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Proceedings of the  
37th Annual Conference on

# ENGINEERING IN MEDICINE AND BIOLOGY

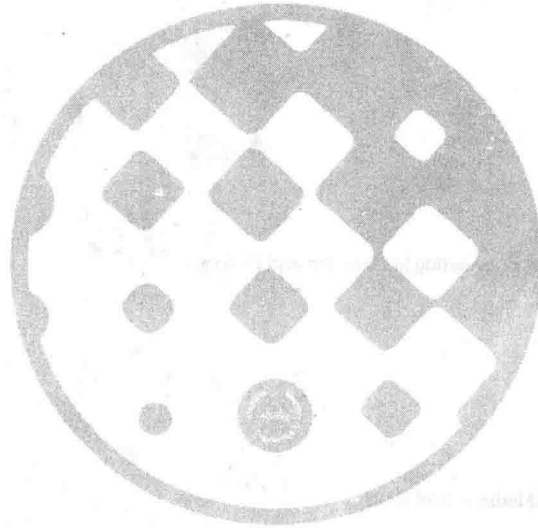
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Proceedings of the  
37th Annual Conference on  
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1984

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# Annual Conference on Engineering in Medicine and Biology

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*Morton D. Schwartz, Ph.D.  
California State University  
Long Beach  
37th ACEMB General Chair*

With approximately 400 papers in 53 traditional sessions, plus 30 poster presentations, this year's program is one of the most interesting and exciting ever. To ensure that we touched as many bases as possible in the vast field of biomedical engineering, many of the papers were invited. Introductory overviews, to provide background and create greater interest for those less familiar with subjects discussed, precede many sessions, and where possible, related sessions have been arranged in tracks to create several mini-symposia within the conference.

Abstracts of all submitted papers and poster presentations, as well as most of the invited papers in this year's Conference, are included in these Proceedings; they are arranged by session and paper number, with poster presentation abstracts following those of the traditional sessions. In many of the sessions there is no abstract for the introduction of the subject by the session chair, and in a few of the others, such as sessions 28 and 43, the only abstract is an overview of the entire session. Session 13, a panel presentation, did not require abstracts; however, one was submitted and it is included. Abstract numbers match presentation numbers in the program, and where abstracts were not submitted, the number was skipped in the proceedings.

Abstracts summarize the latest developments in biomedical engineering and related fields, and are the result of countless hours of research and development effort on the part of the many authors represented. We thank the authors and presenters of these papers for their intellectual effort.

*Fred J. Weibell, Ph.D.  
VA Medical Center, Sepulveda  
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*September 1984*

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American Association for  
Medical Systems and  
Informatics

American Association of  
Physicists in Medicine

American College of  
Physicians

American College of  
Radiology

American Institute of  
Chemical Engineers

American Institute of  
Ultrasound in Medicine

American Society for  
Engineering Education

American Society for  
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American Society of Civil  
Engineers

American Society of  
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Air-Conditioning Engineers

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Biomedical Engineering  
Society

Institute of Electrical &  
Electronics Engineers

Instrument Society of  
America

Neuroelectric Society

Rehabilitation Engineering  
Society of North America

SPIE—International  
Society for Optical  
Engineering

Alpha Eta Mu Beta—  
National Biomedical  
Engineering Honor Society

U.S. Affiliate  
International Federation for  
Medical and Biological Engineering

38th Annual Conference on  
Engineering in Medicine and Biology  
September 30—October 2, 1985  
Americana Congress Hotel  
Chicago, Illinois

American Academy of Orthopaedic Surgeons  
444 N. Michigan Avenue, Suite 1500  
Chicago, Illinois 60611

AMERICAN ASSOCIATION FOR MEDICAL  
SYSTEMS AND INFORMATICS (AAMSI)  
Suite 402, 4405 East-West Highway  
Bethesda, Maryland 20814

The American Academy of Orthopaedic Surgeons, established in 1933, is that medical specialty which embraces the investigation, preservation, development and restoration of the form and function of the extremities, the spine and associated structures of the skeleton by medical, surgical and physical methods.

From the very beginning, the purpose of the Academy has been to foster, support, augment, develop, and encourage investigative knowledge of orthopaedic surgery and to prevent disorders of the musculoskeletal system.

The continuing education of its 10,700 members is the Academy's major function. Among the Academy's many educational tools are its instructional courses, averaging between 115-120, and presented yearly since 1942 at the Annual Meetings. In addition, the courses are published to augment the libraries of orthopaedic surgery and selected abstracts of scientific papers were produced in audio-cassette form for the first time after the 1976 Annual Meeting.

Other endeavors include the Summer Institute program, patterned after the Annual Meeting instructional course format, and videotapes on selected subjects.

Another important educational service is the Academy's sound-slide and film video-cassette programs. Started in the late 1950's, it now provides more than 600 titles for use in all phases of orthopaedic education.

In recent years, the Academy introduced the Self-Assessment Examination, a voluntary procedure enabling an orthopaedist to identify areas of deficiency and to follow through with appropriate remedial continuing education experiences to bridge the gap between what he wants to know and what he needs to know.

The Academy is active in many areas that in some way relate to patient care including liaison with standards developing organizations, particularly as they pertain to implants and other details of orthopaedic surgery. The Academy does not produce standards on its own.

The American Association for Medical Systems and Informatics is the nation's leading organization applying advanced systems and information technologies to promote excellence in health care.

Inasmuch as medical systems, and the computers that are an integral part of such systems, will play an increasingly major role in patient care in the coming decades, the members of AAMSI have a responsibility to use their professional expertise to ensure a continuing flow of information, research, and education within the health care field.

The AAMSI contributes in three ways: (1) through the development of scientific and educational programs and the dissemination of information, (2) by promoting the development and implementation of systems for health care and medical informatics in support of patient care, teaching, research, and health administration, and (3) fostering medical computing and medical information technology through an interdisciplinary forum dedicated to improving patient care and the general health of the public.

These goals are accomplished through a variety of activities that AAMSI offers:

- Conducting scientific, technical, and educational meetings--one of which is the annual meeting of the association.
- Maintaining a Professional Specialty Program whereby members can interact with each other within their specialty fields. The emphasis is on the use of computer technology to improve direct patient care.
- Providing a communications network via telematics (information, technology, computers, and telematics).
- Publishing and disseminating digests, reports, proceedings, and other pertinent documents, independently and in professional literature.
- Providing a focus for the development of standard terminology, coding systems, and guidelines.
- Representing the United States in the international arena of medical systems and informatics. Membership in the American Association for Medical Systems and Informatics provides a means of staying abreast of the rapid changes in medical systems and informatics and is open to individuals and organizations with a demonstrated interest in the field.

The Association's newsletter is published quarterly and serves as a forum for exchanging information and ideas and as a vehicle for informing the membership about important developments in medical systems and informatics.

A scientific congress is held in the spring and the annual conference is held in the fall. Individuals at every level of knowledge and expertise are encouraged to participate actively in these meetings. Members receive reduced rates on conference registration. Proceedings are available at the time of the meetings and a copy of the annual conference proceedings is provided to members without additional charge.

For additional information, write to AAMSI.



AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE  
335 EAST 45TH STREET  
NEW YORK, NY 10017

AMERICAN COLLEGE OF PHYSICIANS  
4200 Pine Street  
Philadelphia, PA 19104

The American Association of Physicists in Medicine, established in 1958, has a current membership of approximately 2,200. The Association's purposes are to promote the application of physics to medicine and biology, to encourage interest and training in medical physics and to prepare and disseminate technical information in this and related fields. The Association's scientific activities lean heavily towards radiological physics (physics of x-ray diagnosis and therapy, radiation safety, etc.) but there is an increasing emphasis on the physics of other, non-radiological techniques for the diagnosis and treatment of disease.

The primary professional activity of Full Members must be in medical physics but certain other membership categories are open to those who do not meet this requirement. Corporate membership is available to industrial organizations.

The principal scientific meeting is held in the Summer, usually in conjunction with an AAPM organized Summer School. A Winter meeting is mounted jointly with the Radiological Society of North America, and the Association through its membership in the International Organization of Medical Physics (IOMP) has sponsored several international conferences. The Association's Regional Chapters, now numbering 18, also hold frequent meetings and symposia.

The Association publishes a bimonthly journal Medical Physics and a Newsletter covering Association affairs. Jointly with the Canadian and British medical physics organizations and with IOMP, AAPM sponsors a second bimonthly journal Physics in Medicine and Biology. Monographs, Technical Reports, and other scientific and educational materials are published.

An important activity is the accreditation of Regional Calibration Laboratories to supplement National Bureau of Standards instrument calibration services.

Under contract to the National Institutes of Health and Human Services, the AAPM coordinates the activities of six Centers for Radiological Physics which are under contract to the National Cancer Institute.

The Association is a Member Society of the American Institute of Physics.

335 East 45th Street  
New York, NY 10017  
212/661-9404

The American College of Physicians is a national medical organization consisting of over 57,000 specialists in internal medicine and related subspecialties. The College is dedicated to maintaining and advancing the quality of patient care in internal medicine and allied specialties. The College accomplishes this through graduate and continuing education and by concerning itself with matters of public policy as related to internal medicine.

The College annually sponsors an Annual Session, 30-40 Postgraduate Courses and 50 Regional Meetings. The College was the major innovator of the concept of self-assessment of medical knowledge combined with continuing medical education and has published 6 Medical Knowledge Self-Assessment Programs (MKSAP). Distribution of the sixth program began in October 1982, with 40,000 subscribers as of May, 1984. MKSAP VII will be published in 1985. In conjunction with the MKSAP VI Program, the College is sponsoring 65 MKSAP Review Courses in various cities throughout the country. In addition, the College presents 8 awards annually, and sponsors 15 teaching and research scholarships.

The American College of Physicians publishes the ANNALS OF INTERNAL MEDICINE and the ACP OBSERVER monthly.

THE AMERICAN COLLEGE OF RADIOLOGY  
20 N. Wacker Drive  
Chicago, Illinois 60606

The ACR was founded in 1923 with the objective of creating "a fellowship among medical men who have distinguished themselves in the science of radiology.

Member and Fellow are the two principal categories of membership in the ACR. Members are those physicians practicing radiology who have been certified by the American Board of Radiology or in radiology by the Royal College of Physicians and Surgeons of Canada. They also are required to be members of their College chapter.

Members and Fellows in Physics are elected from those physicists certified by the American Board of Radiology. The Board of Chancellors elects Gold Medalists and Honorary Fellows.

College Fellows are elected from the membership on the basis of contributions and service to radiology. A minimum of 5 years of membership is required. Fellowship nominations are approved by the Board of Chancellors and election is by the College fellows.

Residents in radiology in approved programs are eligible to become junior members of the ACR upon nomination of their preceptors. Such membership extends for the training period and entitles the resident to receive publications and attend meetings of the College.

Since its reorganization in 1939, the College has functioned as the spokesman for radiology. It has developed programs in radiation protection, professional and public education, technologist training, practice standards, public relations, legislation, and health care insurance.

The College opened a Washington office in 1969 for government liaison and for contact with other organizations of interest to radiologists. It also has offices in Philadelphia and Walnut Creek, California, to carry out special projects.

The officers of the College are the president, vice president and secretary-treasurer. They serve 1-year terms. The president, vice president and sixteen Chancellors are elected by the membership. The administrative head of the College is its executive director. Working with the executive director are an assistant executive director; directors of public relations, the Washington office, education and administration; a comptroller, and other assistants. Legal counsel and legislative consultant also are available.

The American College of Radiology Foundation was created in 1958 to carry out educational and other beneficial activities for radiology. The Foundation has begun to accumulate an endowment and has undertaken several projects.

The Professional Bureau is a placement service designed to aid radiologists, radiology residents, medical clinics and hospital medical staffs.

American Institute of Chemical Engineers  
J. Charles Forman, Executive Director  
345 East 47th Street  
New York, New York 10017  
(212) 705-7338

The American Institute of Chemical Engineers, a technical and professional society of over 60,000 chemical engineers (including students) is dedicated to advancing chemical engineering in theory and practice, to maintaining a high professional standards among its members, and to serving society, particularly where chemical engineering can contribute to the public interest. It is directed by a Council consisting of the officers--President, Vice President, Secretary, Treasurer, Past President--and 12 directors elected for three year terms.

Much of the accomplishment of the AIChE originates in its nearly 30 committees, devoted to such interests as energy, professional development, meeting programs, continuing education and research. In addition, the AIChE has 12 divisions covering the environment; nuclear energy; food, pharmaceutical and bioengineering; forest products; fuels and petrochemicals; heat transfer and energy conversion; computer systems and technology; materials engineering and sciences; safety and health; marketing; management and engineering and construction contracting. Over 104 local sections offer the members in their areas monthly meetings, one-day technical sessions, continuing education programs, plant trips, etc., and there are 400 student chapters.

The American Institute of Chemical Engineers - which celebrated its Diamond Jubilee in 1983 - was the first society to accredit engineering curricula, a function it has performed since 1925. Today the AIChE works with the Accreditation Board for Engineering and Technology in the accreditation process.

During the year AIChE holds three meetings and sponsors the Petrochemical and Refining Exposition every year, Special meetings are also held in cooperation with other societies and with agencies such as the National Science Foundation.

Among its publications are the monthly Chemical Engineering Progress, the bimonthly AIChE Journal, the quarterlies International Chemical Engineering, Environmental Progress, Energy Progress, and Plant/Operations Progress, the AIChE Monograph and Symposium Series, equipment testing procedures, the Student Annual and Chemical Engineering Faculties.

AIChE is a member of the Accreditation Board for Engineering and Technology, American Association of Engineering Societies, and the Interamerican Confederation of Chemical Engineering, among other groups, and is represented on numerous councils and national committees.

Membership grades are Fellow, Member, Associate Member, Affiliate Member, and Student Member. The AIChE has its headquarters in the United Engineering Center in New York.

AMERICAN INSTITUTE OF ULTRASOUND IN MEDICINE  
4405 East-West Highway, Suite 504  
Bethesda, Maryland 20814  
301-656-6117

The American Institute of Ultrasound in Medicine was founded in 1951 to advance the art and science of ultrasound in medicine and research. Its activities are educational, literary, and scientific. AIUM includes committees in the following areas: Archives, Bioeffects, Central Program, Education, Ethics, Manufacturers Commendation, Project Development, Publications, Public Relations and Standards. AIUM invites participation by its members in committee activities.

In this era of rapid expansion in ultrasound diagnosis, therapy, and biological research, the AIUM recognizes that the full potential of this biomedical tool can be achieved only by coordinating efforts of researchers, clinicians and engineers. AIUM is designed to create a forum for interaction among these workers, and to guide a multi-disciplinary, scientific approach to medical ultrasound.

Annual national conventions include educational and scientific sessions, and commercial and scientific exhibits. Meetings open with an educational session covering current diagnostic techniques, held in conjunction with the Society of Diagnostic Medical Sonographers. Scientific sessions consist of papers on medical applications, basic science and instrumentation. There are also less formal luncheon and evening events. Category I credits are awarded on an hour for hour basis. The 1984 meeting is in Kansas City, Sept 16-19; 1985 is Dallas, Oct 8-11; 1986 is Las Vegas, Sept 16-19.

AIUM membership consists of 7000 physicians, engineers, physicists, technical specialists and other scientists. Manufacturer memberships are also available.

AIUM publishes manuals, pamphlets and audiovisual materials to help maintain educational and professional standards in the field. Publications include safety standards, recommended nomenclature, a medical ultrasound bibliography, a guide to standard presentation and labeling, proceedings of annual meetings, an annual buyer's guide to equipment and services, and patient information brochures.

The official journal of the AIUM is the Journal of Ultrasound in Medicine, published monthly under the editorship of George R Leopold, MD; JUM includes a membership news section. Members receive JUM as a benefit of membership.

The AIUM is affiliated with the World Federation for Ultrasound in Medicine and Biology, and with the Society of Diagnostic Medical Sonographers.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION (ASEE)  
Suite 200, Eleven Dupont Circle 202/293-7080  
Washington, DC 20036  
Dr. W. Edward Lear, Executive Director

The American Society for Engineering Education, founded in 1893, is dedicated to the advancement and improvement of all aspects of higher and continuing education concerned with the teaching and training of professional engineers and technologists. With 10,000 individual and 600 institutional members, it serves these aims by giving direct aid to the development of more effective teaching faculty and engineering college administrators, producing advanced instructional materials to stimulate new curricula and programs, improving the content and support of engineering research, and by enhancing ethics and standards in the profession. The Society coordinates the interests and activities of its members through a set of institutional councils, professional interest councils, on-campus activity coordinators or committees at member schools, and geographic zones. Members affiliate themselves with a wide variety of divisions and committees devoted to particular areas of interest, including educational research and methods, liberal studies, continuing and cooperative education, biomedical engineering, environmental engineering, governmental relations, engineering economy, engineering design, energy conservation, nuclear engineering, and engineering design graphics. ASEE confers 13 national awards annually upon engineering educators for distinguished teaching, for outstanding research contributions and for other significant service to engineering education. Under the direction of the executive director, the Society maintains headquarters at Eleven Dupont Circle, Suite 200, Washington, DC 20036, telephone 202/293-7080. The Society to keep in direct contact with federal agencies and other national organizations concerned with engineering manpower and with the role of engineering in developing societies abroad. ASEE has sponsored a congress of engineering educators from throughout the world. As a measure of its recent leadership, the Society has administered or cosponsored over thirty research and study projects, including a study to improve the retention rate of undergraduate engineering students, and activities for the development of predominantly black engineering colleges. ASEE is vigorously pursuing the goal of encouraging more women, as well as members of minority groups, to undertake the scholastic preparation for successful careers in engineering and engineering technology, and encouraging greater awareness among children of junior high school age of opportunities in these fields. During the academic year, ASEE publishes a journal devoted to innovative teaching ideas, Engineering Education, one issue of which is a directory of engineering college research and graduate study. It also publishes a monthly newspaper, Engineering Education News, devoted to current developments in the Society's main areas of interest. Eight Society divisions also produce periodicals.

American Society for Hospital Engineering  
V. James McLarney, Society Director  
840 North Lake Shore Drive  
Chicago, IL 60611

American Society for Testing and Materials (ASTM)  
1916 Race Street  
Philadelphia, PA 19103

The American Society for Hospital Engineering (ASHE), the largest of the 15 health manpower societies, affiliated with the American Hospital Association, embraces multiple engineering disciplines utilized in the delivery of health care services in an institutional setting. Plant engineering, clinical engineering technology, and telecommunications are the major disciplines. Special sections for clinical engineering technology and telecommunications have recently been formed.

ASHE publications include a monthly newsletter, monthly technical reports, the Hospital Engineering Handbook, a hospital recall and reporting system for medical devices, a report on automated infusion devices, a policies and procedures guide, a preventive maintenance manual for small hospitals, video tapes of a symposium on environmental safety issues, special alert bulletins, and more.

Topical areas addressed by committee work include: Codes and Safety, Energy, Technology Radiological Engineers, Equipment Purchasing, Environment, Professional Development and Shared Services.

The ASHE sponsors 15-20 programs a year, the major program being the annual Hospital Engineering Conference.

The American Society for Testing and Materials (ASTM) is the country's leading management system for the development of voluntary consensus standards. Thirty-three thousand experts participate on 140 technical committees to develop standards on a wide range of materials, products, systems and services. Over seven thousand ASTM standards are published each year in the sixty-six volume ASTM Book of Standards.

Standards for medical devices and diagnostic products are a significant part of ASTM's overall program. Committee F-4 on Medical and Surgical Materials and Devices (formerly Surgical Implants) was organized in 1962. Committee F-4's scope is the development of standard definitions of terms, methods of test, specifications and performance requirements for medical and surgical materials and devices. Over four hundred bioengineers, biomaterial scientist physicians, industrial engineers, quality control specialist, government scientist and association representatives are working on F-4 subcommittee on Resources, Orthopaedics, Cardiovascular, Neurosurgery, Plastic and Reconstructive Surgery, Medical/Surgical Instruments and Urology. In addition to over one hundred published standards (Volume 13.01), there are draft technical standards being reviewed on polymers, metals, ceramics, composites, test methods, biocompatibility, device retrieval, packaging, osteosynthesis joint replacement, cardiovascular, neurosurgical, urological, and surgical instruments.

Committee F-19 on Orthotics and External Prosthetics was organized in 1974 to develop standard definitions, classifications, recommended practices, specifications, test methods and performance requirements for Orthoses, Prostheses and Mobility Aids. The ASTM Committees also provide the expertise for U. S. Technical Advisory Groups (TAGS) for the International Standards Organization Technical Committees, 150 on Surgical Implants, 168 on Prostheses and Orthotics.

Medical related standards are also being developed in ASTM Committee D-11 on Rubber and Rubber-Like Materials, D-20 on Plastics, E-20 on Temperature Measurement, E-25 on Microscopy, E-31 on Computerized Laboratory Systems and E-41 on Laboratory Apparatus.

For further information, contact Ray Sansone at (215) 299-5521.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS  
2950 Niles Road  
St. Joseph, Michigan 49085

AMERICAN SOCIETY OF CIVIL ENGINEERS  
United Engineering Center  
345 East 47th Street  
New York, NY 10017

ASAE is a technical society serving engineering in agriculture. Its objectives are to promote the science and art of engineering in agriculture; to encourage original research; to foster agricultural engineering education; to advance the standards of agricultural engineering; to increase and extend the association of agricultural engineers among themselves and with allied scientists and technologists. Founded in 1907, the Society serves 11,000 members in North America and over 100 other countries.

It is organized into 5 major technical interest areas. The Power and Machinery Division is concerned with agricultural tractors and implements for planting, harvesting, transporting and processing food, feed and agricultural fiber. The Soil and Water Division is concerned with irrigation, drainage, hydrology, erosion control and land use planning. The Electric Power and Processing Division is concerned with efficient handling and processing of agricultural products on the farmstead which frequently requires the use of electric power. The Structures and Environment Division is concerned with structures for livestock and plant production as well as storage of agricultural products and waste management. The Food Engineering Division is concerned with production processing, packaging, storage and distribution of food from the farm to the consumer.

In addition there are numerous Society-wide committees that coordinate special interests of concern to all technical interest areas such as safety, standards, instrumentation, energy, environmental quality, countryside development, and bioengineering. One of these, the ASAE Bioengineering Committee, is responsible for coordinating bioengineering interests for the Society. This committee is concerned with the role of agricultural engineering in bioengineering and encourages interest in bioengineering among ASAE members. Recent activities include technical programs on agribioengineering in plant and animal systems; bioengineering for maximum crop production through photosynthesis research, genetic manipulation and mathematical modeling; and bioengineering instruction in agricultural engineering.

The American Society of Civil Engineers, founded in 1852, has as its objective the "advancement of the science and profession of engineering to enhance the welfare of mankind."

The Society presently has over 92,000 members.

Continuing education and professional growth are primary concerns, as are protection and promotion of professional consciousness within the profession and civil engineering students, stimulation of technical research and publication of new technical information.

More than 4,000 members voluntarily serve on nearly 450 different technical committees, in administrative and coordinating committees and about 200 members conduct 27 professional committees. With the activities of Sections, Student Chapters, Joint Councils, and the many working committees, an average of approximately 100 meetings or other functions are held every weekday by ASCE groups.

The following twenty-two Technical Divisions and five Technical Councils of the Society work to develop and disseminate new technical information:

Aerospace	Structural
Air Transport	Surveying & Mapping
Construction	Urban Planning and Development
Energy	Urban Transportation
Engineering Mechanics	Water Resources Planning & Management
Environmental Engineering	Waterway, Port, Coastal, & Ocean
Geotechnical Engineering	Computer Practices
Highway	Lifeline Earthquake Engineering
Hydraulics	Cold Regions
Irrigation & Drainage	Research
Pipeline	

Through the Technical Divisions and Councils the members are stimulated and aided in producing significant contributions to the knowledge of civil engineering techniques.

Publications of the Society include the monthly magazine, CIVIL ENGINEERING, and the monthly newspaper, ASCE NEWS. Technical Division Journals include papers, and a number of Manuals and Reports provide authoritative information on a variety of subjects. ASCE Transactions is published annually providing guide to all published materials.

ASCE participates in AEMB activities through its Engineering Mechanics Division's Committee on Bioengineering.

AMERICAN SOCIETY OF HEATING, REFRIGERATING  
AND AIR-CONDITIONING ENGINEERS, INC.  
1791 Tullie Circle, N.E.  
Atlanta, Georgia 30329

THE AMERICAN SOCIETY OF MECHANICAL  
ENGINEERS  
345 East 47th Street  
New York, New York 10017

The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., known popularly as ASHRAE, is the only technical society devoted exclusively to promoting the arts and sciences of heating, refrigerating, air conditioning, ventilation and their allied technologies. Established in 1894, it has grown to more than 50,000 members, and its membership spreads throughout the United States, Canada and 120 overseas countries.

All members belong to the international organization, which is headquartered in Atlanta, GA, and most members belong to one of the Society's 142 North American chapters.

ASHRAE is a medium for the accumulation and dissemination of technical information in the heating, ventilating, air-conditioning and refrigerating fields, accomplishing this through local and national meetings and an extensive publications program:

ASHRAE JOURNAL is the Society's official monthly publication and the most authoritative periodical on research, design, development, engineering and news in the field.

ASHRAE HANDBOOK & Product Directory is a four-volume series with one updated volume published annually: Applications, Equipment, Fundamentals and Systems.

ASHRAE TRANSACTIONS, published since 1895, contains an unabridged compilation of all technical papers and symposium papers and their discussions presented at Annual and Winter meetings of the Society, plus necrology, and chronological listing of ASHRAE past presidents, Society meetings and honors and awards.

The American Society of Mechanical Engineers was founded in 1880 as an educational and technical society of individual members, which currently total some 107,000 men and women here and abroad. While its principal aims and objectives are: providing continuing education to mechanical engineers, industry, and society as a whole through the development and dissemination of technical information; developing mechanical standards, codes, safety procedures and operating principles; and encouraging the personal and professional development of practicing and student engineers, the Society also conducts programs which will bring a better understanding of technology to legislators, other professionals and the public at large.

To carry out these objectives the Society receives policy direction from a volunteer body of members and officers, and general administration from a Headquarters staff of some 250 in New York, and four Field Service offices in Washington, D.C., Dallas, Chicago, and San Francisco. The Society also maintains an additional office in Washington, D.C. to monitor legislative activities and to provide technical expertise to Congress and the Executive Branch of the Government.

Members can participate in one or several of the 34 Technical Divisions which sponsor or participate in national and international meetings and symposia (approximately 30 per year), and which contribute to the technical literature. In fact ASME conducts one of the largest technical publications operations in the world, committing a broad spectrum of engineering experience and research to the printed word. Spokesman for ASME is the monthly magazine MECHANICAL ENGINEERING.

The Society also plays a coordinating role in engineering research by sponsoring projects which are conducted by research organizations.

# Biomedical Engineering Society

P. O. Box 2399  
Culver City, California 90230

The Biomedical Engineering Society was incorporated as a non-profit organization on February 1, 1968 in response to a need to give equal status representation to both biomedical and engineering interests. The purpose of the Society is to promote the increase of biomedical engineering knowledge and its utilization.

## MEMBERSHIP

**Senior Membership:** Senior Membership is the highest designation for which application may be made. It is designed for those who have exhibited substantial achievement in, as well as sustained devotion to the goals of the Society. These qualifications may be demonstrated in research, education, professional practice, or administration and management in fields relevant to the activities of the Society. Except under very exceptional circumstances, Senior Membership is awarded only to Members in good standing for at least six years.

**Membership:** Members must have a degree in biomedical engineering or a related field and documented evidence of interest and achievement in biomedical engineering. Members must have conducted meritorious original research, or development, or application, or teaching, in biomedical engineering and must now be engaged in biomedical engineering.

**Student Membership:** Students pursuing a course of study in biomedical engineering or in related sciences may be admitted to Student Membership for a period not exceeding five years.

**Sustaining Membership:** A Sustaining Member is a person, firm or corporation which, at the time of application, supports the stated purposes of the Society.

## PUBLICATIONS

The Biomedical Engineering Society publishes a quarterly Bulletin and an annual Directory for its members. The ANNALS OF BIOMEDICAL ENGINEERING, the journal of the Biomedical Engineering Society, publishes original research in biomaterials, biomechanics, rehabilitation engineering, instrumentation, and physiological systems analysis.

## MEETINGS

The Biomedical Engineering Society holds an Annual Meeting for the presentation of technical papers and the conduct of Society business. A membership is held by the Society in the Alliance for Engineering in Medicine and Biology.

The Institute of Electrical and Electronics Engineers, Inc., 345 E. 47th Street, NY, NY 10017

The Engineering in Medicine and Biology Society, of the Institute of Electrical and Electronics Engineers (EMBS/IEEE) is an association of 7595 members concerned with the application of engineering science and methodology to biology, medicine and health care delivery systems. Participation in a Society of IEEE offers the advantages of membership in a specialized field as well as identification with the world's largest professional engineering organization of 248,000 members. The purposes of IEEE are directed toward advancement of the theory and practice of electrical engineering and allied disciplines and to advancement of members of the profession. IEEE programs include: technical activities furthering the state of the art; publications (SPECTRUM, PROCEEDINGS, TRANSACTIONS, JOURNALS, MAGAZINES, IEEE Press Books); local, regional, national and international conferences and meetings; standards development, and recognition through an Awards Program. An IEEE office in Washington, DC, facilitates exchange of information between IEEE members and U.S. governmental agencies.

Biomedical professionals who do not wish to join the IEEE parent organization may join EMBS as affiliate members and participate fully in all EMBS programs and activities which are planned and administered by an elected governing body of EMBS. EMBS activities include: Publications—THE IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING is a monthly publication of reviewed articles reporting original research and development, short communications, tutorials and reviews. The EMB MAGAZINE contains news and events of current interest to biomedical engineering professionals. Conferences—In addition to the annual EMBS conference, the Society also co-sponsors and cooperates in other national and regional biomedical conferences. Conference Proceedings may be purchased at member prices from IEEE. Technical & Professional Committees—EMBS Committees organize conference sessions, workshops, publications and special activities on behalf of the Society. Regional Councils and Chapters—Society members have the opportunity to associate with other members residing in the same geographic area to exchange technical and professional information through the 7 EMBS Regional Councils and more than 37 Chapters. Students participate in these as well as the many Student IEEE and Student EMBS/IEEE Chapters.

Membership in EMBS/IEEE is open to all qualified persons in grades designated student, associate, member, senior member, fellow and affiliate.

Further information may be obtained from Dr. Alfred R. Potvin, President, IEEE/EMBS, Director, Medical Instrumentation Systems Division, Lilly Research Laboratory, Bldg. 58, 307 E. McCarty St., Indianapolis, IN 46285.

INSTRUMENT SOCIETY OF AMERICA  
67 Alexander Drive, P.O. Box 12277  
Research Triangle Park, NC 27709

Anthony Sances, Jr.  
Department of Neurosurgery  
8700 W. Wisconsin Avenue, Milwaukee, WI 53226

The Instrument Society of America is a technical, scientific and educational organization dedicated to advancing and reinforcing the arts and sciences related to the theory, design, manufacture and use of instruments and controls in the various sciences and technologies for the benefit of mankind. With over 35,000 members, ISA identifies, defines and reflects the needs and objectives of engineers, scientists, managers, technicians, and students involved with instrumentation, systems and automation -- worldwide.

ISA was established in 1945 and maintains its International Headquarters at Research Triangle Park, NC. Its membership is distributed throughout 201 Sections in 13 geographical districts in the United States, Canada, Mexico and other countries.

ISA publishes a monthly journal, *InTech*, a quarterly journal, *ISA Transactions*, meeting proceedings, monographs, handbooks, films, video tapes and other educational aids. ISA is an ANSI-accredited standards writing body. Members are given the opportunity to prepare publications; organize conferences and symposia and participate in the activities of twenty-four Special Interest Divisions in the Technology and Industries and Sciences Departments.

The Neuroelectric Society was formed in 1967 for the purpose of studying the effects of electrical currents on biological systems. The Society is dedicated to the furtherance of investigation in the following areas related to the application of electrical currents and their effects on physiological systems:

- Effects of focal and diffuse electrical currents on the central and peripheral nervous systems
  - Neurophysiological effects
  - Ultrastructure
  - Drug interaction
- Neuroanatomical investigations
- Behavioral effects of electrical currents
- Instrumentation and neurophysiological monitoring systems
  - Safety standards
- Neurological monitoring
- Current density and impedance measurement
- Mathematical and physical models of brain characteristics
- Effects of currents on cardiovascular, respiratory and endocrine systems
- Electroprosthetic devices
- Electroneuronal implant systems
- Biomechanical analysis of head and spine injuries

The Society encourages scientific research in these fields, disseminates results to the members and assists individual research groups in communicating with each other and with appropriate national and international societies.

After several meetings of various interested groups, the 1st Annual Meeting of the Neuroelectric Society was held in Milwaukee, WI, Oct. 1967; the 2nd in San Francisco, CA, Feb. 1969; the 3rd in Las Vegas, NV, Mar. 1970; the 4th in San Antonio, TX, Mar. 1971; the 5th in Varna, Bulgaria, Sep. 1972; the 6th in Snowmass, CO, Feb. 1973; the 7th in New Orleans, LA, Nov. 1974. The 8th Meeting was held in conjunction with the 4th International Symposium on Electrosleep and Electroanesthesia in Paris, France, Mar. 1974. The 9th Meeting was held in Marco Beach, FL, Nov. 30-Dec. 4, 1977. The 10th Meeting was held in conjunction with the 5th International Symposium on Electrosleep and Electroanesthesia in Graz, Austria, Sep. 11-16, 1978. The 11th Meeting was held in Key Biscayne, FL, Dec. 14-18, 1980; and the 12th Meeting was held in conjunction with the 6th International Symposium on Electrostimulation in Albena, Bulgaria, Sep. 24-28, 1981. The 13th Meeting was an International Symposium on the Biomechanics of Head and Spine Trauma held in Marco Beach, FL, Nov. 15-20, 1983.

Members receive the *Neuroelectric News* which reviews foreign and national publications. Membership information and meeting registration forms can be obtained from:

The Neuroelectric Society c/o Dr. A. Sances  
Dept. of Neurosurgery 8700 W. Wisconsin Ave.  
Milwaukee, WI 53226



**Rehabilitation Engineering Society  
of North America (RESNA)**

SPIE--The International Society for Optical  
Engineering  
P.O. Box 10, Bellingham, WA 98227-0010  
Telephone: 206/676-3290

The Rehabilitation Engineering Society of North America (RESNA) was founded in Atlanta, Georgia, in 1979. Its membership includes rehabilitation professionals, providers, and consumers. RESNA is dedicated to promoting interaction among these groups so that the benefits of modern technology will be put to work for disabled persons.

RESNA's Annual Conferences are held at various locations in North America. In 1985 the meeting will be held at the Peabody in Memphis, Tennessee, June 22-27, and in 1986 it will be held in Minneapolis. In addition to publishing the Proceedings of its annual conferences, RESNA distributes a variety of publications pertinent to the field. Many of these publications emanate from the work of RESNA's committees, especially the Education and Wheelchair committees; others are developed by rehabilitation professionals here and abroad.

RESNA also conducts special symposia and workshops to debate and seek answers to questions critical to the welfare of the disabled. A series of workshops on specially adapted and sports wheelchairs resulted in recommendations for future research and development, as well as recommendations for future action that will improve the lives of thousands of wheelchair users.

Delivering the benefits of technology to disabled persons requires a systems approach in which the interaction among the components is as important as the system itself. One of RESNA's missions is to develop strategies to deal with these interactions and to break down existing barriers that inhibit effective working of the system: barriers include the lack of an information network and a consensus on such critical questions as definition of needs, working with manufacturers to ensure high standards, and identifying funding sources, both public and private. This a tall order, but RESNA members are committed to this task so that every disabled person can enjoy daily living to the fullest extent possible.

For information on RESNA's publications, meetings, and activities, write to:

Suite 402  
4405 East-West Highway  
Bethesda, Maryland 20814  
301/657-4142.

SPIE--The International Society for Optical Engineering (Society of Photo-Optical Instrumentation Engineers) is a nonprofit society dedicated to advancing engineering and scientific applications of optical, electro-optical, and opto-electronic instrumentation, systems, and technology.

Its members are scientists, engineers, and users interested in the reduction to practice of these technologies. SPIE provides the means for communicating new developments and applications to the scientific, engineering, and user communities through its publications and symposia.

Exclusive privileges and benefits are:

- 1) Subscription to Optical Engineering (SPIE's bimonthly journal).
- 2) Subscription to Optical Engineering Reports (SPIE's monthly newspaper).
- 3) Use of Optical Engineering Reports Placement Exchange.
- 4) Calls for Papers and advance announcements of SPIE conferences and publications.
- 5) Reduced registration fees for conferences and symposia.
- 6) Special member rates for tutorials, workshops, and short courses.
- 7) Member rates often available at functions of other societies with which SPIE is associated as a cosponsoring organization.
- 8) Special member rates for SPIE Proceedings and other books.
- 9) Membership in national working groups.
- 10) Awards program.
- 11) Educational referral service.
- 12) Contacts with optics industry regarding innovations and services.
- 13) Annual Directory for Members.