, operation, and maintenance of equipment for disinfection based upon use of ionizing radiation and its integration with other sludge processing concepts.

12. Prediction and Control of Heavy Metals and Toxic Organic Materials in Sludges; Leon W. Weinberger; Environmental Quality Systems, 1160 Rockville Pike, Suite 202, Rockville, MD 20852; **Award #78-15874 A01**

    The objective of this research is to project the future composition of community wastewater treatment plant sludges with regard to their content of heavy metals and toxic organic substances based upon the implementation of current and likely future pollution abatement regulations. The results of these projections will provide the basis for the formulation, development and evaluation of strategies for control of potentially toxic and hazardous substances in sludges. Existing data are being collected and reviewed to provide a baseline of present composition of sludges from communities differing in size and mix of domestic, commercial and industrial components. Current and anticipated future regulations are being analyzed to predict their impact on sludge composition. The effects of alternative treatment and control strategies are being assessed for their potential role in changing the amounts of inorganic compounds of heavy metals and organic substances of similar significance that are contained in community wastewaters and which become fixed and concentrated in their wastewater treatment plant sludges.

Earthquake Hazards Mitigation

The goals of the Earthquake Hazards Mitigation program are to develop an understanding of earthquakes in relation to constructed facilities, and to reduce casualties, damage and social and economic disruption which are the result of earthquakes. The actions necessary to attain these goals are heavily dependent upon technical capabilities which require development through research.

Primary objectives of EHM-supported research are: to determine 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 rock subjected to strong shaking; to determine the nature of the interaction of structures and their supporting soil during earthquakes; to determine the engineering aspects of reservoir-induced seismicity; to develop procedures for performing dynamic analyses of proposed or existing construction under earthquake loadings; to develop an understanding of materials and structural components subjected to damaging dynamic loads; to develop procedures for analysis and design of non-structural and architectural systems for earthquake effects; and to study the influences of architecture and urban planning activities on the earthquake vulnerability of regions.

1. Investigation of Reinforced Brick Masonry Buildings Undamaged by the San Fernando Earthquake; Samy Adham; Agbabian Associates, 250 N. Nash Street, El Segundo, CA 90245; **Award #79-00013**

    Numerous investigations have been made of damaged buildings in past earthquakes in an effort to understand how they responded to the ground shaking and how they might have been designed to eliminate or minimize the resultant damage. Little attention has been paid to undamaged structures exposed to the same ground motion environment. How a building interacts with an earthquake depends on frequency content, amplitude, and duration of the ground motion as compared with the dynamic response characteristics of the structure.

    Major damage can normally be expected to occur when the predominate frequencies of the earthquake and structure allow resonance conditions to develop. However, it is believed that other aspects of the problem can be just as significant when explaining why buildings in the same area react differently to the same ground shaking. For example, local geology may cause differences in the manner in which a building interacts with the ground motions or differences in construction or building desing may enable a building to respond to the ground shaking without being damaged structurally. Understanding why a structure was not damaged can contribute significantly to our knowledge of earthquake engineering and to the design and construction of earthquake-resistant structures.

2. An Experimental Investigation of the Earthquake Response of Sediment-Filled Valleys in Garm, USSR; Keiiti Aki; Massachusetts Institute of Technology, Department of Earth and Planetary Science, Cambridge, MA 02139; **Award #76-23279 A02**

    In a cooperative project with Russian seismologists sponsored by the U.S. Geological Survey, a self-contained, mini-computer laboratory and four portable, digital seismic stations were operated for a period of six months in 1975 in the Garm district of the USSR. Additional field observations and data analysis were performed during 1976-1977. This grant provides continuing research support to complete the project. Researching will study the response of sediment-filled valleys to local and regional earthquakes; problems of scaling strong motion from weak motion in one such valley, and the source mechanisms of local earthquakes. Data collection and preliminary analysis will be done in the USSR. Final analyses, to be performed at the

Massachusetts Institute of Technology, include 1) completing the analysis of the data taken in 1976 and 1977 concerning the response of three valleys in Garm; 2) installing a nine-station network of digital strong motion instruments and analyzing at M.I.T. the collected data; and 3) studying the source mechanism of local earthquakes using four digital, wide-band seismic recorders arranged in 20 x 20 km array surrounding a region of high seismicity.

3. Methods and Costs of Maintaining Hospital Functions in Earthquakes; Christoph E. Arnold; Building Systems Development, Inc., 120 Broadway, San Francisco, CA 94111; **Award #78-20902**

   Earthquakes pose a major threat to the populous states of the Pacific Coast. Of major concern is the survival of critical facilities which will be immediately necessary for rescue, relief and recovery activities. Since there were two serious hospital failures during the San Fernando Earthquake of 1971 high priority has been placed on providing for the structural and functional survival of hospitals so that the hospitals might be fully operational.

   While considerable attention has been paid to the issue of structural survival (the California Hospital Code, the Veterans Administration Seismic Re-enforcement Program), relatively little study has been directed to the issues of non-structural damage control and its relationship to hospital functionality. Hospitals have intricate electrical, mechanical, and life support systems. The interaction fo these systems during extreme shaking and the impact of non-structural failure on hospital function are not well understood. This research will develop measures for the reduction of non-structural damage in new and existing hospitals and assess the costs involved in alternative damage control strategies.

4. Special Study of Rock Mechanics Research Requirements; Robert L. Bangert; National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, DC 20418; **Award #79-10294**

   The study is a direct follow-on of earlier activities of the U.S. National Committee on Rock Mechanics (USNC/RM). The findings and recommendations of the USNC/RM have identified seven major problem areas. A Panel of specialists will be organized to study past and current rock mechanics research and identify opportunities for further research that will help solve problems which affect energy resource development, construction (both civil works and defense), and earthquake hazard reduction. It is planned that seven subpanels will be formed within the Panel, each subpanel to consist of volunteer members who have had specialized experience in the technical subject assigned. To achieve a broad and balanced perspective, members will be selected from the public and private sectors and universities. Through panel evaluation of the sectors of the seven subpanels, a comprehensive report of the study will be prepared.

   The study will recommend the research to be undertaken, guidelines for how it should be pursued and for determining what organization or ogranizations are best equipped to conduct it, how much it is expected to cost, and how long it may take.

5. Underground Lifelines in a Seismic Environment; Melvin L. Baron; Weidlinger Associates, 110 East 59th Street, New York, NY 10022; **Award #78-15049 A01**

   This research deals with the analysis and design of water distribution and transmission systems for earthquake effects. The aim is to develop rational and practical design procedures which can be used by utilities, governmental agencies and manufacturers in their design activities. Such procedures will involve various aspects of current technology, such as earthquake data, pipe damage statistics, analysis and design procedures, joint types, pipe materials, etc. The research will concentrate on underground water distribution lifelines. Specific research tasks include: studies of incoherent seismic motions, development of pipeline failure/damage criteria, experimental test planning, design decision analysis (to be performed by Columbia University as a project subcontractor), and preparation of design guidelines. Results will be made available in the form of a practical design methodology, including design curves, tables and formulas.

6. A Longitudinal and Cross-Cultural Study of the Post-Impact Phases of a Major National Disaster; Frederick L. Bates; University of Georgia, Department of Sociology, Athens, GA 30602; **Award #77-12721 A03**

   The purpose of this multi-year research project is to analyze the long-term effects of the February, 1976 earthquake in Guatemala on the populations affected by the earthquake; to assess the results of U.S. Government and other relief and rehabilitation efforts; and to determine what social changes have occurred in Guatemala which can be attributed to the earthquake and to relief and rehabilitation efforts. Results are intended to provide information useful to Guatemala, to other Central and South American nations, and to agencies engaged in disaster relief and reconstruction in improving efforts to assist disaster stricken communities in the future.

7. Optimal Design of Earthquake Strong-Motion Networks; Jack R. Benjamin; Jack R. Benjamin Associates Inc., 260 Sheridan Avenue, Palo Alto, CA 94306;**Award # 79-23947**

   The seismic Engineering Branch (SEB) of the United States Geological Survey (USGS) is responsible for locating and maintaining strong-motion networks. Because of the possibility of a greatly expanded strong-motion program in the near future and the need to consider all possible uses of the data, it is important that a

systematic methodology for locating instruments be established. The goal of this project is to provide a decision-making tool to those responsible for strong-motion instrumentation programs.

The research will lead to: (1) Development of a practical decision-making methodology including consideration of network configuration, number and type of instruments, network pattern with respect to tectonic, geologic, seismologic, and structural engineering requirements as well as various cost factors and derived benefits; (2) Application of the methodology for the central and eastern United States, where major gaps in scientific and engineering knowledge exist and where the potential for critical losses also exists; and, (3) Recommendations for coordination between USGS national network programs, State and local agencies, and university projects.

8. Flexible Sub-Surface Building-Foundation Interfaces for Aseismic Design; John M. Biggs; Massachusetts Institute of Technology, Department of Civil Engineering, Cambridge, MA 02139; **Award #79-02989**

   Flexible building-foundation interfaces have the potential to reduce seismic forces, thereby improving the earthquake-resistance of buildings. This project will conduct a feasibility study of a below-ground flexible interface which appears to have several advantages over conventional construction. The research will concentrate on the possible use of sleeved-pile foundations to reduce the seismic effect of the superimposed structure. Researchers will analyse the dynamic behavior of such systems, including soil-structure interaction effects, to establish optimal system parameters and to evaluate potential benefits for building protection. Conceptual design studies will also be made. The final result will be a set of conclusions with regard to the feasibility of the concept, potential benefits to be derived, and the range of possible applications.

9. Scientific and Technical Information Exchange in Earthquake Research Between the United States and the People's Republic of China; John A. Blume; Earthquake Engineering Research Institute, 2620 Telegraph Ave., Berkeley, CA 94704;**Award # 79-23755**

   The Earthquake Engineering Research Institute will host earthquake researchers from the People's Republic of China (PRC) in a tour of the United States. The purpose of the tour is to expedite the signing of an Implementing Accord between the two countries, an act that will formally establish a U.S.-PRC cooperative program in earthquake research. The tour will consist of visits to U.S. research facilities, public utilities and design and consultation firms and Chinese participation in the 2nd U.S. National Conference on Earthquake Engineering. During the three-week tour, the visiting Chinese group members will discuss earthquake research and exchange information about Chinese earthquake studies with U.S. researchers. Discussions will be directed toward identifying mutual research needs and priorities.

10. Seismic Investigation and Design Criteria for Industrial Storage Racks; John A. Blume; John A. Blume and Associates, 130 Jessie Street, San Francisco, CA 94105; **Award #75-16931 A03**

    This project will develop criteria and procedures for the seismic design of industrial steel storage racks. Approximately 40% of all goods consumed in the United States are on storage racks at some time during their production-distribution-sales-consumption cycle. Prior to 1972, storage racks were designed and constructed to resist gravity loads and some impact from loading equipment such as fork lifts. No specific provisions for resisting earthquake motions were included. To reduce the risk of damage in future earthquakes, rational design criteria and procedures are needed.

    Seismic motion criteria will be developed, and detailed dynamic analyses performed using the postulated input motion, rack load-deformation data and results of earlier studies. Results will then be correlated with the results of shaking table tests of full-scale, loaded and unloaded racks. Results of the research program will help ensure that future designs of industrial storage racks incorporate realistic seismic resistance at minimum cost.

11. Taiwan Large-Scale Strong-Motion Array Project; Bruce A. Bolt; University of California-Berkeley, Seismographic Station, Berkeley, CA 94720; **Award #79-08982**

    Lack of a comprehensive set of strong ground-motion data from major earthquakes has handicapped earthquake engineering research. To remedy this situation, dense strong-motion arrays have been recommended for highly seismic locations around the world, including a site in Taiwan. This project will establish a moderate array in Taiwan for both source mechanism and wave propagation studies. The array will be subjected to a two-phase operation: a mobile array deployed in northwestern Taiwan followed by a permanent deployment at a site in southwestern Taiwan, depending on the records obtained and analysis conducted during the first phase study. The project will be implemented as cooperative research between the U.S. and Taiwan. The U.S. will provide the recording instruments and Taiwan will provide the technical staff and local support for the installation, operation and maintenance of the array and data collection and processing over the life of the array.

12. Objective and Subjective Seismic Safety Considerations; Colin B. Brown; University of Washington, Department of Civil Engineering, Seattle, WA 98195; **Award #77-01095 A01**

    In the design and safety evaluation of structures for seismic effects, structural response and capacity are

assumed to be random, thus permitting the construction of probability distributions. To date, subjective features such as numerical errors in design and construction and general omissions and simplifications have not been properly addressed nor included in a formal design process. This project addresses the problem of rationally including both objective and subjective considerations in seismic safety evaluations.

Objective information will be treated as statistical moments and limits. Unbiased distributions will be obtained by maximizing entropy in the manner of Jaynes. Subjective information in the form of linguistic statements will be accommodated within the mathematical theory of fuzzy sets. This ensures a measure and a calculus for such statements.

13. Centrifuge Facility for Research in Geotechnical Engineering; James A. Cheney; University of California-Davis, Department of Civil Engineering, Davis, CA 95616; **Award #78-13922 A01**

    This supplement to a prior award supports an interchange between geotechnical engineering dynamicists and mechanical design engineer groups. The purpose is to develop a sharper definition of the loadings which can be imposed on a building (including multiaxial loadings).

14. US/Taiwan Cooperative Research in Earthquake Engineering; Anil K. Chopra; University of California-Berkeley, College of Engineering, Berkeley, CA 94720; **Award #79-08979**

    This research will develop analytical procedures to determine dynamic stiffness or impedance coefficients for embedded foundations. The approach is based on a hybrid model wherein the near-field (the soil region near the foundation) is idealized as a finite element system and the far-field is treated as a continuum. System identification techniques will be used to represent the effects of the far-field on the near-field.

    The hybrid model will be used to study the dynamic response of structures supported on embedded foundations. Parametric studies will be used to evaluate the effects of structure—soil interaction on earthquake response of embedded structures; to identify the conditions under which these effects are significant; and, to identify the conditions under which such effects can be ignored.

15. Probabilistic Earthquake Hazard and Risk Assessments; Lloyd S. Cluff; Woodward-Clyde Consultants, Three Embarcadero Center, Suite 700, San Francisco, CA 94111; **Award #79-00165**

    Existing deterministic criteria for defining "active" (or "capable") faults do not consider the degree of fault activity, which involves such parameters as rate of slip, amount of slip, recurrence interval, and earthquake magnitude. As a result, faults with low slip rates, small amounts of slip, and long recurrence intervals are considered on an equal basis with faults having high slip rates, large amounts of slip, and short recurrence intervals. A framework must be established that will allow the degree of fault activity to be taken into consideration in quantifying seismic hazards and in assessing seismic risk.

    This study will involve an analysis of fault activity parameters using published and unpublished worldwide data. The result of this analysis will be a refined scheme for classifying degree of fault activity that compares and characterizes different degrees of fault activity in different tectonic environments. Using this classification scheme as a basis, a formula for probabilistic earthquake hazard and risk assessments will be provided.

16. Engineering Ground Motion Prediction Procedures; C. Allen Cornell; Massachusetts Institute of Technology, Department of Civil Engineering, Cambridge, MA 02139; **Award #78-27068**

    This project will develop new engineering procedures for making ground-motion predictions by incorporating recent advances in theoretical ground-motion studies, analyses of strong-motion data, and probabilistic and statistical methodologies for engineering risk applications.

    Theoretical models will be used to develop ground-motion parameter dependence relationships and to study the biases in parameter estimates. Specific research tasks are: inference analysis of geophysical ground motion models to determine parameters of first-order importance and to establish the general dependence relationship between the ground motion and these parameters; to perform regression analysis for improved analytic methods for ground motion predictions; use of representative ground-motion samples to study the biases in the estimations; Bayesian statistical analysis to quantify the uncertainty in prediction resulting from finite sample sizes; and development of a new probabilistic seismic hazard analysis methodology for engineering applications.

17. Duration Characteristics of Horizontal Components of Strong Motion Earthquake Records; Ricardo Dobry; Rensselaer Polytechnic Institute, Department of Civil Engineering, Troy, NY 12181; **Award #79-02871**

    A key aspect in the reduction of earthquake hazards is the characterization of strong ground motions. The overall intensity of the motion has been generally characterized by a single number which is identified with the level of shaking. Theoretical studies and field evidence indicate that the duration of the motion is also important.

    Two parameters for the overall characterization of rock ground motions will be used. Characterizations will include variation with time of the level of shaking and of the principal axes of ground motion. Determination of the frequency content and a study of the peak vector acceleration will also be undertaken. This

detailed characterization of the records will be correlated with the different seismic waves arriving at the site with relevant seismological factors. Finally, a study will also be performed for the individual horizontal components of the records.

18. Maximizing the Learning from Destructive Earthquakes; C. M. Duke; Earthquake Engineering Research Institute, Department of Engineering, Berkeley, CA 94704; **Award #79-02990**

    The previous "Learning from Earthquakes" Project of the Earthquake Engineering Research Institute has produced Planning, Field Guides and Earthquake Response Procedures. The project's implementation effort has included national governmental and private organizations and several state and local areas in the United States. Coordination plans for cooperating organizations have been developed at the national and California levels. Post-inspection team members and others have used the Field Guides following nine foreign and United States earthquakes since 1973, and the important new lessons learned have been disseminated to concerned organizations and individuals. This award will maintain the implementation effort at an acceptable level; revise, publish, and distribute the Guides and Response Procedures; and expand programs to train investigators and to improve the dissemination of lessons learned.

19. Development of Revisions to American National Standard A58—Building Code Requirements for Minimum Design Loads in Buildings and Other Structures; Bruce Ellingwood; National Bureau of Standards, Center for Building Technology, Gaithersburg, MD 20234; **Award #78-23819**

    The purpose of this project is to develop a revised version of American National Standard A58—Building Code Requirements for Minimum Design Loads in Buildings and Other Structures. This standard covers six areas of loadings, load specification methodology and failure modes which are important in building design and are related to building performance. These are Seismic Loads, Live Loads, Wind Loads, Snow Loads, Progressive Collapse and Load Factors.

    The overall effort has two objectives: first, to coordinate revisions to the individual load portions of the existing A58 Standard and prepare drafts of the revised load portions; second, to assemble the revised provisions into a draft load standard (A58.1-1980/D) and supervise its processing and public review.

    The primary task of developing and evaluating load provisions incorporating recent research findings and developments from practice is carried out by volunteer technical subcommittees. Support from this project will facilitate the process by allowing the groups to meet to speed the assembly and circulation of revised material and the draft load standard.

20. Post Event Investigations to Maximize Learning From Destructive Natural Disasters; Edward Epremian; National Academy of Sciences, Committee on Natural Disasters, Civil Engineering, Washington, DC 20418; **Award #78-10631**

    This project will make possible the collection of perishable information after natural disasters (such as earthquakes) which cause sudden, widespread destruction and disruption of the economic and social structure of an area. Such a disaster is, in effect, a full-scale test of facilities designed and built to a variety of codes and standards.

    Because rescue activities may involve large physical movements of debris and damaged facilities and because clean-up operations may start quite quickly after the disaster, it is necessary to have professional teams visit the site immediately to capture information which documents and explains failures and/or satisfactory performance of facilities. The National Academy of Engineering and National Academy of Science are in a unique position to organize and dispatch interdisciplinary teams to collect and publish perishable information which can provide a basis for in-depth studies at a later time. Such an arrangement will, in particular, maximize information from disasters occurring in foreign countries.

21. Methodology for Mitigation of Seismic Hazards in Existing Unreinforced Masonry Buildings; Robert D. Ewing; ABK, 250 North Nash Street, El Segundo, CA 90245; **Award #78-19200 A01**

    This project will evaluate the current state-of-the-art for mitigating the seismic hazards of existing unreinforced masonry buildings, develop a methodology for the mitigation of these hazards, evaluate the methodology, and design a nationwide utilization plan for disseminating the methodology.

    The program is divided into two major efforts. The first effort will evaluate codes and standards applicable to unreinforced masonry buildings; categorize nationwide existing masonry construction; evaluate current methods for selecting earthquake ground-motion input; categorize the damage from past earthquakes; review strength data; assess analytical methods to evaluate these buildings; and evaluate retrofit methods. In the second effort, a program for analytical verification and testing, including retrofit, will be conducted. Both quasi-static and dynamic tests will be performed on wood and metal diaphragms and walls, employing both out-of-plane forces and in-plane forces. The results of both efforts will be integrated in the development of the required methodology.

22. Patterns of Housing Density and Type: A Basis For Analyzing Earthquake Resistance; Urs P. Gauchat; Harvard University, Department of Architecture, Cambridge, MA 02138; **Award #78-20258**

This research project will isolate, identify, and categorize different housing types in selected earthquake-prone areas; determine the respective number and distribution of each identified type; and, conduct seismic vulnerability studies on selected types. The study will use photogrammetric techniques to analyze existing housing stock in a given area with respect to probable behavior during an earthquake. The methodology will have applicability in any hazard location for which suitable aerial photographs and other related data can be obtained. The research will provide the back-up data and analytic tools needed to properly interpret photographic survey information. The results of this research can form the basis for retrofit, redevelopment, and land use planning strategies to mitigate the effects of earthquakes.

23. 1979 Multiprotection Design Institute; August 6 through August 17, 1979; DCPA Staff College; Battle Creek, Michigan; George T. Goforth; Department of Defense, Department of Defense/Defense Civil Preparedness Agency, Washington, DC 20301; **Award #79-13387**

    This award provides support for the 1979 Multiprotection Design Institute. One-week short courses in Earthquake Engineering and Ground Motion, Fire Safety in Building Design, Designing of Buildings Against Wind, and Energy Conservation Design in Buildings will be held for architectural and engineering faculty of accredited colleges and universities who are actively engaged in dealing with natural hazard mitigation problems.

    The purpose of the Institute is to stimulate insights into the nature and complexities of mitigation of natural hazards resulting from earthquakes, fire, and wind. This purpose can be achieved by an informal type of institute consisting of scheduled lectures and discussions by leading experts bringing to the Institute results from the forefronts of research.

24. Study of Earthquake-Induced Bond Deterioration; Neil M. Hawkins; University of Washington, Department of Civil Engineering, Seattle, WA 89195; **Award #76-15366 A02**

    This project studies bond deterioration in reinforced concrete structures subjected to earthquake loadings. Immediate objectives include calibration experiments for collation of bar stress-slip relationships with the development of internal cracking and acoustic emissions and use of these results for experiments simulating practical connection details.

    Approximately eight specimens will be tested to various levels of failure and then examined, using methods from non-destructive to sawing, to determine the degree of bond deterioration. Both straight and hooked bars will be studied. Analytical studies will be undertaken and additional tests run under progressively increasing, reversed cycle loading, using both conventional and light weight concretes. All of these studies have the long-range goals of the development of practical techniques to assess the degree of bond deterioration in a structure surviving an earthquake and the development of improved design methods and regulations for new reinforced concrete structures.

25. National Information Service for Earthquake Engineering; George W. Housner; California Institute of Technology, Department of Civil Engineering/Applied Mechanics, Pasadena, CA 91104; **Award #78-23889**

    This award supports the Center for the National Information Service for Earthquake Engineering at the California Institute of Technology. This service is part of the joint program with the University of California at Berkeley.

    The Center provides a data base for information on earthquake engineering topics through the library services, copies of reports, copies of accelerograms, digitized card decks, and magnetic tapes. The Earthquake Engineering Research Library and the Strong Motion Records Data Bank form the nucleus of the activity. The Service Center provides engineering information to users throughout the country, such as engineering and architectural consulting firms, industrial firms, local, state and Federal agencies, and other professional organizations.

26. *In-Situ* Soil Dynamic Testing and Analysis to Determine Soil Constitutive Properties; Paul Ibanez; Anco Engineers Inc., 1700 Colorado Avenue, Santa Monica, CA 90404; **Award #79-00001**

    This award supports the continuation of research to develop a coupled *in-situ* dynamic testing/nonlinear modeling technique for determining the *in-situ* dynamic properties of soils. Such a method would provide an approach to site soils modeling and earthquake engineering that can supplement laboratory test techniques that involve disturbed soil samples and require substantial engineering judgment to interpret. A major component of this research is the transfer of experimentally validated technology in nonlinear soil modeling and multi-dimensional nonlinear wave propagation computer methods from the defense community to the civilian sector. A better knowledge of subsurface *in-situ* properties would lead to our greater confidence in the seismic safety of structures such as dams and power plants.

    The basic elements of the plans are: (1) execution of a series of *in-situ* dynamic tests at a previously studied site; (2) use of advanced numerical techniques and nonlinear constitutive laws to model the experiments; (3) sensitivity studies to establish a sensitivity matrix; and (4) the use of this sensitivity matrix in parameter identification studies to establish the optimal nonlinear constitutive soil model, taking into consideration both model and experimental uncertainties.

27. Vibration Testing of an Epoxy-Repaired 4-Story Concrete Structure; Donald Kerr; U.S. Department of Energy, Nevada Operations Office, P.O. Box 14100. Las Vegas, NV 89114; **Award #78-12714**

    Epoxy-injection techniques have been used extensively to repair buildings, bridges and other types of reinforced concrete structures which had suffered damage as a result of earthquakes. Experiments have indicated that the epoxy-injection method is quite effective in the repair of laboratory test specimens for strength, but exhibited a loss of stiffness when subjected to dynamic tests on the earthquake simulator. There is no information available concerning the effectiveness of epoxy repaired structures subjected to high amplitude, destructive level vibrations. This project will develop data on this specific aspect of epoxy-repaired structures.

    This will be accomplished by the vibration testing of an epoxy-repaired 4-story concrete structure that was damaged during destructive vibration testing conducted in 1974. Studies to be conducted include comparisons of response of the virgin and the repaired structure over a broad range of motion amplitude; an evaluation of the effect of epoxy repair on the stiffness and natural frequencies of the structure; the effect of damping and energy-absorption characteristics; a comparison of damage patterns of the virgin and repaired structure; and modeling guideline developments for the repaired structure compared to the virgin structure.

28. Development of a Computer Code for the Response of Submerged Structures to Seismic Excitations; Denny R. Ko; Dynamics Technology Inc., 22939 Hawthorne Boulevard, Suite 200, Torrance, CA 90503; **Award #78-09866 A01**

    This research addresses the problems of designing submerged structures, such as oil storage tanks, to resist the combined loadings of earthquake and wave forces. Studies include the dynamic responses of submerged tanks subjected to seismic action. A general finite element solution procedure has been formulated and a general computer program for use in tank response analysis will be developed for use by design engineers and other researchers. Also included will be studies of internal wave sloshing effects inside submerged tanks under horizontal and vertical ground excitations; studies of the coupling between interior and exterior fluids; and the formulation of tank-coupled system solution procedures.

29. Fluctuating Pressures on Tall Buildings; Bernard M. Leadon; University of Florida, Department of Engineering Sciences, Gainesville, FL 32611; **Award #77-26391 A01**

    This research will obtain full-scale dynamic wind measurements and compare these with predictions of theories for the interaction between turbulent winds and obstacles; examine the relation between small-scale wind tunnel studies and full-scale structures to estimate the dynamic response of structures under lateral loadings of low frequency; and estimate the convective film heat transfer coefficient for smooth surfaces in curtain walls.

    Specific studies to be made are: fluctuating pressure measurements, glass light deflections, and lateral displacement of the structure of the Independent Life Tower (I.L.T.) in Jacksonville; wind tunnel tests of a 1/4-scale model of curtain wall section with mullions; wind tunnel tests of models of the I.L.T. (at Colorado State University); and, comparison of results with a theory of the interaction of turbulence with obstacles in the flow.

30. Post-Earthquake Land Use Planning; George G. Mader; William Spangle and Associates, 3240 Alpine Road, Portola Valley, CA 94025; **Award #76-82756 A01**

    An interdisciplinary team of experts in the fields of geology, structural engineering, and city planning have investigated post-earthquake land use planning and reconstruction for three recent earthquakes (San Fernando 1971, Santa Rosa 1969, and Alaska 1964) in an effort to identify impediments to sound post-earthquake land use planning. This study has determined that significant research opportunities exist which were not evident at the outset of the research. Monitoring of responses to major land sliding in Laguna Beach, California and a case of predicted slope failure in Kodiak, Alaska represent unique opportunities which can provide contemporary parallels to out-of-date material which had been used for case studies. Documentation and study of these cases will test conclusions developed with regard to the land use decision process for known earthquake zones. This project will recommend model post-earthquake planning procedures, programs, and regulations.

31. Workshop on Prefabricated Concrete Buildings for Earthquake Loads; Ronald Mayes; Applied Technology Council, 480 California Avenue, Suite 205, San Francisco, CA 94105; **Award #78-27403**

    This workshop will provide an opportunity for researchers and practitioners to identify areas where information is lacking or uncertainty exists in design analysis, construction practices, and design provisions for codes and standards for prefabricated concrete. Areas in need of research will be delineated and discussed so that priorities for research projects may be established. State-of-the-art papers will be presented, followed by group meetings to discuss specific topics of interest. A Proceedings Report will be published.

32. Workshop on Wind Characterization for Dynamic Analysis of Structures; Kishor C. Mehta; Texas Tech University, Department of Civil Engineering, Lubbock, TX 79409; **Award #79-06294**

    This award provides partial support for a two-day workshop on the geographical distribution of wind cli-

mate. Objectives of the workshop are to examine available wind data for its applicability to design practice, to review statistical methods for converting raw wind data into usable forms, to establish current state-of-knowledge in wind climate data collection and recording procedures to recommend guidelines for future data collection, and to promote dialogue between meteorologists and wind engineers.

Many organizations and agencies collect wind data but its usefulness is flawed by lack of continuity, lack of uniformity in collection and recording procedures, and lack of availability. This workshop, involving meteorologists and engineers who are concerned with design for wind climates, will promote better use of collected data and improvement in collection of future data. The resulting information will have direct application in the design of high cost and critical facilities subjected to wind and earthquake loadings.

33. Social-Behavioral Responses to Chemical Hazards; E. L. Quarantelli; Ohio State University, Department of Sociology, Columbus, OH 43210; **Award #77-14445 A02**

    This is a study of the socioeconomic and political factors related to the adjustment of communities to chemical hazards and disasters. The research involves investigation of preparations for chemical disasters in selected vulnerable locations; in-depth analysis of the emergency responses of organizations and communities to catastrophic events, major accidents, acute hazardous episodes and severe chronic events; and examination of the long-term impact of chemical disasters on communities. The study will identify options and alternative strategies public and private groups might use to prepare for, respond to, and recover from chemical disasters.

34. Development of Field Techniques to Measure Damping Values for Near-Surface Rocks and Soils; Bruce B. Redpath; John A. Blume and Associates, Research and Technical Development, 130 Jessie Street, San Francisco, CA 94105; **Award #79-00192**

    Research efforts in the fields of soil-structure interaction and site response to earthquake loading have produced advanced numerical models that require the damping characteristics of the subsurface materials as input. Developments in engineering geophysics have not kept pace with progress in calculational approaches to solving earthquake response problems.

    In order to develop practical field techniques to acquire the needed dynamic properties of site materials, geophysical investigations will be conducted to measure the attenuation of shear and compressional seismic waves. Down-hole and cross-hole surveys of velocities and attenuation rates will be carried out in 200-ft holes at two sites; one, in sedimentary rock; the other, in alluvial deposits. The observed attenuation characteristics (Q), corrected for geometrical spreading and any changes of acoustic impedance in the ray paths, will be used to determine values for the near-surface materials.

    Two methods of data analysis will be applied. One will determine Q indirectly by calculating spectral ratios of both compressional and shear pulses to determine the magnitude and frequency dependence of the attenuation coefficient in the exponential term of the propagation equation. The other method will test a relationship in which the rise-time of a seismic pulse is proportional to its travel time and in which the constant of proportionality is Q^{-1}. The end product of the proposed research will be practical recommendations for field procedures and data analysis to measure Q-values in near-surface materials.

35. An Evaluation of Laboratory Testing Techniques in Soil Dynamics; Adel S. Saada; Case Western Reserve University, Department of Civil Engineering, Cleveland, OH 44106; **Award #79-02612**

    Laboratory testing plays an important role in determining the parameters needed in the design of earthquake-resistant structures, offshore platforms, machine foundations and others. High quality, appropriate tests are necessary to simulate field conditions and to provide the design parameters. The two types of tests that have been traditionally used to determine dynamic soil properties at large strains are the simple shear test and the standard triaxial test. This research will study differences among the various tests used in obtaining the dynamic properties of soils. Particular emphasis will be placed on the cyclic triaxial test, the simple shear test and the thin, long hollow cylinder test. This phase of the investigation will concentrate on clay while the second phase will study sandy soils.

36. Improving Earthquake Resistance of Power Transmission Substations; Anshel J. Schiff; Purdue University, Department of Mechanical Engineering, Lafayette, IN 47907; **Award #78-25485**

    The objective of this project is to improve the earthquake safety of electrical power systems and facilities. Performance of power systems during past earthquakes shows that one weak link in these systems is substations. This project focuses attention specifically on earthquake problems associated with power substations and emphasizes the implementation of the research results for improved seismic design of power systems.

    Three major research tasks will be conducted. A draft seismic design guide for power system transmission facilities emphasizing substations will be developed, a unified design procedure for power system analysis under seismic, ice, wind and short circuit loads will be developed, and the seismic reliability of circuit breakers, including examination of transformer failures during the Sendai, Japan (June 12, 1978) earthquake, will be evaluated.

The research will establish improved analysis and design capabilities which can be easily adopted by utilities to improve their earthquake safety practices. Close interactions with utilities and with professional society power lifeline committees will be maintained to guide the research and to assure its utilization.

37. Probability Distribution of Extreme Wind Speeds; Emil Simiu; National Bureau of Standards, Center For Building Technology, Gaithersburg, MD 20234; **Award #77-16113 A02**

Improved code provisions for the design of structures for wind loads are a prerequisite for achieving more rational and economical designs. To develop such provisions, improvements are necessary in the practical application of the probabilistic approach to the definition of design wind speeds.

Although this approach has already been used in the American National Standard ANSI A58.1-1972, important questions regarding its practical use are still unsolved. The first question is whether the type of extreme value probability distribution that best fits series of maximum annual wind speeds is Gumbel (as is assumed in the National Building Code of Canada and in all probabilistically-based European Codes) or Frechet (as assumed in ANSI A58.1). Second, the magnitude of the sampling errors needs to be estimated. Third, estimates are required of the errors associated with quality of the data. Fourth, the question needs to be examined of the extent to which short-term data (e.g., three years of record) can provide useful information on long-term wind extremes. Fifth, the important question of modeling the probability of occurrence of hurricane winds needs careful examination. Sixth, the question needs to be investigated of the mean recurrence intervals that must be specified for design purposes if consistent levels of safety for structures subjected to wind loads are to be achieved. This research aims at elucidating these questions by using climatological data, as well as results and tools from such disciplines as probability theory, statistics, micrometeorology, climatology and reliability theory.

38. Dynamic Testing and Acoustic Analysis of Concrete Dams; G. Bruce Taylor; Anco Engineers Inc., 1701 Colorado Avenue, Santa Monica, CA 90404; **Award #79-00004**

A dynamic test procedure for concrete dams will be developed to acoustically detect defects in the dam which could cause failure under extreme conditions. A gas expansion device will be submerged in the reservoir near the face of the dam. The shock wave thus produced in the water will interact with the concrete interface and excite motion in the dam. Any defects which exist in the structure will emit acoustic signals which will be located through triangulation. The testing program will be augmented with a detailed analytical study of the structure utilizing finite element analysis techniques. Approximately eight concrete dams located in the United States will be examined. This nondestructive test method should be of great value in helping to evaluate the safety of dams subjected to seismic and other loadings.

39. Dissemination of Earthquake Damage Mitigation Techniques to Homeowners and Renters; I. D. Terner; University of California-Berkeley, Department of Architecture, Berkeley, CA 94720; **Award #78-17842**

The goal of this research is to design, test, and evaluate a prototype technical assistance service to enable homeowners and tenants to make seismic-strengthening modifications to their homes. The research team will establish, operate, and evaluate a pilot-scale prototype of an Earthquake Advisory Service (EAS) in the cities of Oakland and Hayward, California as a joint undertaking between the University of California, Berkeley and the Building Inspection Departments of the two municipalities.

The prototype of the EAS will seek to accomplish five tasks: 1) To catalogue seismic hazard procedures for representative small-scale residential structures; 2) To simplify and translate existing technical information into practical, easy-to-use instructions for homeowners and tenants; 3) To inform residents of seismic hazard zones, and to motivate them to undertake home modifications that will increase their safety in the event of an earthquake; 4) To assist and advise motivated residents to undertake these modifications on a "do-it-yourself" or minimum cost basis; and 5) To evaluate the effectiveness of the outreach, and the safety, cost and efficiency of the hazard mitigation work after it has been completed.

40. An Improved Computational Strategy for the Nonlinear Analysis of Structures Subjected to Earthquake and Wind Loads; Theodore G. Toridis; George Washington University, Department of Engineering and Applied Science, Washington, DC 20052; **Award #79-16263**

This project will develop an effective computational strategy for the nonlinear dynamic analysis of large structures subjected to wind and earthquake loadings. Such a strategy would maximize the quality of results and minimize the total effort (and cost) required to produce them (including the effort in spatial and temporal discretization, handling of algebraic equations and computer implementation).

The following will be investigated: the use of mixed formulation (with displacements and stresses chosen as fundamental unknowns) in conjunction with modified multistep integration schemes (based on first-order equation formulation); and, use of adaptive techniques to automatically control the time step, the order of integration algorithm, and the finite element mesh size based on a preselected set of criteria.

41. Full-Scale Pile Vibration Tests; Chan F. Tsai; Fugro Inc., 3777 Long Beach Boulevard, Long Beach, CA 90807;**Award #79-00193**

    A full-scale pile vibration test will be conducted to monitor the behavior of a pile-soil system under simulated earthquake shaking. Steel piles will be installed into a loose, saturated, fine sand deposit of known properties, and will be loaded to typical vertical design loads. Shaking machines will be mounted on pairs of loaded piles and operated in a controlled fashion to simulate earthquake shaking. Pile response monitoring will include load and deflection and upper pile-wall strains. Soil monitoring will include surface accelerations and pore-water pressures measured at various depths and radial distance. The phenomenon of sand liquefaction adjacent to the vibrated piles will be studied in terms of pore-water pressure build-up in the soil and anomalous pile behavior accompanying the build-up.

42. Earthquake Design Criteria for Water Supply and Wastewater Systems; Leon W. Weinberger; Environmental Quality Systems, Inc., 1160 Rockville Pike, Rockville, MD 20852; **Award #77-22617 A01**

    The objective of this project is to analyze and assess past earthquake events with a view of developing a set of interim design and engineering analysis criteria to be used in the water supply and wastewater control fields.

    The project will develop a set of earthquake planning and design criteria for wastewater treatment plants and appurtenances, water supply treatment plants and appurtenances, sewers and water collection systems, water supply distribution systems and pumping stations, subsurface waste disposal systems, and land disposal systems. A handbook will be prepared and disseminated to the user community.

43. A Clearinghouse on Natural Hazards Research and Applications; Gilbert F. White; University of Colorado at Boulder, Institute of Behavioral Science, Boulder, CO 80309; **Award #79-06160**

    Under this award, the Natural Hazards Research and Applications Information Center will continue to: (1) bring together selected users and producers of important research relating to natural hazards; (2) identify new or emerging needs for research; and (3) identify possible new producers of research findings on earthquakes and other hazards and encourage them to move ahead in the field. A major function of the Center is to help improve the dissemination of information on earthquakes and other natural hazards to such users as local, State and Federal officials. The Center will continue its efforts in this area through its Annual Natural Hazards Research Workshop which brings together research and user groups and through its quarterly publication, *Natural Hazards Observer,* which is distributed to 5,000 persons.

44. Seismic Response of Three-Dimensional Dam Reservoir Systems; Theodore Y. Wu; California Institute of Technology, Department of Engineering Science, Pasadena, CA 91104; **Award #77-16085 A02**

    This research will use theoretical and numerical analysis to determine the seismic response of a dynamically coupled, three-dimensional dam-reservoir system including the hydro-dynamic interaction effect, the flexibility effect, the effect of phase variation and spatial attenuation of seismic waves, and the side confinement of the dam. Hydrodynamic loading functions have been determined for various reservoir configurations. In this project, studies will be made of the hydroelasticity response of the dam-reservoir as a system during an earthquake, the effect of water compressibility, the elastic property of the dam, and the effect of wave propagation.

45. Hydraulic Transients in Liquid-Filled Pipelines During Earthquakes; Fred M. Young; Lamar University, Department of Engineering and Applied Science, Beaumont, TX 77710; **Award #79-23300**

    Liquid-filled pipelines transport fuel and water. Current research on pipeline systems is focused upon damage assessment, dynamic response analysis and design criteria. One remaining question is whether or not over-pressures caused by hydraulic transients in a liquid-filled pipeline have any significant effects on the earthquakes response of the pipeline.

    This research analyzes the effects of hydraulic transients on the failure potential of liquid-filled pipelines during earthquakes. The effects of hydraulic overpressures caused by differential velocity between pipe wall and ground motion and by vaporization and water-column separation will be investigated. An analytical tool involving the modification of a one-dimensional computer program will be developed and used to examine the potential for hydraulic transients-induced damage to water pipeline systems.

Human Nutrition

An estimated 70 percent of the food consumed in the United States is derived from highly refined ingredients and is processed during manufacture with various additives and supplements. The effects on human health and performance of the life-long consumption of such processed foods have not been determined. The objective of the Human Nutrition program is to ascertain the nutritional impact on humans of the changes in food that occur as the result of any aspect of processing at any stage between the raw food and its consumption. Proposals are encouraged that have wide applicability, that stress interdisciplinary research, and that include participation of disciplines not traditionally related to nutrition.

Research at the interface between food science and nutrition is emphasized.

1. Conference and Workshop on "Protein Quality in Humans: Assessment and *In Vitro* Estimation"; March 16-19, 1980; James S. Adkins; Howard University, School of Human Ecology, Washington, DC 20059; **Award #79-19452**

   This award will support a workshop on "Protein Quality in Humans: Assessment and *In Vitro* Estimation". It will bring together leading scientists from universities, government, and industry in the field of protein quality research. The objectives are: to assess the precision of protein nutritional values obtained in human studies; to establish the degree of protein nutritional values acceptable for regulatory and manufacturing purposes; and, to assess the current status and potential applications of *in vitro* measures of protein nutritional quality. The workshop will develop conclusions and make recommendations on the use of rapid *in vitro* assays as alternatives to bioassays with rats or humans for estimating protein nutritional quality.

2. Effects of Food Additives on the Function of the Intestinal Microflora; George W. Chang; University of California-Berkeley, Department of Nutritional Sciences, Berkeley, CA 94720; **Award #79-19105**

   This project will examine the interaction between food additives and intestinal flora. It will study the effects of widely used gums and modified starches on the proliferation and metabolism of intestinal bacteria in rats, and especially on the ability of such bacteria to produce harmful enzymes and toxic substances. Particular attention will be paid to the production of β-glucoronidase, which is involved in the recycling of toxins; mucinases, which may increase the permeability of the gut to toxins; and amino acid metabolites such as indole.

3. The Effects of Processing and Storage on the Oxidative Stability of Cholesterol in Dehydrated Foods; J. I. Gray; Michigan State University, Department of Food Science and Human Nutrition, East Lansing, MI 48824; **Award #79-19103**

   Many foods, particularly those containing unsaturated double bonds, lose stability and nutritional quality through the oxidation of lipids. To date, there has been little data regarding the oxidation of cholesterol and other sterols in dehydrated food systems. This study will determine the environmental factors which contribute to the oxidation of cholesterol in both model food systems and dehydrated foods, such as spray-dried egg and milk products, and will suggest packaging and storage conditions for minimizing the extent of cholesterol oxidation. A quantitative approach for evaluating the effect of environmental factors on storage stability, based on a combination of kinetic data and mass transfer characteristics of the package, will be employed to ascertain the optimum storage conditions for dehydrated cholesterol-containing foods. Results should contribute to improved understanding of the involvement of oxidation products of cholesterol in the development of cardiovascular disease.

4. Nutrient Losses in Pasta Under Constant and Fluctuating Conditions; Theodore P. Labuza; University of Minnesota, Department of Food Science and Nutrition, St. Paul, MN 55114; **Award #79-10370**

   The objective of this project is to determine the kinetics of the loss of the vitamins thiamin, riboflavin, niacin and of the amino acid lysine in a pasta product under steady state conditions in a range of water activity from 0.11 to 0.75 and temperatures from 25 to 45°C. The rate of loss will also be measured under light and dark conditions. From this information, and information gathered on the rate of moisture transfer for various packaging materials, predictions of the losses occurring based on kinetic analysis will be made for different distribution conditions. Finally, the predictions will be tested by an actual measurement of losses that occur in simulated variable temperature, light, and humidity tests. If significant losses do occur under the conditions of this study, the results will be used to make recommendations of how pasta should be packaged and distributed.

5. Effects of Processing on Nutritive Content and Bioavailability of Selected Nutrients in Commonly Consumed Foods; James E. Leklem; Oregon State University, Department of Foods and Nutrition, Corvallis, OR 97331; **Award #79-19119**

   This project will examine the levels of certain nutrients (vitamin B6, selenium, copper, zinc, sodium, potassium, calcium, and phosphorus) at specific stages of processing for ten commonly consumer foods (wheat and wheat products, canned tuna, french fried potatoes, canned peaches, peanut butter, canned and frozen green beans, canned and frozen corn, canned carrots, frozen broccoli, and frozen cauliflower). For two nutrients, vitamin B6 and selenium, bioavailability will be assessed in a microbiological and rat model, respectively. Finally, the bioavailability of vitamin B6 and selenium from tuna, whole wheat bread, and peanut butter will be assessed in humans using a controlled metabolic feeding study. The results obtained with the microbiological and rat study will be compared with the human study to assess the applicability of these two models for determining the bioavailability of selenium and vitamin B6 for food consumed by humans.

6. Conference on Micronutrient Interactions: Vitamins, Minerals and Hazardous Elements; Orville A. Levander; New York Academy of Sciences, 2 East 63rd Street, New York, NY 10001; **Award #79-08575**

Although numerous conferences have discussed specific vitamins, minerals, or hazardous elements, few meetings have considered the possible interactions among these substances. This conference will enable scientists who have done outstanding work in this area to exchange ideas and to stimulate new investigators to initiate research. Certain interactions (such as those of vitamin D and calcium, of copper, molybdenum and sulfur, and of lead and calcium) have been recognized for a long time, but others are not so well appreciated. The timeliness of the conference is assured by the presentation of recent work dealing with the relation between nutritional factors and environmental hazards.

7. Chemico-Physical Analysis of Dietary Fiber in Foods; Bertha A. Lewis; Cornell University, Department of Nutritional Sciences, Ithaca, NY 14850; **Award #79-19135**

   A study will be made of the effects of cooking and processing of foods (freezing, canning, drying) on the composition and bioavailability of non-structural carbohydrates and the dietary fiber complex. One research objective is to evaluate the adequacy and reliability of currently available methods for analyzing dietary fiber and non-structural carbohydrates and to improve these existing methodologies for routine analyses. Since the analytical methods depend on a physical rather than chemical properties of the dietary fiber components, any alteration of physical properties through cooking or processing could affect the validity of the analytical results. Reliable methodology is essential for food labeling regulations, in diet therapy, and in performing and interpreting *in vivo* studies of the effect of dietary fiber on gastrointestinal function. The physical properties of the dietary fiber complex and its components will be determined (in particular, particle size, water-holding capacity, ion-exchange capacity and adsorption of nutrients such as cations, anions and bile acids).

8. Meat Curing Effects on Heme and Nonheme Iron Bioavailability in Rats and *C. botulinum;* Arthur W. Mahoney; Utah State University, Department of Nutrition & Food Science, Logan, UT; **Award #79-19664**

   Data concerning the relative availability of heme and nonheme iron to microbial systems would be of great value in developing nitrite-free meat curing formulations to minimize formation of carcinogenic nitrosamines. Preliminary data indicate that both heating and nitrite curing may lower iron bioavailability for animals. Nitrites may also lower the availability of iron to microbial systems, and that this may cause inhibition of *C. botulinum* growth in cured meats. However, it is not known whether curing affects bioavailability of heme iron, nonheme iron in meat, or both.

   Therefore, the research will evaluate the effects of curing procedures on relative bioavailability of heme and nonheme iron in both animal and microbial models and will also evaluate heme and nonheme iron chelators as substitutes for nitrite in cured meats. These data will be useful in developing nitrite-free meat curing formulations based on the relative levels of heme and nonheme iron in meats.

9. The Bioavailabilities of Iron and Zinc From Foods; Dennis D. Miller; Cornell University, Department of Food Science and Nutrition Science, Ithaca, NY 14850; **Award #79-19124**

   This research will develop *in vitro* methods for estimating the bioavailability of iron and zinc in foods; evaluate the reliability of these methods as estimators of iron and zinc bioavailabilities; and use *in vitro* methods to assess iron and zinc bioavailabilities of selected foods and diets. Emphasis will be given to the measurement of bioavailability changes that occur during food processing. Effects of changes in dietary habits on iron and zinc bioavailabilities will be assessed.

   Methods development will involve adaptations of recently reported *in vitro* methods. Foods will be subjected to simulated gastrointestinal conditions and soluble iron and zinc (both intrinsic stable iron and zinc and added radioactive iron and zinc) will be measured. The reliability of the method will be tested using foods with known iron availabilities.

10. Effect of Food Additives on Metabolic Activities of the Human Colonic Microflora; Abigail A. Salyers; University of Illinois-Urbana, Department of Microbiology, Urbana, IL 61801; **Award #79-19126**

    The chemical environment of the human colon is determined in large part by the metabolic activities of bacteria that reside there. The diet of the host is thought to determine the metabolic activities of the colonic flora. Virtually nothing is known about the effects of processed foods on these metabolic activities. Some components of processed foods which might affect bacterial function are: anti-oxidants such as BHA or BHT which could interfere with membrane function; products of non-enzymatic browning reactions such as glycosylamines which could mimic natural substrates; and polysaccharide emulsifiers such as guar gum which are degraded by some colon bacteria and could act as an alternative carbon source.

    This research is designed to assess the effects of long-term exposure to low concentrations of antioxidants, non-enzymatic browning products and guar gum on key metabolic activities of some major species of colon bacteria. Results will indicate what impact these components of processed foods have on the metabolic activities of colon bacteria. This information will aid in the design of experiments to test the effect of processed foods on colonic microflora *in vivo.*

11. The Effects of Processing on the Protein Quality of Legume-Based Foods and Collaborative Testing of the C-Per Assay; Lowell D. Satterlee; University of

Nebraska-Lincoln, Food Production Research Group, Lincoln, NE 68508; **Award #79-19133**

This project builds upon the findings of a two year NSF-sponsored research program conducted by the Food Protein Research Group (FPRG), University of Nebraska.

The output of the current FPRG models for estimating nutritional quality of proteins closely agrees with data obtained from traditional Protein Efficiency Ratio (PER) assays—except for legume-based proteins, where the models overestimate nutritional quality. Recent human bioassay data also indicate that legume-based proteins are of higher quality than indicated by PER studies. Food processing may alter the methionine, cysteine and lysine residues in a manner that could account for the differing results of human, chemical and rat assays. This project will determine the effects of processing on legume-based food protein nutritional quality.

12. Bioavailability of Selenium and Zinc in Processed Human Food Based on Soy Protein: Studies Using Stable Isotope Tracers; Vernon R. Young; Massachusetts Institue of Technology, Department of Nutrition and Food Science, Cambridge, MA 02139; **Award #79-19112**

    Increasing commercialization and consumption of vegetable protein in human foods originally based on animal proteins (such as meat and milk) raise important nutritional and public health considerations. This research addresses the nutritional content, dietary availability, and collateral dietary effects of a processed meat product and processed infant formula based on soy protein, on two essential trace mineral nutrients, zinc and selenium.

    Stable (non-radioactive) isotopes of minerals will be used as tracers for neutron activation analysis of the fate of zinc and selenium added during food processing. Basic theoretical assumptions related to inherent experimental error, comparability with radioisotopic studies and evaluation of "extrinsic" labeling procedures will be tested in an experimental animal model for mineral bioavailability studies. Analytical methods of stable isotope determination using neutron activation will be refined and extended. The effect of replacing beef or casein with soybean protein in a sausage and infant formula on the bioavailability of zinc and selenium using extrinsic tags (^{70}Zn and ^{74}Se) will be explored and quantitative estimates of the bioavailability of "fortification" levels of zinc and selenium investigated in human subjects. The effect of soy protein on the availability of zinc and selenium from other components of a mixed diet and the relative availability of inorganic (selenite) and organic (selenomethionine) selenium will be determined.

Science and Technology to Aid the Physically Handicapped

The Science and Technology to Aid the Physically Handicapped program supports research on the use of the best available scientific and engineering developments to improve defective speech, visual, tactile, and hearing systems in those persons afflicted with these impairments, and also to find ways to overcome locomotion and manipulatory limitations. The program involves researchers from many disciplines including biomedical engineering, medicine, law, and the social sciences working with the active participation of handicapped persons on these problems. This program supports research which may ultimately lead to products, treatment methods, or societal and environmental changes of significant benefit to the handicapped.

1. Development of a Micro-Solenoid Operated Braille Display Cell; Ernesto E. Blanco; Universal Textile Machine, Department of Mechanical Engineering, P.O. Box 897, Lawrence, MA 01842; **Award #79-17730 (SB S)**

    Embossed braille is costly and bulky. There is great need for "soft-copy" tactile display systems in which braille text can be erased and reset on commend. To date, efforts to develop a bi-stable braille cell unit compact enough to fit into standard braille letter and line spacings have not achieved the desired results.

    The system proposed for development under this award was investigated in preliminary form through an experimental thesis at MIT and found to have the desired characteristics. It consists of individual braille letter units. Each unit or module contains six micro-solenoid-actuated stimulators with a unique passive locking mechanism to hold them in the display mode without drawing power.

    Phase I of this research will investigate critical design parameters such as actualtion force, heat dissipation, locking strength, and materials selection. Emphasis will be on manufacturability and low cost. Phase II will comprise the fabrication of a test surface under digital command for experimentation with blind subjects. A Phase III follow-on is intended to provide the blind with a reasonably priced, portable reading machine, approximately the size of a notebook, operable from a standard tape cassette.

2. Needs and Design Concepts for Voice-Output Communication Aids; Bruce J. Boehm; Telesensory Systems Inc., 3408 Hillview Avenue, P.O. Box 10099, Palo Alto, CA 94304; **Award #79-17629**

    This project will determine the feasibility of, and design concepts for, low-cost voice-output modules for vocally disabled individuals. Such modules speed communication, minimize the need for user interaction, and

are effectively matched to the vocabularies and other output characteristics of available communication aids. The concepts considered will be sufficiently versatile and flexible so as to be useful to non-vocal consumers with a variety of needs and capabilities. Resulting aids will help vocally disabled individuals communicate more effectively, have greater educational and vocational opportunities, and lead richer lives.

Research steps are to evaluate existing communication aids, analyze consumer requirements, analyze the technical, economic and human factors aspects of alternative approaches, develop and evaluate new designs, and investigate the feasibility of cost-effective products. Vocally disabled consumers will play a major role in determining requirements and evaluating alternatives. Commercial development will be encouraged by organizing a workshop and inviting representatives of industrial, academic, research and consumer organizations to learn of early findings, by distributing final reports to these organizations and, if advisable, by other dissemination efforts.

3. An Ocular-Controlled Intelligent Speech Prosthesis; Kenneth M. Colby; University of California-Los Angeles, Department of Psychiatry, Los Angeles, CA 90024; **Award #79-17358**

   This project will interface an intelligent speech prosthesis, already under development at the University of California at Los Angeles, with an ocular-control device under development at the Denver Research Institute. The resultant device, an ocular-controlled intelligent speech prosthesis, will provide a means of communication for the non-vocal population through the use of synthetic speech. The user will generate synthetic speech by looking at letters on the lenses of spectacles connected to the intelligent speech prosthesis.

   In its first phase, the research will involve the hardware-software linkage of the two devices which utilizes a microprocessor and a speech synthesizer. In the second phase of the research, the feasibility of the device will be evaluated using individually selected patients, in particular those suffering from aphasia following a stroke, patients with cerebal palsy, and quadriplegics unable to speak.

   The significance of this research lies in its ability to utilize new technological advances to procide spoken communication for the non-vocal population.

4. Study of Fast Feature Extraction for Blind Mobility; Carter C. Collins; Institute of Medical Sciences, Department of Visual Sciences, San Francisco, CA 94115; **Award #79-06299**

   The research will investigate the feasibility of employing real-time automatic obstacle and landmark recognition for increasing and improving the mobility of the blind. The research team has successfully demonstrated a new feature extraction algorithm which will be implemented in real-time with a fast, portable microprocessor. Input will be obtained from a miniature, solid-state TV camera worn by the user. The description and location of obstacles and navigational landmarks will be presented to a blind pedestrian through a combination of simple codes and machine generated speech. This information should improve mobility, permitting a blind person to acquire desired landmark goals as well as to avoid obstacles.

   Feasibility of this approach will be tested in terms of objectively measured mobility performance. Indoor tests will be made on a mobility obstacle course with an existing sonar subject tracking system and microcomputer statistical evaluation equipment. Outdoor tests will measure environmental sensing, orientation and navigational skill improvements compared with the long cane. The criteria for success of the evaluation trials will be the subjects' reaching their destinations safely, efficiently and in reasonable time.

5. Replacement of Sensory Capabilities for the Physically Handicapped; Donald R. Cowsar; Southern Research Institute, Biosystems Divisions, 2000 9th Ave. South, Birmingham, AL 35205; **Award #79-15314**

   At this time, there are no good measures to prevent decubitus ulcers and accidental injuries which result from loss of tactile and pain sensory capabilities. This problem adds millions of dollars annually to national health care costs. This project will seek to develop a new method to replace the senses of touch and pain in neurologically-injured patients by developing pressure-sensitive conductive elastomers in which electrical conductance is related to static pressure. The films can be made very thin and can readily conform to the shape of the interface without significantly distoring the pressure distribution. Sensors will be fabricated as a matrix array with strips of highly conductive elastomer connecting each sensor to electronic circuitry. The resistance of each sensor will be processed and converted into a pressure profile which can then be displayed in a form appropriate to the particular clinical application.

6. Electrical Stimulation of the Skin as a Basis for Sensory Prostheses; William H. Dobelle; Columbia University, Department of Surgery, New York, NY 10023; **Award #79-17634**

   This project investigates the potential use of electrocutaneous stimulation in prosthetic devices for individuals with sensory handicaps. The investigation will differ from previous studies of similar devices which focused on mechanical stimulation systems which were expensive, bulky, and had high power requirements. Unlike many previous studies, this project will determine general methods of presenting patterns on the skin, rather than the investigation of a specific prosthetic system.

A highly flexible computer-controlled electrical stimulation system and electrode technology will be used for this investigation because the investigators feel that previous studies in this area were limited by the use of hardwired (and thus inflexible) stimulation and input transfer systems. The equipment was designed and is used for the safe electrical stimulation of the visual cortex and cochlea. Researchers will conduct a systematic investigation of electrocutaneous display methods using psychophysical techniques aimed at providing a body of basic information about the ability of human observers to perceive complex, dynamic patterns of input imposed on the skin. This information will be essential for the future design of non-invasive prosthetic devices.

7. Microprocessor-Based Prosthetic Control; Donald E. Gustafson; Scientific Systems, Inc., 186 Alewife Brook Parkway, Cambridge, MA 02138; **Award #78-21670**

   This research is concerned with the design of a system to provide control signals for a multifunctional prosthesis from a set of surface electromyelogram (EMG) signals. This will be accomplished by using both temporal and spatial variations in an effort to extract all of the available information. Temporal information at frequencies up to about 1000 Hz will be utilized. Spatial variation will be studied using at least four electrodes. The EMG signals will be modeled as multivariate Markov processes, with a different model used for each prosthesis function. Models will be developed using modern system identification techniques. A multiple-model Kalman filter will be designed to detect and identify the intended prosthesis function on-line; muscle force and intended velocity of the prosthetic arm will also be estimated. Recordings from both normal subjects and amputees will be made and will include: (1) elbow flexion and extension, (2) subination and supination, (3) wrist flexion and extension, (4) grasp, (5) relax, (6) thumb and index finger closure. The investigation will include analysis of electrode locations to maximize discrimination accuracy, and determination of the minimum number of required electrodes. Crosstalk between signals from different electrodes will be used to determine the location of the active muscles. This information is required for efficient function discrimination. In addition, the optimal sampling rate for the EMG will be determined. Algorithms will be developed and evaluated. The feasibility of microprocessor implementation will be evaluated through simulation.

8. Application of Personal Computers to Assist the Handicapped; Paul L. Hazan; Johns Hopkins University, Applied Physics Laboratory, Baltimore, MD 21218; **Award #79-21124**

   The Johns Hopkins University Applied Physics Laboratory will administer the problem definition phase of project to organize a series of regional and national competitions to trigger innovative applications by individual Personal Computer users to assist the handicapped.

   The handicapped, computer, educational, government, and volunteer service communities will be represented on an Advisory Committee which will define the detailed program. This definition will establish: Categories of Applications, Handicapped Situations to be Addressed, Levels of Individual Participation, Individual Project Maturity Level, and Award Strategies and their Potential Sources. The Advisory Committee will also establish evaluation procedures.

9. Neurophysiologically-Based Adaptive Controllers for Assistive Devices; Neville Hogan; Massachusetts Institute of Technology, Department of Mechanical Engineering, Cambridge, MA 02139; **Award #79-17348**

   The objective of this project is to develop the best controller for interfacing a disabled user with an assistive device (such as an artificial limb) by taking advantage of the state-of-the-art in both technology and neurophysiology. Because of the importance of human operators' ability to adapt their behavior to a task being performed, this project will design, develop, test and evaluate a controller which will give an artificial limb the same adjustable capabilities as a natural limb. Myoelectric activity (the natural electrical activity of muscle) will be used for communication between man and machine. The controller will use natural patterns of simultaneous contraction of opposing muscles to control the adjustment of the artificial limb. To permit active involvement of the user population in the design and development phases, the research methodology features a wearable, versatile, artificial limb simulator which can be programmed to mimic the behavior of any proposed artificial limb design. Because it is worn by an amputee, the amputee can evaluate the proposed design and indicate its weaknesses; modifications can be made directly by simply reprogramming the device. The final design arrived at in this way will then be implemented on a self-contained artificial limb.

10. Low-Cost, High Performance Speech Recognizer for the Handicapped; Charles S. Klayman; Threshold Technology Inc., 1829 Underwood Boulevard, Delran, NJ 08075; **Award #79-17038 (SB S)**

    The limited ability of handicapped persons to control their actions and to perform useful tasks makes them dependent on external systems and assistance. By using voice-controlled aids and devices, the performance of simple functions may be made possible for physically handicapped individuals and may thereby allow them to communicate with their environment, to control it, and perform productive tasks.

    This research involves the development of low-cost, high performance speech recognition devices suitable

for use by the handicapped. Although low-cost speech recognition devices previously have been demonstrated, their performance has not been adequate. This research studies techniques whereby existing high-quality speech recognition devices can be modified or adapted so that they can be produced at low cost while maintaining high performance.

11. Hearing Aids for Spatial Perception and Localization; George F. Kuhn; Vibrasound Research Corp., 4673 South Zenobia Street, Denver, CO 80236; **Award #79-17067 (SB S)**

    It is well known that for human listeners the primary localization cues in the horizontal plane are the interaural time- and the interaural pressure level-differences at low and high frequencies, respectively. An analytical model developed by the Principal Investigator has been found to be an accurate predictor of the localization cue in the horizontal plane for normally hearing individuals. The localization cue in the vertical median plane is known to be produced by spectral cues generated by the diffraction of sound by the torso and head at low frequencies; spectral cues at high frequencies are produced by higher order acoustic modes in the pinna. A correlation between these modes and their associated localization cues has recently been determined by the Principal Investigator. While mathematical and physical models of the auditory information are beginning to be defined for the normally hearing person, no models, analytical or empirical, exist for partially deaf individuals. Therefore, models for auditory localization for aided listeners are proposed to be investigated and developed. An error analysis will be made of localization cues as a function of hearing aid location and frequency. These models and error analysis are expected to lead to a hearing aid design, using digital filtering techniques and/or delay networks, to reconstitute the localization cue as nearly as possible to that of the unaided listener. Thus, localization ability is restored to the partially deaf person.

12. Investigation of Polyvinylidene Fluoride as a Tactile Stimulator for the Optacon; James F. Tetzlaff; Telesensory Systems, Inc., 3408 Hillview Avenue, P.O. Box 10099, Palo Alto, CA 94304; **Award #79-18431 (SB S)**

    At present, the tactile stimulators for the Optacon, a reading aid for the blind, are made from ceramic (PZT) bimorphs. Although the tactile screen made of PZT has given reliable service, it is the part of the instrument most susceptible to damage in use and contributes significantly to the size, weight, and cost of the instrument. An alternative approach to construction of the tactile screen is an array of cylindrical stimulators made from the piezoelectric polymer polyvinylidene fluoride (PVF_2). These stimulators can operate directly in the transverse mode resulting in a simple mechanical design with low acoustic noise.

    A PVF_2 tactile stimulator array will enable construction of a one-hand Optacon in which the photo-sensing and tactile output arrays are located in the same package and small enough to be held in one hand. This configuration would eliminate the need for two-handed coordination. This feature would expand the range of tasks with which a blind person could use an Optacon.