

# *International Pump Users Advisory Committee*

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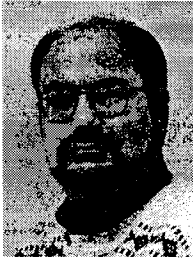


**Dara W. Childs** has been Director of the Turbomachinery Laboratory since 1984. He holds the Leland T. Jordan Chair in Mechanical Engineering at Texas A&M University. He received his B.S. (1961) and M.S. (1962) degrees (Civil Engineering) from Oklahoma State University, and his Ph.D. (Engineering Mechanics) from the University of Texas (1968).

Dr. Childs' expertise is in the area of dynamics and vibrations, with an emphasis in the area of rotordynamics. He has conducted research and engineering projects for NASA, DOD, and private firms related to rotordynamics.

Dr. Childs is the author of numerous reviewed publications related to rotordynamics and vibrations, and author of the book, *Turbomachinery Rotordynamics*. He is currently carrying out tests on honeycomb and hole-pattern gas damper seals for a 17-member industrial consortium. He was named an ASME Fellow Member in 1990, and received ASME's Henry R. Worthington Medal in 1991 for contributions to pumping machinery.

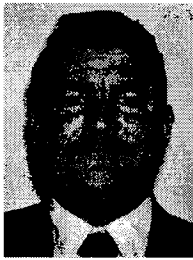
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**William A. (Alan) Evans** is Manager of Engineering for the Mechanical Seal Division of A.W. Chesterton Company, in Groveland, Massachusetts. During his eight years with the company, he has held several positions. He has spent 20 years in the field of rotating equipment, focusing primarily in pumps and turbomachinery. He gained broad experience as an end-user of rotating equipment during his 14 years as maintenance/reliability engineer in process industries. Mr. Evans' technological background and experience cover a wide range of topics, including tribology, machine design, predictive maintenance, and reliability engineering. He has conducted lectures, seminars, and presentations on improving reliability as it relates to pumps/seals and pumping systems. He has published articles for the STLE, of which he is a member.

Mr. Evans received his MBA from Northeastern University and his BSME from Rochester Institute of Technology. He also has an Associate's degree in Applied Science from Pennsylvania State University.

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**Gary E. Glidden** is a Specialist at Reliant Energy Generation, in Houston, Texas. He has been with REI for more than 30 years. Before his current position, he was Crew Leader in the Maintenance Division for more than 17 years. Twelve of those years were spent in Field Maintenance with responsibilities of performance monitoring, vibration analysis, troubleshooting, field inspections, and repair of all types of rotating equipment. The last five years as Crew Leader, Mr. Glidden was in charge of rotating equipment repairs in the Central Repair Shop.

Mr. Glidden has written several articles for *Pumps & Systems* magazine and for the past six years served on their User Advisory Team. He is a member of the International Pump Users Advisory Committee and is a certified Mechanical Inspector with the American Society for Quality.

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**S. (Gopal) Gopalakrishnan** is Vice President of Technology for the Pump Division of Flowserve Corporation, in Los Angeles, California. He is responsible for development of new technology in all areas relevant to their present and future businesses. He has been responsible for the development of several new products including: a long life nuclear seal for pressurized water reactor pumps; a software product for diagnosis of high energy horizontal pumps; a multivolute horizontal pump for the cogeneration and refinery industries; a water turbine for power generation; an advanced primary coolant pump for nuclear reactors; and sealless pumps including magnetic bearings and magnetic drives.

Dr. Gopalakrishnan obtained his M.S. degree (Aeronautics) from California Institute of Technology (1966) and his Ph.D. degree from Massachusetts Institute of Technology (1969). He is on the Industry Advisory Committee to California Polytechnic State University and he is a Fellow of ASME.

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**Herman A.J. Greutink**, formerly Vice President and Technical Director, is now Consultant to Johnston Pump Company, in Brookshire, Texas. Mr. Greutink has demonstrated his engineering expertise on large vertical pump projects worldwide, and he is internationally acknowledged as one of the pump industry's long standing experts on vertical pump design, testing, and application. He frequently conducts pump seminars for the engineering personnel of customers and for consulting and construction firms throughout the world.

He was educated at the Mechanical Engineering College in Enschede, The Netherlands. From 1951-58, Mr. Greutink was Project Engineer for Aramco, Oil Handling Facilities, Dhahran, Saudi Arabia. Since 1958, he has been in engineering management at Johnston Pump Company. He is a member of the Hydraulic Institute and ASME.

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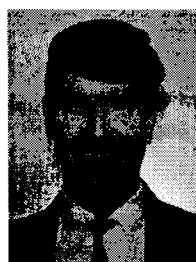
**Kerry F. Gunn** is currently a Rotating Equipment Technologist at Sterling Chemicals, Inc., in Texas City, Texas. He is involved in technical support for machinery repair; troubleshooting of rotating equipment; and design, selection, and installation of new machinery. Prior to his current position, Mr. Gunn worked for five years at Quantum Chemicals Houston Plant as an Area Maintenance Engineer and Project Engineer. Previously, Mr. Gunn was a Senior Research Engineer at Exxon Research and Engineering for nine years. He participated in design, construction, and operation of synthetic fuels pilot plants.

Mr. Gunn received a B.S. degree (Mechanical Engineering, 1975) from Oklahoma University and an M.S. degree (Mechanical Engineering, 1977) from Purdue University. He is a member of the Vibration Institute and ASME.



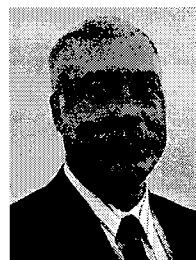
**John P. Joseph II** is a Consultant with Rotating Equipment Systems Technical Associates, in Houston, Texas. He was previously with BP Amoco where he provided technical and maintenance support for rotating equipment systems to existing asset organizations in BP Amoco, and to Project Management on new projects. Prior to that, Mr. Joseph was with the Amoco Petroleum Products Refinery, in Texas City, Texas. He supervised the rotating equipment engineers and the rotating equipment specialists for the refinery. Mr. Joseph spent six and one half years as Superintendent of Central Shops and three years in Amoco's Refining and Transportation Engineering Department, in Chicago, Illinois. Previous assignments at the Amoco Texas City refinery also included the Rotating Equipment Consulting Group, the Project Engineering Group, and as a Maintenance Engineer on the Hydrocracking Unit.

Mr. Joseph received his B.S. degree (Mechanical Engineering, 1972) from the University of Texas at El Paso.



**William E. (Bill) Key**, is Manager of Research for the Fluid Sealing Division of Flowserve Corporation, in Temecula, California. Prior to joining Borg-Warner (Flowserve) in 1974, he held positions in North American Aviation and TRW Systems Group. He is responsible for development of new sealing technology and the generation of mathematical models of seal performance. Mr. Key is a member of STLE Seals Technical Committee and the Advanced Projects Subcommittee, and is a former Chairman of the STLE Seals Course. He is a lecturer in the International Pump Users Symposium Advanced Seals Course.

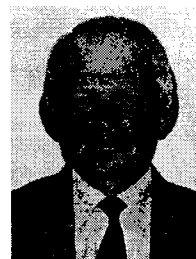
Mr. Key received his B.S. and M.S. degrees (Mechanical Engineering) from the University of California at Berkeley and did graduate work in Biophysics at the University of Western Ontario, Canada.



**Gary A. Krafft** is a Technical Representative with HydroTex Dynamics, Inc. and BFI Pump Company, in Houston, Texas. He began this role in January 1998. His current responsibilities include utility and industrial accounts for pump repairs/improvements, along with engineering support for systems.

Previously, Mr. Krafft was an Engineering Specialist at TU Electric. He worked in power plant maintenance functions for 22 years and was heavily involved with the troubleshooting and problem resolution of large rotating equipment. This type of equipment not only included pumps, but also steam turbines, generators, fans, and electric motors.

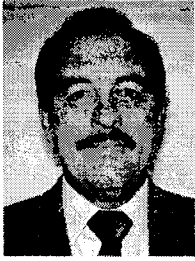
Mr. Krafft received his B.S. degree (Mechanical Engineering) from Texas A&M University. He was the originator of TU Electric's Equipment Repair Group (1982), which was formed to improve reliability. He has worked with fossil and nuclear plants, and the gas pipeline and mining divisions. Mr. Krafft is a registered Professional Engineer in the State of Texas.



**Alan O. Lebeck** started Mechanical Seal Technology, Inc. (MSTI) in 1987, in Albuquerque, New Mexico. MSTI performs research and product development, designs software, and consults, all in relation to mechanical seals.

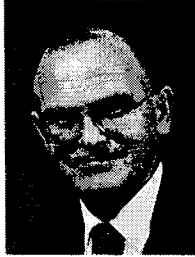
Dr. Lebeck served on the faculty of the University of Illinois, then worked for Shell Development. From 1971 to 1987, he served as Professor and Director of the Mechanical Engineering Department at the University of New Mexico, and as Director of the Bureau of Engineering Research. During this time, he started a mechanical seal research program under the sponsorship of the National Science Foundation and the U.S. Navy. This work served as the basis for numerous papers, reports, and inventions. A seal test program was started in 1978 and has continued. His book, *Principles and Design of Mechanical Face Seals*, was published by John Wiley (1991).

Dr. Lebeck received his B.S. (1964), M.S. (1965), and Ph.D. (1968) degrees (Mechanical Engineering) from the University of Illinois.



**Julien LeBleu, Jr.**, is the Principal Engineer for Rotating Equipment for Lyondell Chemical, in Lake Charles, Louisiana. He is responsible for all rotating equipment in the Lake Charles facility and has more than 25 years of experience in the field of rotating equipment. He has worked for General Electric Company as a technical director for the installation and maintenance of large steam turbine and generator sets. Mr. LeBleu is a licensed aircraft mechanic and has worked on both reciprocating and jet aircraft engines. He is a member of the International Pump Users Advisory Committee, has authored several articles, and has lectured at Pump Symposia.

Mr. LeBleu received his B.S. degree from the University of Florida (1974).



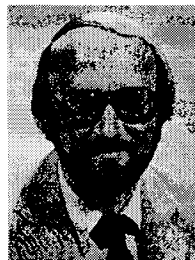
**William J. (Bill) Mabe** is the Director of Technology Development and Quality Assurance for Sundyne Corporation, in Arvada, Colorado. He is primarily responsible for coordinating technology and product development for Sundyne's business units. Mr. Mabe joined Sundyne in 1974 as a Senior Engineer involved in high speed centrifugal pump design. Previous turbomachinery experience includes six years at Rocketdyne, Liquid Rocket Division of Rockwell International, where he was a member of the technical staff responsible for the analysis and design of the space shuttle turbo pumps. He has several patents related to pumping equipment.

Mr. Mabe holds a B.S. degree (Mechanical Engineering) from the University of Missouri at Rolla and a Masters of Business Administration and Technology Management from the University of Phoenix. He also serves on the corporate advisory board for the Colorado School of Mines.



**Vernon L. (Vern) Maddox** is Senior Engineering Advisor with Equistar Chemicals LP, Channelview, Texas. In this capacity, he serves as a consultant to all Equistar facilities on machinery engineering, condition monitoring, and vibration analysis for new and existing equipment. Mr. Maddox also provides services to new projects in the area of equipment selection, specifications, and installation and startup of rotating and reciprocation equipment. He has more than 35 years of experience in machinery engineering, troubleshooting, and condition monitoring. Prior to his current assignment, he was in charge of reliability engineering and condition monitoring operations at the Equistar facilities at Clinton, Iowa, and LaPorte, Texas.

Mr. Maddox has a B.S. degree (Mechanical Engineering) from the University of Texas, Austin. He is a member and former Director of the Vibration Institute and is a registered Professional Engineer in the State of Texas.



**Thomas H. (Tom) McCloskey** is the Manager for Turbomachinery, Generation Division, for the Electric Power Research Institute (EPRI), in Palo Alto, California. Mr. McCloskey's responsibilities include the planning, management, and technology transfer of research and development projects relating to the thermal performance, availability, and life assessment of steam turbines, pumps, and related auxiliaries.

Mr. McCloskey has more than 30 years of experience in the design, operation, maintenance, and troubleshooting of steam turbines, pumps, and related auxiliaries and holds seven patents in mechanical engineering. Mr. McCloskey was the recipient of the ASME/EEI Prime Movers Award for best technical paper in 1984 and 1997, and the ASME George Westinghouse Gold Medal in 1995. He is an author of more than 70 technical papers on power plant equipment and in particular steam turbine generator and pump availability, life assessment, and thermal performance improvements.



**Perry C. Monroe, Jr.**, formed Monroe Technical Services, in Houston, Texas, in 1989, which specializes in all aspects of turbomachinery. He resigned from Exxon Chemical Company after serving as a Senior Staff Engineer. He provided worldwide services on rotating machinery design, troubleshooting, new installations, and repairs. Prior to joining Exxon, Mr. Monroe worked in Borneo with Roy M. Huffington, Inc., and at the P.T. Badak LNG Plant.

In 1966, Mr. Monroe graduated from Auburn University with a B.S. degree (Mechanical Engineering) and has worked for more than 30 years on turbomachinery repair techniques. Prior to graduation, he worked as a designer of rocket engine components for NASA at Redstone Arsenal.

Mr. Monroe is a member of Texas A&M University's International Pump Users Symposium Advisory Committee. He is an active lecturer for ASME, the International Maintenance Institute, the Vibration Institute, and is a registered Professional Engineer in the State of Texas.



**Gerald L. (Jerry) Morrison** is the Nelson-Jackson Professor of Mechanical Engineering at Texas A&M University. He received his Ph.D. degree from Oklahoma State University (1977). He is a member of various societies including: ASEE, Associate Fellow in AIAA, Fellow in ASME, Pi Tau Sigma, and Tau Beta Pi.

Dr. Morrison's research interests are in turbulent fluid flow and instrumentation. His research in coherent structures in turbulent flows has enabled him to develop expertise in hot wire anemometry, laser Doppler anemometry, acoustic measurements, and spectral analysis, and in other conditional sampling techniques.

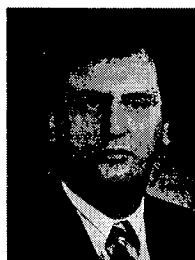
Dr. Morrison manages a program to study labyrinth seals. This includes empirical and analytical schemes to predict leakage rates with experimental verification of the two schemes, and the use of a 3-D laser Doppler anemometer to measure the flowfield inside an actual seal. He is also active in the research area of flow fields inside centrifugal pumps and turbochargers.



**Thomas R. (Tom) Morton** is Vice President for Engineering for Sulzer Pumps (U.S.) Inc., in Portland, Oregon. His current responsibilities include direction of Design, Order Related Engineering, Field Engineering, Hydraulics Department, and CAD. He has been with Sulzer Bingham (formerly Bingham Willamette Company) since 1969, serving in managerial/leadership positions.

Mr. Morton was born, raised, and educated in Scotland at Stow College, Glasgow. Before leaving Scotland, he was employed at G&J Weir Pump Company, Glasgow.

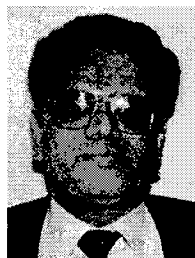
Mr. Morton is a member of ASME and the International Pump Users Symposium Advisory Committee.



**Lev Nelik** is a President of Liquiflo Equipment Company, in Garwood, New Jersey. He has over 20 years of engineering, manufacturing, sales, field, and management experience in the pump industry. Previously, he worked at Roper Pump, IDP (Ingersoll-Rand), and ITT (Goulds Pumps).

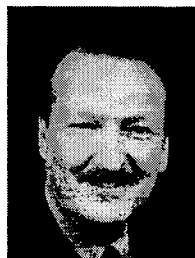
Dr. Nelik is a registered Professional Engineer and has published over 50 documents, including a "Pumps" section for the *Encyclopedia of Chemical Technology*, a section for the *Handbook of Fluids Dynamics*, and a book *Centrifugal and Rotary Pumps: Fundamentals with Applications*.

Dr. Nelik is a member of the International Pump Users Symposium Advisory Committee, an Advisory Board Member of *Pumps & Systems* and *Pumping Technology* magazines, and a former Associate Technical Editor of the *Journal of Fluids Engineering*. He is a full member of ASME, and a Certified APICS (CIRM). He is a graduate of Lehigh University with an M.S. degree (Manufacturing Systems) and a Ph.D. degree (Mechanical Engineering).



**Vinod P. Patel** is a Senior Principal Machinery Engineer, Machinery Technology, for Kellogg-Brown & Root (KBR), in Houston, Texas. He has been with KBR for 27 years. In his current assignment, he is responsible in the preparation and auditing of specifications, equipment evaluation, engineering coordination, and testing and installation startup of rotating and special equipment. He has worked in the various application of rotating machinery in the petrochemical and refinery processes including ammonia, LNG, olefins, cat-cracking, and hydrotreating for domestic and international projects.

Mr. Patel received B.S. and M.S. degrees (Mechanical and Metallurgical Engineering) from Maharaja Sayajirao University of Baroda, India, and Youngstown University, respectively. He is a registered Professional Engineer in the State of Texas.



**David Redpath** is a Senior Rotating Machinery Engineer for BP Amoco Oil, Refining Technology Group, at Sunbury on Thames, Middlesex, England. In his present position, he provides technical and reliability improvement support for BP Amoco refineries worldwide. Mr. Redpath has 32 years' experience in the specification, selection, testing, operation, and troubleshooting of rotating equipment in refining and oil production and has worked for BPA for 22 years. Prior to that, he worked in refining and petrochemical contracting.

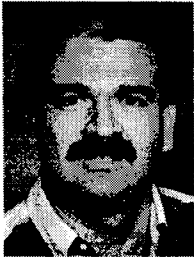
Mr. Redpath graduated from the University of Liverpool with an Honors degree (Mechanical Engineering, 1967). He is a Chartered Engineer and a member of the Institution of Mechanical Engineers, where he has served as a member of the Fluid Machinery Committee. He is also a member of the International Pump Users Symposium Advisory Committee.



**Eugene P. (Gene) Sabini** is the Director of Technology for the Industrial Pump Group of ITT Industries, in Seneca Falls, New York. He is responsible for applied research and hydraulic design of all new products and field rerates. Other responsibilities include testing, FEA, CFD, rotordynamics, rapid prototyping, and condition monitoring. Mr. Sabini was previously Manager of Energy Engineering Design with Goulds. He was responsible for both the product engineering and the mechanical/hydraulic design and testing of the energy related double suction and multistage API pumps.

Mr. Sabini has 32 years of experience in the pumping industry including design and development of many centrifugal pumps for the chemical, API, power utilities, and municipal industries. He spent 25 years with Worthington Pump designing, engineering, and testing custom centrifugal pumps from both a mechanical and hydraulic standpoint.

Mr. Sabini received a BSME (1968) and M.S. (1975) degree from Stevens Institute of Technology.



**Kenneth J. (Ken) Savoie** is a Senior Staff Engineer with Equilon Enterprises LLC. He is currently assigned as a Rotating Machinery Specialist at the Shell Deer Park Refinery, in Deer Park, Texas. He began his career with Shell Oil Company and spent five years working as a Project and Maintenance Engineer in various areas of the refining and chemical facilities until moving into the Rotating Equipment group in 1985. Since then, Mr. Savoie has worked as a Machinery Engineer throughout the 290K B/D Refinery. In this capacity, he was responsible for providing technical support for rotating and reciprocating machinery systems. This included implementation of strategies and programs to improve the reliability of pump and compressor systems. He also specializes in solving multidiscipline engineering and maintenance problems in refineries.

Mr. Savoie has a B.S. degree (Civil Engineering, 1980) from the University of Southwestern Louisiana. He is a member of ASME.



**Bruno Schiavello** has been Director for Fluid Dynamics at Flowserve Pump Division, Technology Department, in Phillipsburg, New Jersey, since 2000, and previously served in the same position with Ingersoll Dresser Pump Company. He started in the R&D Department of Worthington Nord (Italy), joined Central R&D of Worthington, McGraw Edison Company, and then Dresser Pump Division.

Mr. Schiavello was co-winner of the H. Worthington European Technical Award in 1979. He has written several papers and lectured at seminars in the area of pump recirculation, cavitation, and two-phase flow. He is a member of ASME, AIAA, Societe Hydrotechnique de France, and the International Association for Hydraulic Research. He has served on the International Pump Users Symposium Advisory Committee since 1983.

Mr. Schiavello received a B.S. degree (Mechanical Engineering, 1974) from the University of Rome, and an M.S. degree (Fluid Dynamics, 1975) from Von Karman Institute for Fluid Dynamics, Rhode St. Genese, Belgium.



**John W. Silcott** is Maintenance Engineering Section Leader for Celanese Chemical Group at its Clear Lake plant near Houston, Texas. His responsibilities are in the area of maintenance engineering/reliability for rotating equipment and fabricated equipment. These responsibilities include improving maintenance technology, project review and support, materials technology, predictive/preventive maintenance, and mechanical integrity.

Mr. Silcott received a B.S. degree (Mechanical Engineering, 1970) from New Mexico State University. He is a member of: ASME, the Board of Directors of the International Maintenance Institute in Houston, an Advisory Committee at Texas State Technical College for the Industrial Maintenance Mechanic Program, the Inspection and Maintenance Task Group with the Chemical Manufacturers Association, and of Texas A&M University's International Pump Users Advisory Committee.



**Joseph A. (Joe) Silvaggio, Jr.** is Manager, Pump Projects and Engineering at Demag Delaval Turbomachinery Corporation, Trenton, New Jersey, and has been with them since 1968. His past experience at Demag Delaval includes the areas of aerodynamics, flow analysis, seal development, design of centrifugal compressor stage elements, centrifugal pump design and flow analysis, boiler feedpump design and analysis, and testing of steam turbines.

Mr. Silvaggio is a member of Sigma Tau and Pi Tau Sigma. He is also an active member of ASME and has held several offices in the Trenton, New Jersey, section. At present, he is on two ASME Performance Test Code Committees and is a member of the Board on Performance Test Codes.

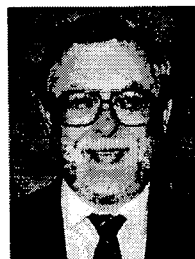
Mr. Silvaggio holds both B.S. and M.S. degrees (Mechanical Engineering) from the University of Pennsylvania. He has written and coauthored numerous technical publications, and is a member of the International Pump Users Symposium Advisory Committee.



**Dewey W. Stump** is employed with Duke Power Company, in Charlotte, North Carolina, as a Senior Production Specialist. He is presently assigned to the McGuire Nuclear Station in the Maintenance Execution Support group.

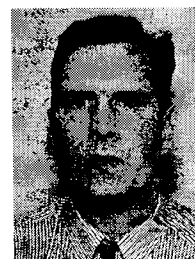
His present duties include technical oversight, parts specification, and repair for rotating equipment maintenance activities. He is responsible for reactor coolant pumps and motors, multistage pumps, compressors, and general pump and motor maintenance. He is responsible for root-cause analysis, mechanical seal specifications, and failure analysis. His previous duties include eight years in Maintenance Engineering Services Group and five years as Maintenance Crew Supervisor.

Prior to joining Duke Power Company, Mr. Stump worked as an assistant to the plant Maintenance Manager at a large brewing company. He developed and set up the preventive maintenance program and initiated the company's lubrication and spare parts program. He is a member of the *Pumps and Systems Magazine* User Advisory Team.



**Jerry C. Swalley** is a Principal Consultant with the DuPont Company, in Wilmington, Delaware. He is currently Technology Leader for the Rotating Machinery Group that provides specifications, standards, analysis, consulting, and other technology for pump, turbomachinery, and other rotating equipment systems used by DuPont, and has been with the company for 32 years. His work has varied from vibration analysis and emergency repairs through compressor design and performance analysis.

Mr. Swalley contributed to ASME B73 Pump Standards from 1972-1994. He presented a paper at the Turbomachinery Symposium in 1985, and has coauthored two Short Courses and led several Discussion Groups. Before joining DuPont, he worked in a machine design group for the Dravo Corporation in Pittsburgh, Pennsylvania. He graduated from the University of Illinois with a BSME degree (1964) and an MSME degree (1965). He is a member of ASME and a registered Professional Engineer in the State of Illinois.



**Joseph M. Thorp** is an Engineering Specialist within the Technical Services Department of Aramco Services Company (ASC), in Houston, Texas. He has provided technical support for Saudi Arabian Oil Company (Saudi Aramco) projects in Europe and North America, along with supporting field activities during interim assignments in Saudi Arabia as part of the Consulting Services Department. Mr. Thorp is Saudi Aramco's designated representative to the American Petroleum Institute Subcommittee on Mechanical Equipment that includes Vice Chairmanship of API 610 (Centrifugal Pump) and Chairmanship of API 682 (Seals). He is the API mechanical equipment representative to the International Standards Coordinating Committee who interfaces with ISO, headquartered in Europe.

Prior to joining ASC, Mr. Thorp worked with Phillips Petroleum Company. He holds a B.S. (Mechanical Engineering) from Michigan State University and an MBA from the University of St. Thomas. Mr. Thorp is a registered Professional Engineer in the State of Texas.



**Bruce Weber** is the Operations Manager for Best Equipment, in Houston, Texas. As Operations Manager, his duties include supervision of the pump repair facility, consulting with clients concerning pumping systems, and pump troubleshooting. Other areas include failure analysis, pump modifications, bearings, high pressure mechanical seals, and lubrication systems. Prior to joining Best Equipment, Mr. Weber was associated with Koch Hydrocarbon, in Medford, Oklahoma, for 18 years. His responsibility as Maintenance Supervisor included 10,000 miles of pipelines that employed 2300 pumps. He also served as a consultant for Koch's four light hydrocarbon processing plants.

Mr. Weber is currently enrolled at the University of Oklahoma, working toward a B.S. degree.

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#### *Corresponding Members*

**Michael Cotter**  
World Pumps  
Oxford, United Kingdom

**Andreas Schachenmann**  
Sulzer Pumps Ltd.  
Winterthur, Switzerland

**Gerhard Vetter**  
University of Erlangen-Nürnberg  
Erlangen, Germany

## Professional Staff

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**Dara W. Childs** has been Director of the Turbomachinery Laboratory since 1984. He holds the Leland T. Jordan Chair in Mechanical Engineering at Texas A&M University. He received his B.S. (1961) and M.S. (1962) degrees (Civil Engineering) from Oklahoma State University, and his Ph.D. (Engineering Mechanics) from the University of Texas (1968).

Dr. Childs' expertise is in the area of dynamics and vibrations, with an emphasis in the area of rotordynamics. He has conducted research and engineering projects for NASA, DOD, and private firms related to rotordynamics.

Dr. Childs is the author of numerous reviewed publications related to rotordynamics and vibrations, and author of the book, *Turbomachinery Rotordynamics*. He is currently carrying out tests on honeycomb and hole-pattern gas damper seals for a 17-member industrial consortium. He was named an ASME Fellow Member in 1990, and received ASME's Henry R. Worthington Medal in 1991 for contributions to pumping machinery.

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**John M. Vance** is Professor of Mechanical Engineering at Texas A&M University. He received his B.S. (Mechanical Engineering, 1960), M.S. (Mechanical Engineering, 1964), and Ph.D. (1967) degrees from the University of Texas.

Prior to joining Texas A&M (1978), Dr. Vance held positions at Armco Steel, Texaco Research, and Tracor, Inc., and developed a Rotordynamics Laboratory at the University of Florida. He conducts research on rotordynamics, damper seals, and bearing dampers. He has published a book, *Rotordynamics of Turbomachinery* (John Wiley, 1988), and over 50 technical articles and reports. Dr. Vance is consultant to industry and government and has held numerous summer appointments. He organized the annual short course for industry at Texas A&M on "Rotordynamics of Turbomachinery" and co-organized the biennial "Workshop on Rotordynamics Instability Problems in High Performance Turbomachinery." Dr. Vance is a member of ASME and ASEE, and is a registered Professional Engineer in the State of Texas.

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**Gerald L. Morrison** is Nelson-Jackson Professor of Mechanical Engineering and Head of Fluid Mechanics Division at Texas A&M University. He received his Ph.D. degree from Oklahoma State University (1977), and is a member of various technical and honor societies, including AIAA, Pi Tau Sigma, and Tau Beta Pi.

His research interests are in the areas of turbulent fluid flow and instrumentation. In particular, Dr. Morrison has been active since 1973 in the area of coherent structures in turbulent flows. This research has enabled him to develop expertise in hot wire anemometry, laser Doppler anemometry, acoustic measurements, and spectral analysis, and also in other conditional sampling techniques.

Dr. Morrison initiated a program to study labyrinth seals. This includes empirical and analytical schemes to predict leakage rates with experimental verification of the two schemes, and the use of a 3-D laser Doppler anemometer to measure the flowfield inside an actual seal.

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**Kalyan Annamalai** is a Professor in Mechanical Engineering. He came to Texas A&M in 1981. He received a B.S. degree (Mechanical Engineering) from Anna University, Madras, an M.S. degree from Indian Institute of Science, and a Ph.D. degree from Georgia Institute of Technology.

Dr. Annamalai worked as a Research Associate in the Division of Engineering at Brown University, and as Associate Scientist at AVCO-Everett Research Laboratory. At AVCO-Everett, he was involved in the study of gasification of coal, slag flow in MHD channels, and wood combustion in boiler burners. He is conducting research in the area of group combustion of liquid sprays and coal suspension, and pollutants formation and destruction. Dr. Annamalai has extensive journal publications and has acted as a panel member for several federal agencies. He is a Fellow of ASME, the Combustion Institute, and is on the ASME Committee on Fire and Combustion.

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**Paul G. A. Cizmas** is Assistant Professor of Aerospace Engineering at Texas A&M University. He received his Dipl. Ing. degree (Aerospace Engineering, 1984) from the Polytechnic Institute of Bucharest and his Ph.D. degree (Mechanical Engineering, 1995) from Duke University.

Dr. Cizmas' expertise is in the areas of unsteady aerodynamics, computational fluid dynamics and heat transfer, and propulsion. He worked as a Senior Engineer/Scientist at Westinghouse Science and Technology Center. At Westinghouse, he developed computer codes for numerical simulation of stall flutter and rotating stall in turbomachinery, as well as parallel computation of multistage unsteady flows. He received the ASME Liquid Propulsion Best Paper Award (1996) and the Westinghouse Science and Technology 1997 Technical Publication Award.

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**Je-Chin Han**, holds the HTRI Professorship of Mechanical Engineering at Texas A&M University, received his B.S. degree from the National Taiwan University (1970), M.S. degree from Lehigh University (1973), and Sc.D. from Massachusetts Institute of Technology (1976), all in Mechanical Engineering. He worked for four years as a Process Development Engineer at Ex-Cello-O Corporation. This experience included design techniques for industry process heating and thermal performance improvement of heat transfer equipment such as boilers, heat exchangers, condensers, cooling towers, etc.

Dr. Han is a member of ASME and AIAA. His current research is in the areas of high temperature gas turbine blade cooling and heat transfer augmentation. He is the principal investigator for recent research programs on blade internal cooling sponsored by NSF and General Electric Aircraft Engines. He is also working on blade film cooling, supported by the U.S. Air Force and Textron-Lycoming.



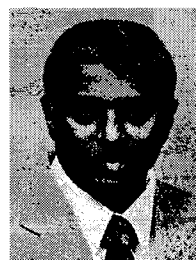
**C. Fred Kettleborough** is a Distinguished Professor of Mechanical Engineering at Texas A&M University. He received his B. Eng. degree (1947) and Ph.D. degree (1950) from the University of Sheffield, England. Dr. Kettleborough came to Texas A&M University after serving as Head of the Department of Mechanical Engineering at the University of New South Wales, Sydney, Australia, and previously at the University of Auckland, Auckland, New Zealand. Previous appointments included the University of Melbourne, Australia; the Westinghouse Research Laboratories, Pittsburgh, Pennsylvania; the British Thompson Houston Company, Rugby, England; and the Royal Naval Scientific Service, United Kingdom. He also served a two year industrial apprenticeship at the United Steel Company in England.

His major research interests are in the area of tribology, solar systems, and numerical fluid mechanics and heat transfer. Current research interests are oil mist lubrication, starting phenomena of thrust bearings, and solar assisted desiccant cooling systems.



**Robert P. Lucht** is Professor of Mechanical Engineering at Texas A&M University. He received his B.S. degree (Nuclear Engineering, 1977), and M.S. degree (1979) and Ph.D. degree (1981) in Mechanical Engineering from Purdue University. Dr. Lucht was then employed with Sandia National Laboratories. He accepted a faculty position at the University of Illinois at Urbana/Champaign and moved to Texas A&M University in 1998.

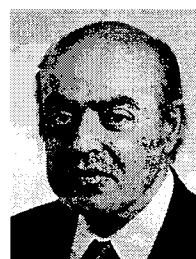
Dr. Lucht's research activities center around the development and application of advanced laser diagnostic techniques for probing gas phase media. These diagnostics include laser-induced fluorescence, coherent anti-Stokes Raman scattering, and polarization spectroscopy for the measurement of species concentration and temperature. His research program ranges from fundamental research on the physics of emerging laser techniques to application of laser diagnostics in practical combustion devices. He is published and is a member of AIAA, ASME, SAE, the Combustion Institute, and a Fellow of the Optical Society of America.



**Swaminadham Midturi** joined Texas A&M University in 1990. He has taught courses in mechanics, strength of materials, and applied vibrations. He received the Outstanding Faculty Award for excellence in teaching and research. His research concerns vibrations of turbomachinery components. He has worked on turbo-fan vibration control, spin-pit test rig diagnostics, vibrations of advanced cooled blades, image derotated laser interferometric applications for traveling mode shapes of rotating bladed-disks, and finite element applications for vibration and stress analysis of turbomachinery blades and disks.

Dr. Midturi developed and offered courses for inhouse training of technicians and entry level engineers in machinery diagnostics and predictive maintenance of rotating machinery in the petrochemical, process, and power generation industry.

Dr. Midturi received his Ph.D. degree (Mechanical Engineering) from the Indian Institute of Technology. He is a former Alexander von Humboldt Research Fellow of West Germany, a UNESCO Fellow, and a member of ASME.



**Sherif T. Noah** is a Professor in the Mechanical Engineering Department. He received his B.S. degree (Mechanical Engineering) from Cairo University, Egypt (1964), and his M.S. degree (Mechanical Engineering, 1970) and Ph.D. degree (1974) from West Virginia University.

Dr. Noah worked as a Senior Engineer in the Nuclear Department of Foster Wheeler Energy Corporation, and on the graduate faculty of the Mechanical Engineering Department of the Catholic University of Rio de Janeiro, Brazil. Since joining Texas A&M University in 1978, he has been conducting research in dynamics, vibrations, stability, and tribology. He has conducted research concerning structure modeling and dynamic stability of rotor systems. Currently, he is pursuing research, initiated by a grant from NSF, to study the dynamics and wear in nonlinear systems, and a study for NASA concerning the nonlinear response of the space shuttle main engine turbopumps.

Dr. Noah has published numerous journal articles and technical reports.





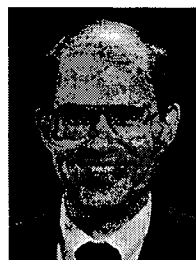
**Alan B. Palazzolo**, Professor of Mechanical Engineering, received his B.S. degree (1976) from the University of Toledo, and M.S. (Mechanical Engineering, 1977) and Ph.D. degrees (Mechanical Engineering, 1981) from the University of Virginia. He worked for Bently Nevada, University of Virginia, Allis Chalmers, and Southwest Research Institute, before joining Texas A&M in 1985.

Dr. Palazzolo's expertise is in vibrations, rotordynamics, finite, and boundary elements. He has been involved with field troubleshooting of mechanical malfunctions in rotating and reciprocating machinery. Dr. Palazzolo has presented papers at ASME Gas Turbine and Vibration Conferences, Texas A&M Turbomachinery Symposium, Society of Tribologist and Lubrication Engineers, and has published 50+ papers in technical journals. His current research includes magnetic bearings, cryogenic vibration dampers, active vibration and noise control, fluid film bearings, shaft currents, and gear couplings. Dr. Palazzolo has done consulting for Southwest Research Institute, Goodyear, and Wright Patterson AFB, along with Forensic Engineering.



**Alexander G. Parlos** is an Associate Professor of Mechanical Engineering at Texas A&M University. He received his B.S. degree (Nuclear Engineering, 1983) from Texas A&M University, M.S. degrees (Mechanical Engineering, 1985; Nuclear Engineering, 1985), and a Sc.D. degree (Automatic Control and Systems Engineering, 1986) from the Massachusetts Institute of Technology.

Dr. Parlos' current research interests center around the development and application of methods and algorithms for the proactive fault diagnosis and prognosis, and end-of-life prediction of complex electromechanical and mechanical systems, with emphasis on rotating machinery. Dr. Parlos has been involved with research and teaching in neural networks, control systems, and system identification since 1988. He has conducted extensive sponsored research on the development and applications of artificial neural networks to modeling, fault diagnosis, and control of complex machines. Dr. Parlos has served on the editorial board of the IEEE Transactions on Neural Networks since 1994.



**David L. Rhode** is a Professor of Mechanical Engineering. He received his B.S. (1972) and M.S. (1978) degrees (Mechanical Engineering) from the University of Texas at Austin, and his Ph.D. degree from Oklahoma State University (1981). His membership includes ASME, and Phi Kappa Phi. His experience includes Frederick Air Conditioning and Refrigeration Company where he developed a variety of product quality tests, supervised computational optimization of air conditioning design, and conducted several research projects.

Dr. Rhode's primary research interests lie in the thermal science area, especially in computational fluid dynamics and heat transfer. His research has included the computation and measurements of turbulent swirling flow in idealized gas turbine combustors, and the two-phase flow of geopressured geothermal fluid in wellbores, geothermal power plants, etc. Currently, he is developing a finite difference computer code to predict the destabilizing fluid pressure forces on labyrinth seal rotors of the configuration found in turbomachines.



**Luis A. San Andres**, Professor of Mechanical Engineering, received his M.Sc. degree from the University of Pittsburgh (1982) and his Ph.D. degree from Texas A&M University (1985). He received the Organization of American States Applied Science and Technology Award, and has been a TEES Fellow since 1993.

Dr. San Andres' research interests concern fluid film lubrication at high speeds, mechanics of squeeze film flows, and rotordynamics. He has contributed extensively to the understanding of fluid inertia effects in thin film squeeze flows and performed experimental work on the measurement of pressure fields on squeeze film damper apparatus.

Dr. San Andres' current research includes the development of computational fluid flow models for prediction of static and dynamic force performance of hydrostatic journal and pad bearings, and annular pressure seals for cryogenic liquid applications. He is also developing a test program to measure the effects of advanced integral squeeze film dampers on rotorbearing systems.



**Taher M. Schobeiri** is a Professor of Mechanical Engineering at Texas A&M University. He received his Dipl.-Ing. (M.Sc, 1970) and Dr.-Ing. (Ph.D., 1978) degrees from Technical University of Darmstadt, Germany. Dr. Schobeiri has eight years industrial experience at BBC Brown Boveri Turbomachinery, Switzerland. As Group Leader for Aerothermodynamic Design, he was responsible for development of design methods for new gas turbine types. He joined Texas A&M in 1987. His research interests include unsteady flow behavior in turbomachinery, turbine, and compressor flow.

Dr. Schobeiri is the author of numerous articles. He is a member of the ASME Turbomachinery Committee and VDI (the German Society of Mechanical Engineers).



**Stuart L. Scott** is Associate Professor of Petroleum Engineering at Texas A&M University. He holds a B.S. degree (Petroleum Engineering, 1982), an M.S. degree (Computer Science, 1985), and a Ph.D. degree (Petroleum Engineering, 1987) from The University of Tulsa, where he was the 1986-1987 Shell Doctoral Fellow.

Dr. Scott leads several research projects relating to multiphase oil, and gas transportation and production including multiphase pumping. Before joining Texas A&M, he was an Assistant Professor at Louisiana State University and worked nine years for Phillips Petroleum Company. International winner of the 1987 Society of Petroleum Engineers graduate student paper contest, he is an active member, having served as Chair of the Panhandle Section and the Production Operations Technical Committee. In 1992, Dr. Scott served as the overall Chair for the first SPE Forum on Multiphase Flow, Pumping, and Separation Technology and, in 1998, organized the first MMS/LSU Workshop on Deepwater Production.

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# Turbomachinery Laboratory

Director: Dara W. Childs, Ph.D., P.E.

Founded in 1971, the faculty and staff of the Turbomachinery Laboratory and Texas A&M University continue to address the needs of the pump and turbomachinery industries. We moved into a new building in 1993 that is located a short distance from the George Bush Presidential Library. We are proud to continue Texas A&M's land-grant charter and tradition of attention to industry's needs in the following three areas:

- Continuing Education and Professional Development
- Undergraduate and Graduate Education
- Basic and Applied Research

## CONTINUING EDUCATION AND PROFESSIONAL DEVELOPMENT

With respect to continuing education and professional development, the Turbomachinery Symposium was the initial principle activity of the Laboratory. From a modest beginning on the Texas A&M campus, the symposium has become the principle annual meeting for the users and manufacturers of industrial turbomachinery. The attendance for this meeting has grown to more than 3500, with over 220 exhibitors. Because of the continued growth of the Turbomachinery Symposium, the meeting moved to Houston. The papers presented at the symposium are invited by the Advisory Committee from recognized industrial leaders. The high quality and enduring value of these papers have been confirmed by practicing engineers who carefully hoard the symposium *Proceedings* within their professional libraries, and by the frequency of their citation in other transactions.

In 1984, the Turbomachinery Laboratory began a new symposium, the International Pump Users Symposium, which was patterned after the Turbomachinery Symposium, but devoted entirely to pumps. The inaugural Pump Symposium had 520 attendees and more than 50 exhibitors, representing pump manufacturers and users from the petrochemical industry and the utilities. Recent Pump Symposia have shown strong growth and clearly confirm the need for a forum for industrial pump users. The attendance has grown to more than 3400, with over 220 exhibiting companies.

Short courses are offered in advance of both symposia. The Short Courses are offered by experienced turbomachinery and pump users. Some topics covered by recent short course offerings include:

- "Use Your Head" Understanding Turbocompressor Performance
- Flexible Couplings
- Gas Turbine Technology
- Managing Turbomachinery Lubrication
- Machinery Installation and Installation Design—API Standard 686
- Centrifugal Compressor Performance Testing—Basics for Users
- Maintenance Issues for Reciprocating Compressors
- Basic Vibration Analysis Applied to Pumps
- Basic Pump Hydraulics with a Minimum of Mathematics
- Mechanical Seals—Advanced
- Centrifugal Pump and System Interaction
- Couplings for Pumps

- Advanced Vibration Analysis Applied to Pumps
- Positive Displacement Pumps
- Pump Hydraulics—Advanced

## UNDERGRADUATE AND GRADUATE EDUCATION

At Texas A&M University, faculty expertise related to turbomachinery has traditionally provided equal emphasis on performance and reliability. Our undergraduate program provides students with elective options in turbomachinery performance, fluid and thermal science, vibrations, stress analysis, and other related topics. Our M.S. program provides a balance between performance and reliability with more specific electives in turbomachinery performance, rotordynamics, etc. A majority of the M.S. thesis research projects involve experimental validation of theoretical and computational developments. The emphasis on experimental validations of predictions stands in contrast to many graduate programs around the country. Ph.D. students generally concentrate on research topics related to ongoing research programs within the Laboratory.

## BASIC AND APPLIED RESEARCH

Faculty and staff of the Turbomachinery Laboratory carry out research activities for both industry and government. Most of the industrial research support is provided through the Turbomachinery Research Consortium (TRC). Currently, 22 industrial firms provide grants of \$15,000 per year to support a broad range of industrial research projects. In addition, grants and contracts from government and private agencies provide continuing support for graduate research and education related to performance, rotordynamics, seals, computational fluid dynamics, torsional vibrations, materials, and finite element analysis. Brief summaries are provided below for some of our current research activities.

### *Turbomachinery Performance*

- Modeling the flow field in a centrifugal pump to measure the impeller radial forces and the effects of impeller displacement on performance.
- Development of computational programs for both compressible and incompressible, radial-flow turbomachines.
- Computing the thrust force on shrouded pump impellers in the presence of several leakage mechanisms.

### *Rotordynamics and Reliability*

- Identification of force coefficients from measurements of the imbalance response in a test rotor supported on series tilting pad bearings and integral squeeze film dampers.
- Identification of rotordynamic performance of squeeze film dampers and heavily loaded hydrodynamic bearings subject to natural air entrainment.
- Measurements of responses to imbalance (100,000 rpm) and shock loads in a test rotor supported on gas bearings for oil-free turbomachinery.
- Experimental characterization of the rotordynamic (nonlinear) performance of automotive turbochargers supported on floating and semifloating ring journal bearings.
- Measurement of stiffness and damping coefficients for ball bearings.

- Effects of air/oil bubbly mixtures and air entrainment on the performance of squeeze film dampers.
- Rotordynamics of rub rings and bumpers.
- Experimental and theoretical investigation of rotordynamic instability and steady-state behavior of flexible rotordynamic systems with oil journal bearings—computer program for the nonsynchronous response and bifurcation of their nonlinear dynamics.
- Experimental tests for identification of rotordynamic coefficients in fluid film bearings, gas damper seals, and brush seals.
- Experimental determination of rotor foundation parameters for improved critical speed predictions.
- Effect of shrink fits on threshold speeds of rotordynamic instability.
- Experimental evaluation of a Met-L-Flex bearing damper in a high speed test rig.
- Development of high temperature magnetic bearings.
- Flywheel stress and vibration.
- Development of a new multiline, finite-element, real component-mode-synthesis rotordynamics code.
- Techniques for experimental tools for detecting and controlling chaos in axial compressors of aircraft engines and land-based engines of process and power plants.

### *Seals*

- Computational analysis of process fluid hydrostatic/hydrodynamic thrust bearings: effects of collar misalignment and prediction of moment-angle coefficients.
- Computational bulk flow analysis of Lomakin bearings for cryogenic turbopumps.
- Computational bulk flow analysis of labyrinth seals for cryogenic turbopumps.

- Computational analysis of gas tilting pad bearings, spiral groove face seals and herringbone bearings for oil-free turbomachinery.
- Computational transient (linear and nonlinear) response of turbocharger rotors supported on floating ring bearings. Identification of limit cycle amplitudes and whirl frequency ratios.
- Annular, honeycomb seals—analysis and high-pressure (70 bar supply pressure) testing for leakage and rotordynamic coefficients.
- Labyrinth seals—analysis and testing for leakage and rotordynamic coefficients.
- Three-dimensional finite difference solution approaches for flow in labyrinth seals and calculation of seal forces.
- Three-dimensional LDA measurement of fluid flow, currently applied to flow in labyrinth seals and flowmeters.
- Dynamic pressure and shear stress measurements on the stator wall of whirling labyrinth and annular seals.
- CFD based rotordynamic coefficients for labyrinth seals and impeller shroud leakage paths.
- Rotordynamic effects of damper seals.
- Measurement of static and dynamic characteristics of high-pressure, laminar, oil bushing seals for centrifugal compressors or pumps.

### FUTURE PROGRAMS

Several of the following programs are being planned for the future.

- LDV measurement capability for compressible and incompressible flow fields (compressors and pumps).
- Use and improvement of magnetic bearings for parameter identification.
- Visualization of the flows around blade surfaces and tips.
- Visualization of bubbly flows (air entrainment) in squeeze film dampers.