



Ian King

Consulting Specialist

Ian is an internationally recognised expert in the application of state-of-the-art computer simulation techniques to practical engineering problems and has pioneered the application of the Finite Element Methods to water resource problems. He is the author of more than 50 technical papers in the field of water resource and water quality modelling and structural engineering.

Ian developed the finite element method for application to one, two, and three-dimensional hydrodynamic and water quality problems. He is the principal author of the RMA suite of finite element models that are in worldwide use by governmental agencies and the consulting profession. He applied the finite element method to complex nonlinear problems associated with groundwater flow and transport; and has carried out research as a post-doctoral fellow in the fields of stress analysis of pressure vessels, shells and bridges and rock media. For many years, he has had a continuing association with the Water Research Laboratory, where he is currently a Consulting Specialist.

Qualifications

BA Hons, (Mechanical Sciences), University of Cambridge, England, 1960

MSc (Civil Engineering), University of California, Berkeley, 1962

PhD (Structural Engineering and Structural Mechanics), University of California, Berkeley, 1965

Professional history

- 1965-1966:** **Post-Doctoral Research Fellow**, Berkeley Nuclear Laboratory, Berkeley, England
- Carried out research into the application of finite element method to pressure vessels and shell structures.
- 1966-1967:** **Post-Doctoral Research Fellow**, University of Wales, Swansea, Wales, UK
- Carried out research and supervised students in the following studies utilising the finite element method: Linear stress analysis of slab bridges, shells and arch dams; elasto-plastic analysis of metals and fiber reinforced materials; visco-elastic analysis of two-dimensional stress systems; no-tension analysis of rock media.
- 1969, 1980:** **Lecturer (quarter time)**, University of California, Davis, California, USA
- Undergraduate - Mechanics of Materials Course
- 1967-1974:** **Principal Engineer**, Water Resources Engineers, Inc., Walnut Creek, California, USA
- Dr. King was engaged in a number of research and development projects in the field of computer modelling of Water Resource and Structural Systems. He has been active in the development of computer methods for water quality simulation of ground water systems. He was responsible for the development of methods for optimum development and operation of multi-basin reservoir systems, and developed a finite element method to model stratified flow in reservoir systems under a research contract for the Office of Water Resources Research.
 - Other assignments included providing expert advice on water resource planning and water quality simulation for United Nation's sponsored projects in Poland and Romania, development of ecological models for streams and two-dimensional systems, and analysis of ground water seepage through proposed earth fill dams.

- 1974-1999:** **Associate (part time),** Resource Management Associates, Lafayette, California, USA
- Development of two and three-dimensional models for fluid flow, including effects of salinity and thermal stratification. Applications have included San Francisco Bay, the offshore area from Sydney Australia and lakes and reservoirs in the Sacramento and Columbia River system.
 - Development and use of the two-dimensional finite element flow and quality transport models to predict the effects of possible chemical spills in the surface runoff and waste outfall locations in the San Francisco Bay system.
 - Simulation of heat, moisture flow and radio nuclide transport processes for a deep basalt aquifer.
 - Development of one-dimensional flood routing and water quality-ecological models.
 - Computer simulation using the finite element method for one, two and three-dimensional cases of heat and moisture transport in the unsaturated groundwater zone in the vicinity of toxic storage tank leaks.
 - Consultant to Department of Water Resources, State of California on the application of numerical groundwater models to the San Joaquin Valley, California, and the application of estuarial models in the Sacramento-San Joaquin Delta system.
 - Development of a computer system for analysis, interpretation and display of field data.
 - Installation of a data management and retrieval system for hydraulic and hydrologic data for the Niger River Basin in West Africa.
 - Simulation of currents in the Sacramento River system for use in a ship simulator.
- 1983-Present:** **Professor/Emeritus Professor,** Civil & Environmental Engineering - University of California, USA
- Taught undergraduate courses in statics, mechanics of materials, hydraulics, simulation, groundwater systems and application of computers to civil engineering problems.
 - Taught graduate courses in unsteady flow in surface waters, modelling of water quality, advanced groundwater analysis, modelling of groundwater systems, application of the finite element method to fluids.
- Research has included:**
- Application and development of numerical models for surface water and groundwater systems.
 - Development of 3D models for estuary and coastal systems, including the effects of stratification, wind tractions and the use multiple levels of approximation within the same model.
 - Development and use of the 2D finite element flow and water quality transport models to predict the effects of chemical spills in the surface runoff and waste outfall locations in the San Francisco Bay system.
 - Development of modelling techniques and energy loss relationships for application to the modelling of marshes and tidal wetlands.
 - Extension of a two-dimensional finite element water quality model to incorporate nutrient cycles and higher trophic levels and the development of methods to describe the influence of benthic algae.
 - Development of an Eulerian-Lagrangian finite element method for water quality analysis.
- 1999-Present:** **Principal,** Resource Modelling Associates Pty Ltd, Sydney, NSW
- Consultant to SOGREAH on the application of RMA models to the coast and marshes near Abu Dhabi.
 - Consultant to Golder Associates on the application of RMA models to solar ponds.
 - Consultant to Riversdale Mining reviewing application of the HEC RAS model to the Zambezi River.
 - Chair of an international peer review panel for evaluation of a modelling project projecting impact of heavy metals in stormwater in central Auckland harbour for Auckland Regional Council, NZ.
 - Chair of an international peer review panel for evaluation of a modelling project projecting sediment build-up in local estuaries surrounding Auckland harbour for Metrowater, Auckland, NZ.
 - Consultant to FTN Associates on the application of RMA models to the flood plains and coastal zone south of New Orleans, USA.
 - Consultant to the Water Research Laboratory on the application of RMA models for prediction of brine transport in a coastal zone.

- Consultant assisting Kuwait Institute for Scientific Research with modelling of power station outfalls in Kuwait Bay using RMA models.
- Application of the RMA models to Darwin Harbour (in cooperation with the Water Research Laboratory, UNSW, and the Northern Territory Government).
- Development of flood plain models for various locations in western New South Wales.
- Development of a morphological model for prediction of the evolution of bed level at the entrance to the Murray River in South Australia. This model incorporates interactive hydrodynamics, wave transport and sand transport models to predict changes in bed elevation.
- Consultant, specialising in assistance with application of the RMA Modelling Suite.
- Assistance to Lyonnaise Des Eaux with numerous applications of the RMA models to water supply problems.
- Development of new levee elements for RMA-2 to assist Patterson Britton Pty Ltd with modelling of floods in complex urban systems.

Publications

- King, I.P., Clough, R.W. and Wilson, E.L. (1964) "Large Capacity Multistory Frame Analysis Programs" *Journal of the Structural Division*, ASCE, Vol. 89, No. ST4, August, pp. 179-204
- King, I.P. & Clough, R.W. (1964) "Analysis of Three-Dimensional Building Frames" *Publication of IABSE*, Vol. 24, pp.15-30
- King, I.P., Clough, R.W. and Wilson, E.L. (1964) "Structural Analysis of Multistory Buildings" *Journal of the Structural Division*, ASCE, Vol. 90, No. ST3, June, pp. 19-34
- King, I.P. (1965) "Finite Element Analysis of Two-Dimensional Time-Dependent Stress Problems" *Ph.D. Thesis*, University of California, Berkeley, January
- King, I.P. and Brown, C.B. (1966) "Automatic Embankment Analysis: Equilibrium and Instability Conditions" *Geotechnique*, September, pp. 209-219
- King, I.P. and Marcal, P.V. (1967) "Elastic-Plastic Analysis of Two-Dimensional Stress Systems by the Finite Element Method" *International Journal of Mechanical Sciences*, Vol. 9, March, pp. 143-154
- King, I.P., Zienkiewicz, O.C. and Valliappan, S. (1968) "Stress Analysis of Rock as No Tension Material" *Geotechnique*, March, pp. 56-66
- King, I.P., Zienkiewicz, O.C. and Parekh, C. (1968) "Arch Dams Analysed by a Linear Finite Element Shell Solution Program" *Symposium on Arch Dams*, March, pp. 19-22, London
- King, I.P., Cheung, Y.K. and Zienkiewicz, O.C. (1968) "Slab Bridges with Arbitrary Shape and Support Conditions, and General Method of Analysis" *Proceedings of Institution of Civil Engineers*, May, pp. 9-36
- King, I.P., Zienkiewicz, O.C. and Watson, M. (1968) "A Numerical Method of Visco-Elastic Stress Analysis" *International Journal of Mechanical Sciences*, Vol. 10, October, pp. 807-827
- King, I.P., Zienkiewicz, O.C. and Valliappan, S. (1969) "Elasto-Plastic Solutions of Engineering Problems 'Initial Stress', Finite Element Approach" *International Journal for Numerical Methods in Engineering*, Vol. 1, January, pp. 75-100
- King, I.P. (1970) "An Automatic Reordering Scheme for Simultaneous Equations Derived from Network Systems" *International Journal for Numerical Methods in Engineering*, Vol. 2, pp. 523-533
- King, I.P., Filimowski, J. and Kindler, J. (1971) "The Out of Kilter Algorithm as a Single Step Method for Simulation and Optimization of Vistula River Planning Alternatives" *International Symposium on Mathematical Models in Hydrology*, Warsaw, July
- King, I.P. (1971) "The Finite Element Method in Engineering Science" by O.C. Zienkiewicz (Chapter 20), McGraw Hill
- King, I.P. and Guymon, G.L. (1972) "Application of the Finite Element Method to Regional Water Transport Phenomena" *Sparse Matrices and Their Applications*, Edited by Rose, D.J. and Willoughby, R.A. Plenum Press, pp. 115-120
- King, I.P. (1972) "A Computer Program for Analysis of Guyed Transmission Towers" presented at *National Symposium on Computerized Structural Analysis and Design*, Washington, D.C., March

- King, I.P., Orlob, G.T. and Kibler, D.F. (1972) "Development of Mathematical Modelling Capabilities for the Vistula River Project, Poland" *Proceedings of First International Conference on Transfer of Water Resources Knowledge*, Ed. Evan Vlachos, Ft. Collins, CO, September
- King, I.P., Orlob, G.T. and Evenson, D.E. (1972) "Optimal Allocation of Limited Water Resources" *International Symposium on the Planning of Water Resources*, International Association of Hydrologic Sciences in cooperation with Secretariat of Water Resources, Government of Mexico, Mexico City, 4-8 December
- King, I.P. and Norton, W.R. (1975) "Mathematical Simulation to Determine the Effects of Raising an Existing Dam" *Conference on Thermal Pollution Analysis*, Blacksburg, VA, Vol. 36, pp. 53-70
- King, I.P., Norton, W.R. and Iceman, K.R. (1975) "A Finite Element Solution for Two-Dimensional Stratified Flow Problems" *Finite Elements in Fluids*, Chapter 7, Vol. 1, Ed. Gallagher, R.H., Oden, J.T., Taylor, C. and Zienkiewicz, O.C., John Wiley and Sons, pp.133-156
- King, I.P. (1976) "Finite Element Models for Unsteady Flow Routing through Irregular Channels" presented at the *International Conference on Finite Elements in Water Resources*, Princeton University, July
- King, I.P., Baca, R.G. and Norton, W.R. (1978) "Finite Element Models for Simultaneous Heat and Moisture Transport in Unsaturated Soils" *Finite Elements in Water Resources*, Pentech Press, London
- King, I.P., Norton, W.R. and Baca, R.G. (1978) "Finite Element Analysis of Heat, Moisture and Pollutant Transport for Arid Site Vadose Zones" *Interdisciplinary Finite Element Analysis*, proceedings of the U.S.-Japan Seminar, New York
- King, I.P. and Norton, W.R. (1978) "Recent Application of RMA's Finite Element Models for Two Dimensional Hydrodynamics and Water Quality" *Finite Elements in Water Resources*, Pentech Press, London
- King, I.P. (1980) "Finite Element Models for Unsaturated Groundwater Zones" *Finite Elements in Water Resources*, proceedings of the 3rd International Conference on Finite Elements in Water Resources, The University of Mississippi
- King, I.P., Baca, R.G. and Arnett, R.C. (1981) "Numerical Modelling of Flow and Transport Processes in a Fractured Porous Rock System" presented at *22nd Annual Symposium on Rock Mechanics*, Cambridge, MA
- King, I.P. (1982) "A Three Dimensional Finite Element Model for Flow" Proceedings of the *4th International Conference on Finite Elements in Water Resources*, Hannover, West Germany
- King, I.P. (1982) "A Three Dimensional Model for Stratified Flow" Proceedings of the *4th International Symposium on Finite Elements in Flow*, Tokyo, Japan
- King, I.P. (1984) "A Review of Strategies for Finite Element Modelling of Three Dimensional Hydrodynamic Systems" Presented at the *5th International Conference on Finite Elements in Water Resources*, Burlington, Vermont
- King, I.P. (1985) "Finite Element Modelling of Stratified Flow in Estuaries and Reservoirs" *International Journal for Numerical Methods in Fluids*, Vol. 5, pp. 943-955
- King, I.P. (1985) "Strategies for Finite Element Modelling of Three Dimensional Hydrodynamic Systems," *Advanced Water Resources*, Vol. 8, June, pp. 69-76
- King, I.P., Granat, M.A. and Ariathurai, C.R. (1986) "An Inundation Algorithm for Finite Element Hydrodynamic and Sediment Transport Modelling" Proceedings of the *Third International Symposium on River Sedimentation*, Eds. Wang, S.Y., Shen, H.W. and Ding, L.Z., Mississippi, April
- King, I.P. (1986) "Simulation of Sediment Scour in a Stratified Reservoir" *Advancements in Aerodynamics, Fluid Mechanics, and Hydraulics*, proceedings of the Specialty Conference sponsored by the Aerospace Division, Engineering Mechanics Division, and Hydraulics Division of the ASCE, Minnesota, June
- King, I.P., Nour el-din, M.M. and Tanji, K.K. (1987) "Salinity Management Model: I. Development" *Journal of Irrigation and Drainage Engineering*, ASCE, Vol. 113, No. 4, November, pp. 440-453
- King, I.P., Nour el-din, M.M. and Tanji, K.K. (1987) "Salinity Management Model: II. 1- and 2-D Applications" *Journal of Irrigation and Drainage Engineering*, ASCE, Vol. 113, No. 4, November, pp. 454-468
- King, I.P. and Smith, D.J. (1988) "Flow and Quality Simulation of a Proposed Marina Development" *National Conference on Hydraulic Engineering*, Fort Collins CO, August

- King, I.P. and Roig, L.C. (1988) "Two-Dimensional Finite Element Models for Flood Plains and Tidal Flats" *International Conference on Computational Methods in Flow Analysis*, Okayama, Japan, September
- King, I.P. and Rachiele, R.R. (1990) "Multi-Dimensional Modelling of Hydrodynamics and Salinity in San Francisco Bay" *ASCE Conference on Estuarine and Coastal Modelling*, pp. 511-521
- King, I.P. (1990) "Modelling of Flow in Estuaries Using Combination of One and Two-Dimensional Finite Elements" *Hydrosoft*, Vol. 3, No. 3, pp. 108-119
- King, I.P. (1991) "Evaluation of Modelling Parameters for Simulation of Estuarial Systems" *Proceedings of the 2nd ASCE Conference on Estuarine and Coastal Modelling*
- King, I.P. and Roig, L.C. (1991) "Continuum Model for Tidal Flows through Emergent Marsh Vegetation" *2nd Proceedings of the 2nd ASCE Conference on Estuarine and Coastal Modelling*
- King, I.P., Peirson, W.L. and Cathers, B.L. (1993) "Numerical Modelling of Deepwater Plumes at Sydney" *Australian National Conference on Coastal Engineering*
- King, I.P., Shrestha, P.L., Saviz, C.M., Orlob, G.T., Sobey, R.J. and Ford, R.G. (1993) "San Francisco Bay and Delta Oil Spill Fate Studies, Part I Hydrodynamic Simulation" *ASCE National Conference on Hydraulic Engineering*
- King, I.P., Sobey, R.J., Ford, R.G., Shrestha, P.L., Saviz, C.M. and Orlob, G.T. (1993) "San Francisco Bay and Delta Oil Spill Fate Studies, Part II Oil Spill Simulation" *ASCE National Conference on Hydraulic Engineering*
- King, I.P., Peirson, W.L. and Cathers, B.L. (1993) "Three-Dimensional Modelling of the Coastal Region Offshore from Sydney, Australia" *ASCE National Conference on Hydraulic Engineering*
- King, I.P., Shrestha, P.L. and Orlob, G.T. (1993) "Wind Induced Circulation and Contaminant Transport in Shallow Lakes" *ASCE National Conference on Hydraulic Engineering*
- King, I.P. and DeGeorge, J.L. (1994) "A Multi-Dimensional Transport Model Utilising A Characteristic-Galerkin Approach" *Proceedings of the 3rd ASCE Conference on Estuarine and Coastal Modelling*
- King, I.P., Peirson, W.L. and Cathers, B.L. (1994) "Modelling of Deepwater Plumes in the East Australian Coastal Ocean" *Proceedings of the 3rd ASCE Conference on Estuarine and Coastal Modelling*
- King, I.P. and DeGeorge, J.L. (1996) "Multi-Dimensional Modelling of Water Quality Using the Finite Element Method" *Proceedings of the 4th ASCE Conference on Estuarine and Coastal Modelling*
- King, I.P. and Peirson, W.L. (1996) "Coastal Ocean Model Performance in Eastern Australia" *Proceedings of the 4th ASCE Conference on Estuarine and Coastal Modelling*
- King, I.P., Anderson, J.D. and Orlob, G.T. (1996) "Modelling Combined Stresses on Ecosystems" *Proceedings of the ASCE Congress on Water Resources, Global '96, June, Anaheim, California*
- King, I.P., Breithaupt, S.A. and Orlob, G.T. (1996) "Simulation of Perilithic Algae as a Biofilm and Its Interaction with the Water Column" *Proceedings of the ASCE Congress on Water Resources, Global '96, June, Anaheim, California, June*
- King, I.P., Anderson, J.D. and Orlob, G.T. (1997) "Linking Hydrodynamic, Water Quality and Aquatic Ecosystem Response to Stress" *Proceedings of the IAHR Conference - Water for a Changing Global Community, August, San Francisco, California*
- King, I.P., Rozenblit, A. and Wylie, S. (1997) "Mathematical Modelling of the Lower Mary River, NT Australia" *Proceedings of the 13th Australasian Coastal and Ocean Engineering Conference, September, Christchurch, New Zealand*
- King, I.P. and Williams, D.K. (1999) "The Mary River Estuary - A New Approach to Modelling of Marshes and Over-Bank Areas" *Presented at the 6th ASCE Conference on Estuarine and Coastal Modelling, New Orleans*
- King, I.P. (2001) "Modelling of Marshes and Wetlands" *Special Issue No 27. Journal of Coastal Research*

Research reports

- King, I.P., Orlob, G.T. and Kibler, D.F. (1971) "Mathematical Models for Planning the Future Development and Management of the Vistula River System, Poland" Prepared for United Nations Office of Technical Cooperation, New York
- King, I.P., Norton, W.R. and Orlob, G.T. (1973) "A Finite Element Model for Lower Granite Reservoir," Prepared for Walla Walla District, U.S. Army Corps of Engineers, Walla Walla, WA
- King, I.P., Norton, W.R. and Orlob, G.T. (1973) "A Finite Element Solution for Two-Dimensional Density Stratified Flow" Prepared for the U.S. Department of the Interior, Office of Water Resources Research
- King, I.P., Orlob, G.T. and Norton, W.R. (1975) "Mathematical Simulation of Thermal Discharges from Johnsonville Steam Plant" For Tennessee Valley Authority
- King, I.P. and Norton, W.R. (1979) "A Final Report on the Development of a Decay Chain Model for Analysis of Long Term Vadose Zone Radionuclide Storage Tank Leaks" For Rockwell Hanford Operations, Richland, WA
- King, I.P., McLaughlin, D.B., Norton, W.R., Baca, R.G. and Arnett, R.C. (1980) "Parametric and Sensitivity Analysis of Waste Isolation in a Basalt Medium" RHO-BWI-C-94, Rockwell Hanford Operations, Richland, Washington
- King, I.P. and McLaughlin, D.B. (1981) "Analysis of Release Rate Mechanics in a Near Field Repository Zone" Report to Rockwell Hanford Operations, Richland, Washington
- King, I.P. (1988) "A Finite Element Model for Three-Dimensional Hydrodynamic Systems" Report to Waterways Experiment Station, U.S. Army Corps of Engineers, Vicksburg, Mississippi
- King, I.P. (1992) "The Influence of Wind Stresses on Three-Dimensional Circulation in Canal Systems" Report to the Department of Public Works, NSW, Australia