PROFESSIONAL RESUME OF
DR. PATRICK J. ROACHE

PROFESSIONAL INTERESTS

Primary: numerical solutions of partial differential equations, particularly for fluid dynamics, unsteady aerodynamics, porous media flow and transport, heat transfer, electrodynamics, and grid generation, with special interest in Verification and Validation.

Secondary: solar energy, multiphase flow, gas dynamics, free convection, flow visualization, wind tunnel testing, boundary layer transition, aircraft and missile performance, base pressure, analytical flight dynamics, symbolic manipulation, optimization.

EDUCATION

B.S. Aeronautical Engineering, University of Notre Dame, 1960.
M.S. Aeronautical Engineering, University of Notre Dame, 1962.
Ph.D. Aerospace Engineering, University of Notre Dame, 1967.

Other graduate work during NSF Summer Institutes at Oklahoma State University (1963) and University of Arizona (1964).

INDUSTRY EXPERIENCE

Consultant, 1/97-present.
President, Ecodynamics Research Associates, Inc., 11/75-12/96.
Senior Scientist, Science Applications, Inc., 12/73-10/75.
Research Aerodynamicist, Sandia Laboratories, 12/67-11/73.
Electronics Manual Technical Writer, Heath Company, summer 1961.
Aerodynamicist, Chrysler Missile Corporation, summer 1962.
Flight Test Engineer, Sikorsky Helicopter, summer 1958.

TEACHING EXPERIENCE

Short Course on "Verification and Validation in Computational Fluid Dynamics", AIAA 41th Aerospace Sciences Meeting, Reno, Nevada, January 2003.

Short Course on "Verification and Validation in Computational Physics," Los Alamos National Laboratory, 9-11 September 2002.

Short Course on "Verification and Validation in Computational Fluid Dynamics", NASA-Langley Research Center, Virginai (under auspices of AIAA), 22-24 July 2002.

Short Course on "Verification and Validation in Computational Physics," Los Alamos National Laboratory, June 3-5, 2002.

Short Course on "Verification and Validation in Computational Science and Engineering", Center for Applied Mathematics, University of Notre Dame, 11-13 March 2002.

Short Course on "Verification and Validation in Computational Fluid Dynamics", AIAA Meeting, Anaheim, California, 9-10 June 2001.

Short Course on "Verification and Validation in Computational Fluid Dynamics", AIAA 39th Aerospace Sciences Meeting, Reno, Nevada, January 2001.

Short Course on "Verification and Validation in Computational Fluid Dynamics", NASA-Glenn Research Center, Cleveland, Ohio (under auspices of AIAA), June 2000.

Short Course on "Verification and Validation in Computational Fluid Dynamics", AIAA 38th Aerospace Sciences Meeting, Reno, Nevada, January 2000.

Short Course on "Numerical Model Verification Techniques for Hydraulic Engineers", ASCE International Conference on Water Resources Engineering, Seattle, Washington, August 1999.

Visiting Professor (Melchor Chair) of Civil Engineering and Geological Sciences, University of Notre Dame, Fall 1996. Taught graduate seminar course in Advances in Computational Fluid Dynamics.

Part of CFD Short Course, "Verification of Codes and the Grid Convergence Index," Canadian CFD Society of Canada Meeting, Banff, July 1995.

Visiting Professor of Mathematics, University of New Mexico, 1986- 1987. Taught graduate courses in Numerical Methods.

Visiting Professor of Mechanical Engineering, University of California at Davis, Spring 1985. Taught section of graduate course in Computational Fluid Dynamics.

Visiting Professor of Aerospace and Mechanical Engineering, North Carolina State University, Spring 1978. Taught section of graduate course in Computational Fluid Dynamics.

Adjunct Professor of Mechanical Engineering, University of New Mexico, 1977. Taught graduate course in Numerical Methods.

Adjunct Professor of Mechanical Engineering, University of New Mexico, 1977. Taught graduate course in Differential Equations.

Lecturer, University of Tennessee Space Institute, November 1972. Taught section of short course on Separated Flows.

Visiting Associate Professor of Mechanical Engineering, University of Kentucky, Fall 1970. Taught graduate course in Computational Fluid Dynamics.

Adjunct Professor of Mathematics, University of Albuquerque, 1969. Taught senior-level course in Analysis.

Adjunct Professor of Mechanical Engineering, University of New Mexico, 1968. Taught graduate course in Boundary Layer Theory.

Instructor at Sandia Laboratories, 1967-1973. Out-of-hours and in-hours courses in Aerodynamics and Computational Fluid Dynamics.

Assistant Professor of Mechanical Engineering, University of North Dakota, 1964-1965. Taught undergraduate courses in Basic Aerodynamics; Gas Dynamics; Thermodynamics; Heat Transfer.

Instructor, Aeronautical Engineering, University of Detroit, 1962- 1964. Taught undergraduate courses in Basic Aerodynamics; Gas Dynamics; Advanced Gas Dynamics; Aircraft and Missile Dynamics, Aircraft and Missile Performance; Advanced Missile Performance.

EDITORIAL AND COMMITTEE EXPERIENCE

Associate Editor for Numerical Methods, *ASME Journal of Fluids Engineering*, 1985-1988.

Advisory Editorial Boards: *Computers and Fluids*; *International Journal of Numerical Methods in Fluids; Numerical Heat Transfer; Computer Methods in Applied Mechanics and Engineering; International Journal for Numerical Methods in Engineering.*

Member, AIAA Technical Committee on Fluid Dynamics, 1992/93.
Chairman, Subcommittee on Publication Standards for CFD.

Chairman, Numerical Fluid Dynamics Panel, *Workshop on NSF (RANN) Numerical Simulation of Combustion for Applications to Spark and Compression Ignition Engines*.

Member, ASME Coordinating Group for Computational Fluid Dynamics, 1992/94.

Member, ASCE/EWRI Task Committee on 3D Free Surface Flow Model Verification/Validation Monograph, 1998-2006.

Member, ASME/IUTAM Committee on Verification and Validation, 2000-2003.

Member, Subcommittee of the ASME CFD Technical Committee, subcommittee for Publication Standards, 2001-2004.

Member, ASME Fluids Engineering Division CFD Standards Committee, 2004-2007.

Member, Committee PTC-60 on Verification and Validation in Computational Solid Mechanics, 2000-2006.

Member, ASME Committee PTC-61 on Verification and Validation in Computational Fluid Mechanics and Heat Transfer, 2004-2008.

Reviewer for Journals: *Computers and Fluids; International Journal of Numerical Methods in Fluids; Numerical Heat Transfer; Computer Methods in Applied Mechanics and Engineering; International Journal for Numerical Methods in Engineering; Journal of Computational Physics; AIAA Journal; AIAA Journal of Spacecraft and Rockets; ASME Journal of Fluids Engineering; ASME Journal of Heat Transfer*.

Reviewer for Funding Agencies: Army Research Office; Air Force Office of Scientific Research; National Science Foundation; U.S. Environmental Protection Agency (Chairperson of Panel to Review Atmospheric Modeling Proposals).

Committee to Evaluate Computational Needs at the U.S. Army Ballistic Research Laboratories.

Review Board, New Mexico Energy Institute.

Evaluation Committee, 1980-1981 AFOSR-HTTM-Stanford Conference on Complex Turbulent Flows.

Review Board, Maui High Performance Computing Center.

Idaho National Laboratory, Problem Oversight Committee, 2006-2007

PROFESSIONAL SOCIETIES

American Institute of Aeronautics and Astronautics (Associate Fellow)
American Society for Mechanical Engineering (Fellow)
Environmental & Water Resources Institute of ASCE
Sigma Xi
Philosophy of Science Association

Past:
American Physical Society
American Society for Civil Engineering
American Society for Engineering Education
American Geophysical Union
Society for Industrial and Applied Mathematics

AWARDS

University of Cincinnati, Department of Aerospace Engineering and Engineering Mechanics, 18 February 1994, *R. T. Davis Memorial Lecture Award*. "For Fundamental and Scholarly Contributions to the Field of Mechanics, with Respect for Seeking Truth with Intellectual Honesty."

American Society of Mechanical Engineers, Fluids Engineering Division, 8 November 1994, *Robert T. Knapp Award*. "This award recognizes the best paper dealing with results from analytical or laboratory research that has been presented to the Fluids Engineering Division of the ASME within the last two years."

University of Notre Dame, *Distinguished Alumnus Engineering Honor Award*, 1995.

American Society of Mechanical Engineers, Election to Fellow Grade, July 1999.

American Institute of Aeronautics and Astronautics , Election to Associate Fellow, January 2002.

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PUBLICATIONS, REPORTS, AND PRESENTATIONS

PUBLICATIONS: BOOKS AUTHORED

Roache, P. J. (1972), ***Computational Fluid Dynamics***, Hermosa Publishers, Albuquerque, December 1972; revised printing, December 1976.

(Japanese Translation, Kozo Keikaku, Tokyo, 1978)

(Russian Translation, MIR Publishers, Moscow, 1980)

(Chinese Translation, Beijing, 1982)

Roache, P. J., (1995), ***Elliptic Marching Methods and Domain Decomposition***, CRC Press, Boca Raton, Florida.

Roache, P. J. (1998), ***Verification and Validation in Computational Science and Engineering***, Hermosa Publishers, Albuquerque, August 1998.

Roache, P. J. (1998), ***Fundamentals of Computational Fluid Dynamics***, Hermosa Publishers, Albuquerque, December 1998.

PUBLICATIONS: BOOKS EDITED

Celik., I, Chen, C. J., Roache, P. J., and Scheurer, G. (1993), Eds., *Symposium on Quantification of Uncertainty in Computational Fluid Dynamics*, American Society of Mechanical Engineers, ASME FED-Vol. 158.

PUBLICATIONS: BOOK CHAPTERS

Steinberg, S. and Roache, P. J., (1991), "Bifurcation of Grids on Curves," Chapter 5 in *Mathematical Aspects of Numerical Grid Generation*, Jose E. Castillo, Ed., Society for Industrial and Applied Mathematics, Philadelphia, 1991, pp. 59-73.

Roache, P. J. (1997), "Quantification of Uncertainty in Computational Fluid Dynamics," *Annual Review of Fluid Mechanics*, Volume 29, pp. 123-160

Roache, P. J. (2002), "Terminology and Definitions", Chapter II in *3D Free Surface Flow Model Verification and Validation*, ASCE/EWRI Monograph. (Expected 2008.)

Pelletier , D. and Roache, P. J. (2006), "Verification and Validation of Computational Heat Transfer", Chapter 13 of *Handbook of Numerical Heat Transfer*, Second Edition, W. J. Minkowycz, E. M. Sparrow, and J. Y. Murthy, eds., Wiley, New York.

PUBLICATIONS: BOOKS BY COMMITTEE

ASME Committee PTC-60, *ANSI Standard V&V 10. ASME Guide on Verification and Validation in Computational Solid Mechanics*, 29 December 2006.

ASCE/EWRI Task Committee on 3D Free Surface Flow Model Verification/Validation, *3D Free Surface Flow Model Verification/Validation*, (expected) 2008.

ASME Committee PTC-61, *ANSI Standard V&V 20. ASME Guide on Verification and Validation in Computational Fluid Dynamics and Heat Transfer*, (expected) 2008.

PUBLICATIONS: THESES, DISSERTATIONS

Roache, P. J. (1962), *Studies in Shock Wave-Boundary Layer Interaction*, M.S. Thesis, Department of Aeronautical Engineering, University of Notre Dame, June 1962.

Roache, P. J. (1967), *Numerical Solutions of Compressible and Incompressible Laminar Separated Flows*, Department of Aerospace Engineering, University of Notre Dame, Dec. 1967.

PUBLICATIONS: JOURNALS AND CONFERENCE PAPERS

Roache, P. J. (1962), *Studies in Shock Wave-Boundary Layer Interaction*, M.S. Thesis, Department of Aeronautical Engineering, University of Notre Dame, June 1962.

Roache, P. J. (1965), "The Neutral Point in Static and Dynamic Stability Analysis," Comment for *AIAA Journal of Aircraft*, July 1965.

Roache, P. J. (1967), *Numerical Solutions of Compressible and Incompressible Laminar Separated Flows*, Department of Aerospace Engineering, University of Notre Dame, December 1967.

Knapp, C. F. and Roache, P. J. (1968), "A Combined Visual and Hot-Wire Anemometer Investigation of Boundary Layer Transition," *AIAA Journal*, Vol. 6, No. 1, January 1968, pp. 29-36.

Roache, P. J. (1968), "Reply by Author to A. Michalke," *AIAA Journal*, Vol. 6, No. 6, June 1968.

Roache, P. J. and Mueller, T. J. (1968), "Numerical Solutions of Compressible and Incompressible Laminar Separated Flows," AIAA Paper No. 68-741, June 1968.

Roache, P. J. and Mueller, T. J. (1970), "Numerical Solutions of Laminar Separated Flows," *AIAA Journal*, Vol. 8, No. 3, March 1970, pp. 530-538.

Roache, P. J. (1970), "A New Direct Method for the Discretized Poisson Equation," in *Lecture Notes in Physics*, Vol. 8, Springer-Verlag, Berlin, December 1970.

Roache, P. J. (1970), "Sufficiency Conditions for a Commonly Used Downstream Boundary Condition on Stream Function," *Journal of Computational Physics*, Vol. 6, No. 2, October 1970.

Mueller, T. J., Hall, C. R., and Roache, P. J. (1970), "Influence of Initial Flow Direction on the Turbulent Base Pressure in Supersonic Axisymmetric Flow," *AIAA Journal of Spacecraft and Rockets*, Vol. 7, No. 12, December 1970.

Roache, P. J. (1972), "On Artificial Viscosity," *Journal of Computational Physics*, Vol. 10, No. 2, October 1972, pp. 169-184.

Mueller, T. J. and Roache, P. J. (1973), "Base Drag Calculations in Supersonic Turbulent Axisymmetric Flows," *AIAA Journal of Spacecraft and Rockets*, Vol. 10, No. 4, April 1973.

Roache, P. J. (1973), "Finite Difference Methods for the Steady- State Navier-Stokes Equations," in *Lecture Notes in Physics*, Vol. 18, Springer-Verlag, Berlin, 1973, pp. 138-145.

Roache, P. J. (1975), "The Split NOS and BID Methods for the Steady-State Navier-Stokes Equations," in *Lecture Notes in Physics*, Vol. 35, Springer-Verlag, Berlin, 1975, pp. 347-352.

Roache, P. J. (1975), "The Split NOS and BID Methods for the Steady-State Navier-Stokes Equations," *Lecture Notes in Physics*, Vol. 35, Springer-Verlag, Berlin, 1975, pp. 347-352.

Roache, P. J. (1975),"The LAD, NOS, and Split NOS Methods for the Steady-State Navier-Stokes Equations," *Computers and Fluids*, Vol. 3, 1975, pp. 179-195.

Roache, P. J. (1975), "Recent Developments and Problem Areas in Computational Fluid Dynamics," *Lecture Notes in Mathematics*, Vol. 461, Springer-Verlag, Berlin, 1975, pp. 195-256.

Roache, P. J. and Ellis, M. A. (1975), "The BID Method for the Steady-State Navier-Stokes Equations," *Computers and Fluids*, Vol. 3, 1975, pp. 305-320.

Roache, P. J., et al. (1975), "Report of the Numerical Fluid Dynamics Panel," *Workshop on Numerical Simulation of Combustion for Applications to Spark and Compression Ignition Engines*, NSF (RANN) Grant No. AER 75-10575.

Roache, P. J. (1975), "A Review of Numerical Techniques," *Proceedings First International Conference on Numerical Ship Hydrodynamics*, 20-22 October 1975, J. Schot and N. Salveson, eds., David W. Taylor Ship Research and Development Center, Bethesda, Maryland.

Roache, P. J. (1977), "Prospects for Accurate Computer Simulations of Fluid Dynamics Problems of Nuclear Reactors," *Nuclear Science and Engineering*, Vol. 64, September 1977, pp. 219-221.

Roache, P. J. (1977), "A Semidirect Method for Internal Flows in Flush Inlets," AIAA Paper 77-647, June 1977.

Roache, P. J. (1978), "A Pseudo-Spectral FFT Technique for Non- Periodic Problems," *Journal of Computational Physics*, Vol. 27, No. 2, p. 204, May 1978.

Roache, P. J. (1978), "Marching Methods for Elliptic Problems: Part 1," *Numerical Heat Transfer*, Vol. 1, No. 1, 1978, pp. 1-25.

Roache, P. J. (1978), "Marching Methods for Elliptic Problems: Part 2," *Numerical Heat Transfer*, Vol. 1, No. 2, 1978, pp. 163-181.

Roache, P. J. (1978), "Marching Methods for Elliptic Problems: Part 3," *Numerical Heat Transfer*, Vol. 1, No. 2, 1978, pp. 183-201.

Roache, P. J. (1978), "Semidirect Calculation of Steady Two- and Three-Dimensional Flows," *Proceedings First International Conference, Numerical Methods in Laminar and Turbulent Flow*, 17-21 July 1978, University College, Swansea, Wales, Pentech Press, London, pp. 17-28.

Gartling, D. K. and Roache, P. J. (1978), "Efficiency Trade-Offs on Steady-State Methods Using FEM and FDM," *Proceedings First International Conference, Numerical Methods in Laminar and Turbulent Flow*, 17-21 July 1978, University College, Swansea, Wales, Pentech Press, London, pp. 103-112.

Roache, P. J. (1979), "A Sixth-Order Accurate Direct Solver for the Poisson and Helmholtz Equations," *AIAA Journal*, Vol. 17, No. 5, May 1979, pp. 524-526.

Roache, P. J. and Zoltani, C. K. (1979), "A Preliminary Investigation of the Singular Behavior of Fluids Near a Sliding Corner," *Proceedings 1979 Army Numerical Analysis and Computers Conference*.

Roache, P. J. (1979), "A Semidirect Method Suitable for Recirculating Flows Driven by Buoyancy and Shear," *Proceedings International Conference on Numerical Methods in Thermal Problems*, 2-6 July 1979, Pineridge Press, Swansea, Wales.

de Vahl Davis, G., Jones, I. P., and Roache, P. J., "Natural Convection in an Enclosed Cavity: A Comparison Problem," *Computers and Fluids*, Vol. 7, pp. 315-316, 1979.

Roache, P. J. (1980), "GEM Solutions of Elliptic and Mixed Problems with Non-Separable 5-and 9-Point Operators," *Elliptic Problem Solvers*, Academic Press, M. Schultz, ed., 1981, pp. 399-403.

Roache, P. J. (1981), "The GEM Code: Direct Solutions of Elliptic and Mixed Problems with Non-Separable 5- and 9-Point Operators," *Proceedings 1981 Army Numerical Analysis and Computers Conference*, Huntsville, Alabama, 26-27 February 1981.

Roache, P. J., Moeny, W. M., and Filcoff, J. A. (1981), "Computational Solutions in Body-Fitted Coordinates of Electric Fields in Externally Sustained Discharges," *Proceedings 3rd IEEE International Pulsed Power Conference*, 1-3 June 1981, Albuquerque, New Mexico.

Roache, P. J. (1981), "A Semidirect Method for Combined Natural and Forced Convection Problems Including Solute," *Proceedings Second National Symposium on Numerical Methods in Heat Transfer*, University of Maryland, 28-30 September 1981.

Roache, P. J. (1981), "Performance of the GEM Codes on Non-Separable 5-and 9-Point Operators," *Numerical Heat Transfer*, Vol. 4, No. 4, 1981, pp. 395-408.

Roache, P. J. (1982), "Scaling of High Reynolds Number Weakly Separated Channel Flows," *Numerical and Physical Aspects of Aerodynamic Flows*, (Proc. California State University Long Beach, 19-21 January 1981) T. Cebeci, ed., Chapter 6, Springer Verlag, New York, pp. 87-98.

Roache, P. J. (1982), "Interactive Design of Laser Electrodes Using Elliptic Grid Generation and Semidirect/Marching Methods," *Proceedings 1982 Army Numerical Analysis and Computers Conference*.

Roache, P. J. (1982), "Semidirect/Marching Methods and Elliptic Grid Generation," *Proceedings Symposium on the Numerical Generation of Curvilinear Coordinate Systems and Use in the Numerical Solution of Partial Differential Equations*, April 1982, Nashville, Tennessee, J. F. Thompson, ed., North-Holland Publishing Co., Amsterdam, pp. 727-737.

Happ, J. J., Moeny, W. M. and Roache, P. J. (1983), "Unsteady 2D Electric Field Modeling with High Accuracy on Conductor Surfaces," *Proceedings 4th IEEE Pulsed Power Conference*, 6-8 June 1983, Albuquerque, New Mexico.

Roache, P. J., Steinberg, S., Happ, J. J. and Moeny, W. M. (1983), "3-D Electric Field Solutions in Boundary-Fitted Coordinates," *Proceedings 4th IEEE Pulsed Power Conference*, 6-8 June 1983, Albuquerque, New Mexico.

Roache, P. J. and Steinberg, S. (1984), "Symbolic Manipulation and Computational Fluid Dynamics," AIAA Paper No. 83-1952. Also, *AIAA Journal*, Vol. 22, October 1984, pp. 1390-1394.

Roache, P. J., Steinberg, S., and Moeny, W. M. (1984), "Interactive Electric Field Calculations for Lasers," AIAA Paper 84-1655, AIAA 17th Fluid Dynamics, Plasma Physics, and Lasers Conference, 25-27 June 1984, Snowmass, Colorado.

Steinberg, S. and Roache, P. J. (1985), "Symbolic Manipulation and Computational Fluid Dynamics," *Journal of Computational Physics*, Vol. 57, No. 2, January 1985, pp. 251-284.

Roache, P. J. (1985), "Additional Performance Aspects of Marching Methods for Elliptic Equations," *Numerical Heat Transfer*, Vol. 8, 1985, pp. 519-535.

Roache, P. J. and Steinberg, S. (1985), "A New Approach to Grid Generation Using a Variational Formulation," AIAA 85-1527-CP, *Proceedings AIAA 7th Computational Fluid Dynamics Conference*, 15-17 July 1985, Cincinnati, Ohio.

Von Dadelszen, M., Moeny, W. M., and Roache, P. J. (1985), "Electric Field Calculations Using the ELF Codes," *Proceedings IEEE Pulsed Power Conference*, 10-12 June 1985, Crystal City, DC.

Steinberg, S. and Roache, P. J. (1985), "Using VAXIMA to Write FORTRAN Code," *Applications of Computer Algebra*, Pavelle, R., ed., Kluwer, New York, 1985, pp. 74-93.

Roache, P. J. (1985), "The ELF Codes: Electrode Design for Lasers and Switches," Invited Paper, *Proceedings CTAC-85 Conference*, 25-28 August 1985, Melbourne, Australia.

Steinberg, S. and Roache, P. J. (1986), "Using MACSYMA to Write Fortran Subroutines," *Journal of Symbolic Computation*, Vol. 2, 1986, pp. 213-216. See also *MACSYMA Newsletter*, Vol. II-2, 1985, pp. 10-12.

Steinberg, S. and Roache, P. J. (1986), "Variational Grid Generation," *Numerical Methods for Partial Differential Equations*, Vol. 2, 1986, pp. 71-96.

Roache, P. J. and Steinberg, S. (1986), "Application of a Single- Equation MG-FAS Solver to Elliptic Grid Generation Equations (Sub-grid and Super-grid Coefficient Generation)," *Applied Mathematics and Computation*, Vol. 19, 1986, pp. 283-292.

Steinberg, S. and Roache, P. J. (1986), "A Tool Kit of Symbolic Manipulation Programs for Variational Grid Generation," AIAA Paper No. 86-0241, AIAA 24th Aerospace Sciences Meeting, 6-9 January 1986, Reno, Nevada.

Steinberg, S. and Roache, P. J. (1986), "A Tool Kit of Symbolic Manipulation Programs for Variational Grid Generation," *Transactions of the Fourth Army Conference on Applied Mathematics and Computation*, Ithaca, New York, 1986.

Steinberg, S. and Roache, P. J. (1986), "A Tool Kit of Symbolic Manipulation Programs for Variational Grid Generation," *Proceedings of the Coupling of Symbolic and Numeric Computing in Knowledge Based Systems Workshop*, Boeing Computer Services, Seattle, Washington, 1987.

Roache, P. J., Ghia, K. and White, F. (1986), "Editorial Policy Statement on the Control of Numerical Accuracy," *ASME Journal of Fluids Engineering*, Vol. 108, No. 1, March 1986, pg. 2.

Roache, P. J. (1986), "Review of 'Computational Methods for Fluid Flow'," *AIAA Journal*, Vol. 24, No. 6, June 1986, pp. 1053-1054.

Steinberg, S. and Roache, P. J. (1986), "Grid Generation: A Variational and Symbolic-Computation Approach," *Proceedings Numerical Grid Generation in Fluid Dynamics Conference*, July 1986, Landshut, W. Germany.

Roache, P. J. and Steinberg, S. (1986), "Symbolic Manipulation and Computational Fluid Dynamics," Invited Paper, *Proceedings NSF Workshop on Computational Engineering*, 24-25 June 1986, NSF San Diego Supercomputer Center, San Diego, California.

Dietrich, D. E., Marietta, M. G., and Roache, P. J. (1987), "An Ocean Modelling System With Turbulent Boundary Layers and Topography: Numerical Description," *International Journal for Numerical Methods in Fluids*, Vol. 7, Sept. 1987, pp. 833-855.

Castillo, J. E., Steinberg, S. and Roache, P. J. (1987), "Mathematical Aspects of Variational Grid Generation II," *Journal of Computational and Applied Mathematics*, Vol. 20, 1987, pp. 127-135.

Castillo, J. E., Steinberg, S. and Roache, P. J. (1988), "On the Folding of Numerically Generated Grids: Use of a Reference Grid," *Communications in Applied Numerical Methods*, Vol. 4, 1988, pp. 471-481.

Castillo, J. E., Steinberg, S. and Roache, P. J. (1988), "Parameter Estimation in Variational Grid Generation," *Applied Mathematics and Computation*, Vol. 28, 1988, pp. 155-167.

Roache, P. J. (1988), "A Comment on the Paper 'Finite Difference Methods for the Stokes and Navier-Stokes Equations' by J. C. Strikwerda," *International Journal for Numerical Methods in Fluids*, Vol. 8, 1988, pp. 1459-1463.

Roache, P. J. and Dietrich, D. E. (1988), "Evaluation of the Filtered Leapfrog-Trapezoidal Time Integration Method," *Numerical Heat Transfer*, Vol. 14, 1988, pp. 149-164.

Roache, P. J. (1990), "Need for Control of Numerical Accuracy," *AIAA Journal of Spacecraft and Rockets*, Vol. 27, No. 2, March-April 1990, pp. 98-102. Also, AIAA Paper No. 89-1669.

Dietrich, D. E., Roache, P. J. and Marietta, M. G. (1990), "Convergence Studies with the Sandia Ocean Modeling System," *International Journal for Numerical Methods in Fluids*, Vol. 11, pp. 127-150.

Roache, P. J., Knupp, P. M., Steinberg, S. and Blaine, R. L. (1990), "Experience with Benchmark Test Cases for Groundwater Flow," ASME FED-Vol. 93, *Benchmark Test Cases for Computational Fluid Dynamics*, I. Celik and C. J. Freitas, eds., Book No. H00598-1990, pp. 49-56.

Roache, P. J. and Salari, K. (1990), "Weakly Compressible Navier- Stokes Solutions with an Implicit Approximate Factorization Code," AIAA Paper 90-0235.

Salari, K. and Roache, P. J. (1990), "The Influence of Sweep on Dynamic Stall Produced by a Rapidly Pitching Wing," AIAA Paper 90-0581.

Steinberg, S. and Roache, P. J. (1990), "Anomalies in Grid Generation on Curves," *Journal of Computational Physics*, Vol. 91, No. 2, December 1990.

Roache, P. J., Salari, K. and Steinberg, S. (1991), "Hybrid Adaptive Poisson Grid Generation and Grid Smoothness," *Communications in Applied Numerical Methods*, Vol. 7, 1991, pp. 345-354.

Steinberg, S. and Roache, P. J., (1991), "Bifurcation of Grids on Curves," Chapter 5 in *Mathematical Aspects of Numerical Grid Generation*, Jose E. Castillo, ed., Society for Industrial and Applied Mathematics, Philadelphia, 1991, pp. 59-73.

Steinberg, S. and Roache, P. J. (1991), "Generating Fortran Code for Finite-Volume Algorithms," *Proceedings 13th IMACS World Congress*, July 22, 1991, Dublin.

Steinberg, S. and Roache, P. J. (1991), "Discretizing Elliptic Operators in General Logically-Rectangular Grids," *Proceedings 13th IMACS World Congress*, July 22, 1991, Dublin.

Roache, P. J. (1991), "Computational Fluid Dynamics Algorithms and Codes Developed for WIPP Site Simulations," *Proceedings Asian Pacific Conference on Computational Mechanics*, 11-13 December 1991, University of Hong Kong, J.H.W. Lee, et al., eds., H. Balkeema, Amsterdam.

Dietrich, D. E. and Roache, P. J. (1991), "An Accurate Low Dissipation Model of the Gulf of Mexico Circulation," *Proceedings International Symposium on Environmental Hydraulics*, 14-16 December 1991, University of Hong Kong, J.H.W. Lee, et al., eds., H. Balkeema, Amsterdam.

Steinberg, S. and Roache, P. J. (1992), "Variational Curve and Surface Grid Generation," *Journal of Computational Physics*, Vol. 100, No. 1, pp. 163-178.

Salari, K., Knupp, P., Roache, P., and Steinberg, S. (1992), "TVD Applied to Radionuclide Transport in Fractured Porous Media," *Proceedings IX International Conference on Computational Methods in Water Resources*, Denver, Colorado, 9-12 June 1992, T. Russell, et al., eds., pp. 141-148.

Roache, P. J. (1992), "Validation Exercises of a One-Dimensional Flux-Based Modified Method of Characteristics," *Proceedings IX International Conference on Computational Methods in Water Resources*, Denver, Colorado, 9-12 June 1992, T. Russell, et al., eds., pp. 64-76.

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"Verification, Validation, Confirmation, Error Estimation, and Quantification of Uncertainty," CFD Seminar, Department of Civil Engineering and Geological Sciences and Department of Aerospace and Mechanical Engineering, University of Notre Dame, 21 November 1996.

"Verification and Validation in Computational Science and Engineering," Phillips Symposium Series, Computer-Aided Engineering in the 21st Century, New Nexico State University, Las Cruces, New Mexico, 24 April 1997.

Panel Discussion, ASCE Task Committee on 3D Free-Surface Flow Model Verifications, ASCE National Meeting, Memphis, Tennessee, 4 August 1998.

Panel Discussion, ASCE Task Committee on 3D Free-Surface Flow Model Verifications, ASCE International Conference on Water Resources Engineering, Seattle, Washington, 7 August 1999.

"Verification and Validation", Numerical PDE's Seminar, Department of Mathematics and Statistics, University of New Nexico, Albuquerque, New Mexico, 30 November 1999.

"Verification, Validation and Other Assurance Exercises for Modern Computational Physics", Los Alamos National Laboratories, 9 October 2001.

"Code Verification by the Method of Manufactured Solutions", Sandia National Laboratories - Albuquerque, 5 December 2001.

"Code Verification by the Method of Manufactured Solutions", TICAM, University of Texas at Austin, 21 March 2002.

"An Overview of Verification and Validation for Computational Science and Engineering", Lawrence Livermore National Laboratories, 18 April 2002.

"Recent Contributions to Verification and Validation Methodology," Keynote Address, Minisymposium on Verification and Validation II, Mondial Congress World Congress on Computational Mechanics V, Vienna, 10 July 2002.

"Recent Contributions to Verification and Validation Methodology," Institute of Heat Transfer (CTTC), University of Barcelona, 12 July 2002.

"An Overview of Verification and Validation for Computational Science and Engineering", Knolls Atomic Power Laboratories, 25 July 2002.

"Error Bars for CFD," AIAA 41st Aerospace Sciences Meeting, January 2003, Reno, Nevada.

"Panel Discussion on Numerical Uncertainty", AIAA 41st Aerospace Sciences Meeting, January 2003, Reno, Nevada.

"Assessing Discretization Uncertainty in V&V", Keynote Lecture, *Minisymposium on Verification & Validation in Computational Mechanics, Seventh USACM Congress on Computational Mechanics*, Albuquerque, NM, 28-30 July 2003.

"Calculation Verification: an Overview", Keynote Lecture, Workshop on CFD Uncertainty Analysis, Instituto Superior Tecnico, Lisbon, Portugal, 21 October 2004.

"Code Verification", D. Pelletier, P. J. Roache, B. Blackwell (presenter), IMECE05, ASME National Meeting, Orlando, FL, 6 November 2005.

"Verification and Validation Fundamentals", Keynote Lecture, Workshop on the Future of Modeling and Simulation for Combustion Applications, 21-23 February 2006, Pittsburgh, Pennsylvania.

"Recent Developments in Verification and Validation," Keynote Lecture, Second Workshop on CFD Uncertainty Analysis, Instituto Superior Técnico, Lisbon, Portugal, 19 October 2006.

"Recent Developments in Verification and Validation," Mathematics Seminar, New Mexico Institute of Mining and Technology, Socorro, New Mexico, 18 November 2006.

"Standards for Analyses", Seminar at Idaho National Laboratories, Idaho Falls, Idaho, "Requirements and Capabilities for CFD Analysis of Reactors" held 6 November 2007.

"Fundamentals of Verification and Validation," Mechanical Engineering Seminar, Louisiana State University, Baton Rouge, LA, 14 March 2008.

"Framework for Verification, Validation and Uncertainty Quantification," Keynote Address, Verification and Validation for Nuclear Systems Analysis Workshop, Idaho Falls, ID, 21-25 July 2008.

"Validation: Definitions or Descriptions?", Keynote Address, *3rd Workshop on CFD Uncertainty Analysis*, Lisbon, 23-24 October 2008, Instituto Superior Técnico, Lisbon.