trations. Perhaps unavoidable are the common drawbacks of a multi-author book, such as unbalances and repetitions. The southern oscillation/monsoon relation, for example, is discussed by not less than five authors, while a systematic discussion of the two-way interaction of monsoons and oceans is missing. The monsoon trough is mentioned by many authors without definition for the broad readership the book addresses; it finally is explained on page 558. In general the headings of the chapters promise more than they contain, a consequence of the overwhelming focus on the Indian summer monsoon. For future editions, one would like to see a good geographical map of the monsoon areas inserted at the beginning of the book. The printing and figures in the book are generally excellent. Only a few minor printing errors were found. Unfortunately the price is a little on the high side for a private citizen.

The editors, authors, and publishers are to be congratulated for this remarkable and timely book which is highly recommended to a broad readership.—*Joachim P. Kuettner*

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Boundary Elements IX, Vols. 1–3. C. A. Brebbia, W. L. Wendland, and G. Kuhn, Eds. Vol. 1, 607 pp. Vol. 2, 641 pp. Vol. 3, 642 pp. $237.00 ($79.00 each). Hardbound. Computational Mechanics and Springer-Verlag.

This three-volume edition contains edited versions of 128 papers presented at the 9th International Conference on Boundary Elements held at the University of Stuttgart, Germany, from 31 August to 4 September 1987. The conference series is devoted to a review of the latest developments in the technique and theory of the boundary element methods (BEM) with emphasis on new advances and trends. This particular meeting was to be devoted to "the engineering aspects versus mathematical formulations, in an effort to consolidate the basis of many new applications." Whether this goal was achieved is necessarily going to be determined by whether the reader has the mathematical ability to digest and interpret the several papers that address the mathematical bases of some of the newer applications. Each volume is divided into six to eight sections of related papers. One or two invited papers lead off most of the sections, followed by three to five contributed papers touching on both mathematical theory and applications of boundary elements. The references at the end of each contribution, when summed together, represent a substantial compilation of related literature representing a diversity of languages.

In volume 1, an informative history of the BEM and its various forms is the subject of the opening address by C. E. Massonnet and P. Morelle entitled "Origins of the Boundary Element Method and its Variants." The history of some of the important early work in the field is cited, starting with the first uses of the indirect approach and concluding with the more recently developed and powerful direct approach. A basic discussion of the differences and similarities between the direct and indirect approaches is presented and would be worthwhile reading for the novice or those unfamiliar with the basics of the method. Conspicuously absent, however, from the chronology of the direct approach is any reference to the early work of Rizzo (1967), although the class notes of his former student T. Cruse are cited.

As might be expected, the nine papers in the section entitled "Mathematical Aspects" are purely mathematical, such as that by Makarov and Khlobystov on the identification and application of non-linear operators, and the Ortner paper on methods of construction of fundamental solutions of decomposable linear differential operators. Immediate conclusions, consequences, and implications of the nine papers in this section are hard to find, and whether they help to "consolidate the basis of new applications" is questionable, although some may be important contributions.

The six papers in the section "Convergence and Error Estimates" also are highly mathematical and likely to be of interest only to mathematicians. Notable in this section is a well-written paper by Hsiao, replete with references, on stability of the BEM. He addresses the stability and convergence rate of integral equations of the first kind and provides an optimal grid refinement parameter that accounts for round-off error. This work should be of interest to those concerned with mesh optimization in the indirect method.

The title "Numerical Aspects" is given to a section covering nine papers with the loosely common theme of adaptive methods. The invited paper of E. Rank gives an overview of the state of affairs for adaptive techniques as applied to the BEM. The direct boundary element formulation of the BEM for the potential problem (Laplace's equation) with the usual collocation procedure is used to demonstrate the h-method (mesh refinement), p-method (polynomial order of shape functions), and combined hp-method. An adaptive algorithm with associated error measure, borrowed from the finite element method, is given and applied to two example problems. The numerical results show exponential convergence for the hp-method, even in the presence of weak singularities on the boundary. Two other papers in this section are devoted to adaptive methods.

The second invited paper in this section by R. P. Shaw et al. concerns the BEM and so-called T-matrix method in the context of wave-scattering problems. A review of the T-matrix method is given and may be of interest to anyone seeking an introduction. The paper deals with the fictitious eigenfrequency problem associated with integral formulations of time harmonic scattering problems in exterior domains, and contrasts the two numerical problems methods near such critical frequencies.

A novel, although poorly written, paper in this section is that of Fengsheng and Jiaqi on fundamental solutions, wherein a matrix method is developed to determine fundamental solutions as may be required by the BEM. A numerical example is given for a one-dimensional problem, and the algorithm is laid out for a two-dimensional elliptic operator. This could be an important ingredient for BEM formulations for nonhomogeneous problems where fundamental solutions have been impossible to obtain. The final paper, by Ortiz et al., shows a development of the Overhauser splines as used in interpolation on boundary elements in both two and three dimensions, and would be valuable material for those developing specialized elements where interelement continuity is required.

A section on coupling BEM with finite-element methods contains four papers, all of which are fairly mathematical in nature, with the exception of Du, Yao, and Cen's paper on this coupling for elastostatics, plate-bending, and the fluid-solid interaction problem. Both displacement based and hybrid/mixed finite elements are interfaced with BEM equations, and a practical example for a three-dimensional elastostatic problem is given. Some of the theoretical aspects of the coupling, such as symmetry and convergence, are discussed in Costabel's paper, and Grannell gives a "simplified" hybrid formulation for coupling with indirect methods.

The sophisticated mathematics carries on into the section entitled "Computational Aspects," especially in the invited paper by Hackbusch on the panel clustering technique, and that by Schippers on multigrid methods. The latter paper deals with the solution of the algebraic equations required in the BEM, especially for large systems. A multi-grid (different boundary discretizations) integration scheme is advocated for the solution of large degree-of-freedom problems. Numerical experiments were made for potential flow about an airfoil to confirm the accelerated convergence rate of the method. Two other papers in this section are concerned with the solution of the systems of BEM equations, while the final paper, by Mitra and Ingber, addresses the well-known problem of corners and discontinuous boundary data.

Their solution, as implemented and illustrated through examples for the potential problem and the biharmonic equation, is a variation of the double-node concept, where all distinct variables are retained at corners or points of discontinuous data, but additional collocation points are chosen outside the region to supplement the usual boundary collocation equations.

The final section of volume 1 is devoted to BEM software. The two commercially available programs, BETSY and BEASY, are demonstrated in papers by Schneider, et al. and Brebbia and Adey, respectively. Both of these programs are devoted to structural-type problems of linear elasticity, including thermal-analysis capabilities. Hartmann discusses the use of BEM programs on PC's, and Katz presents a rather interesting commentary on BEM programs and programming entitled "Murphy's Law in Boundary Element Implementations." He points out some common errors associated with BEM programming and gives some good advice for would-be BEM programmers. It is light, comical, and sometimes pointed reading. Two other programs, one for viscous and thermal fluid-flow problems and DBETSY, an offspring of the aforementioned BETSY, also are presented.

Volume 2 of the series is devoted almost entirely to applications and will be of considerably more interest to practitioners and engineers. The "Plates and Shells" section contains eight papers on various topics such as BEM implementation of Reissner's plate theory, written by one of the editors (Brebbia), specialized Green's functions for rectangular plates, and for the biharmonic equation in static and dynamic plate analysis. Shear deformation of shallow spherical shells, in-plane and transverse loads, forced vibrations, and the use of spline elements also are covered.

The "Stress Analysis" section also is of a very applied flavor. A new idea for eliminating the inaccuracy involved in determination of near-boundary stresses is given in a paper by Guang-xian and Hong. Although poorly written, their idea is to use both the constant (rigid) and linear-displacement field solutions to eliminate the strong singularities in the interior stress representation to arrive at an interior formula that does not degrade in accuracy at points near, or on, the boundary. This approach, to our knowledge, is new and could have implications in other contexts.

Under "Fracture Mechanics," the BEM is used to determine stress intensity factors in both two- and three-dimensional elastostatic problems, and the contribution of Nishimura et al. uses the BEM for time harmonic scattering from cracks in two dimensions. The interesting aspect of this paper is that the integrals required to determine the crack opening displacement in the frequency domain involve strongly singular kernels that must be evaluated in the sense of a finite part integral. The regularization procedure used to evaluate these integrals would be of interest to other researchers of scattering problems.

Elastoplasticity is the predominant theme of the papers in the NonLinear Mechanics section. Theoretical aspects of formulating the elastoplastic rate problem to determine a symmetric-definite BEM equation from variational principles is examined by Polizzotto, and a direct time-marching scheme is used by Kontonti and Beskos for inelastic and viscoelastic problems. Thermal and large deformation effects are included in the paper by Potrc et al. Only three papers are given in each of the sections on "Contact Problems" and "Shape Optimization and Design Sensitivity", wherein the BEM generally is used in an iterative mode with updated boundary shape for each iteration. Friction models are included in two of the papers devoted to contact problems.

Atmospheric scientists may be particularly interested in the paper by Gavze on "The Fluid Dynamic Force on a Particle Near a Plane Wall with a Hole" in the "Interaction of Structures and Fluids" section. Therein, the motion of a particle in the vicinity of a pore is modeled by the BEM by assuming low Reynolds numbers and Stokes flow. The use of the fundamental solution for a half space alleviates any need to discretize the plane wall and reduces the model to just the rigid particle and the hole or pore. The intent here is to model aerosol sampling or filtration by a multipore layer.

A section on "Applications of the BEM" concludes Volume 2. The variety of problems addressed here gives evidence of the growing popularity and usefulness of the BEM as an analysis tool. Problems range from human inhalation modeling, lubrication and bearing hydrodynamics, slope stability in soils, and foundation response on irregular topology, to simulation of animal propulsion in a fluid.

Volume 3 addresses the topics of acoustics, dynamic problems, heat transfer and diffusion, porous media flow, fluid mechanics, aerodynamics, and electromagnetic problems. The first invited paper in the "Acoustics" section presents a method for approximate solutions to the inverse acoustic-scattering problem by reformulating it as a nonlinear optimization problem. The mathematical aspects of the problem, including the ill-posedness, nonlinearity, convergence, and uniqueness, are addressed through a series of theorems and proofs. Some numerical examples are given. The second and third papers discuss the structural-acoustic coupling problem. The acoustic and structure problems are considered separately and then combined by means of the finite-element method. Applications to an acoustic cavity and a plane wave hitting an elastic membrane are given. Additional papers focus on underwater scattering problems (also considered as a coupled structure-vibration system) and the computation of scattering frequencies for a resonator.

The "Dynamic Problems" section is led off with an invited paper that applies the BEM to the Laplace-transformed problem for time-dependent applications and includes an extensive mathematical analysis of error. The next paper surveys the boundary integral equations for the transient scattering problem and asserts that they should be considered space-time integro-differential equations to be analyzed in a space-time functional framework. A discussion of a combination of BEM and perturbation theory for application to certain hyperbolic and parabolic problems is presented in one of the more readable contributions in this volume. Also included under dynamical problems are an application of the BEM to the study of surface and internal waves in two-fluid layers, elastodynamic inclusion, half-plane wave propagation, fluid-sloshing problems, and dynamic soil-structure interaction problems where the soil is considered of semi-infinite extent.

The "Heat Transfer and Diffusion" section, despite the name, has few contributions applicable to geophysical problems. The first paper is an invited paper that sets out the mathematical framework and establishes the well-posedness of the heat-potential operator equation as a prototype of the BEM application to boundary value problems for parabolic differential equations. The second paper establishes the stability and convergence of the Galerkin method for the Neumann problem in three dimensions. Contributed papers describe uses of BEM to solve the heat-transfer problem for a source of heat moving on a surface, and present a convergence analysis for engineering problems in radiative heat transfer. Other issues addressed include improved methods for evaluating the volume integral over initial conditions for the BEM formulation of the transient heat-conduction problem, thermal modeling of the components in micro-electronic circuits, the use of BEM in a self-adaptive grid for phase changes in nonlinear time-dependent radial heat flow, three-dimension convection-diffusion, and neutron diffusion.

The section on "Porous Media" is more applications-oriented and brings us back closer to geophysical problems. The first paper presents a new method that avoids solution oscillations without smoothing in the BEM for computation of the transient seepage problem in anisotropic porous media. The problem of salt groundwater invasion is addressed by use of coupled integral equations in the BEM and by weighted finite difference method for comparison. Additional papers present a solution of Darcy's flow with variable permeability by combining the BEM with perturbation theory and an analysis of seepage through embankments by use of the BEM formulation for zoned porous media with free surfaces.

The first invited paper in the "Fluid Mechanics" section reviews applications of BEM to a three-dimensional flow field in the acoustic-wave approximation and to dynamic vortex flow. In the latter problem the BEM has a computational advantage in that the entire solution can be confined to the vortical region. The second invited contribution

describes the application of the BEM to solve the Boussinesq equations for the thermally driven cavity and the heated rotating annulus. The contributed papers describe the BEM representation of viscous, incompressible fluid flow at low Reynold's numbers; a use of BEM combined with a spectral solver and characteristics (to handle the advective terms); flow over a series of like shapes; buoyancy-driven viscous, incompressible flow with applications to the downwind facing step and driven cavity; turbulent flow past a step; and coupling the integral equation for potential flow with the boundary-layer equation on a prolate spheroid.

The "Aerodynamics" section is led off with an invited paper that gives a discussion of panel methods, which are widely used for analysis of the flow field around complex configurations such as a complete aircraft. Some interesting examples are shown and a large number of references are included. The second invited paper gives an overview of the use of conformal transformations in the BEM and comparison to panel methods. The author points out that conformal transformation uses more convenient vortex sheets to approximate the vorticity distribution of the real flow, rather than source/sink panels as required in the panel method. Two papers addressing transonic flow probably are of limited interest to geophysical modelers. The final paper focuses on the problem of vibrations of a pneumatic structure. With the increased use of such structures (e.g., domed stadia) and their being subjected to a wide range of atmospheric conditions (they are only used in areas having adverse weather conditions!), consulting meteorologists might find this paper to be one for their reference files.

In the section on electromagnetic problems, the first paper suggests that BEM may be useful in the study of the asymptotic properties of solutions of the wave equation. With the recent interest in the theory of chaos, this paper might be useful to researchers studying chaotic behavior of physical systems. The final papers of the volume consider topics in electrical engineering, levitation in electromagnetic fields, and eddy current problems, and are probably of limited interest to meteorologists.

Immediately obvious, from the opening paper and through the three volumes, is that the English is often very broken. Admittedly, most of the contributions are non-native speakers of English, and the technical content is usually clear, but editors should be more attentive to this problem. Some papers are presented in an elegant style, whereas others have a very amateurish appearance due to use of hand-written equations, poor reproduction due to the use of a dot-matrix printer, or type-size reduction to the point of requiring a microscope.

A new set of volumes in this series comes out every year, so it should not be expected that this particular three-volume set would contain all new material—and it doesn't. Nor does it have a large number of papers directly related to atmospheric problems. Its use in the atmospheric sciences is for the person looking for a new way to solve an existing problem. A wide variety of applications in other fields may suggest an adaptation to atmospheric problems. In this regard, one or more of the volumes may be a useful reference but probably does not merit purchase by individual atmospheric scientists.—*Thomas J. Rudolphi* and *Eugene S. Takle.*

Thomas J. Rudolphi is associate professor of engineering science and mechanics at Iowa State University, and Eugene S. Takle is professor of meteorology and agricultural climatology at Iowa State University.

Reference

Rizzo, F. J., 1967: "An integral equation approach to boundary value problems of classical elastostatics." *Quart. of Appl. Math.*, **25**, 83–95. ●

new publications

Expert Systems for Software Engineers and Managers (S. D. Hu, 1988, 295 pp., $57.50, hardbound, Chapman & Hall). This book intends to help software designers, engineers, and managers introduce expert systems into their products. In contrast to conventional procedural languages such as Fortran or C, expert systems use high-level programming languages which allow the user to tap into the judgmental knowledge of experts such as doctors, lawyers, bankers, or geologists.

This book explores various aspects of expert system development and provides computer professionals with the capability of employing expert system technology in software development. The author defines and gives an overview of expert systems, describes the basics of expert system technology, and details the skills, knowledge, and tools that software engineers and managers will need to have. He also describes major applications of expert systems to conventional business software packages.

In addition, the author gives practical advice on how to introduce expert system development within the corporate structure and shows how integrating expert systems can increase cost-effectiveness.

Exploiting Remotely Sensed Imagery (K. A. Browning, B. J. Conway, J.-P. A. L. Muller, and D. J. Stanley, Eds., 1988, 176 pp., £48, hardbound, The Royal Society). The papers in this volume, the report of a Royal Society Discussion Meeting held in March 1987, address the new challenges created by using image data in practical applications. Ways of using interactive display systems and special computer architectures for demanding tasks are described, and the problems of incorporating image data into geographic information systems are examined. The second half of the book discusses those emerging techniques which may allow some of the very difficult recognition and analysis tasks to be automated.

Groundwater Flow and Quality Modelling (E. Custodio, A. Gurgui, and J. P. Lobo Ferreira, Eds., 1988, 843 pp., $149.00, hardbound, D. Reidel Publishing Co.). This book contains the proceedings of a NATO Advanced Research Workshop held within the program of activities of the NATO Special Programme on Global Transport Mechanisms in the Geosciences, running from 1983 to 1988, as part of the activities of the NATO Science Committee. Topics covered include principles, basic equations, and analytical solutions; modeling flow and transport in porous-like media; modeling flow and transport in fractured media; consideration of fluid-solid phase interactions and heterogeneities in modeling; multiphase flow and transport modeling; aquifer parameter identification by models; and data gathering and utilization of models. It also includes conclusions, a subject index, an author index, and a list of participants.

Preparing for Climate Change (The Climate Institute, 1988, 516 pp., $74.00 plus $3.00 shipping and handling, paperbound, Government Insitutes, Inc.). This volume contains the proceedings of the First North American Conference on Preparing for Climate Change, held in Washington, D.C., by the Climate Institute. It presents 69 national and international authorities