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Recent Awards: July-September 1980

NATIONAL SCIENCE FOUNDATION
Division of Problem-Focused Research
Directorate for Engineering and Applied Science
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 (PFR).

This brochure describes awards made by PFR primarily during the period of July 1 through September 30, 1980 (fourth quarter, Fiscal Year 1980). Awards made before July 1, 1980 are included here if they were not reported in a previous issue of *Recent Awards*. The data have been reconciled with the NSF's Management Information System.

PROGRAM ANNOUNCEMENT: SOCIETAL RESPONSE TO NATURAL HAZARDS AND DISASTERS

The Societal Response element of the Earthquake Hazards Mitigation Program in NSF's Division of Problem-Focused Research, Directorate for Engineering and Applied Science, will award approximately $1.8 million in Fiscal Year 1981 for social science, interdisciplinary, and policy-related research which deals with the socioeconomic, political, and legal aspects of natural hazards and disasters. Research proposals dealing with one or more of the following topic areas will be considered for support: Social and Economic Aspects of Mitigation; Preparedness; Disaster Impacts and Responses; and, Hazard and Disaster Information Dissemination.

Only proposals received before March 1, 1981 can be considered for Fiscal Year 1981 funding. Proposals received after that date will be considered for possible support in Fiscal Year 1982.

Anyone wishing a copy of this Program Announcement should write or call Ms. Ramona Lauda, Room 1134A, NSF, 1800 G. Street, N.W., Washington, D.C. 20550 (202) 357-7815. For additional information on the objectives of the Societal Response element of the Earthquake Hazards Mitigation Program contact Dr. William Anderson, Room 1134C, NSF, 1800 G Street, N.W., Washington, D.C. 20550 (202) 357-9780.

HOW TO OBTAIN RESEARCH REPORTS

One of the most important objectives of PFR is the timely and widespread dissemination of the results of PFR-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 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 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 found instead of furnishing a copy of the article.

DEFINITIONS AND EXPLANATION OF FORMAT

Study of Earthquake-Induced Bond Deterioration;[1] Neil M. Hawkins;[2] University of Washington, Department of Civil Engineering, Seattle, WA, 89195;[3] **Award #76-15366 A02**[4] $59,647 for 12 months beginning May 15, 1979[5]

1. **Title of the Award**
2. **Principal Investigator:** the chief scientist or administrator who is responsible for the research plan and fiscal expenditures as an NSF awardee.
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.
5. **Amount, Duration and Starting Date of the Award** (a duration of 0 months means the amount awarded is a supplement to an existing award).

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 topics have been selected for investigation in Fiscal Year 1980: Biological conversion of lignocellulosic materials to useful chemicals; production of speciality chemicals from arid land plants; and biosaline resources.

1. Chemicals from Biomass by Radiant Flash Pyrolysis; Michael J. Antal; Princeton University, Mechanical and Aerospace Engineering, Princeton, NJ 08540; **Award #80-08690**; $161,706 for 12 months beginning July 15, 1980.

   The objective of this project is to produce chemicals of industrial importance from biomass by thermochemical processes. Investigations deal with transport reactors which rely on radiant flash pyrolysis of particulate biomass to optimize yields of gaseous volative products, followed by very rapid gas phase cracking of the evolved products. Lignocellulosic materials to be investigated include selected hard and softwoods, agricultural residues (corn cobs), and various lignins, celluloses and hemicelluloses.

   Volatile matter evolved during the flash pyrolysis can be rapidly quenched and carried out of the reactor by a high countercurrent flow of relatively cold inert gas. This volatile matter is an intermediate between the solid phase biomass materials and the usual products observed in more traditional pyrolytic reactors. A peculiar aspect of the radiant flash pyrolysis reactor is its ability to rapidly heat solid particles in an otherwise cold environment, thus preserving their intermediate volatile matter for later chemical analysis. This project investigates whether the intermediate material may be a possible source of alkenes, carboxylic acids, ketones, and other industrial chemicals.

2. Microalgae Production of Glycerol and Related Chemicals on Saline Waters; John R. Benemann; Eco-energetics Inc., 2038 Pleasants Valley Road, Vacaville, CA, 95688; **Award #80-09848;** $24,901 for 6 months beginning September 1, 1980.

   Glycerol, an important industrial chemical, can be synthesized by salt-tolerant algae of the *Dunaliella* genus. To make such a synthesis commercially feasible, this project addresses such problems as the cost of harvesting the algae, maintaining a stable culture, the high capital costs of the ponds, and the processing of the algae biomass to obtain desired products. The primary objective of this project is to develop a low-cost harvesting technique for the glycerol-producing algae and to screen other salt-tolerant algae for high concentrations of valuable osmotic regulators (chemicals) including cyclitols and proline.

3. Enzymatic Transformations of Lignin; Wolfgang G. Glasser; Virginia Polytechnic Institute, Department of Chemistry, Blacksburg, VA 20461; **Award #79-13135 AO1;** $236,721 for 12 months beginning July 15, 1980.

   Lignin is the second most abundant organic material produced by plants. Lignin constitutes a vast potential renewable resource base for producing chemicals and organic polymers, but to date its structural and chemical complexity has prevented effective utilization. Biotransformation of wood, including its lignin component, is accomplished naturally by various 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 to develop enzymatic or microbial processes for the conversion of lignin to commercially valuable materials. Specifically, the objectives of this three-year project are to: (a) refine determinations of the actual chemical changes brought about in lignin during transformations by microorganisms in laboratory cultures or by cell-free lignin-transforming enzymes; (b) investigate the effect on lignin of enzymatically generated reactive oxygen species; (c) explore alternatives to classical fermentation systems for lignin transformations; and (d) pursue actual utilization schemes for the microbially and enzymatically transformed lignins.

4. A Multifaceted Approach to Enhancing Biological Nitrogen Fixation; Marvin Lamborg; Charles F. Kettering Research Foundation, 150 East South College Street, Yellow Springs, OH 45387; **Award #77-27269**; $194,702 for 12 months beginning July 15, 1980.

   The goal of this continuing research project is to increase the capacity for nitrogen fixation of several living organisms and of the enzyme involved in the process through physiological and chemical manipulations. During the first two years of this project, the effect of various environmental conditions on the growth of *Azolla* has been determined, the relationship between extracellular polysaccharide production and nitrogenase activity of *Rhizobia* clarified, and measurements on the spectral and electrochemical properties of pure molydenum-iron cofactor completed. In the projects third year, physiological studies on *Azolla* and *Rhizobia* continue and the chemical properties of the Fe-Mo cofactor are further elucidated.

5. 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 AO3**; $667,819 for 12 months beginning June 15, 1980.

   The four major objectives of this continuing multidisciplinary research 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 of 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.

   During this, the project's fourth year (out of five), the research includes (1) the regulation and expression of hydrogenase genes in *Rhizobium japonicum*; (2) the construction, identification and field testing of more effective strains of *R. japonicum*; (3) the evaluation of selected *Azolla-Anabaena* under fallow field and rice culture conditions; and, (4) the transport of nitrogen compounds in the soil and their assimilation by the plant.

6. Photoproduction on Hydrogen by Marine Blue-Green Algae; Akira Mitsui; University of Miami, 4600 Rickenbacker Causeway, Miami, FL 33124; $135,117 for 12 months beginning August 15, 1980.

   Marine environments contain many species of blue-green algae and photosynthetic bacteria capable of producing hydrogen gas from renewable resources. Marine blue-green algae are particularly attractive, for they produce hydrogen gas from seawater using sunlight as the ultimate source of energy.

   The objective of this project is to assess a previously discovered marine *Oscillatoria* algae (Miami BG 7), capable of very high hydrogen production for further development. Objectives include evaluating the effectiveness of natural seawater as a medium for growth, determining the role of key environmental parameters in regulating growth in scale-up cultures, and designing and operating an outdoor hydrogen production system.

   This year's research objectives represent the necessary next steps in the development of a scaled-up system for producing hydrogen and are based on work performed by the Principal Investigator under previous NSF support.

7. Investigation of a New Source of Natural Rubber in the United States; W. Kent Ostler; Native Plants Inc., 2842 South West Temple, Salt Lake City, UT 84115; **Award #80-09401**; $24,999 for 6 months beginning September l, 1980.

   In addition to guayule, several other plants were studied as potential sources of natural rubber for the U.S. during world War II (e.g., Russian dandelion, Madagascar rubber vine, rabbitbrush and Edison's goldenrod). The objective of this award is to assess the potential of rabbitbrush, *Chrysothamnus nauseosus*, a native shrub of Western United States. It is more cold tolerant and grows over a wider region than guayule.

   Under this award, researchers will collect plants from 9 regions in 10 states, extract rabbitbrush rubber and compare yield and quality with guayule rubber, assess the plants environmental characteristics at the sample sites; and formulate plans for further research.

8. The Chinese Tallow Tree as a Source of Petroleum Substitutes; H. William Scheld; Simco Inc., 61 River Road, Weston, CT 06883; **Award #80-10567**, $25,000 for 6 months beginning September 1, 1980.

   The Chinese tallow tree, *Sapium Sebiferum* Roxb., is an introduced species of semi-tropical plant which has become naturalized in coastal wetlands from south Carolina to Texas. It is a potential high-yielding source of fat and oil which could substitute for petroleum-derived lubricants and chemical intermediates.

   This project makes a preliminary survey of the economic potential of the Chinese tallow tree on which detailed research plans for its development and exploitation can be based.

9. Development of Superior Cultivars of Jojoba; Demetrios M. Yermanos; University of California-Riverside, Department of Plant Sciences, Riverside, CA 92521; **Award #78-12709 AO2**, $77,129 for 12 months beginning October 1, 1980.

   The objective of this three-year continuing grant is to develop superior cultivars of jojoba, a potential rubber producing crop for the arid lands of southwestern U.S. and northern Mexico.

   During the past two years, 1200 single plants selected for high seed oil content, cold resistance or salt tolerance were field tested for further evaluation. Cloning of jojoba plants has been accomplished by tissue culture and via cuttings. An apparently monoecious strain of jojoba has been developed. Agronomic experiments have been initiated. In the project's third year these studies continue to identify and establish agronomically superior cultivars suitable for commercial plantings.

10. Biological Systems for Lignocellulose Conversion; J. G. Zeikus; University of Wisconsin-Madison, Department of Bacteriology, Madison, WI 53706; **Award #79-10084 AO1**, $78,740 for 12 months beginning August 1, 1980.

    Cellulose and lignin constitute the bulk of plant matter on earth. 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 the 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 on cellulosic matter to high yields of ethanol or acetic acid is to be evaluated in mono- and co-culture fermentations with *C. thermocellum*.

EARTHQUAKE HAZARDS MITIGATION

The goals of the Earthquake Hazards Mitigation (EHM) 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. Earthquake Induced Longitudinal Vibration of Earth Dams; Ahmed M. Abdel-Ghaffar; Princeton University, Department of Civil Engineering, Princeton, NJ, 08450; **Award #80-05615**, $22,410 for 10 months beginning January 15, 1980.

   This research analyzes the longitudinal vibrational behavior of earth dams during earthquakes. The principal objectives of the investigation include development of a simplified method, using an analytical elastic model, for evaluation of dynamic characteristics of earth dams in a direction parallel to the dam axis, and development of estimates of earthquake-induced strains and stresses in that direction. Both shear and compressional (axial) deformations will be considered. In addition, results of full-scale dynamic ambient and forced tests, and real earthquake observations of some existing dams will be utilized to confirm and improve the method of analysis. Secondly, a procedure will be developed to estimate dynamic strains and corresponding elastic moduli and damping factors for earth dams from their hysteretic responses to real earthquakes utilizing the hysteresis loops from the crest as well as the base records of earth dams. This will lead to a study of the nonlinear behavior in terms of the variation of stiffness and damping properties with the strain levels of different loops. Data so obtained are compared with data previously available from laboratory investigations.

2. Improved Numerical Modeling and Computer Techniques for Predicting Tsunami Inundation; William M. Adams; University of Hawaii-Manoa, Institute of Geophysics, Honolulu, HI 96822; **Award # 80-08289**; $34,845 for 12 months beginning October 15, 1980.

   This research is concerned with predicting in real-time the amount of inundation along a coastline which will occur due to a tsunami running up on shore. The method used is based on a physical runup model containing coefficients which are adjusted to combine the physics pertinent to a tsunami and the estimated best-fit using available historical data. A numerical computation technique has been developed using a finite difference approach. This model provides a great deal of flexibility in representing coastal configurations and relief. The technique is being tested on a number of areas for which data are available. The program will be modified to operate on small computers which are now readily available. This will permit very economical further studies and make possible more widespread practical use of the inundation model.

3 Guidelines for Mitigation of Seismic Hazards in Tilt-Up-Wall Structures; Samy A. Adham; Agbabian Associates, 250 North Nash Street, El Segundo, CA 90245; **Award #80-09736**; $23,863 for 6 months beginning September 1, 1980.

   Tilt-up-wall construction is a form of precast construction used primarily in one-or-two story buildings. Wall panels are cast in a horizontal position at the site and after curing are tilted up into place.

   Practical and reliable analysis methods and construction guidelines are needed to determine the seismic response and failure mechanisms of tilt-up-wall structures. This Phase I research identifies improved methods and construction guidelines for the analysis and construction of tilt-up-wall structures subjected to earthquake motions. Test procedures are developed for execution in a Phase II program.

4. Investigation of Reinforced Brick Masonry Buildings Undamaged by the San Fernando Earthquake; Samy A. Adham; Agbabian Associates, 250 North Nash Street, El Segundo, CA 90245; **Award #79-00013 AO1**; $9,348 for 3 months beginning August 1, 1980.

   This research project analyzes a group of unreinforced brick masonry buildings that were subjected to strong ground motions during the 1971 San Fernando earthquake but which sustained no significant structural damage. Post-quake attention is generally focused on damaged buildings; however, a study of undamaged buildings of similar construction located in the same area is needed to understand why such significant variations in building response and damage occur. Factors studied include local geology, soil-structure interaction, frequency content, amplitude

and duration of ground motion, the specific dynamic response characteristics of a structure or differences in construction details. An explanation of the differences in response of similar structures shaken by the same earthquake will greatly improve knowledge of earthquake engineering and will lead to improvements in the design and construction of earthquake-resistant structures.

5. Investigation of the Seismic Resistance of Interior Building Partitions; Raymond W. Anderson; Agbabian Associates, 250 North Nash Street, El Segundo, CA 90245; **Award #80-09921** $23,864 for 6 months beginning September 1, 1980.

   This study investigates the effectiveness and participation of interior shear wall partitions in determining the ultimate resistance capacity of a masonry building to seismic loading. If shear wall partitions contribute significantly to the lateral load resistance of a building, this could mean a significant reduction in the cost of strengthening existing structures when increased seismic resistance is required.

   This research combines analysis and testing to investigate the in-plane shear load resistance of various combinations of construction material commonly utilized for interior partition walls. The goal of this research is to contribute to the establishment of guidelines and recommendation for utilizing existing interior partitions as shear walls for strengthening these systems when additional shear wall resistance is required.

6. Earthquake Response and Aseismic Design of Underground Piping Systems; Teoman Ariman; University of Tulsa, 600 South College Avenue, Tulsa, OK 74104; **Award #80-26573**; $38,900 for 12 months beginning October 1, 1980.

   This research investigates the earthquake response and earthquake-resistant design of underground piping systems utilized in energy transport. The earthquake protection of utility systems has become increasingly important because of accelerated urbanization. As a result of population growth and land development, more substructures for utilities and transportation systems are being placed underground, and the need to maintain the critical services of such utility systems during and after an earthquake has become clear. The vulnerability of such underground lifelines systems to earthquakes is well known, but current design regulations are insufficient due in large part to an absence of basic scientific and engineering research directed specifically to this topic.

   This research is directed particularly at the study of buried gas pipelines. The research includes a comprehensive review of current design practice for underground gas pipelines and an analysis of various pipe failure mechanisms due to seismic excitation. Special emphases is placed on the fracture failure of pipelines. A set of practical tools for the design of underground pipelines in a seismic environment is developed.

7. Methods and Costs of Maintaining Hospital Functions in Earthquakes; Christopher Arnold; Building Systems Development Inc., 120 Broadway, San Francisco, CA; **Award #78-20902 AO1**; $18,199 for 6 months beginning September 1, 1980.

   A major concern in earthquake disasters is for the survival of critical facilities which will be immediately necessary for rescue, relief and recovery activities. Since the San Fernando Earthquake of 1971, in which there were two serious hospital failures, high priority has been placed on providing for the structural and functional survival of hospitals in earthquakes. This is important both for the safety of patients and staff during the earthquake and in order that the hospital be fully operational following the earthquake in order to dispense aid to the injured.

   While considerable attention has been paid to the issue of structural survival (the California Hospital Code and the Veterans Administration seismic reinforcement program), relatively little study has been directed to the issue of non-structural damage control in hospitals and its relationship to hospital functionality. Hospitals are very complex systems with intricate electrical, mechanical, and life support systems. The interaction of these systems during extreme shaking is not well understood. The impact of non-structural failure on hospital function is also not well understood. This research develops alternative measures for the reduction of non-structural damage in new and existing hospitals and assess the costs involved in alternative damage control strategies.

8. Analysis of Lifelines Subjected to Earthquakes; Richard E. Barlow; University of California-Berkeley, Operation Research Center, Berkeley, CA 94720; **Award #78-22265 AO1**; $92,819 for 12 months beginning June 1, 1980.

   This research addresses the development of a systematic procedure for assessing the reliability of lifeline systems subjected to strong motion earthquakes. Emphasis is on a methodology for review of existing lifeline systems. Common features and differences of these systems are mathematically modeled to permit systematic refinement of details based on experience. The behavior of elements of the lifeline system is studied from a structural engineering viewpoint. The resulting methodology is applied to an actual lifeline system in California.

9. 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 AO4**; $28,072 for 0 months beginning June 1, 1980.

   The objective of this project is to develop a body of knowledge on how to prepare for and respond to a major national earthquake disaster by studying the aftermath of the Guatemalan earthquake of February 4, 1976. Specific project objectives are to study: (1) the impact of an earthquake on a nation and its society; (2)

the effects of U.S. Government and private sector disaster relief on the recovery process; (3) coordination of U.S. relief with relief from more than 30 other countries; (4) the effects of the earthquake and the relief efforts on U.S. sponsored development programs in Guatemala.

10. U.S.-Japan Cooperative Earthquake Research Program: Earthquake Simulator Tests of a Replica Model Reinforced Concrete Building; Vitelmo V. Bertero; University of California-Berkeley, Department of Civil Engineering, Berkeley, CA 94720; **Award #80-09478**; $225,000 for 12 months beginning September 15, 1980.

    This project represents an integrated analytical and experimental study centered around the shaking table tests of a one-fourth scale true replica model of the prototype reinforced concrete (R/C) building to be tested at Tsukuba Science City, Japan. The project's objective is to improve current seismic design practices by 1) conducting analytic studies to review the design of the R/C test building and to predict the response of prototype and model; 2) constructing a one-fourth scale true replica test specimen and conducting shaking-table tests and free and forced vibration tests; and 3) conducting correlation and evaluation studies of the results of analytic and experimental studies. This project is supported under the U.S.-Japan Cooperative Earthquake Research Program on Large-Scale Testing.

11. Investigation of Performance of the Imperial County Services Building during the 1979 Imperial Valley Earthquake; Vitelmo V. Bertero; University of California-Berkeley, Department of Civil Engineering, Berkeley, CA 94720; **Award #80-09040**; $64,914 for 12 months beginning September 15, 1980.

    This project conducts integrated field, experimental and analytical studies of the performance of the Imperial County Services Building in El Centro, California which was damaged during the Imperial Valley earthquake of 15 October 1979. Results obtained from these studies will be valuable not only in evaluating current and future seismic-resistant design and construction practices but also in improving such practices. This is the first time that precise and reliable information regarding both the nature of the damaging ground motions, and the response of a building to that ground shaking, has been available for detailed study.

    This project includes (1) field studies to document the performance of the structural and nonstructural components of the building, and to select proper locations for removal of specimens of materials and columns whose behavior is investigated experimentally; (2) laboratory experimental studies to determine the mechanical characteristics of material to predict the elastic and inelastic behavior of the columns that failed, and, (3) analytical studies to estimate the time histories of the response of the entire building, particularly the internal forces and deformations which the failed columns experienced during the response of the building to the recorded ground motions.

12. Scientific and Technical Information Exchange in Earthquake Research Between the United States and the People's Republic of china: E E R I Delegation; John A. Blume; Earthquake Engineering Research Institute; 2620 Telegraph Avenue, Berkeley, CA 94704; **Award #80-19240**; $28,800 for 12 months beginning August 15, 1980.

    The Earthquake Engineering Research Institute (EERI) sent a delegation of U.S. earthquake engineering experts to tour the People's Republic of China (PRC) in September 1980. The purpose of the tour is to broaden the Implementing Protocol in earthquake research signed by the U.S. and the PRC in January 1980. The program calls for the formation of a working group to coordinate U.S. earthquake research activities with those of the PRC. The U.S. delegation to the PRC consisted of eleven persons (ten delegates and one staff member).

    The delegates toured the PRC as guests of the Chinese Earthquake Engineering Committee, visiting areas damaged by earthquakes and meeting with representatives of organizations and institutions engaged in earthquake research in the PRC.

    At the conclusion of the visit, a report will be prepared and published by EERI. The report will describe the tour and will identify additional U.S.-PRC mutual research needs and priorities that are revealed through the visit. The report will be useful in guiding and broadening the Implementing Protocol for U.S.-PRC cooperative earthquake research.

13. The Impact of Disaster Aid Programs of Long-Term Family Recovery: A Longitudinal Comparison of a Rural and an Urban Site; Robert Bolin; New Mexico State University, Department of Sociology and Anthropology, Las Cruces, NM 88003; **Award #80-20231**; $101,280 for 18 months beginning August 1, 1980.

    This study examines the role of local, state, and Federal relief programs in facilitating family recovery from natural disaster. Differences between rural and urban families regarding the availability and utilization of relief and recovery aid are studied, as well as differences between age and socioeconomic groups.

    Two disaster sites in Texas which were struck by recent tornados are studied: an urban location and a smaller community. Data gathering include interviews with victim families and officials in relief agencies. This research will lead to recommendations on how aid programs might be modified to promote faster and more complete family recovery following various natural disasters including earthquakes.

14. The National Strong-Motion Program; Roger Borcherdt; Geological Survey, 12201 Sunrise Valley Drive, Reston, VA 22092; **Award #73-07125 AO9**; $1,100,000 for 12 months beginning October 1, 1980.

    This project continues support of the national earthquake strong-motion (SM) program. The principal ob-

jectives of the program are: to maintain and operate the national SM network, to record SM data, to develop and operate a national center to acquire, process, disseminate, and archive SM data for use by research scientists and engineers worldwide, and to establish data-management standards in cooperation with university groups and other Federal, State, and local agencies.

The program is structured around SM data acquisition and SM data management. Research elements pertaining to data management include: operation, improvement and development of established networks; evaluation of digital SM instruments; and investigation of existing SM site characteristics. Elements for SM data management include the establishment of a interactive SM data management system and development of command language and interactive software. The results obtained will be presented in the publication entitled, "Seismic Engineering Program Report," which summarizes the preliminary data and information obtained each quarter, in "Strong-Motion Data Reports" that present more detailed data and analysis, and through papers published in technical journals.

15. Seismic Design Decisions in the Building Process; Michael Brill; Buffalo Organization for Social and Technical Innovation, Inc., 1479 Hertel Avenue, Buffalo, NY 14216; **Award #79-20566**; $67,440 for 9 months beginning September 15, 1980.

    Many building process decision-makers are insensitive to the importance of their role in increasing the siesmic safety of buildings. This is often due to: the building industry's complex, decentralized and fragmented nature, which impedes information flow even when useful information is available; lack of a systems framework within which decision-makers can see and understand the seismic safety implications of their decisions; pressures to trade-off seismic safety for other benefits; and, failure of some decision-makers, such as mortgage bankers and realtors, to perceive themselves as making decisions which have critical impact on seismic safety of buildings.

    In order to make better use of available seismic information throughout the design-decision process, this project develops a multi-phase decision model of the entire building process and tests its clarity to all participants. This work may be applied in subsequent research to ascertain which of these decisions are seismically critical through hazard analysis of prototype buildings under earthquaked simulation.

16. Cyclic Response of Masonry Anchor Bolts; Russell H. Brown; Clemson University, Department of Civil Engineering, Clemson, SC 29631; **Award #78-06095 AO1**; $67,285 for 20 months beginning July 15, 1980.

    Masonry load-bearing structures depend on diaphragm and shear wall action to resist lateral forces from wind or earthquake. The connection between the floor system and the bearing wall is a critical part of the structural system. Many such connections require the use of anchor bolts. This project will provide information on the cyclic strength and behavior of anchor bolts in masonry.

    Anchor bolts are embedded in masonry walls and subjected to cyclic reversed loading (applied axially and transversely simultaneously). Variables include loading history, bolt size, bolt spacing, bolt position, mortar type, masonry unit type, and wall reinforcing. Specific objectives of this research are to determine the strength of anchor bolts in masonry subjected to cyclic axial forces and shear forces acting simultaneously; to develop design recommendations for anchor bolts in masonry structures in high wind and earthquake zones; and to develop mathematical models to predict the behavior of anchor bolts in masonry.

17. Special Studies Related to the Imperial Valley Earthquake of October 15, 1979; James N. Brune; University of California-San Diego, Institute of Geophysics, La Jolla, CA 92093; **Award #80-07418**; $61,445 for 12 months beginning September 1, 1980.

    The Imperial Valley Earthquake of October 15, 1979 provided a wealth of strong motion data. This event produced the highest recorded accelerations and velocities of any earthquake to date, even though it was only of moderate magnitude (6.6). Extensive instrumentation in the area has allowed, for the first time, a detailed study of the focusing of energy by rupture propagation and of the performance of digital and conventional acceleragraphs.

    The research includes: (1) preparation and analysis of strong motion data obtained from special new digital accelerographs; (2) special instrument checkout and calibration to verify the data recorded; (3) reconnaisance survey of site conditions and shallow site geology of each station; (4) preparation and analysis of data from numerous aftershocks recorded on digital seismographs and on digital strong motion instruments; and (5) comparison of integration using digital delay records with integration using conventional records.

18. Application of the Random Technique to Improve the Earthquake Survivability of Structures on Soil Foundation; Jigien Chen; Advance Technology Research Inc., Department of Mechanical Engineering, Silver Spring, MD 20903; **Award #80-09731**; $25,000 for 6 months beginning September 1, 1980.

    This research applies a new method, Random Decrement Analysis, to measure the damping of structures on soil foundation and to assess their integrity after a major earthquake.

    The Random Decrement is used not only to measure the damping of the structure and soil foundation, but also to find the resonant frequencies and mode shapes from which it is possible to develop simplified analytical models that simulate their dynamic response. These analytical models can then be used to assess hazard potential in the event of exposure to a major earthquake.

The method can also be used to detect major earthquake damage in a structure by noting changes in the Random Decrement signature before and after exposure to the earthquake.

This method may provide a very efficient means of structural evaluation because any type of in-service random loading excitation (i.e., wind or earthquake) can be used to obtain the Random Decrement response signature.

19. Risk Analysis for Natural Hazards Damage Mitigation, Arthur N. Chiu; University of Hawaii-Manoa, Department of Civil Engineering, Honolulu, HI 96822; **Award #79-24726**; $60,000 for 12 months beginning August 1, 1980.

    The objective of this project is to improve the methodology and data base for safe design due to extreme lateral loads on structures such as occur from earthquakes and wind. Yearly reports of structural damages caused by natural hazards indicate that current design methods and criteria are apparently dificient. This research treats the problem of predicting extreme effects over a long time period from a run of data which are available only for a portion of the time period. Although the problem is common to both earthquake and wind effects, there is a better data base available for wind effects (particularly as developed by researchers in Taiwan) which can be used to test the methods developed. The research is carried on cooperatively with researchers at the National Taiwan University. Specific tasks include review of historical data, collection and analysis of current data, a study of techniques to carry out measurements on structures to better relate response to leads, and the development of improved design methods for extreme lateral loads on structures.

20. Seismic Behavior of Cellular Cofferdams; Paul P. Christiano; Carnegie-Mellon University, Department of Civil Engineering, Pittsburgh, PA 15213; **Award #80-06781**; $64,638 for 12 months beginning October 15, 1980.

    This research deals with the seismic behavior of a single cellular cofferdam bearing on a rigid base in the absence of surrounding soil or water. The objective is to determine stress and displacement distributions in the shell and fill under the action of earthquakes having a range of characteristics such as intensity, duration, frequency, and other related parameters. Typical ranges of geometries and materials are also considered.

    Specific objectives of this research are to: (1) establish the characteristics of a cofferdam which is modeled as a linear damped finite element system; (2) investigate the extent to which "equivalent" material properties which account for the reduction in shear modulus and increase in material damping with increasing shear strain affect the results of the seismic analyses; and (3) investigate the importance of incorporating nonlinear material properties through a time-domain analysis. Nonlinearities include the change of mean and deviatoric stresses and their effect on stiffness and dilation. Both fully drained and undrained conditions are investigated.

21. U.S.-Japan Cooperative Earthquake Research Program: Quasi-Static Tests on Planar Reinforced Concrete Structures; W. G. Corley; Portland Cement Association, Engineering Development Division, Skokie, IL, 60076; **Award #80-08753**; $120,964 for 12 months beginning September 15, 1980.

    Three medium-scale reinforced concrete assemblies are designed, fabricated, instrumented, and tested under quasi-static reversing loads. The assemblies include an isolated wall, a wall-frame combination and a plane frame. Details of the assemblies are based on a full-scale, seven-story test structure. Loading history applied to the specimen will simulate corresponding analytically predicted deformations of the prototype structure under moderate and severe earthquake conditions.

    Test results are used to validate mathematical modeling of similar elements in prototype structures. They also provide information about performance of assemblies prior to construction and testing of full-size structures. This project, which deals with the test of major structural assemblies, is an integral component of the U.S.-Japan Cooperative Earthquake Research Program on Large-Scale Testing.

22. In Situ Testing in Regions Liquefied During the 1979 Imperial Valley Earthquake; Bruce J. Douglas; Fugro Inc., Department of Earthquake Engineering and Soil Dynamics, Long Beach, CA 90807; **Award #80-07419**; $46,603 for 12 months beginning July 15, 1980.

    The Imperial Valley earthquake of October 15, 1979 produced lateral spreading, slumping, and sand boiling as a result of widespread liquefaction. These events provide a timely opportunity for gathering of in situ data defining physical characteristics of recently liquefied soils. Field investigations are performed both within and outside of the affected areas, and include static cone penetrometer tests (CPT), standard penetration tests (SPT), and self-boring pressuremeter tests (PMT).

    The data obtained will provide a set of baseline measurements of soil physical characteristics that can be used for calibration of data measured in the future. Subsequent measurements will contribute to an understanding of the effects of time upon the measured properties. The data allow determination of site stratigraphy and strength, relative density, and stress state of soils from both the nonliquefied as well as from the liquefied regions, and permit verification of the physical changes theorized as occuring in soils undergoing liquefaction. The data are used to develop the CPT as a standard, reliable, and cost-effective tool for use in liquefaction potential assessment on a site-specific or regional basis.

23. Earthquake Mitigation Policy Formulation Processes: A Comparative Case Study; Thomas E. Drabek; University of Denver, Department of Sociology, Denver, CO, 80208; **Award #80-06449**; $149,000 for 12 months beginning July 15, 1980.

    This project investigates the development of earthquake mitigation policy in Utah and Washington, two states with major seismic risks. Case studies of these states provide a comparative picture of how earthquake policy develops, how networks or organizations which establish and implement such policy form, and how patterns of interorganizational communication and cooperation influence policy outcomes.

    This 18 month study consists of three phases: (1) interviews with officials responsible for making earthquake mitigation policy; (2) studies of controversies about earthquake mitigation policy; and, (3) mail surveys of county officials to determine their knowledge of and attitudes toward earthquake mitigation policies.

24. Earthquake Studies on the Imperial County Services Building Modeling; C. M. Duke; University of California-Los Angeles, Mechanics and Structures, Los Angeles, CA 90024; **Award #80-13666**; $50,000 for 12 months beginning September 1, 1980.

    This project analyzes the strong motion earthquake records obtained in the Imperial County Services Building and at its associated free-field station during the 15 October 1979 earthquake. Analytical models of the building are developed; these are used to extend the information obtained from the strong motions records in order to obtain detailed building component responses. The usefulness of the models in describing the mechanism of failure of the building is evaluated. The seismic performance of the Imperial County Service Building is assessed.

25. Methodology for Evaluating and Improving Operational and Non-Structural Aspects of Office Buildings; Michael E. Durkin; Space for People, 672 South Layfayette Park Place, Suite 45, Los Angeles, CA 90057; **Award #80-09893**; $25,000 for 6 months beginning September 1, 1980.

    The product of this research is a commercially viable methodology for evaluating and improving operational and non-structural aspects of office buildings to reduce earthquake loss. A pressing need exists for a methodology for evaluating and improving operational and non-structural aspects of office buildings. Previously, attention has been directed to structural survival without consideration on non-structural effects. However, there is increasing recognition that operational and non-structural aspects are significant factors in the total amount of the loss that an office building and the organizations and individuals who occupy that building are likely to suffer in an earthquake.

26. Earthquake Safety of Water Distribution Networks Based on the Concept of Balanced Risk; Ronald T. Eguchi; J.H. Wiggins Company, Department of Earthquake Engineering, Redondo Beach, CA 90277; **Award #80-05083**; $206,486 for 18 months beginning August 15, 1980.

    Design decisions about the severity of seismic environments have been primarily limited to special structures (e.g., nuclear power plants and high rise buildings). Recently, attempts have been made to extend similar risk concepts to other systems, such as lifelines. Lifeline systems are critical and, in many respects, unique, because they must remain functional after a major earthquake. Because of this, it is important to be able to determine quantitatively the reliability of a system and to determine whether that reliability is acceptable.

    This research is concerned with developing a methodology for determining system reliability as a function of regional seismicity and lifeline system vulnerability. Reliability is defined as the probability that the system operates at a specified level of performance within a given period of time. Performance levels are developed in terms of the percentage of people without service after the earthquake, the outage time, and the time to full restoration.

    The analysis of system reliability is used to generate probabilistic maps of potential outage areas. An outage area is defined as an unacceptable percentage of the population without service for a specified length of time. Because these maps delineate vulnerable areas of the system, they are used to ensure that critical emergency equipment and supplies be available in the event of an earthquake and to establish and plan retrofitting and repair programs.

27. Earthquake Damage Evaluation; Robert Englekirk; Kuthroff Englekirk and Hart, 3242 West 8th Street, Los Angeles, CA 90005; **Award #80-09902**; $24,301 for 6 months beginning September 1, 1980.

    This research develops a computer program which calculates the expected dollar damage to a specific building due to earthquake. The program incorporates uncertainty in various parts of the estimation process and the damage estimates reflect this uncertainty. The computer program is for use by structural engineers and reflects the special requirements imposed by the structural design profession and the developer/structural engineer relationship.

28. Theoretical and Experimental Studies on Timber Diaphragms Subjected to Earthquake Motions; Hota V. Gangarao; West Virginia University, Department of Civil Engineering, Morgantown, WV 26506; **Award #78-04769 AO1**; $58,965 for 12 months beginning July 1, 1980.

    Wood is widely used for many structural applications because of its inherent economic advantages, ease of construction, high-strength-to-weight ratio, and excellent thermal properties. Plywood roof and floor diaphragm systems under cyclic and earthquake type loading conditions are theoretically analyzed for

several boundary conditions and joint configurations where orthotropic material properties and joint slip effects will be considered.

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

29. Morphology of Tensile and Pneumatic Structural Systems for Seismic Design; Susan P. Gill; Abri Inc., 888 Massachusetts Avenue, #517, Cambridge, MA 02139; **Award #80-09956**; $25,000 for 6 months beginning September 1, 1980.

    Aside from the effects of great fires, over 90% of the loss of life occasioned by earthquakes, and more than half the property loss, results from the failure of works of construction. Tensile and pneumatic fabric structures, because of their lightness and response flexibility, are particularly seismically resistant. Tensile and pneumatic structures have unique advantages in that all parts of the structure are tied together, providing for a balanced morphological response to loading. Recent developments in structural fabrics and inflatable thermal quilt insulation systems have made possible the consideration of such structures as permanent constructions.

    The objective of this study is to identify tensile and pneumatic structural systems which are particularly stable under earthquake loading. Various types are considered with respect to their structural performance and potential application in earthquake-prone regions.

30. Influence of Non-Structural Cladding on Dynamic Properties and Response of High-Rise Buildings; Barry J. Goodno; Georgia Institute of Technology, Department of Civil Engineering, Atlanta, GA 30332; **Award #77-04269 AO2**; $96,041 for 12 months beginning July 1, 1980.

    Studies of the exterior cladding of multi-story buildings subjected to seismic forces have shown that cladding may actually provide considerable resistance to low level excitation and thus help control inter-story drift and building motion. This research investigates whether the stiffness and energy absorption capacity of cladding can be used to advantage in modern building designs by studying the problem of cladding-structure interaction.

    Findings are expected to be of immediate use to designers in integrating cladding into structural design, and are directly applicable to problems of low level response, which are largely linear. With experience gained in the linear problem, future studies of cladding-structure interaction which encompass both material and geometric nonlinearities and strong ground motion excitation are anticipated.

31. Workshop on Seismic Performance of Low Rise Buildings; Ajaya K. Gupta; North Carolina State University at Raleigh, Department of Civil Engineering, Raleigh, NC 27607; **Award #80-24726**; $7,700 for 12 months beginning September 1, 1980.

    A two day workshop on the seismic performance of low-rise buildings was organized by Professor Gupta and held in Chicago during the period May 13-14, 1980. Professor Gupta, who is now at North Carolina State Universtiy, is working under the present grant to publish a Proceedings of the workshop and presented a report on the conclusions of the workship at the 7th World Congress on Earthquake Engineering held in Istanbul, Turkey in September 1980.

32. Studies of Ground Motion of Two California Earthquakes; Thomas C. Hanks; Geological Survey, Office of Earthquake Studies, Menlo Park, CA 94025; **Award #80-13669**; $140,040 for 24 months beginning August 15, 1980.

    Approximately 150 strong motion accelerograms, including significant records of aftershocks, of the Imperial Valley Earthquake (October 15, 1979) will be digitized. The digital accelerograms processed by computer and put into specific data formats, and the data are analyzed with respect to the efficacy of the root-mean-square and faulting duration pair as potentially useful measures of high frequency strong ground motion for engineering purposes. Seismological investigations of the causative source mechanisms are studied. The project permits rapid dissemination of these important data to the earthquake engineering community.

33. U.S.-Japan Cooperative Earthquake Research Program: Development and Verification of the Psuedo-dynamic Test Method; Robert D. Hanson; University of Michigan, Department of Civil Engineering, Ann Arbor, MI 48109; **Award #80-08583**; $60,000 for 12 months beginning August 1, 1980.

    The pseudo-dynamic (computer-actuator on-line) test method for simulating earthquake behavior, which uses a prescribed ground motion acceleration and measured sequential nonlinear characteristics, can be thought of as a slow motion shaking table (or real earthquake) test. In this method, the structure is forced to follow its dynamic displacement histories (unknown until the previous history is known) by slowly applying forces.

    This project studies various numerical algorithms for this method and studies the sensitivity of the method to numerical and experimental measurement errors. A computer-actuator control system is developed which enables the experiment to run continuously without human interfaces. The applicability of this testing method to distributed mass system is examined. This project is an integral part of the U.S.-Japa

Cooperative Earthquake Research Program on Large-Scale Testing.

34. U.S.-Japan Cooperative Earthquake Research Program: Test of Full-Size Reinforced Concrete Building; Robert D. Hanson; University of Michigan, Department of Civil Engineering, Ann Arbor, MI 48109; **Award #80-18901**; $189,000 for 12 months beginning August 1, 1980.

    The U.S.-Japan cooperative Earthquake Program plans coordinated efforts utilizing full-size tests, small-scale tests, component, and subassemblage tests, and analytical studies to improve seismic safety practices in the United States and in Japan.

    One of the primary efforts of the cooperative program is the large-scale test of a multistory reinforced concrete building. This project constructs, at the Building Research Institute Ministry of Construction test facility in Tsukuba, Japan, a full-scale seven-story reinforced concrete test specimen to be used for major research studies in this cooperative program. Recommended design and reinforcement details of the test structure are modified based upon preliminary results obtained by other research projects in this cooperative earthquake research program.

35. Seismic Institute for Building Officials; Cheryl Healer; Education Development Center, School and Society Programs, Newton, MA 02101; **Award #80-06606**; $0 for 7 months beginning September 1, 1980.

    Building officials play a key role in the application of research findings to the actual reduction of earthquake hazard. The Education Development Center (EDC) is planning, administering, and conducting a seismic institute for building officials in the New England area. The purpose of the workshop is to increase participant awareness of the need for implementing siesmic codes in the area and to determine from them the most effective way to do so. Strategies are developed to involve building officials in the educational process and to determine with them the interest and capability of the larger audience of regional, State, and local officials in applying knowledge of seismic design in achieving earthquake-resistant construction. EDC will produce a manual on earthquake hazard mitigation for building officials.

36. Connections in Concrete Masonry Buildings under Seismic Excitations; Gilbert A. Hegemier; University of California-San Diego, Applied Mechanics and Engineering Sciences, La Jolla, CA 92093; **Award #78-16581 AO2**; $315,000 for 12 months beginning July 1, 1980.

    This project investigates the behavior of connections between floors and walls, between walls, and between roofs and walls in concrete masonry buildings when subjected to seismic excitations. This research investigates out-of-plane forces in conjunction with in-plane loads on various types of connections. Experimental investigations are supplemented by mathematical models to develop design criteria techniques to evaluate existing buildings and to predict the behavior of newly constructed buildings.

    The systems to be investigated are: precast reinforced concrete slabs supported by interior walls, a cast-in-place slab on an interior wall, and a hollow core prestressed concrete plank on an interior masonry wall. Various oscillatory horizontal loadings are applied to the connections while a constant force vertical load is maintained.

37. Feasibility of Establishing a National Testing Capability for the Simulation of Earthquake Loads on Large-Scale Structures; Cornelius J. Higgins; Higgins Auld and Associates, Inc., 2601 Wyoming Boulevard, N.E., Suite H-1, Albuquerque, NM 87112; **Award #80-09884**; $24,628 for 6 months beginning September 1, 1980.

    This project evaluates the feasibility of establishing a national testing capability for subjecting large-scale structures to simulated earthquake loads. This capability is needed to provide data under realistic field conditions which can be used to validate existing design and analysis methods and provide the basis for improving these methods.

    The project includes verification of the need for large-scale testing and identification of high priority projects; identification of potential test sites and documentation of their characteristics and limitations; evaluation of instrumentation and other field support requirements; and development of management and implementation plans and associated cost estimates.

38. Engineering Study of 15 October 1979 Imperial Valley Earthquake Data; George W. Housner; California Institute of Technology, Department of Civil Engineering, Pasadena, CA 91104; **Award #80-13668**; $97,937 for 12 months beginning August 15, 1980.

    This project analyzes data obtained during the destructive Imperial Valley earthquake of October 15, 1979. Thirteen sensors recorded the motions of various points in the modern six-story county Services Building, which vibrated to the point of severe damage and almost to collapse. Ground motions were recorded at a number of locations in the general vicinity of the building. This study makes dynamic analyses of the building and relevant ground motions and correlates these data with the initiation of damage and the progressively worse damage as the earthquake continued.

    A second part of the study collects data on the performance of large petroleum storage tanks which sustained damage. Dynamic analyses are made of the behavior of these tanks when subjected to earthquake shaking and these data are correlated with observed damage. These studies provide data to improve methods of design of such tanks.

39. Development and Implementation of a Computerized Linear and Nonlinear Seismic Design Methodology for Bridges; Roy A. Imbsen; Engineering Computer Corp., 555 University Avenue, Suite 175, Sacramento, CA 95825; **Award #79-19844**; $129,619 for 12 months beginning August 15, 1980.

The San Fernando earthquake of 1971 caused the collapse of many highway bridges. This indicated that new analysis and design methods were required to mitigate losses from future earthquakes. As a result, new concepts for the design of bridges were developed quickly. These concepts are now being used to construct seismically resistant bridges. However, the concepts are based on linear behavior, and do not include the effects of nonlinearity, ductility, and risk.

This project develops dynamic techniques to consider linear and nonlinear behavior, ductility, risks, and effects of expansion joint hinges. The reliability of the response spectrum method of analysis is evaluated using the dynamic procedures being developed. The final product of this project will be dynamic analysis techniques for several types of bridges which are continuous, and for simply supported girder bridges of medium-to-large span-to-width ratios.

40. U.S.-People's Republic of China Cooperative Strong-Motion Array; Wilfred D. Iwan; California Institute of Technology, Department of Earthquake Engineering, Pasadena, CA 91104; **Award #80-18271**; $200,481 for 12 months beginning August 15, 1980.

    A joint research project between the United States (U.S.) and the People's Republic of China (P.R.C.) installs and operates strong-motion earthquake measuring instruments in China. A unique aspect of this project is that the instruments deployed combine the features of fixed and mobile arrays. The majority of the instruments are deployed in the Beijing-Tianjing region in an array designed to be rapidly redeployable in the event of a credible earthquake prediction. Ample technical support is available from the P.R.C. in the area of the array.

    The U.S. contribution to this project is to provide U.S. manufactured strong-motion accelerographs and some supplemental support for technical activities and travel. On the P.R.C. side, the State Seismological Bureau makes a substantial contribution in the form of salaries for scientific and technical personnel for site investigation and preparation, and for the installation, operation, and maintenance of the array.

41. U.S.-Japan Cooperative Earthquake Research Program; Full-Scale Tests of Beam-Column Joints; James O. Jirsa; University of Texas-Austin, Department of Civil Engineering, Austin, TX 78712; **Award #80-09039**; $75,632 for 12 months beginning August 1, 1980.

    As an integral part of the U.S.-Japan cooperative earthquake research program on large-scale testing, this project focuses on quasi-static tests of reinforced concrete joint assemblies. Three joint assemblies are tested: 1) exterior column-to-beam assemblies, 2) interior column-to-beam assemblies, and 3) wall-to-beam assemblies. Loading is applied in a controlled deformation pattern and in reversed cycles corresponding to deformation levels in the elastic, inelastic, and near failure ranges. These tests permit correlation between experimental data from laboratory studies of full-scale joints with responses of a full-scale structure subjected to simulated earthquake loads.

    The results provide a basis for a critical examination of current design practice and recommendations for joints in reinforced concrete structures. These tests are coordinated with tests of the full-scale 7-story structure at the Large-Size Structure Laboratory of the Building Research Institute in Tsukuba, Japan.

42. Development of a Comprehensive Computer Program for Earthquake Analysis of Buildings — Phase II; Lindsay R. Jones; Computech, 2150 Shattuck Avenue, Berkeley, CA 94704; **Award #80-00538**; $151,848 for 12 months beginning September 15, 1980.

    The objective of this research is to develop a comprehensive computer program for the analysis of buildings subject to seismic excitation. New analytical capabilities have been incorporated into the program, which is intended for general design office use.

    In the project's first year, basic computer program was completed. This program allows for simulating the three dimensional behavior of the building and variations in floor configurations (such as flexible, perforated or rigid diaphragm action). A finite element approach was used for structural shear walls. The program has the flexibility to incorporate various types of foundations.

    This phase of the project consists of four main elements: 1. development of pre- and post-processor programs for the input and output features; 2. parameter studies to provide guidance when modeling complex structures; 3. development of comprehensive documentation; and, 4. several seminars to disseminate the results.

43. Investigations of Sites Where Strong-Motion Data Were Recorded in the Imperial Valley Earthquake of 1979; William B. Joyner; Geological Survey, Earthquake Studies Offices, Menlo Park, CA 94025; **Award #80-13665**; $74,195 for 12 months beginning August 15, 1980.

    In view of the importance to earthquake engineering of the strong-motion data from the Imperial Valley Earthquake of October 15, 1979, the strong-motion recording sites are investigated and described. Investigations include drilling, sampling, and P- and S-wave velocity surveys to a target depth of 250 feet at 12 sites and to a depth of 500-1000 feet at one additional site. At four of the sites close to the fault, cone penetrometer surveys are made and samples are taken for laboratory studies at high strain levels.

44. Seismic Pile-Soil-Pile Interaction in Lateral Vibration Mode; Takaaki Kagawa; McClellan Engineers, Inc., 6400 Hillcroft, Houston, TX 77081; **Award #80-01503**; $71,873 for 12 months beginning October 1, 1980.

    Pile-soil-pile interaction are studied parametrically to clarify the fundamental aspects of pile group effects under seismic loading conditions. Theoretical solutions to the pile-soil-pile interaction are derived assum-

ing soil stress distribution patterns around piles in a homogeneous and elastic material, utilizing the fourier Transform technique, and decomposing the soil displacement into the mode shapes of the soil layer. Lateral pile-soil-pile interaction of end-bearing piles under seismic loading conditions are studied in terms of: (1) dynamic load deflections relationships of piles represented by soil-pile springs and energy dissipation due to material and radiation dampings; (2) shear and moment distributions among the piles; and (3) dynamic group efficiency factors for horizontal stiffness of the pile group as compared to static considerations. The research leads to a rational basis for evaluating the significance of the seismic pile group effects for a wide class of pile foundations, and provides a basis for development of analytical technique for more complex soil conditions.

45. Friction Dampers for Earthquake Protection of Buildings; W. O. Keightley; Montana State University, Department of Civil Engineering Mechanics, Bozeman, MT 59715; **Award #80-11545**; $74,512 for 24 months beginning October 15, 1980.

    This work advances the technology of energy dissipating devices intended to decrease building sway during earthquakes and strong winds. The devices, which are connected within the structural frame of a building, consume energy as the frame distorts and thus reduce the buildup of large vibrations. Work supported by the National Science Foundation over the past two years has resulted in a damping strut in the form of a telescoping steel tube surrounded by steel plates which are clamped against it and which rub against each other as the tube changes length. Vibrational energy of the structure is consumed through friction. Powdered Colorado oil shale is used as a lubricant between the plates.

    Digital computer studies have shown how the stiffness and slip force of the dampers should be related to the stiffness and mass of the building for best results with certain kinds of buildings during a particular earthquake. This research involves additional testing and improvement of the dampers, studies of dampers in other types of buildings under a wider range of earthquake motions, and the development of other forms of the dampers, such as walls and diaphragms.

46. Earthquake Hazard Mitigation by Friction Cells Damping; George Kostro; Iffland Kavanage Waterbur, 1501 Broadway, New York, NY 10016; **Award #80-09780**; $23,750 for 6 months beginning September 1, 1980.

    A major hazard is presented by the earthquake vulnerability of existing buildings. To date most efforts to reduce that vulnerability have taken the form of reinforcement to enhance resistance to seismic forces. This research investigates the basic concept of the mitigation of seismic inertia forces of existing and new framed buildings through modification of their dynamic damping characteristics by insertion of appropriate friction cells. A friction cell consists of two overlapping steel plates attached to the different joints of a frame. The steel plates are pressed together to maintain friction, but are free to move with respect to each other.

    The insertion of such friction cells could significantly increase the earthquake resistance of a framed structure at very low cost. In that case, hundred of thousands of old structures in seismic zones could be made earthquake-resistant economically and the cost of new structures could be reduced.

    This research focuses on the theoretical behavior of a plane, single bay rigid frame, articulated at the foundation, subjected to seismic and gravity loads. Inelastic nonlinear stability limits, or collapse load under dynamic earthquake loading as well as gravity loads, are studied on a computer with and without insertion of a friction cell.

47. Fluctuating Pressures on Tall Buildings; Bernard M. Leadon; University of Florida, Department of Engineering Sciences, Gainesville, FL 32611; **Award #77-26391 AO2**; $60,770 for 12 months beginning October 1, 1980.

    The objectives of this research are: to obtain full-scale wind measurements and to compare these with theoretical predictions for the interaction between turbulent winds and obstacles; to 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 to estimate the convective film heat transfer coefficient for smooth surfaces in curtain walls.

    Specific studies include: 1) Fluctuating pressure measurements, glass light deflections, and lateral displacement of the structure of the Independent Life Tower (I.L.T.) in Jacksonville, FL; 2) wind tunnel tests of a ¼ scale model of curtain wall section with mullions; 3) wind tunnel tests of models of the I.L.T. (performed at Colorado State University); 4) survey of turbulence and mean wind profile to 274m. and WJXT-TV tower which is near the I.L.T.; and 5) comparison or results with a theory of the interaction of turbulence with obstacles in the flow.

48. Strong Motion Earthquake Instrumentation Array in Shillong Assam, India; C. E. Lindvall; Lindvall Richter and Associates, 825 Colorado Boulevard, Los Angeles, CA 90041; **Award #80-07159**; $344,540 for 24 months beginning October 1, 1980.

    At present, earthquake ground motion data near the centers of destructive earthquakes is scarce. Existing instrument arrays are inadequate to provide the necessary engineering data. The International Workshop on Strong-Motion Earthquake Instrument Arrays (Hawaii, May 1978) and the Indo-U.S. Workshop on Natural Disaster Mitigation Research (New Delhi, December 1978) designated the Shillong, India area as the highest priority site worldwide for potential array locations. The Shillong, India Array Project can provide much needed information on the deployment of strong mo-

tion arrays designed for gaining detailed information about the generation, transmission, and local magnification of strong ground motion.

For this initial phase of the Shillong Array, approximately 50 analog strong motion instruments are installed. Research into the reliability, response characteristics, data processing, and system compatibility of digital accelerographs is carried out to assess their role in remote location instrument arrays.

49. U.S.-Japan Cooperative Earthquake Research Program: Design and Preliminary Experimental Studies for the Recommended Structural Steel Test Building; Le-Wu Lu; Lehigh University, Engineering Laboratory, Bethlehem, PA 18015; **Award #80-08587**; $28,705 for 12 months beginning August 1, 1980.

As part of the U.S.-Japan Cooperative Research Program Utilizing Large-Scale Testing Facilities, a full-scale, seven-story structural steel building has been recommended for testing to study its response and resistance to earthquakes. The test structure is designed according to current building design practices in both countries and is loaded pseudo-dynamically to simulate the effect of earthquake ground excitations.

This project completes detailed structured design of the steel test building, performs preliminary elastic and inelastic dynamic analysis for selected ground motions, and conducts cyclic load tests on certain girder-to-column connections in the structure. In addition, preliminary planning of other types of component and associated tests is carried out.

50. U.S.-Japan Cooperative Earthquake Research Program: Evaluation of Psuedo-Dynamic Test Methods; Stephen A. Mahin; University of California-Berkeley, Department of Civil Engineering, Berkeley, CA 94720; **Award #80-08584**; $66,348 for 12 months beginning August 1, 1980.

The objective of this project is to develop, and evaluate the reliability of pseudo-dynamic test methods. Pseudo-dynamic test methods for experimentally assessing nonlinear response of structures subjected to severe seismic excitations provide a realistic and relatively inexpensive means for seismic performance testing of structures which are too large, strong or massive for testing on available shaking tables. To assess the suitability of pseudo-dynamic test methods for the full-scale tests under the U.S.-Japan Cooperative Earthquake Research Program, a series of analytical and experimental investigations are conducted.

In the pseudo-dynamic method, a computer is used on-line to monitor and control a test specimen so that quasi-statically imposed displacements closely resemble those that would be developed if the structure were tested dynamically. Computer software to implement the method for multistory buildings subjected to a horizontal component of ground motion is developed. Results of pseudo-dynamic and comparable shaking table tests of representative structural models are used to evaluate the reliability and practicability of the methods.

51. Estimation of Seismic Shear Wave Spectra; Robin K. McGuire; Dames and Moore, 1626 Cole Boulevard, Los Angeles, CA 90071; **Award #80-07088**; $72,290 for 12 months beginning August 1, 1980.

The accuracy of the Brune seismic source model for predicting farfield shear wave acceleration spectra is determined by comparing predicted Fourier amplitude spectra with those computed from the shear waves recorded by strong motion accelerograms in California. A large number and variety of accelerograms are used for the comparisons, including San Fernando earthquake records, accelerograms from eight other earthquakes, and records from four aftershocks of the 1975 Oroville earthquake. Random vibration analysis is used to predict linear-elastic response spectra for these earthquakes, and the accuracy of this theory is assessed by comparison with response spectra from the same accelerograms. When completed, this study will offer an accurate, theoretically (rather than empirically) based method of estimating high frequency strong ground motion close to the energy release of moderate and large earthquakes.

52. Development of an Earthquake Engineering Computer-Based System; Robert J. Melosh; Duke University, Department of Civil Engineering, Durham, NC 27706; **Award #79-02991**; $101,499 for 12 months beginning July 15, 1980.

The aim of this research is to make existing earthquake engineering information more usable by practicing engineers by means of computer-based techniques of knowledge-based consultation. Work is carried out as a two-phase effort, with attention to technical and utilization goals in each phase.

The Technical Project of the first phase yields and illustrates use of a data-base-form of consultation rules and simulation software. The rule-set codifies knowledge of siting, design, and analysis methods, requirements of simulation codes, and case histories of previous analyses. When operated upon by the appropriate logic-synthesizing software (in a user-computer interactive environment) and supplied with particular structural configuration information, the rule-set guides, applies factual information, directs simulation, and assists in interpreting and qualifying results of earthquake engineering analyses.

The second phase work improves the consultation and extends the knowledge base to encompass much of the relevant literature. Improvements are made in the consultation system in response to suggestions from research engineers. New requirements that may arise broaden the knowledge base. Second phase plans to insure utilization of research results emphasize the extension of the mail-telephone mode and use of satellite seminars to involve practicing engineers.

53. Development of a Unified Approach to the Design of Window Glass Subjected to Dynamic Forces; Joseph E.

Minor; Texas Tech University, Institute for Disaster Research, Lubbock, TX 79409; $128,430 for 12 months beginning January 1, 1980.

The objective of this research is to utilize current knowledge and techniques in a critical review of the process by which glass panels are selected for use in engineering structures. This review reduces uncertainties inherent in the current process and provides the practitioner with the confidence needed in effecting safe, economical designs for glass windows.

The effort has two major thrusts. First, research develops a tractable approach to the design of glass windows which utilizes current knowledge in wind engineering, glass material properties, and structural response of thin rectangular panels. Second, a utilization plan is implemented to relate the new approach to the design of glass windows to current professional practice, and to take appropriate initial steps toward exposing the architectural and engineering professions to the new approach.

54. Improvements in Collection and Dissemination of Tsunami Data; Dennis W. Moore; University of Hawaii-Manoa, Department of Geophysics, Honolulu, HI 96822; **Award #80-07158**; $42,606 for 12 months beginning August 15, 1980.

    Progress in tsunami research is highly dependent on tsunami data. At present these data consist of tide gage records and occasional measurements of inundation heights along a coastline immediately after the occurrence of a tsunami. The purpose of this study is to improve the collection and transmission of both kinds of data and to provide for tsunami observations and measurements during the event. Instructions for organizing and conducting tsunami surveys are prepared for future tsunamis. Various technical means such as photography, portable wave gages, and observers are developed for use in collecting tsunami information. The inverse tide gage problem is investigated to find ways of making the best estimate of tsunami wave heights from tide gage records.

55. An Improved Computational Strategy for the Nonlinear Analysis of Structures Subjected to Earthquake and Wind Loads; Ahmed K. Noor; George Washington University, Department of Engineering and Applied Science, Washington, DC 20052; $71,912 for 12 months beginning September 1, 1980.

    The objective of this study is to develop an effective computational strategy for the nonlinear dynamic analysis of large structures subjected to wind and earthquake loadings. Such a strategy maximizes the quality of results and minimizes the total effort and cost required to produce them (including the effort in spatial and temporal discretization, handling of algebraic equations, and computer implementation).

    As a first step toward this goal, the following aspects of the computational process involved in nonlinear dynamic analysis are investigated: a) 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 b) use of adaptive techniques to automatically control the time step and the order of integration algorithm as well as the finite element mesh size based on a preselected set of criteria.

56. National Information Service for Earthquake Engineering; Joseph Penzien; University of California-Berkeley, Earthquake Engineering Research Center, Berkeley, CA 94720; **Award #77-20667 AO2**; $150,429 for 12 months beginning April 1, 1980.

    The National Information Service in Earthquake Engineering (NISEE) is a national focus for earthquake engineering data, project information and research reports. NISEE provides for the transfer of earthquake information generated through research to public users. NISEE collects and assesses information from many different sources and provides single, efficient comprehensive collection geared to meet the needs of both academic researchers and design engineers. NISEE's computer program distribution service has many programs, each fully developed and suitable for use by professional engineers. New programs are added to the library and made available for distribution as they are developed. The Earthquake Engineering Research Library maintains collections of reports (both published and unpublished), site visit records, data acquired from various seismic regions, and provides an abstracting service and a technical journal directed to the needs of earthquake engineers. FY 81 emphasis is on service expansion (covering a much broadened users group) and on research utilization.

57. Factors Affecting the Design and Implementation of Community Disaster Evacuation Plans; Ronald W. Perry; Battelle Memorial Institute, Battelle Human Affairs, Seattle, WA 98105; **Award #77-23697 AO2**; $15,988 for 6 months beginning June 15, 1980.

    This research focuses upon evacuation of people from the impact area of some hazard. Data are collected in three communities and a model is being developed of the social and psychological determinants of pre-impact evacuation. The public policy implications of the model for natural hazards response are determined and evacuee reactions to official evacuation programs are assessed.

    Intended outcomes of this study include: (1) production of a theoretically and empirically grounded model of the factors affecting evacuation which will help isolate key issues in the design and implementation of evacuation plans; (2) development of guidelines for designers of community emergency plans which isolate conditions and incentives for evacuation; (3) development of information regarding evacuee feedback which can be incorporated into future evacuation planning; and (4) establishment of a body of data on the optimal use of evacuation as a management tool in responding to natural hazards. The principal source of data for the study is interviews from samples of private

citizens and officials in the three selected communities.

58. Victimization by Natural Hazard in the United States; Peter H. Rossi; University of Massachusetts Amherst Campus, Department of Sociology, Amherst, MA 01003; **Award #79-26741**; $352,895 for 15 months beginning July 1, 1980.

    This study is designed to provide the first scientifically-based estimates on the extent and distribution of losses from natural hazards in the United States. Losses suffered by victims of earthquakes, floods, hurricanes, fires, tornadoes and other hazards will be investigated through a national survey. The study is divided into two parts. This first phase involves a telephone survey of 12,000 respondents to locate a probability sample of hazard victims. The second part consists of mail follow-up questionnaires to a resultant sample of 2400 victims. Data are collected to shed light on hazard costs over a ten-year period, relief and recovery aid received from government and private sources, the problems victims experienced in attempting to obtain aid, and how such aid was actually used.

59. Stability of Earth Structures Under Seismic Loading; Wolfgang H. Roth; Dames and Moore, 1100 Glendon Avenue, Suite 1000, Los Angeles, CA 90071; **Award #79-26691**; $115,443 for 12 months beginning August 1, 1980

    This research includes development of a dynamic response computer program capable of modeling nonlinear behavior of embankments and slopes; verification of its validity with extensive centrifuge model testing; and evaluation and refinement of selected simplified methods of dynamic slope stability analysis currently in use. A parametric study is conducted for a limited range of embankment configurations subjected to several acceleration histories of earthquakes that are of practical interest. Several actual case histories of seismic embankment performance are studied to compare the results with data measured or calculated by others. The centrifuge shaking table at California Institute of Technology is used to produce a prototype earthquake of up to 0.8g peak horizontal acceleration and 10-second duration corresponding to an earthquake of Magnitude 5.5 to 6.0.

60. Analysis of Earthquake Induced Response for Structures with Localized Nonlinearities; Dennis G. Row; Structural Software Development, 1930 Shattuck Avenue, Berkeley, CA 94704; **Award #79-22695**; $123,126 for 24 months beginning June 15, 1980.

    The objective of this project is to extend analytical techniques for the dynamic analysis of structures with locally nonlinear zones. An existing general purpose program, based on the substructure technique and developed by the Principal Investigator, is used as a basis for demonstration of the technique. Efficient analysis procedures are developed based on a specification of linear and nonlinear substructures. Two methods, an "exact" and an approximate, are used. The techniques are demonstrated by analyzing structures in which seismic response is highly dependent on local nonlinearities. Structures which fall into this category include arch dams; buildings that permit foundation uplift; structures with inelastic energy-absorbing devices; and buildings with "soft stories." Analyses are performed on an arch dam, taking into account the nonlinear effects observed between elastic monoliths and building systems where the foundations are permitted to uplift. The techniques are compared against existing linear and nonlinear techniques for seismic analysis to demonstrate their accuracy and economy.

61. Public Response to Geologic Hazards; Thomas F. Saarinen; University of Arizona, Department of Geography, Tucson, AZ 85721; **Award #80-02581**; $58,895 for 12 months beginning June 15, 1980.

    This one year study focuses on how hazard information provided by such agencies as the U.S. Geological Survey is used by other organizations and the public. A major objective of the study is to evaluate the effectiveness of hazard information dissemination in connection with the Mt. St. Helens volcano hazard. Data are collected on the character and content of information releases, the channels of communication used, interagency cooperation, the character of the hazard area and population at risk, and types of adjustments made by individuals and organizations in the threatened area.

62. Simple Earthquake Analysis of Multistory Reinforced Concrete Structures; Mehdi Saiidi-Movahhed; University of Nevada-Reno, Department of Civil Engineering, Reno, NV 89507; **Award #80-06423**; $37,323 for 15 months beginning July 1, 1980.

    High computer costs and the involved data preparation procedures required to use available "multi-degree" models for earthquake response of multistory structures have imposed a serious constraint on the number of alternative structures and/or earthquakes to be studied for any particular project.

    The development of a Q-Model (a "single-degree"-model, with the computer cost of only three percent of the multi-degree models) has resulted in satisfactory approximate response prediction for structures with no abrupt change of stiffness. There is a need for a comparable new model for general types of structures (with or without uniform stiffness). In this research program the development of such a more general model is investigated.

    Analytical results from this research program are compared with measured responses of model structures tested at the University of Illinois.

63. Improving Earthquake Response of Power Transmission Substations; Anshel J. Schiff; Purdue University, Department of Mechanical Engineering, Lafayette, IN 47907; **Award #78-25485 AO1**; $100,094 for 12 months beginning September 1, 1980.

    The objective of this research is to improve the

earthquake safety of electrical power systems and facilities. Performance of power systems during past earthquakes has shown that one of the weak links in the systems is within substations. This project focuses attention specifically on earthquake problems associated with power substations and emphasizes implementation of the research results for improved seismic design of power systems where earthquake engineering practices have not been current.

The major research tasks are: (1) development of a draft seismic design guide for power system transmission facilities emphasizing substations, (2) development of a unified design procedure for power system analysis under seismic, ice, wind and short circuit loads, and (3) evaluation of the seismic reliability of circuit breakers, including examination of transformer failures during the Sendai, Japan (June 12, 1978) earthquake.

64. Earthquake Engineering of Large Underground Structures; Roger E. Scholl; John A. Blume and Associates, 130 Jessie Street, San Francisco, CA 94105; **Award #77-06505 AO2**; $11,000 for 5 months beginning May 15, 1980.

The objective of this project is to identify and evaluate the current state-of-the-art in underground earthquake engineering practice, and to determine those areas in which additional research is most needed. Transportation tunnels, utility tunnels, and other large underground structures are emphasized. Instrumentation aspects are given special consideration. The studies conducted include: seismic wave propagation analyses, a summary of observed effects of earthquakes on underground structures, and a summary commentary on contemporary seismic-resistive analysis, design, and construction procedures. The research results are published in a report summarizing worldwide experience concerning underground earthquake engineering, describing important features of earthquake wave propagation, recommending future experimental and analytical research.

65. Materials Studies on the Imperial County Services Building-Materials Testing; Lawrence G. Selna; University of California-Los Angeles, Department of Mechanics and Structures, Los Angeles, CA 90024; **Award #80-13664**; $50,000 for 12 months beginning August 1, 1980.

The Imperial county Services Building suffered heavy damages in the October 15, 1979 Imperial Valley Earthquake. This research focuses on three items associated with the seismic performance of the building: 1) materials used in the building; 2) quality of construction or workmanship; and, 3) damage to structural and non structural elements. The contribution of these items to the seismic performance of the building is assessed.

66. A Generalized Study of Seismic Risk Analysis; Haresh C. Shah; Stanford University, Department of Civil Engineering, Stanford, CA 94305; **Award #77-17834 AO1**; $22,772 for 9 months beginning September 1, 1980.

The seismic safety requirements for a community depend on the acceptable level of risk for that community and the corresponding cost in achieving it. Rational and acceptable building regulations or codes should be based upon a proper understanding of the uncertainties associated with seismic risk and its consequences. The objective of this project is to establish an improved seismic risk analysis procedure to aid design engineers and to provide a solid basis for future code modification.

Current seismic risk analysis procedures suffer from many shortcomings. This project is intended to improve such procedures by conducting analytical research to develop: (1) a better approach for estimating ground motion input duration and defining response duration; (2) more stable parameters to represent input amplitude and frequency content; (3) better statistical models that take into account specific geologic and seismologic conditions; (4) a consistent, probabilistic approach for the above analyses; and (5) a clear understanding of the needs of structural designers, the objectives of building codes, and their relationships to probabilistic information on the seismic environment.

67. An Evaluation of the Earthquake Response and Associated Damage of the El Centro Imperial County Services Building; Roland L. Sharpe; Applied Technology Council, 2150 Shattuck Avenue, Berkeley, CA 94704; **Award #80-10645**; $60,797 for 12 months beginning September 15, 1980.

On October 15, 1979, an earthquake of Richter magnitude 6.4 occurred on the Imperial fault approximately 25 km southeast of El Centro, California, an area well instrumented with a number of strong motion instruments. The El Centro Imperial County Services Building, which was extensively instrumented, suffered significant damage from the earthquake. Applied Technology Council (ATC) is evaluating the results of these recorded data and the damage observed from the viewpoint of enhancement of public safety.

The provisions of the 1973, 1976, and 1979 Uniform Building Codes and the ATC-3-06 Tentative Provisions are assessed to determine what impact these provisions have had on reducing damage. Recommended research and suggested code improvements are developed during the evaluation.

68. Film on Earthquake Hazards Mitigation Research (Formerly RFP 78-102: Production of An ASRA Film); Gregg Snazelle; Snazelle Films, Inc., 155 Fell Street, San Francisco, CA 94102; $5,542 for 9 months beginning August 15, 1980.

Public information on the progress and future directions of research in earthquake hazards mitigation is needed to promote understanding and facilitate application of research results. It is also important to provide public officials, professionals, and the informed

public with an overview of research activities in the field. Such a film is being developed by Snazelle Films.

69. U.S.-Japan Cooperative Earthquake Research Program: Earthquake Simulation Tests on Small-Scale Building Models; Mete A. Sozen; University of Illinois-Urbana, Department of Civil Engineering, Urbana, IL 61801; **Award #80-07713**; $109,265 for 12 months beginning August 1, 1980.

    Earthquake simulation test of one-tenth scale reinforced concrete (R/C) models are conducted to advance the following engineering objectives: 1) to interpret and generalize the results from the full-scale test of a seven-story R/C building, and 2) to test the usefulness of small-scale models in estimating response of full-scale structures.

    The first model test structure is made up of three plane systems working in parallel. The second model tested is of nonstructural walls and elements in the transverse direction. The third model under consideration includes additional structural and nonstructural features. These models are subjected to selected earthquake-like base motions of increasing intensity in successive test runs.

70. Experimental Analysis of the California Imperial County Services Building; Mete A. Sozen; University of Illinois-Urbana, Department of Civil Engineering, Urbana, IL 61801; **Award #80-07160**; $54,120 for 12 months beginning August 1, 1980.

    This project is investigating, by an experimental analysis, the causes of failure of the Imperial County Services Building in El Centro, California during the earthquake of October 15, 1979. An earthquake simulation test of a small-scale reinforced mortar model of a structural system is being investigated for the feasibility of this type of analysis for determining the dynamic behavior of full-scale structural systems. The accelerometer records obtained in the County Services Building during the shaking and leading to partial collapse of the building provide a very valuable benchmark for testing the applicability of experimental model analysis.

    The scope of this project includes the design, fabrication, instrumentation and dynamic testing of a small-scale structure representing the structural system used in the prototype building to resist lateral forces.

71. Multiprotection Design Summer Institute; Dan Sullivan; Federal Emergency Management Agency, Department of Training and Education, Washington, DC 20472; $25,000 for 10 months beginning August 1, 1980.

    The Multiprotection Design Institute offers six one-week courses in: 1) Earthquake Engineering and Ground Motion; 2) Fire Safety in Building Design; 3) Designing of Buildings Against Wind; 4) Energy Conservation Design in Buildings; 5) Environmental Engineering; 6) Flood Hazard Mitigation. Courses are designed for architectural and engineering faculty of accredited colleges and universities 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, wind or depletion of energy resources. This is achieved by scheduled lectures and discussion groups. Leading experts bring results to the Institute from the forefronts of research. The Institute disseminates new information and ideas to an extent that could not be achieved through usual channels of publications and presentations at scientific and professional meetings.

    Under this award, the Institute conducted courses at the FEMA Staff College in Battle Creek, Michigan from July 28 through August 15, 1980. Enrollment was limited to 25 participants in each course.

72. A Study to Determine the Cost Effectiveness of Seismic Rehabilitation Through Base Isolation; Alexander G. Tarics; Reid and Tarics Associates, 1019 Market Street, San Francisco, CA 94103; **Award #80-17675**; $99,690 for 12 months beginning September 1, 1980.

    A very high percentage of the nation's existing buildings have been constructed without consideration and allowance for the effects of earthquake activity. Researchers have been studying a base isolation system which is particularly well suited to limiting earthquake effects in low-rise structures (5-10 stories). Many such structures—low-rise apartment, commercial, and industrial buildings of masonry or inadequately braced structures—do not meet current seismic code regulations. In previous tests, horizontal loads induced in such structures by dynamic loads were reduced substantially when the model building was mounted on base isolation rubber bearings. The open question is that of cost effectiveness. This research develops engineering procedures whereby existing buildings can be cut at their foundation level and a set of bearings inserted. This project develops an engineering design of the process. The rehabilitation process is detailed and drawings of the modifications to the building and its foundation are prepared. The cost of the procedure, and associated costs such as bearing costs and the cost of modifying utility connections, are estimated. The safety of the base-isolated building is evaluated by calculating its response to several possible earthquakes. These costs and benefits are compared to those of a conventional rehabilitation procedure.

73. Tide Gage Response to Tsunamis; William G. Van Dorn; University of California-San Diego, Ocean Research Division, La Jolla, CA 92093; **Award #80-06198**; $114,946 for 24 months beginning August 12, 1980.

    One of the principal unsolved problems in the chain of events linking a tsunamigenic earthquake with consequent, ensuing motions on some remote shoreline is distortion of the incident wave spectrum in shallow water near shore. Despite recent advances in numerical modeling of tsunami generation and deep

sea propagation, the problem of coastal interaction remains. Verification of tsunami models is dependent on interpretation of tide gage records obtained during tsunamis. However, both the amplification and phase response of a tide gage within a harbor may depend on the precise location of the gage for all frequencies higher than the lowest model frequency for that harbor.

This research is directed at a re-examination of existing tide gage records of past tsunamis using modern statistical methods. This should lead to a means of "calibrating" tide gages so that predictions for future tsunamis (real or model) can be made. Present numerical time-stepping methods can then be used to make predictions for the near field (harbor, bay, etc.), using the tide gage as a normalizing response indicator.

74. Spatial Models of Seismicity for Engineering Risk; Daniele Veneziano; Massachusetts Institute of Technology, Department of Civil Engineering, Cambridge, MA 02139; $116,824 for 12 months beginning July 1, 1980.

Probabilistic models of regional seismicity are needed for analysis of engineering risk and the design of strong-motion instruments networks. Current models typically assume spatial independence of epicenters, temporal stationarity, and homogeneous magnitude distribution, and therefore are susceptible to large uncertainty. To correct this situation, more advanced methods and sophisticated models for seismic risk analysis are needed.

This project develops methods for engineering hazards assessments by using physical-statistical models of seismicity in space and time that account probabilistically for different hypotheses about tectonics, earthquake source zones, zone shapes, zone spatial extent and variation, etc. The interference properties of such models are investigated, computer routines for model parameter estimation developed, and applications in developing provincial risk maps and in the design of strong-motion instrument networks demonstrated.

The project's first year's effort was devoted to the theoretical work required; this second year's effort emphasizes engineering applications of the developed models.

75. Bridge Response to Traveling Seismic Waves; Stuart D. Werner; Agbabian Associates, Department of Engineering, El Segundo, CA 90245; **Award #80-07518**; $114,993 for 12 months beginning September 15, 1980.

This two-year research program is investigating the three-dimensional response of bridge structures subjected to arbitrarily incident traveling seismic waves. The study consists of two main parts. First, an existing methodology for analyzing three-dimensional traveling wave effects on free-standing structures is being extended to incorporate representation of the bridge abutments and backfill. Second, this methodology is being used to carry out parametric analyses that provide insight into how various parameters related to the bridge configuration, abutments and backfill, soil properties, and input motions influence the bridges' response. These analyses should provide guidelines regarding bridge behavior characteristics useful for new designs, existing bridges, instrumentation of bridges, and experimental studies of bridge behavior during earthquakes.

76. A Clearinghouse on Natural Hazards Research and Applications; Gilbert F. White; University of Colorado at Boulder, Institute of Behavioral Sciences, Boulder, CO 80309; **Award #79-06160 AO3**; $20,000 for 12 months beginning June 1, 1980.

The Natural Hazards Research and Application Information Center continues its efforts to improve the dissemination of natural hazards research information to potential users such as emergency management officials through publication of its quarterly newsletter, the *Natural Hazards Observer*, and through both an annual workshop involving hazard researchers and users as well as more focused workshops undertaken in cooperation with other groups and organizations. The Center also provides information on a day-to-day basis in response to individual requests. Funds for this project are also being provided by the Federal Emergency Management Engineers, and the U.S. Geological Survey.

77. Earthquake Resistance Costs-Benefits of Factory-Produced Houses and Mobile Homes; Steven Winter; Steven Winter Associates, Inc., 6100 Empire State Building, New York, NY 10001; **Award #79-17307**; $90,216 for 12 months beginning July 15, 1980.

Objectives of this research project include documentation of the earthquake vulnerability of precut, factory produced mobile dwelling units; development of techniques and details whereby vulnerability can be reduced, preparation of a cost/benefit matrix equating degrees of prevention with levels of risk; and, compilation of a Manual of Recommended Practices wherein architects, builders and housing manufacturers have access to the technical, cost, and code aspects of earthquake resistance measures.

The research includes surveys of housing projections, locations, construction techniques and earthquake damage costs, analyses of costs of damage repair and costs of techniques for increased resistance, comparisons of building code requirements and overlaps among natural hazards (earthquake, wind and snow load), and compilation and dissemination of a Manual of Recommended Practices.

78. Response Surface Method in Geotechnical/Structural Analysis—Phase I; Felix S. Wong; Weidlinger Associates, 3000 Sand Hill Road, Building 4, Suite 245, Menlo Park, CA 94025; **Award #80-09770**; $24,122 for 6 months beginning September 1, 1980.

Though sophisticated modeling techniques have

been developed for the study and design of structures to resist earthquake loads, they are not widely used in statistical analyses of geotechnical/structural systems because of high computer costs.

The objective of this research is to investigate the feasibility of applying the response surface method to statistical analysis of geotechnical/structural systems. In the response surface method, graduating functions are developed systematically to provide fast-running approximations to a long-running system model. The graduating functions can then be used in statistical evaluations in place of the long-running model.

Potential applications include probabilistic analysis of dynamic, nonlinear soil-structure systems and complex structures where finite element methods have previously been limited to deterministic analysis.

79. U.S.-P.R.C. Cooperative Earthquake Research: Earthquake Ground Motion Studies; Francis T. Wu; SUNY at Binghamton, Department of Geological Sciences, Binghamton, NY 13901; **Award #80-01505**; $55,740 for 24 months beginning August 1, 1980.

This cooperative research project with the Institute of Geophysics State Seismological Bureau, People's Republic of China, records and analyzes free ground accelerations from large and small earthquakes. This project is aimed at the study of the source effects, the path effects, and the local site effects of large earthquakes. Free field data are used for the testing of an empirical-theoretical method, an impulse response method of predicting strong motions from weak motions by earthquakes in the magnitude range 2-4.

This project involves the establishment of a four-station mobile network in an area where magnitude 2-4 earthquakes often occur and where large earthquakes (M>6) are expected to occur in the vicinity or within the network. When a large earthquake (M>7) occurs elsewhere, or when a M>6 earthquake has been predicted elsewhere, the network will be moved into the near-source region to monitor aftershocks. Weak motion from fore- or after-shocks can be used in conjunction with strong motion data at the same stations for the development and testing of an "impulse response method" of strong ground motion prediction.

HUMAN NUTRITION

An increasing percentage of the American diet comes from refined and processed foods. Concern is growing about the nutritional value of such foods and about the effects of long-term consumption of processed foods on human health and performance. The major objective of the Human Nutrition program is to evaluate nutritional changes brought about by processing, including refining, cooking, packaging, storage and the use of additives, supplements and substitutes. The objective is achieved by supporting basic and applied investigations of the physical, chemical and biological changes that occur as a result of processing. Research at the interface of food science and nutrition is encouraged, as are proposals that stress interdisciplinary research and research in disciplines not traditionally involved in nutrition research.

1. Bioavailability of Zinc in Human Foods; Helen L. Anderson; University of Missouri-Columbia, Department of Human Nutrition, Columbia, MO 65201; **Award #80-11114**; $211,990 for 18 months beginning October 1, 1980.

   This research develops an economical and rapid method for assessing human bioavailability of zinc in a diet. Zinc availability from a variety of foods of plant and animal origin is measured in young adults using plasma zinc concentrations and zinc balances, compared with availability from pure zinc salts fed at similar levels. The availability of zinc to animals is determined using several techniques: (1) extrinsic 65 Zn labeling; (2) zinc balance; (3) growth; (4) plasma zinc levels; and, (5) bone concentrations of zinc. Results from animal studies are correlated with those from human studies to establish an optimum method.

2. The Measurement of Dielectric Constant as a Method for Quality Assessment of Frying Oils; Fred P. Boerwinkle; Northern Instruments Corp, 6680 North Highway 49, Lino Lakes, MN 55014; **Award #80-10551**; $24,550 for 6 months beginning September 1, 1980.

   Thermal oxidation of frying oils produces decomposition products, some of which are toxic. This deterioration increases an oil's polar components, thereby increasing its dielectric constant. An instrument to measure the change has been developed and is being tested under a variety of conditions. Changes in dielectric constant are being correlated with changes in oil composition as determined by gas chromatography.

3. The XII International Congress of Nutrition, San Diego, California, August 1981; Earl C. Chamberlayne; National Institutes of Health, Fogarty International Center, Bethesda, MD 20014; **Award #80-12210**; $5,000 for 18 months beginning July 15, 1980.

   Selected scientists received assistance to enable them to attend the XII International Congress of Nutrition. The primary purpose of this Congress is to provide a three year international update of nutrition research related to the Congress's theme: "Nutrition — Basic to Human Health and International Development." The program included major symposia, mini-symposia and presentation of papers.

4. 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 AO1**; $67,120 for 12 months beginning October 1, 1980.

   Guar gum, modified starches and other polysaccharides are often added to foods. The interaction bet-

ween these additives and intestinal bacterial flora is studied, and the proliferation and metabolism of intestinal bacteria in the presence of these additives monitored. Particular attention is given to production of B-glucuronidase (an enzyme involved in the recycling of toxins) and to mucinases (which may increase the permeability of the lower gut to toxic material).

5. Assessment of Toxicological Hazards from Chloroganics Formed in Foods; James R. Kirk; University of Florida, Food Science and Human Nutrition, Gainesville, FL 32611; **Award #78-27067 AO1**; $72,463 for 12 months beginning September 1, 1980.

   When chlorine is used in water treatment or food processing to control microbial growth, chloro-organic compounds, some of which may be carcinogens, may be formed. This study determines the effect of reactant species, reactant concentration, pH, temperature, and light on the rate of chlorine incorporation by bio-organic compounds in foods. The incorporation of chlorine into proteins, lipids, carbohydrates, vitamins and selected food additives is studied by determining the identity and concentration of chlorinated reaction products.

   Initial studies are carried out in model systems containing a single substrate in a buffered solution or suspension to which various concentrations of hypochlorous acid are added. Chlorine incorporation is determined by scintillation counting of labeled chlorine in organic reaction products. Identification of chlorinated organic compounds is carried out using chromatography and mass spectrometry.

   Real food systems are investigated to determine the effect of these complex systems on chlorine incorporation. The rate of diffusion of hypochlorous acid and chlorinated reaction products is determined as a function of pH, temperature, and basic physiological structure of the food system. The stability of chloro-organics is studied. Collection and interpretation of these data may be used to establish guidelines for the safe use of aqueous chlorine with foods.

6. 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 AO1**; $60,648 for 12 months beginning October 1, 1980.

   Economic conditions and changing patterns of consumption suggest an increase in consumption of complex carbohydrates from cereals and grains, with a concomitant decrease in the consumption of refined sugars and meat. Pasta is likely to become a significant source of protein and B-vitamins. Because of the long time these products remain in the distribution system significant losses of nutrients may occur.

   The objective of this project is to determine the kinetics of the loss of thiamin, riboflavin, niacin and lysine in a pasta product under steady state conditions in a range of water activity and temperatures. The rate of loss also measured under light and dark conditions. From this information and information on the rate of moisture transfer for various packaging materials, predictions of the losses which occur are based on kinetic analysis made for different distribution conditions. Finally the predictions are tested by an actual measurement of losses that occur in simulated variable temperature, light, and humidity tests.

7. Effect 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 AO1**; $87,004 for 12 months beginning November 1, 1980.

   This project examines the levels of certain nutrients (vitamin B6, selenium, copper, zinc, sodium, potassium, calcium, and phosphorus) at specific stages of processing for ten commonly consumed 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 vitamin B6 and selenium, bioavailability is assessed (in a microbiological and rat model, respectively). Finally, the bioavailability of vitamin B6 and selenium from tuna, whole wheat bread, and peanut butter is assessed in humans using a controlled metabolic feeding study. The results obtained with the microbiolgical and rat study are compared with the human study to assess the applicability of these two models for determining bioavailability of selenium and vitamin B6 for food consumed by humans.

8. Effects of Wheat Bran Processing on Human Gastrointestinal Functions; Donna L. Payne; Oklahoma State University, Nutrition Administration, Stillwater, OK 74074; **Award #80-17730**; $62,407 for 24 months beginning October 1, 1980.

   Epidemiologic data imply that the low fiber content of the refined Western diet contributes to cancer, cardiovascular and colonic disease and the poor control of diabetes. Based on these data, processors have begun fortifying various foods with fiber of various sorts. Experimental studies to determine parameters in the physiological activity of dietary fiber have given conflicting results. This variability of effects has been traced to the complexity of dietary fiber both with regard to chemical composition and physical state.

   The physical structure of dietary fiber may effect its physiological function. This structure can be altered by milling. The following physical parameters of wheat brans altered by milling are determined: particle size by sieving and laser illumination, surface area, pore area, pore volume and pore radius by mercury penetration porosimetry, and hydration capacity by centrifugation and dialysis equilibrium. The small intestinal transit time and the colonic fermentability of the various brans are measured in man by quantitation of expired hydrogen and methane using gas chromatrography and infrared analysis.

9. 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 Science and Technology, Lincoln, NE 68508; **Award #79-19133 AO1**; $79,566 for 12 months beginning November 1, 1980.

   Regulatory, academic and food industry leadership have expressed interest in obtaining approval and acceptance of a rapid assay for estimating protein nutritional quality. 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 methionine, cysteine and lysine residues in a manner that could account for the differing results of human, chemical and rat assays. This project determines the effects of processing on legume-based food protein nutritional quality.

10. Bioavailability of Selenium and Zinc in Processed Human Foods Based on Soy Proteins: Studies Using Stable Isotope Tracers; Vernon R. Young; Massachusetts Institute of Technology, Department of Nutrition and Food Science, Cambridge, MA 02139; **Award #79-19112 AO1**; $87,312 for 12 months beginning October 1, 1980.

    Increasing commercialization and human consumption of vegetable protein raises important nutritional and public health considerations. This research addresses issues concerning the nutritional content, dietary availability, and collateral dietary effects of soy protein based meat products and processed infant formulas on two essential trace mineral nutrients, zinc and selenium.

    Stable, non-radioactive isotopes of minerals are used as tracers to monitor the fate of added zinc and selenium during food processing. Basic theoretical assumptions related to inherent experimental error, comparability with radioisotopic studies, and evaluation of "extrinsic" labeling procedures are tested in an experimental animal model for mineral bioavailability studies. Analytical methods of stable isotope determination are refined and extended. The effect of replacing beef or casein with soybean protein in a sausage and infant formula on bioavailability of zinc and selenium is explored. Quantitative estimates of the bioavailability of "fortification" levels of zinc and selenium are 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 are determined.

SCIENCE AND TECHNOLOGY TO AID THE HANDICAPPED

In Fiscal Year 1980, the Science and Technology to Aid the Handicapped program supported fundamental scientific research which may lead to products, treatment methods, or societal and environmental changes of significant benefit to the handicapped. (As defined for purposes of this program, handicapped persons are those who have a physical or mental impairment which substantially limits their vocational, educational, or social activity.) Awards are made on the basis of scientific and technical merit and the probability that the research will be successful in helping to meet high priority needs of the handicapped.

1. An Ocular-Controlled Intelligent Speech Prosthesis; Kenneth M. Colby; University of California-Los Angeles, 405 Hilgard Avenue, Los Angeles, CA 90024; **Award #79-17358 AO1**; $144,863 for 12 months beginning October 1, 1980.

   This project interfaces an intelligent speech prosthesis, under development at the University of California at Los Angeles, with an ocular-controlled device under development at the Denver Research Institute. The resultant device, an ocular-controlled intelligent speech prosthesis, provides a means of communication for non-vocal persons. Users of the device generate synthetic speech by looking at letters on a lens of spectacles connected to the intelligent speech prosthesis.

   In its first phase, the research involves the hardware-software linkage of the two devices, which utilize a microprocessor and a speech synthesizer. In the second phase of the research the feasibility of the device is tested and evaluated using individually selected patients, in particular those suffering from aphasia following a stroke, patients with cerebral palsy, and quadriplegics unable to speak. The significance of the research lies in its ability to utilize new technological advances to provide spoken communication for the non-vocal population.

2. Replacement of Sensory Capabilities for the Physically Handicapped; Robert J. Cosgrove; Southern Research Institute, 2000 Ninth Avenue South, Birmingham, AL, 35205; **Award #79-15313 AO1**; $102,698 for 12 months beginning September 1, 1980.

   The objective of this project is to develop a new method to replace the senses of touch and pain in neurologically injured patients. There are as yet no good measures to prevent decubitus ulcers and accidental injuries which result from loss of tactile and pain sensory capabilities. As a consequence, many millions of dollars are added annually to national health care costs.

   Pressure-sensitive conductive elastomers are developed in which the electrical conductance is related to the static pressure. The films can be made very thin and can readily conform to the shape of the interface without significantly distorting the pressure distribu-

tion. The 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 clincial application.

3. 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 AO1**; $85,900 for 12 months beginning June 19, 1978.

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

   An existing, highly flexible computer-controlled electrical stimulation system and electrode technology is used for the current investigation. Previous studies in this area were limited by the use of hardwired and thus inflexible stimulation and input transfer systems. The equipment is designed for the safe electrical stimulation of the visual cortex and cochlea.

   A systematic investigation of electrocutaneous display methods is conducted, using psychophysical techniques to obtain a body of basic information about the ability of human observers to perceive complex, dynamic patterns imposed on the skin. This information is essential for the future design of non-invasive prosthetic devices.

4. The Effect of Chemical Modification of Bone Cements on Their Young's Moduli; B. David Halpern; Polysciences Inc., Paul Valley Industrial Park, Warrington, PA 18976; **Award #80-09941**; $24,965 for 6 months beginning September 1, 1980.

   As prosthetic procedures are used on increasingly younger and more active patients, the functional life of the prosthetic system must be extended. The present cement used in fixation of prostheses *in vivo* has been the principal cause of orthopedic failures. Gross modulus mismatches in mating bone to prosthesis by cement has lead not only to prothesis failure, but bone resorption, tissue necrosis, deterioration and/or movement of the implant device, and other complications, particularly as the implants age.

   The specific objective of this research is to study the effect of systematic variations in the composition of a proposed bone cement. To be useful as a cement, the rheological properties of compositions of polymer and monomer have to be suitable, and rates of polymerization at room temperature have to be within a certain time frame. This research consists of two stages—a material synthesis stage during which several acrylate and methcrylate polymers are prepared, and a physical testing stage to determine the "cured" composition of these cements. Improved bone cement will significantly reduce medical care cost, improve surgical techniques, and enable patients to lead more active and productive lives.

5. Application of Personal Computing to Assist the Handicapped; Paul L. Hazan; Applied Physics Laboratory, Applied Physics Laboratory, Laurel, MD 20810; **Award #80-17898**; $15,800 for 8 months beginning October 1, 1980.

   The Johns Hopkins University Applied Physics Laboratory manages and administers a series of regional and national competitions to find innovative applications of personal computers to assist the handicapped. To provide opportunities for a broad spectrum of participants, prizes will be awarded for each of the following categories: students, amateurs, professionals, and corporations. A handicapped person has been broadly defined as a person suffering from any chronic impairment, either physical or mental in nature. Rules for participation and judging have been drawn up with the assistance of an Advisory Committee composed of individuals selected from corporations, universities, governmental agencies, and groups of handicapped persons.

6. Microprocessor-Based Integration of Artificial Reflexes and Sensory Feedback for Prosthetic Control; Wolfram Jarisch; Scientific Systems, Inc., Department of Biomedical Engineering, Cambridge, MA 02138; **Award #80-09412**; $25,000 for 6 months beginning September 1, 1980.

   This project seeks to improve the performance and usefulness of prosthetic limbs for the handicapped. The specific objective of this research is to develop a microprocessor-based prosthetic aid so that requirements for continuous visual supervision of prosthetic movements are lowered. Research activities are underway on the design and development of necessary hardware and control systems for a prosthetic arm.

7. Electrodes to Aid the Handicapped; John A. R. Kater; Annex Research, P.O. Box 15044, Costa Mesa, CA 92626; **Award #80-09361**; $25,000 for 6 months beginning September 1, 1980.

   A reliable and low-cost method to measure potassium (K^+) and calcium (Ca^{2+}) electrolytes during patient hemodialysis is needed. Imbalance of these electrolytes can cause cardiac arrythmias, irreversible complications, and death. The thrust of this research is to study the feasibility of using solid substrate technology to develop disposable K^+ and Ca^{2+} electrodes and simple, portable meters suitable for bedside monitoring during dialysis.

   The ability to monitor K^+ and Ca^{2+} continuously or frequently with disposable electrodes and simple, portable, dedicated, digital meters should result in lower cost hemodialysis treatments and better care.

8. Enhancement of Speech Intelligibility for the Hearing Impaired; James M. Kates; Signatron, Inc., 12 Hartwell

Avenue, Lexington, MA 02173; **Award #80-09372**; $25,000 for 6 months beginning September 21, 1980.

Conventional hearing aids are inadequate for people with sensorineural hearing loss. A truly effective hearing aid would be one that would work in a noisy environment. A substantial improvement in hearing aids is possible by designing signal processing that takes into account the properties of speech generation, perception, and the characteristics of sensorineural hearing loss.

This research enhances speech intelligibility by removing pitch irregularities and by emphasizing perceptually important speech features. By removing pitch irregularities, the effects of noise are further reduced through adaptive filtering of the speech waveform. The use of signal processing in the hearing aid leads to a significant improvement in the quality of hearing aids.

9. Identification of the Relevant Parameters and their Magnitudes for Electrical Stimulation of Bone Remodeling; Edward Korostoff; University of Pennsylvania, 3451 Walnut Street, Franklin Building, Philadelphia, Pa 19104; **Award #80-06137**; $101,109 for 12 months beginning July 15, 1980.

   There are important current and projected clinical uses of exogeneous electrical bone stimulation. One problem in advancing this field is that very little theory is known. What is known is that between 10 and 20 microamperes of current will cause bone growth or fracture healing.

   This project is aimed at advancing our theoretical understanding of this phenomenon and providing guidelines for clinical application. Experiments conducted to understand the process by which bone develops stress generated potentials. This is important because the assumption is made that it is this endogeneous electricity that mediates normal bone remodeling. This assumption is tested by combining a recently developed microelectrode technique for measuring microscopic stress generated potentials with an immunohistochemical technique for identifying active bone cells. These experiments identify the correlation between endogeneous potentials and new cells. Another set of experiments uses standard reference electrodes to obtain the electrochemical potentials at both anode and cathode in order to identify the electrochemical and biochemical reactions taking place. These experiments provide insight into the mechanism of electrical stimulation and identify critical parameters and magnitudes for clinical application.

10. Research on Transitory Tactile Displays; Douglas Maure; American Foundation for the Blind, 15 West 16th Street New York, NY 10001; **Award #80-06382**; $155,907 for 18 months beginning August 1, 1980.

    This project investigates the feasibility of developing a new inexpensive approach to locate, address, raise and lower multiple tactile pins in a transitory array of any configuration. Projected costs are 5 to 100 times less than for alternative approaches (depending on size of array). This research will lead to development of a new generation of transient tactile arrays to expand reading and information processing opportunities for blind persons. Potential uses include presentation of braille text stored on a tape cassette and computer terminal output displays.

    Experimental studies will determine human factor and mechanical design specifications for a range of sizes and configurations. Presentation of graphic data, currently impossible with any transitory display, is emphasized. Reliability and manufacturing feasibility are tested using prototypes.

11. Planning Workshops for Science and Technology for the Handicapped; Martha R. Redden; American Association for the Advancement of Science, 1776 Massachusetts Avenue, N.W., Washington, DC 20036; **Award #80-23146**; $106,601 for 12 months beginning October 1, 1980.

    The AAAS will bring together handicapped persons, researchers, and industry representatives to stimulate communication focused on research of benefit to the handicapped. Specifically, the Association will organize and conduct over the next three years a series of nine regional workshops of handicapped scientists, engineers and other researchers, as well as representatives of consumer organizations interested in science and technology for the handicapped. They will review current research issues, make recommendations, and suggest priorities for research. They will provide a continuing update of the program priorities for the ongoing NSF program, Science and Technology for the Handicapped.

    The second specific area of activity will be the publication of conference and workshop proceedings and a quarterly bulletin. These publications will be distributed widely to the workshop participants, mission agencies, and the Congress.

12. Voice Response Aids for the Handicapped—An Innovative Technique; David Y. Wong; Signal Technology Inc, Department of Electrical Engineering. Santa Barbara, Ca 93101; **Award #80-09724**; $25,000 for 6 months beginning September 1, 1980.

    The usefulness of voice-response devices for the handicapped, especially the blind, is well acknowledged. For example, it would be much easier for the blind to operate a computer if the machine could respond to the operator with voice. This study involves a technique for storing speech in a highly efficient manner based on recent advances in the information theoretic coding of speech signals. The technique allows the vocabulary of a voice response device to be expanded by factors of two or better at little additional cost. The development of these coding techniques allows speech sounds to be stored digitally in a highly efficient manner in a portable device. Without such coding techniques, voice response devices would simply be too bulky and expensive for general use.

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