RECENT AWARDS: JANUARY-MARCH 1979

NATIONAL SCIENCE FOUNDATION
DIVISION OF PROBLEM-FOCUSED RESEARCH APPLICATIONS
DIRECTORATE FOR APPLIED SCIENCE AND RESEARCH APPLICATIONS
WASHINGTON, D.C. 20550

INTRODUCTION

RECENT AWARDS keeps researchers, research users and policy makers informed about projects being supported by NSF's Division of Problem-Focused Research Applications (PFRA).

The format and content of RECENT AWARDS has been changed for Fiscal Year 1979. To keep our readers informed in the most effective and convenient way, PFRA RECENT AWARDS now provides a more detailed summary of each project than was given in last year's brochures. Readers should contact Principal Investigators directly to obtain additional information about projects or to learn of available publications.

This brochure describes the awards made by PFRA during the period January 1, 1979 through March 31, 1979 (second quarter, Fiscal Year 1979). The data have been reconciled with the NSF's Management Information System.

Readers may return the post card on page 16 to request the NSF/ASRA/PFRA publications listed. Questions on PRFA program objectives, procedures for application, or general information should be addressed to the Professional Assistant for PFRA, Room 1134 A, National Science Foundation, Washington, D.C. 20550.

HOW TO OBTAIN PFRA RESEARCH FINDINGS AND RESULTS

One of the most important objectives of PFRA is the timely and widespread dissemination of the results of PFRA-supported 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 relevent 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 development 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 looked up 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, Pittsburg, 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, laboratory, 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.

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. Three particular topics have been selected for investigation in Fiscal Year 1979: biological conversion of lignocellulosic materials to useful chemicals; biological nitrogen fixation; and production of specialty chemicals from arid land plants (specifically, production of rubber from the guayule plant).

1. Mycorrhizae for Guayule and Jojoba Productivity; H. Earl Bloss; University of Arizona, Department of Plant Pathology, Tucson, AZ 85721; **Award #78-27065**

   The development of guayule and jojoba as resource crops from marginal, semi-arid lands of the Southwestern United States is the focus of considerable governmental, scientific and commercial interest. Guayule is a potential domestic source of natural rubber while jojoba produces an oil similar to sperm whale oil. Research is underway to improve the productivity of both plants by breeding, selection, and appropriate horticultural and agronomic studies.

   The use of mycorrhizal fungi to form symbiotic associations with plant roots offers another approach to improving the productivity of guayule and jojoba. Such associations are now practiced commercially with considerable success to increase crop yields. The mycorrhizae enhance the absorption by roots of key nutrients, e.g., phosphates and potassium. They would be particularly valuable for plants grown in marginal lands where heavy application of chemical fertilizers would be economically unattractive. Both guayule and jojoba in their native habitat have been shown to develop mycorrhizal associations. The objective of the research is to explore the use of induced mycorrhizal associations as a means to enhance the vigor and productivity of guayule and jojoba.

   Two research tasks will be pursued. The first task will be to establish associations between guayule and jojoba and various strains of mycorrhizae. Young seedlings will be inoculated with mycorrhizal cultures, with and without plant growth hormones, and examined for evidence of symbiosis. The second task will be to select mycorrhizal associations capable of increasing the productivity of guayule and jojoba. Seedlings with healthy mycorrhizal associations will be transplanted to the field and their performance, in terms of survival rate and biomass production, evaluated. The most effective combinations will be tested further.

2. Chemical Stimulation of Rubber Synthesis in Guayule; George P. Hanson; California Arboretum Foundation, 301 North Baldwin Avenue, Arcadia, CA 91006; **Award #78-09567 A01**

   The objective of this project is to assess the feasibility of using chemical bioregulators to maximize yield and quality of rubber in guayule. During the past year, the stimulation of rubber synthesis by 2-(3, 4-dichlorophenoxy)-triethylamine has been confirmed by tests on 18-month old plants grown in the field. Several strains which respond well to chemical stimulation have been identified. Ten new potential bioregulators have been synthesized and are undergoing evaluation. The quality of the rubber produced under chemical stimulation was found to be unchanged and optimization of treatment parameters is in progress. These tasks, as well as determination of the composition of the resins, will be continued in this, the project's second year.

3. Nitrogen Fixation with Photosynthetic Marine Microorganisms; Akira Mitsui; University of Miami, Department of Biology and Living Resources, Miami, FL 33124; **Award #76-17159 A02**

   This project is to survey photosynthetic marine microorganisms for enhanced nitrogen fixation. The research plan for the the three-year project consists of collecting microorganisms from tropical marine environments, isolating nitrogen-fixing species, assessing the production potential of isolates, and evaluating the use of these microbes as a source of food and fertilizer. Research for this period focuses on assessing the production potential of nitrogen-fixing isolates and the use of these microbes as a source of food for aquacultural purposes.

4. Isolation of Lignocellulose-Transforming Microorganisms; Dale M. Norris; University of Wisconsin, Department of Entomology, Madison, WI 53706; **Award #77-08279 A01**

   Cellulose and lignin are the two most abundant naturally occurring organic materials on earth. They are presently used for a variety of purposes. These organic materials represent potentially important sources of industrial materials if efficient processes for converting them can be developed.

   Such a possibility exists with biological systems based on lignocellulose-transforming microorganisms. The objectives of this three-year project are to isolate symbiotic lignocellulose-transforming microbes from wood-degrading insects and to characterize the transformations of lignin with the free-living microbes. Research for this period focuses on optimizing the culture conditions for the microbial transformations of lignin and investigating the animal feeding stimulant activity of the resultant products.

5. The Conversion of Agricultural By-Products to Sugars; Peter J. Reilly; Iowa State University of Science and Technology, Department of Chemical Engineering and Nuclear Engineering, Ames, IA 50010; **Award #77-00198 A02**

   This research assesses the feasibility of converting xylan (the predominant hemicellulose in grasses,

cereal grains, and hardwoods) into xylose and other sugars. Specifically, the major objectives are to isolate and purify the xylanase enzymes involved in xylan hydrolysis; to characterize the individual enzymes in terms of the operational characteristics of stability, specificity, and kinetic properties; and to assess the feasibility of using an ultrafiltration enzyme reactor for converting corn cob and corn hull xylan to useful sugars.

6. Toxicological Studies on Guayule; Eloy Rodriguez; University of California—Irvine, Department of Ecology and Evolutionary Biology, Irvine, CA 92717; **Award #78-25162**

   Development of guayule (*Parthenium argentatum* Gray) as a domestic source of natural rubber is currently the focus of considerable governmental, scientific and commercial interest. However, many *Parthenium* species have been shown to cause allergic skin reactions in humans. It is therefore prudent to question whether guayule is a potential allergen before it is grown and processed on a large scale.

   This project will test leaf and stem extracts of guayule, as well as refined fractions derived from them, by a standard skin sensitization test with guinea pigs. Fractions which induce a positive reaction will be analyzed further to isolate and identify the active components.

7. Regeneration, Selection and Evaluation of Plants from Protoplasts of Potato; James F. Shepard; Kansas State University, Department of Plant Pathology, Manhattan, KS 66506; **Award #77-12161 A01**

   The objective of this three-year continuing project is to develop the technology by which mutants of potato leaf protoplasts with certain desirable characteristics can be created, selected and regenerated into useful cultivars of potato.

   During the first year of the project the efficiency of regeneration of plants from protoplasts has been raised from 20-30% to 70-80%. Protoplasts resistant to fungal toxins have been regenerated and grown in the field to yield plants which are resistant to early-blight disease. In the second year, emphasis will be on the generation of strains resistant to virus and fungal infections.

Chemical Threats to Man and the Environment

The Chemical Threats to Man and the Environment Program supports applied research relevant to the prediction, identification, characterization, and control of hazards resulting from chemical compounds in the environment. Emphasis is placed on the development of techniques and methodologies that can be applied to a spectrum of situations, and on research on problems that are not amenable to routine approaches. Proposals in areas that are receiving considerable support from other agencies, such as NIH and EPA, are usually not funded by this program.

The Chemical Threats to Man and the Environment program's allocation for FY 1979 is $3,600,000. All awards that will be made under this program category in FY 1979 will be directed toward completion of prior program objectives. **No funds were requested for continuation of the Chemical Threats to Man and the Environment program in the FY 1980 budget submitted to the Congress on January 22, 1979.**

1. A Water Pollution Monitoring Laser System; Silverio P. Almeida; Virginia Polytechnic Institute, Department of Physics, Blacksburg, VA 24061; **Award #77-10184 A01**

   An important indicator of the quality of a water body is its population of diatom species. Diatom species can be identified and counted manually using a microscope, but this technique is subjective, expensive for large numbers of samples, and too slow for detection of rapidly changing conditions. The object of this research is to develop and test a system for the automatic assay of various diatom species in water samples.

   Diatoms are observed under a microscope with illumination from the coherent light of a low-power laser. The microscope produces a real, magnified, coherent image of the specimen. The image plane is followed by two successive Fourier transform (FT) planes. In the first FT plane, low and high frequency spatial filters are used as preprocessing filters to enhance image quality. The enhanced signal is re-imaged to the second FT plane, which contains a matched spatial filter used for specimen identification. On-line computer processing evaluates the match between the specimen and spatial filter. Work will be directed to the optimization and testing of the system for its capability to perform on-line operation under simulated and real biomonitoring conditions in which mixed populations of diatoms are present.

2. Field Studies of Biologically Produced Atmospheric Sulfur Compounds; Alan R. Bandy; Drexel University, Department of Chemistry, Philadelphia, PA 19104; **Award #76-80322 A02**

   Worldwide emissions of volatile sulfur compounds of biogenic origin are commonly believed to exceed the total flux of sulfur dioxide released to the atmosphere as a result of human activities. Unlike anthropogenic sources, which emit mostly sulfur dioxide, biogenic sources are believed to contribute hydrogen sulfide, dimethyl sulfide, and minor amounts of other sulfur compounds. Like sulfur

dioxide, the latter sulfur carriers seem likely to oxidize in the air to form sulfuric acid or other particulate sulfates. These sulfate forms are believed to be hazardous to human health.

This project questions whether the biogenic emissions believed to be dominant on the global scale are also significant for the production of airborne sulfate particulates in regions affected by anthropogenic sources of sulfur dioxide such as coal- or oil-burning plants. The research will be done by gas-chromatographic analysis of estuarine waters and the overlaying air in a pristine area (Wallops Island, Virginia). Samples will be analyzed for hydrogen sulfide, sulfur dioxide, methyl mercaptan, dimethyl sulfide, carbon disulfide, and carbonyl sulfide. Meteorological observations will be made as aids to the identification of sources. Surface emission rates will be estimated by model calculations based on wind velocities and air analyses at different elevations.

3. Natural and Fertilizer-Induced Emissions of Nitrous Oxide from Soils; John M. Bremner; Iowa State University of Science and Technology, Department of Agronomy, Ames, IA 50010; **Award #77-23835 A01**

Recent research has suggested that increased use of nitrogen fertilizers to aid food production may increase release of nitrous oxide from soils to the atmosphere and may thereby promote destruction of the stratospheric ozone layer. The primary purpose of this project is to obtain information needed to assess this risk and to study the processes responsible for emission of nitrous oxide from soils.

Emissions of nitrous oxide from unfertilized and fertilized soils will be measured in field and laboratory studies, and factors affecting release of nitrous oxide from soils through denitrification and nitrification of fertilizer nitrogen will be investigated. The soils selected for study will include diverse types, and measurements of nitrous oxide emissions will be performed under a wide variety of field conditions. Nitrous oxide will be determined by a gas chromatographic procedure that involves use of an ultrasonic detector and permits use of the xenon in air as an internal standard. The work will include a critical evaluation of methods available for nitrous oxide analysis of air and for field measurements of nitrous oxide emissions from soils. The mechanism of nitrous oxide production during nitrification of ammonium and ammonium-yielding fertilizers in soils will be studied, and an attempt will be made to determine if nitrous oxide is an obligatory intermediate in reduction of nitrate to nitrogen by soil microorganisms.

4. Studies on the Metabolism of Ochratoxin A and Citrinin; Fun Sun Chu; University of Wisconsin-Madison, Food Research Institute, Madison, WI 53706; **Award #78-22974**

Ochratoxins and citrinin are a group of nephrotoxic dihydroisocoumarins produced by a number of fungi in the genera *Aspergillus* and *Penicillium*. The metabolism of this series of toxins in animals will be studied. The objectives of this research are to elucidate the mechanism of the toxic effect of these mycotoxins through metabolic studies in animals, and to determine whether such mycotoxins and their metabolites accumulate in meat, milk, organs and tissues of food-producing animals which have consumed mycotoxin-contaminated feed.

Radioactive mycotoxins will be fed to rats, chickens, goats and monkeys. The kinetics of accumulation of toxin and its metabolites in urine, serum, milk and different organs will be determined. Major metabolites will be purified by different chromatographic methods. Toxicity of the new metabolites will be determined by chicken embryo, day-old chicks, and Ames' tests. Kinetics of metabolism and binding of toxin and/or metabolites with cellular macromolecules and organelles of liver and kidney will be compared using young and adult rats and also chickens of resistant and susceptible species. In addition, the kinetics of metabolism of the toxin by liver (and kidney) microsomes or homogenates of different animal species will be compared *in vitro*. For elucidation of the mode of action of ochratoxins, correlations among the kinetics of metabolism, the degree of binding, and the toxicity (LD_{50}) of the mycotoxin(s) of these experiments will be determined.

5. Sources, Transformations, and Chemical Nature of Atmospheric Pollutants; Glen E. Gordon; University of Maryland-College Park, Department of Chemistry, College Park, MD 20742; **Award #75-02667 A06**

This is a continuation of NSF research on the trace elements in size-graded particulates emitted by power plants, refuse and sludge incinerators, automotive traffic, airports, copper smelters, steel mills, and cement plants. The objective is to identify sources of toxic elements in the atmosphere and to measure the relative contributions of natural and individual man-made sources to the particulates of urban atmospheres.

This grant extends the study to a more complete characterization of copper smelters, a cement plant, and a steel mill, and to the aircraft sampling of two or three other non-ferrous smelters (zinc, lead, or nickel). This extension will add size-graded particulate analyses of the copper smelter plumes (and of the other smelters), will expand the list of elements to be measured, determine solubilities of toxic elements in the particulates, and will provide analyses of in-plant materials to determine the role of fractionation processes governing the composition of the stack emissions. The resulting expanded data base will be used to refine the existing model

for estimating source contributions to urban air particulates.

6. Cytogenetic Effects of Mutagens and Mitotic Poisons on Mammalian Cells; T. C. Hsu; University of Texas, M.D. Anderson Hospital and Tumor Institute, Galveston, TX 77550; **Award #76-82241 A02**

There is an urgent need for quick, inexpensive and reliable tests for screening chemicals for adverse health effects. Conventional tests in laboratory animals are accepted as applicable to the human experience, but there are not adequate resources, trained personnel or time to test the 30,000 or more commercial chemicals in use in the United States annually. New, rapid techniques are needed for screening chemicals for their potential to cause mutations so that those with the highest potential can be extensively tested and their risk assessed so that intelligent regulatory decisions can be made concerning their use. Several test systems using bacteria are in wide use, but the simplicity of the bacterial mechanisms obsures possible effects to humans.

This project uses mammalian cells as test systems. A protocol has been developed for the rapid screening of water-soluble chemicals for their ability to cause chromosome breaks or to interfere with mitosis in mammalian cells in cell culture and *in vitro*. Modifications necessary for water-insoluble compounds will be made. In addition, attempts will be made to refine a technique for visualizing premature condensed chromosomes so that background abnormality rates can be estimated. An investigation will also be initiated to assess the feasibility of using male mammalian meiosis as a test system for environmental mutagens. And finally, investigations will be made using selected chemicals which cause "dominant lethals" in the Chinese hamster to ascertain the mechanism of this process.

7. Analytical Instrumentation for the Determination of Formaldehyde in the Ambient Atmosphere; Gregory L. Kok; Harvey Mudd College, Department of Chemistry, Claremont, CA 91711; **Award #78-19671**

Formaldehyde is present at trace levels (approximately ten parts per billion) in polluted urban atmospheres. Improved analytical data on ambient levels of formaldehyde are necessary to verify photochemical smog models and to provide more information on the spatial and temporal distribution of this irritant gas in the atmosphere.

Current analytical techniques for measuring formaldehyde lack sufficient sensitivity for reliable work at ambient levels. This research is designed to develop a new method based on the chemiluminescent reaction of gallic acid with formaldehyde.

The research plan is divided into three parts. A liquid-phase chemiluminescent system for formaldehyde analysis will be set up and optimized. The system will be tested with ambient air samples. Atmospheric formaldehyde levels will be measured and compared with those obtained by state-of-the-art methodologies, including the chromotropic acid method.

8. Poroplastic Personnel Vapor Monitoring Badges; Arthur S. Obermayer; Moleculon Research Corp., 139 Main Street, Cambridge, MA 02142; **Award #78-19225**

Toxic vapors in the occupational environment pose a significant threat to workers. There is a need for a toxic vapor personnel monitoring badge for individual use which is convenient, rapid and specific in its response, easy to interpret, reliable, inexpensive, and capable of alerting a worker to a hazard at the time of exposure. Colorimetric vapor-sensing badges represent a practical response to this need. This project employs transparent, liquid-impregnated Poroplastic film which combines in one component the ability to acquire vapor, to conduct a colorimetric reaction, and to display the resulting color. A previous NSF-supported project showed the feasibility of detecting phosgene and formaldehyde with film impregnated with suitable reagents. This extension of that project will allow for feasibility testing with seven additional vapors and for the design of a prototype badge for routine use.

9. Atmospheric Transformations and Mutagenic Activity of Primary and Secondary Air Pollutants; James N. Pitts; University of California-Riverside, Statewide Air Pollution Research Center, Riverside, CA 92521; **Award #78-01004 A01**

Polluted urban air is the product of a diverse mixture of man-made contaminants that react chemically with one another and with naturally-occurring atmospheric constituents to form secondary pollutants that include visibility-degrading aerosols, gaseous bioirritants, and various substances having unspecified effects on human health. These smog-forming chemical processes have a definite time-course and therefore determine the quality of a moving body of air at locations remote from the original pollutant sources. The diversity of chemical species emitted by sources, and the complexity of the chemical and photochemical processes involved, complicate the work of pollution control authorities, who cannot defend regulatory decisions without credible scientific evidence connecting demonstrable effects with identifiable sources subject to regulation.

The research objectives are to: (1) refine an existing kinetic model of smog photochemistry by including aromatic hydrocarbons (toluene, xylenes, trimethylbenzenes) and carbonyl compounds (aldehydes and ketones); (2) isolate and chemically characterize mutagens in ambient airborne particu-

late matter; (3) assess reproducibility of the Ames test in its application to the quantitative determination of the mutagenicity of ambient particulate matter; (4) determine the chemical transformation of amines, nitrosamines, and their photooxidation products in simulated polluted atmospheres; and (5) investigate unknown causes by which smog chambers perturb experiments in pollutant photochemistry. Experimental techniques include simulated photochemical smog formation, infrared spectroscopy, chemical analysis, gas and liquid chromatography, mass spectroscopy, and bacterial assays for mutagenic activity.

10. Chemical Threats to Man's Nervous System; Peter S. Spencer; Yeshiva University, Albert Einstein College of Medicine, New York, NY 10033; **Award #78-12701**

    The purpose of this project is to respond to the need for the development of sensitive biological assay systems to screen new and existing manufactured chemicals for neurotoxic properties. It is based on a triple classification of neurotoxic chemicals according to their site of tissue damage: nerve and cell body (neuronopathy), the axonal process (axonopathy), and the myelin sheath or myelin-producing cell (myelinopathy). Representative chemicals from each neurotoxic group will be studied to determine their effects on tissue components of the nervous system of mammals. For this purpose, light and electron microscope examination of the central and peripheral nervous tissues of animals and organotypic tissue cultures exposed to the chosen neurotoxins will be used to determine the timing and sequence of tissue damage.

    By focusing on the earliest phases of neurotoxic insult in each of the three classes of disease, it will be possible to design sensitive animal and tissue culture assays to screen existing and newly-identified chemicals for possible neurotoxic properties. This will provide the mechanisms to screen out from the present and future inventory of manufactured chemicals those substances which are hazardous to the brain and nervous system.

Community Water Management

The Community Water Management program addresses the Nation's capability to efficiently and effectively manage the use and reuse of water in the built environment, and to reduce risks to public health, safety, and the environment that arise from or are otherwise associated with the use and reuse of water.

There were no awards made during the second quarter of FY 1979 for this program. The Community Water Management program's allocation for FY 1979 was reduced by administrative action to a level of $700,000, an amount which is based upon continuation needs for existing grants. It is not likely that awards will be made under this program category in FY 1979 which are not directed toward completion of prior project and program objectives. **No funds were requested for continuation of the Community Water Management program in the FY 1980 budget submitted to Congress on January 22, 1979.**

Earthquake Hazards Mitigation

The objectives of the Earthquake Hazards Mitigation program are to develop methods and techniques that can provide effective protection for man, his works and institutions from life loss, personal injury, property damage, social dislocations, and economic and ecological disruption associated with potential or realized earthquake hazards. Three major aspects of the problem are considered: Siting, Design and Policy. SITING focuses on the relationship between soil and geological conditions at a given site; strong ground motions; tsunamis; lifelines; the potential earthquake hazard of the region; and the architectural, land use and engineering practices and policies necessary to make buildings at that site earthquake resistant. DESIGN investigates the elastic and inelastic behavior of building materials used on the behavior of structures during seismic and wind excitation; ways to minimize the risk of older buildings not built to meet earthquake code standards; and the behavior of nonengineered structures and secondary components of buildings. POLICY deals with social, economic, legal, institutional and other factors which facilitate or hinder the adoption of social and technological solutions, including prediction and warning, to earthquake hazards, and also seeks effective dissemination of earthquake information to the public and to government decision-makers.

1. A New Approach to the Prediction of Earthquake Strong Motion; Keiiti Aki; Massachusetts Institute of Technology, Department of Earth and Planetary Science, Cambridge, MA 02139; **Award #77-23336 A01**

    Scientific evidence has shown that no part of the United States is immune to earthquake threat. For safety of structures, the determination of the expected earthquake ground motion at any given site is essential. For areas where historic earthquake data are available, design ground motion data can usually be constructed without much difficulty. For areas where little or no historic earthquake data exist, the problem of predicting site ground motion and establishing design bases for earthquake-resistant structures remains unsolved.

The objective of this project is to predict earthquake strong motions where no historical data exists. The research will develop means for predicting earthquake strong motion for given seismic regions on the basis of the laws of physics, using information on the physical properties of earthquake faults. This project will test the validity of the "Barrier Model," a new versatile earthquake model which is characterized by five site parameters: fault length, width, maximum slip, rupture velocity, and barrier interval. The Barrier Model will be tested using data on earthquakes in California, the Central United States, Hawaii, and Japan.

2. Seismic Resistance of Precast Concrete Panel Buildings; James M. Becker; Massachusetts Institute of Technology, Department of Civil Engineering, Cambridge, MA 02139; **Award #78-18742**

   In recent years large panel precast concrete buildings have become economically and architecturally viable. While originally developed for use in regions that were essentially nonseismic in character, such buildings are now being used in seismic regions in the United States and throughout the world. This research involves experimental and analytical work. The experimental program will examine the inelastic response of dry-type vertical connections subjected to seismic reversals. The analytical work will be in three areas: the development of a detailed nonlinear dynamic program capable of modeling two-dimensional assemblages of large panels; development of a simplified program to allow for more design-oriented analysis; and the extension of current three-dimensional linear-elastic models to handle certain aspects of inelastic response. In all three cases, the modeling efforts will use the information developed in the experimental portion of the program.

   The last phase of the project will be the integration of the experimental and analytical efforts, combined with parametric studies, to develop information relevant to the aseismic design of large panel structures.

3. Dynamic Analysis of Earthquake Shaking Deformations for Large Caverns in Jointed Rock; Theodore B. Belytschko; Northwestern University, Department of Civil Engineering, Evanston, IL 60201; **Award #78-09271**

   This research concentrates on the development of analytical procedures to predict the response and stability of rock caverns to earthquake shaking. Computer programs to be developed will be able to account for rock mass inhomogeneities in the form of continuous joints or shear zones, irregular geometry of both the opening and intact rock blocks, and seismic excitation. As an integral part of this effort, procedures and guidelines for modelling jointed media in the vicinity of an excavation will be investigated. Rational procedures for devising prototypical joint configurations will be developed exercising the model and calibrating it with recorded experience.

   The anticipated outcome will be not only a computational tool but also guidelines for engineering analysis. Even though this project focuses primarily on earthquake response, the results will have application in other fields of study such as feasibility studies for underground nuclear reactors, underground storage of oil and radioactive waste in seismically active areas, and hazard assessment studies for lifeline systems.

4. Partial Support of the Committee on Seismology; Joseph W. Berg; National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, DC 20418; **Award #78-16505**

   This award provides partial support for the activities of the Committee on Seismology of the Assembly of Mathematical and Physical Sciences, National Research Council. These activities will consist of completion of a report on earthquake problems related to the siting of critical facilities; completion of a report on national, regional, and local seismograph networks; four regular business meetings of the Committee on Seismology; preparation of other reports by the Committee and its Panels; and initiation, if warranted, of additional studies on topics of importance both to the scientific community and to the general public.

5. Safety Evaluation of Buildings Exposed to Earthquakes and other Catastrophic Environmental Hazards; Boris Bresler; University of California-Berkeley, Department of Civil Engineering, Berkeley, CA 94720; **Award #76-82384 A02**

   This research project attempts to predict the potential damage which could occur to an existing structure when it is subjected to a catastrophic event such as an earthquake, severe windstorm or other natural hazard. Such information will help assess the degree of hazard for existing structures and will also be useful in guiding rehabilitation programs and in improving the design of new buildings. The approach is to establish indices of damage for both the nonstructural and structural components of buildings. These damageability indices are developed for various parts of the building as well as the entire building.

   After damageability indices have been developed, they will be tested using a systematic procedure aimed at establishing priorities for reviewing classes of buildings. A methodology will be developed which may be used to assess the hazard potential in existing buildings quickly and at reasonable cost.

6. Methodology and Pilot Study to Inventory Local Building Stock in Regard to Seismic Hazard;

Kenneth Britz; Carnegie Mellon University, Department of Architecture, Pittsburgh, PA 15213; **Award #78-22857**

This research has as its goal the development of a "sketch" inventory method to profile a city's building stock with respect to potential seismic hazards. The "sketch" method will utilize stratified sampling techniques with sampling frames classified by land use. Therefore, only 10 small samples of buildings need be studied for their typical characteristics. The profile will describe the interrelation between structural and non-structural components, occupancy load and any special characteristics of use. Each contiguous set of land parcels defined by a land use category will be associated with a set of existing building conditions considered to be typical for that use. Each land use parcel will become a planning unit. The planning unit data will be mapped over a local soils geology analysis so that a potential seismic hazard perspective can be described for each planning unit. A pilot study will apply the sketch inventory method to the city of Buffalo, New York. The results will be used to evaluate the method and to provide a factual basis for decision-making on seismic safety and planning at the local level.

7. Earthquake Behavior of Techi Dam; Ray W. Clough; University of California-Berkeley, Department of Civil Engineering, Berkeley, CA 94720; **Award #78-19333**

   Numerical methods, particularly finite element procedures, for seismic response analyses of arch dams have been well developed. However, many assumptions inherent in the analyses have not been verified by experiments, and uncertainties remain in the results even after refined analyses. The objective of this project is to conduct U.S.-Republic of China cooperative research to obtain seismic response information from the Techi Dam in Taiwan. The Techi Dam, a modern, thin shell concrete arch structure located in a region of significant seismicity, offers a unique opportunity to obtain data on the actual seismic behavior of an arch dam. The project will install additional instrumentation in the dam, calculate and measure the dam vibration properties, refine the mathematical model through numerical analysis, observations and correlation study, evaluate the seismic response, and perform table tests of scaled dam models.

   The project will demonstrate the effectiveness of current response analysis procedures and will provide improved techniques for treating reservoir and foundation interaction, as well as better understanding of expected failure mechanism.

8. Earthquake Engineering Research Facility Support; Ray W. Clough; University of California-Berkeley, Department of Civil Engineering, Berkeley, CA 94720; **Award #77-21787**

   The ultimate goal of this project is to develop improved computer procedures for predicting the dynamic response of structures to intense earthquake motions. The effort is divided into six technically interrelated sub-projects.

   These sub-projects are: (1) Earthquake Simulator Studies—to perform dynamic tests of steel and concrete structures, (2) System Identification—to develop methods of evaluating mathematical model properties, (3) Computer Program Development—to evaluate the dynamic response of the mathematical model, (4) Energy Absorption Devices—to develop and test special structural components for improving the seismic resistance of structural systems, (5) Field Measurements—to measure the dynamic properties of actual buildings and structures, and (6) Post-Earthquake Damage Studies—to conduct reconnaissance surveys and detailed engineering analyses of earthquake damaged structures.

   The earthquake simulator has proven to be a most versatile research tool during its five year existence. Continuing exploitation of its effectiveness and efforts to overcome its limitations are necessary to provide direct evidence of actual structural performance under realistic base excitations and to evaluate the predictive capability of developed computer programs. System identification studies are required to define physical properties and to incorporate them into mathematical models, which will be formulated and coded to represent different structural elements and used to develop general purpose non-linear analysis programs. Mechanisms and practical utilization of energy absorbing devices will be investigated to improve the seismic performance of various types of structures. Finally, field measurements and actual earthquake damage investigations will be conducted to supplement the analytical and experimental research to achieve an improved understanding of, and to develop improved predictive capability for, the seismic behavior of structures.

9. A Model Study of Pile Bearing Capacity in Liquefiable Sand Deposits Under Earthquake Loading; Pedro A. De Alba; University of New Hampshire-Durham, Department of Civil Engineering, Durham, NH 03824; **Award #78-22876**

   A model study will be conducted of pile settlement and bearing capacity in a saturated sand subjected to earthquake loading. Liquefaction will be induced in sand samples six inches high and 22 inches in diameter by means of a simple-shear type apparatus. One or more piles will be inserted into a sample already subjected to confining pressure, thus producing stress conditions similar to those existing

around a driven pile in the field. This testing program will investigate the behavior of single piles and four-pile groups for different sand densities and confining pressures, including both freshly-deposited samples and samples previously subjected to minor earthquake loading. Pile settlement and intergranular pore pressures developed during loading will be monitored continuously for each test and the results presented in the form of normalized plots applicable to field situations.

10. Studies on Timber Diaphragms Subject to Earthquake Motions; Hota V. S. Gangarao; West Virginia University, Department of Engineering, Morgantown, WV 26506; **Award #78-04769**

    Woods which possess high strength-to-weight ratios and excellent thermal properties are being widely used for many structural applications because of inherent economic advantages and ease of construction. Plywood roof and floor diaphragm systems under cyclic and earthquake type loading conditions will be analyzed theoretically for several boundary conditions, and for joint configurations wherein the orthotropic material properties and joint slip effects will be considered.

    Sixteen different diaphragms will be subjected to cyclic and earthquake-type loadings to establish methods of construction and to verify simple design formulas developed from rigorous theoretical investigations of the seismic behavior of each system as a whole. If required, necessary modifications in the theory and the test program will be made to introduce efficient and versatile plywood roof and floor systems. Standard general purpose design guidelines for the use of practicing engineers will be developed.

11. The Development of a Cost-Effective Approach to the Aseismic Design of Buildings for the Pacific Northwest; Dean R. Heerwagen; University of Washington, Department of Architecture, Seattle, WA 98195; **Award #78-22875**

    This research will develop a technique for assessing the cost-effectiveness of aseismic building designs for the Pacific Northwest. This methodology will be employed by several building case studies. Guidelines will be developed for use by building owners, designers, and regulatory officials. The research will provide a means for optimizing the trade-offs between building costs and the reliability of future buildings.

    The research plan includes: (1) modification of an optimization technique developed by Liu, Dougherty, and Neghabat for seismicity experienced in California; (2) writing of a computer program based on this modified optimization methodology; (3) identification of several medium-and high-rise buildings for analysis as case studies; (4) from consideration of framing and cladding systems for these case studies, design alternatives will be generated; (5) the existing buildings and the additional alternate schemes will be analyzed for cost-effectiveness; and (6) preparation and distribution of a final report, professional papers, and a catalogue of the design guidelines.

12. Seismological Investigation of Strong Ground Motion: The San Fernando Earthquake; Donald V. Helmberger; California Institute of Technology, Department of Geological and Planet Science, Pasadena, CA 91104; **Award #78-08813**

    Many researchers consider the wealth of near- and far-field data obtained from the San Fernando earthquake to be the single most important data set for understanding the dynamics of earthquakes to date. However, the event was a complicated one, involving complex rupturing situated in a complex geological environment. In 1976, funds were provided for the support of a 24-month California Institute of Technology project involving theoretical and observational investigations of the physical significance of the strong ground motion generated by the San Fernando earthquake. This project will continue the numerical modeling of the ground motions of the earthquake. The results of this research, in conjunction with recent progress in the deterministic models of other earthquakes, should greatly improve our ability to predict strong ground motions in many situations.

13. Contribution of Floor Systems to Earthquake Resistance of Building Structural Frames; Ti Huang; Lehigh University, Department of Civil Engineering, Bethlehem, PA 18015; **Award #76-00715 A02**

    This study will investigate and evaluate the contribution of floor systems to the earthquake resistance of building structural frames. The response of floor systems under earthquake loading is not adequately considered in present design practice of various floor systems. This study will examine the behavior of floors and will develop design guidelines which will analyze the floor system contribution under repeated loading into full consideration.

    Both analytical and experimental investigations will be included. The study will cover many floor systems frequently used in steel or concrete buildings. Testing of typical floor system panels will provide information leading to the identification of design parameters controlling the behavior of floor systems. A computerized parametric study will be used for the generation of data and development of design guidelines suitable for incorporation into design codes.

14. Reduction of Overturning Potential of Seismically Excited Structures; Arthur Huckelbridge; Case

Western Reserve University, Department of Civil Engineering, Cleveland, OH 44106; **Award #78-08013**

This research will extend our current understanding of the overturning moment problem associated with seismically excited structures. Major earthquakes impose loading conditions on structural systems in excess of normal design levels. In recognition of this fact, building codes have structural requirements which ensure ductile behavior under overload conditions. There are no corresponding provisions, however, to consider the effect of overturning moments in excess of normal design levels.

Requiring full overturning moment capacity corresponding to levels produced by large earthquakes imposes a twofold economic penalty on the designer: the loading on the superstructure is increased, and supplementary foundation anchorage capacity may be required. Conversely, designing a limited overturning moment capacity, e.g. only that provided by gravity, implies a transient uplift condition for those time intervals when the applied overturning moment exceeds the capacity of the system.

Prior investigations have indicated that the latter approach has a number of inherent advantages: load levels are reduced, expensive anchorage may be eliminated, and damage to the superstructure may be reduced. In this effort, an analytical method validated through prior experimental investigations will be employed to explore various structural systems, configurations, and seismic ground motions with the objectives of clarifying and quantifying in exactly which situations transient uplift response could be utilized most effectively. Structural design details suitable for a prototype application will be investigated as an integral part of the program.

15. Statistical Investigation of Engineering Seismology; Leon Knopoff; University of California-Los Angeles, Institute of Geophysics and Planetary Physics, Los Angeles, CA 90024; **Award #77-24742 A01**

    This project addresses two significant problems of engineering seismology: seismic risk estimation and the theory of earthquake sources. These two problems are interrelated and interdependent. The methods of analysis in the study of these problems are statistical investigations of seismicity and physical models of earthquake faults.

    The project will be based on recently developed stochastic models of earthquake occurrence and previous theoretical results. This research will develop basic procedures for seismic risk estimation in a given region, investigate periodicities of seismicity by statistical means, improve the established stochastic dependence between seismicity and source complexity, and refine and test the developed synthetic seismicity program.

    The goals of this research are to develop an improved model and numerical methods, based on physics and statistics, for estimating regional earthquake risk, and to quantify the risk for engineering applications.

16. Community Response to Natural Hazard Warnings; Robert K. Leik; University of Minnesota, Department of Sociology, Minneaspolis, MN 55455; **Award #77-01452 A02**

    This continuing research is providing information on how families and organizations in communities at risk to hurricanes, tornadoes, floods and earthquakes perceive, prepare for, make decisions on, and respond to warnings of natural hazards. Data have been obtained from 1,085 organizations involved with issuing and responding to warnings and from 5,714 households in hazard-prone sites. Laboratory experimental studies are being conducted to determine responses to specific types of warnings. Analyses of the data obtained will focus on matters such as the relationships between warning responses and the content and timing of the warning message; the comparative effectiveness of alternative organizational arrangements in responding to the occurrence of a natural hazard; and the levels of knowledge and of preparedness of households in sites subject to hazards.

17. Numerical Modeling of Tsunamis; Philip L. F. Liu; Cornell University, Department of Environmental Engineering, Ithaca, NY 14850; **Award #78-15358**

    Tsunamis are ocean waves generated primarily by undersea earthquakes of shallow focus depth during which vertical dislocations of the sea floor occur. Tsunamis present a major hazard to life and property when they strike the shoreline of exposed areas. To minimize such loss, it is essential to develop an accurate and efficient computation method describing the generation, propagation, and amplification of tsunamis.

    This project is primarily devoted to the problem of tsunami wave generation. Its objective is to establish a more sophisticated numerical model of tsunami generation which includes both non-linear and dispersion effects. The Boundary Integral Equation Method (BIEM), which can solve free surface flow problems more efficiently and economically than either finite difference or finite element methods, will be formulated, investigated and applied to tsunamis problems.

18. Nonlinear Analysis and Design of Steel Frames; William McGuire; Cornell University, Department of Structural Engineering, Ithaca, NY 14850; **Award #78-15357**

This research will further the development of interactive computer graphics as a practical, economical method for the static and dynamic nonlinear analysis and design of steel framed structures. An interactive design analysis system for two-dimensional static and dynamic nonlinear problem is to be developed. Clear directions are to be established for the treatment of three-dimensional nonlinear problems associated with earthquake-resistant design.

19. Shear Behavior of Reinforced Concrete Beam-Column Connections Under Earthquake Loadings; Donald F. Meinheit; University of Notre Dame, Department of Civil Engineering, Notre Dame, IN 46556; **Award #78-22860**

    This research will review existing information and data on reinforced concrete beam-column connections with the objective of finding additional and more comprehensive means to correlate behavioral data with anticipated earthquake loadings. Experimental data on the behavior of reinforced concrete beam-column connections under simulated earthquake loadings have been accumulating since 1967. These data will be analyzed to provide a better mathematical model for design purposes and to provide a basis for upgrading existing structural systems.

20. Vulnerability of Transportation and Water Systems to Seismic Hazards; Irving J. Oppenheim; Carnegie Mellon University, Department of Civil Engineering, Pittsburgh, PA 15213; **Award #75-20977 A04**

    Lifeline engineering is the evaluation of the dependence of urban regions on their service systems. The essential features of lifelines are their geographical extent and their redundancies (or lack thereof).

    Lifeline models will be developed which will permit the preparation of inverse iso-seismal maps for given lifelines: zones within which a shock of given magnitude will cause lifeline failure. The integrated value of earthquake frequency over the areas contained within the inverse iso-seismals (or the "damage areas") is a direct measure of seismic risk. This problem is particularly significant for areas in the east-central part of the United States.

    Lifeline models and earthquake risk calculations will be generated for selected major eastern and western cities. The techniques will be presented in a manner facilitating their use by other analysts. The results of the analyses of the selected cities will serve to illustrate the increased seismic risk encountered in a lifeline analysis (as opposed to an *in-situ* structural analysis) and the increased relative risk for east-central areas.

21. Envelope Curves for Confined Concrete Subjected to Cyclic Loading; Surendra P. Shah; University of Illinois-Chicago Circle, Department of Materials Engineering, Chicago, IL 60680; **Award #78-22878**

    The primary goal of this investigation is to verify the hypothesis that an "envelope" curve exists for cyclically loaded concrete specimens and that the envelope curve is approximately the same as the complete stress-strain curve of the corresponding concrete. An envelope curve is the line which no stress-strain curve exceeds regardless of the loading history. If this hypothesis is verified, then the complete stress-strain curve provides a simple means to quantify the limit behavior of concrete subjected to seismic excitation, and provides a basis on which a more rational analysis of the response of reinforced and prestressed concrete structural members can be performed. Normal weight and lightweight concrete specimens of compressive strengths varying from 3,000 to 12,000 psi and with different amounts and types of confining reinforcement will be subjected to a variety of cyclic loading as well as monotonically increasing loading. Analytical expressions for the envelope curves will be developed to include the effects of lateral reinforcement, compressive strength and the type of aggregates.

22. Effects of Earthquake Motions on Reinforced Concrete Buildings; Mete A. Sozen; University of Illinois-Urbana, Department of Civil Engineering, Urbana, IL 61801; **Award #78-16318**

    The objectives of this study are to develop information to improve design methods and to investigate the effects of abrupt changes in stiffness on the response of structural frames and frame-wall combinations in the nonlinear range of response.

    The principal experimental program involves small-scale structures subjected to simulated earthquake motions. The scope of the work includes tests of a nine-story frame with a tall first story; tests of three nine-story structures, each comprising two frames and a wall; development of analytical models to interpret and expand the scope of the experimental results; comparative studies of the observed behavior of all types of structures tested (coupled walls, frames, and frame-wall combinations); and synthesis of the resulting information for the development of practical methods for proportioning structures and for selecting structural systems for earthquake resistance.

    The amount and distribution of reinforcement in each test structure will be based on a simple "design model" which reflects the influence of design decisions made concerning the tolerable damage in different structural elements.

23. Community Response to Earthquake Threat in Southern California; Ralph H. Turner; University of California-Berkeley, Department of Sociology, Berkeley, CA 94720; **Award #78-23887**

This study focuses on social response to a major uplift along the San Andreas fault and other premonitory signs of a destructive earthquake in the Los Angeles area. The data include results of a sample survey of residents of Los Angeles County, periodic follow-up telephone interviews, monitoring of the mass media, and interviews with selected public- and private-sector leaders. An innovative feature of the research plan is the development of special variations of a telephone reinterview schedule that can be fielded within a few days of any of the following contingencies: a destructive earthquake; a mild but widely felt earthquake; a new or more definite or threatening prediction announcement; cancellation of a prediction or warning; or disconfirmation of a prediction. The research should produce recommendations on optimal ways to release earthquake prediction information, effective strategies for involving State and local government leaders in the warning process, and useful strategies for securing public cooperation in a hazard-reducing response to earthquake prediction.

24. Risk-Based Assessment of the Safety of Dams; Erik H. Vanmarcke; Massachusetts Institute of Technology, Department of Civil Engineering, Cambridge, MA 02139; **Award #78-15898**

The objective of this project is to develop a methodology for quantitative assessment of the risk of dam failure, to assess alternative measures for dam hazard mitigation, and to establish a scientific basis for risk-based dam safety design provisions and criteria.

Risk analysis methodology will be developed for specific dam failure causes and mechanisms such as hydrology, earthquake, stability and landslide, foundation defects and uneven settlement, and load combinations. Efforts will also be made to apply the methods developed to specific dam engineering problems in order to test methodologies, and to uncover needed improvements in procedures.

25. Seismic Vulnerability, Behavior and Design of Underground Piping Systems; Leon R. Wang; Rensselaer Polytechnic Institute, Department of Civil Engineering, Troy, NY 12181; **Award #78-15856**

Seismic damage to lifeline systems has been receiving increasing attention from the engineering profession because of potential impact upon the populace during and after a major earthquake. Buried water and sewer lines may affect the health and safety of the population through possible contamination of water supplies and reduction of firefighting capabilities after an earthquake. Usually the design of underground piping for water and sewer distribution systems to resist external loads is based on static analyses; thus, there are no codified provisions for the design of lifeline systems to resist seismic loads.

This research will result in systematic ways of assessing the adequacy of existing water and sewer distribution systems, determining the vulnerability of such systems to earthquake damage and studying the cost-effectiveness of new designs for earthquakes of various magnitudes. Emphasis will be placed on the development of different levels of analysis and design procedures for piping systems in various seismic, soil and geological environments. The aim is to develop easily usable procedures for the design and assessment of buried water and sewer distribution systems.

26. Prediction of Earthquake Resistance of Structures; Ping Chun Wang; Polytechnic Institute of New York, Department of Electrical Engineering and Electrophysics, Brooklyn, NY 11201; **Award #76-14893 A02**

This project continues research on the development of a minimum method to generate reliable structural designs. A linear method has already been fully developed and a nonlinear method has been partially developed. Both methods have been applied to a limited number of test designs in previous studies.

This project is directed at the full implementation of the developed methods for elastic structures, and will complete the development of the theory, method, and design methods for inelastic structures. The research tasks to be carried out include: development of critical response spectra; development of computer programs; establishment of procedures for the choice of representative design variables; and the development of computational aids and computer programs in forms that can be directly used by the practicing engineers.

27. Seismic-Structure-Soil-Structure Interaction of Two or More Three Dimensional Structures; Hung L. Wong; University of Southern California, Department of Civil Engineering, Los Angeles, CA 90007; **Award #78-20901**

In the seismic design of structures, it is generally recognized that dynamic soil-structure interaction may significantly affect the response of the structure. One such interaction problem that requires further research is the interaction between two or more adjacent structures erected on the same soil medium.

To date, only a few reports have been presented on the subject of structure-soil-structure interaction for two or more foundations; most of the literature in the past has been devoted to the study of an isolated building placed on soil. This project will study the problems in structure-soil-structure interaction.

Parametric studies of seismic interaction of two or more three-dimensional structures will be

conducted. Computer programs for the analysis and engineering design will be developed. Simple and economical algorithms for embedded foundations and techniques to include nonlinear soil effects will be developed.

28. Stochastic Response of Tall Structures Under Environmental Loads; J. N. Yang; George Washington University, Civil, Mechanical and Environmental Engineering, Washington, DC 20052; **Award #78-24553**

    One of the most important problems in earthquake hazards mitigation research is to develop methods for stochastic dynamic analyses of structural responses. Environmental loads caused by earthquakes and wind are generally random in nature. Stochastic methods have not been fully developed or utilized to date because of the high level of mathematical sophistication and computational schemes required.

    This research will develop efficient analytical procedures for stochastic dynamic response analysis, taking into account the coupling effect of torsional and lateral motions. Loadings will be modeled as stationary and non-stationary random processes. A transfer matrix formulation will be developed and the computations will be performed utilizing a computer program. Development of approximate analytic procedures, treatment of non-linear effects, and sensitivity studies will also be included.

29. Simple Shear Behavior of Fine Grained Soils Subjected to Earthquake and Other Repeated Loading; Thomas S. Zimmie; Rensselaer Polytechnic Institute, Department of Civil Engineering, Troy, NY 12181; **Award #78-18743**

    The objective of this study is to develop a theoretical model based on effective stress principles for both normally consolidated and overconsolidated soils. Stress-strain characteristics will be investigated, as well as the static behavior of soils previously subjected to repeated loading. Probability theory and reliability analysis will be used to describe the cyclic behavior of soils. Because the *in-situ* structure of cohesive soils is an important parameter in determining their behavior, only natural undisturbed soil samples will be used. Undisturbed core samples from the Atlantic Coast, the Gulf of Mexico and the Gulf of Alaska will be tested. Strength and deformation behavior will be evaluated using a Norwegian Geotechnical Institute (GEONOR) Direct Simple Shear Device. Utilizing an actuator, a wide range of controlled stress or strain load forms will be used. Equipment characteristics will also be investigated.

Human Nutrition

The Human Nutrition program will address some important nutritional concerns. 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. However, effects on human health and performance of the life-long consumption of such processed foods have not been determined. PFRA will support research on the assessment of the nutrient value of processed foods through investigations of the physical, chemical and biochemical changes which occur in these foods during cooking, processing, packaging and storage. There were no awards made during the second quarter of FY 1979 under this program.

Science and Technology to Aid the Physically Handicapped

Science and Technology to Aid the Physically Handicapped will support 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 will involve researchers from many disciplines including biomedical engineering, medicine, law, and the social sciences working with the active participation of handicapped persons on these problems.

1. Automatic Measurement of Laryngeal Vibratory Patterns; Donald G. Childers; University of Florida, Department of Electrical Engineering, Gainesville, FL 32611; **Award #78-16965**

    Inability to provide vocal output prevents communication acoustically. This research will lead to an improved understanding of laryngeal vibrations and thereby aid in addressing the problems of correcting this physical handicap.

    This study is directed toward establishing a relationship between parameters of vocal cord motion as measured from ultra high speed laryngeal films and acoustic parameters extracted from audio recordings of phonation obtained simultaneously during the laryngeal filming process. The specific goal is to quantify and relate aspects of laryngeal vibratory motion by processing ultra high speed laryngeal films and simultaneously recorded phonations.

Automated analysis procedures will be developed to process both the films and the recorded phonations. Numerous parameters will be measured including glottal area, length, width, perimeter, velocity of motion, opening and closing phase, closed phase, open quotient, speed quotient, jitter and shimmer. The film analysis system will include algorithms to compensate for artifacts such as mucus in the glottal opening and the occlusion of the glottal boundary by the epiglottis and/or the arytenoids. The phonations will be processed by inverse filtering to obtain the glottal volume-velocity and residue. Comparisons will be made between the glottal area, the glottal volume-velocity and other parameters to determine which features are the most sensitive indicators of variations in the frequency and intensity of the subject's phonations.

The results of the study will contribute to our understanding of the manner in which the motions of the vocal folds are transformed into the unique sound generated.

2. Visual Feedback Speech Training for the Deaf—Phase II: Speech Analysis using Acoustic and Glottal Sensors; Walter C. Gish; Integrated Sciences Corp., 1640 Fifth Street #204, Santa Monica, CA 90401; **Award #78-21347**

This award supports Phase II of research initiated under NSF Program Solicitation 77-12: "Small Business Innovation Applied to National Needs." The goal is to develop a visual display of speech in a form useful for training the deaf.

The overall objective of Phase II is to provide an accurate parameterization of speech signals in terms of a speech model derived from the linear speech production theory. Results are expected to facilitate the application of previously developed statistical and pattern recognition techniques in providing more accurate and robust determinations of the speaker invariant characteristics of speech.

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