

Numerical Simulation In Fluid Dynamics A Practical Introduction Monographs On Mathematical Modeling And Computation

The numerical simulation of the Euler equations of Fluid Dynamics has been these past few years a challenging problem both for research scientists and aerospace engineers. The increasing interest of more realistic models such as the Euler equations originates in Aerodynamics and also Aerothermics where aerospace applications such as military aircrafts and also space vehicles require accurate and efficient Euler solvers (which can be extended to more complicated modelisations including non-equilibrium chemistry) for supersonic and hypersonic flows at high angles of attack and Mach number regimes involving strong shocks and vorticity. This book contains the proceedings of the GAMM Workshop on the Numerical Simulation of Compressible Euler Flows, that W:LS held at INRIA, Rocquencourt (France), on June 10-13, 1986. The purpose of this event was to compare in terms of accuracy and efficiency several codes for solving compressible inviscid, mainly steady, Euler flows. This workshop was a sequel of the GAMM workshop held in 1979 in Stockholm; this time, though, because of the present strong activity in numerical methods for the Euler equations, the full-potential approach was not included. Since 1979, other Euler workshops have been organised, several of them focussed on airfoil calculations; however, many recently derived methods were not presented at these workshops, because, among other reasons, the methods were not far enough developed, or had not been applied to flow problems of sufficient complexity. In fact, the 1986 GAMM workshop scored very high as regards to the novelty of methods.

This informal introduction to computational fluid dynamics and practical guide to numerical simulation of transport phenomena covers the derivation of the governing equations, construction of finite element approximations, and qualitative properties of numerical solutions, among other topics. To make the book accessible to readers with diverse interests and backgrounds, the authors begin at a basic level and advance to numerical tools for increasingly difficult flow problems, emphasizing practical implementation rather than mathematical theory. *Finite Element Methods for Computational Fluid Dynamics: A Practical Guide* explains the basics of the finite element method (FEM) in the context of simple model problems, illustrated by numerical examples. It comprehensively reviews stabilization techniques for convection-dominated transport problems, introducing the reader to streamline diffusion methods, Petrov-Galerkin approximations, Taylor-Galerkin schemes, flux-corrected transport algorithms, and other nonlinear high-resolution schemes, and covers Petrov-Galerkin stabilization, classical projection schemes, Schur complement solvers, and the implementation of the k-epsilon turbulence model in its presentation of the FEM for incompressible flow problem. The book also describes the open-source finite element library ELMER, which is recommended as a software development kit for advanced applications in an online component.

This book will interest researchers, scientists, engineers and graduate students in many disciplines, who make use of mathematical modeling and computer simulation. Although it represents only a small sample of the research activity on numerical simulations, the book will certainly serve as a valuable tool for researchers interested in getting involved in this multidisciplinary field. It will be useful to encourage further experimental and theoretical researches in the above mentioned areas of numerical simulation.

The GAMM-Committee for Numerical Methods in Fluid Mechanics (GAMM-Fachausschuss für Numerische Methoden in der Strömungsmechanik) has sponsored the organization of a GAMM Workshop dedicated to the numerical simulation of three dimensional incompressible unsteady viscous laminar flows to test Navier-Stokes solvers. The Workshop was held in Paris from June 12th to June 14th, 1991 at the Ecole Nationale Supérieure des Arts et Métiers. Two test problems were set up. The first one is the flow in a driven-lid parallelepipedic cavity at $Re = 3200$. The second problem is a flow around a prolate spheroid at incidence. These problems are challenging as fully transient solutions are expected to show up. The difficulties for meaningful calculations come from both space and temporal discretizations which have to be sufficiently accurate to resolve detailed structures like Taylor-Görtler-like vortices and the appropriate time development. Several research teams from academia and industry tackled the tests using different formulations (velocity-pressure, vorticity velocity), different numerical methods (finite differences, finite volumes, finite elements), various solution algorithms (splitting, coupled ...), various solvers (direct, iterative, semi-iterative) with preconditioners or other numerical speed-up procedures. The results show some scatter and achieve different levels of efficiency. The Workshop was attended by about 25 scientists and drove much interaction between the participants. The contributions in these proceedings are presented in alphabetical order according to the first author, first for the cavity problem and then for the prolate spheroid problem. No definite conclusions about benchmark solutions can be drawn.

Numerical Simulation in Micropolar Fluid Dynamics presents a detailed study of various multi-physical flow problems of micropolar non-Newtonian fluids. A comprehensive overview of modern micropolar fluid mechanics and applications is provided. A number of powerful numerical methods including finite element methods, homotopy analysis methods, network simulation and differential transform methods are then applied to specific steady flow scenarios. Magnetohydrodynamic, double-diffusive convection, magneto-tribological, stagnation point, chemically-reacting and enclosure flows are all studied. Extensive details of numerical analysis are provided. It is hoped that this monograph will stimulate further research in related fields.

This book deals with the simulation of the incompressible Navier-Stokes equations for laminar and turbulent flows. The book is limited to explaining and employing the finite difference method. It furnishes a large number of source codes which permit to play with the Navier-Stokes equations and to understand the complex physics related to fluid mechanics. Numerical simulations are useful tools to understand the complexity of the flows, which often is difficult to derive from laboratory experiments. This book, then, can be

very useful to scholars doing laboratory experiments, since they often do not have extra time to study the large variety of numerical methods; furthermore they cannot spend more time in transferring one of the methods into a computer language. By means of numerical simulations, for example, insights into the vorticity field can be obtained which are difficult to obtain by measurements. This book can be used by graduate as well as undergraduate students while reading books on theoretical fluid mechanics; it teaches how to simulate the dynamics of flow fields on personal computers. This will provide a better way of understanding the theory. Two chapters on Large Eddy Simulations have been included, since this is a methodology that in the near future will allow more universal turbulence models for practical applications. The direct simulation of the Navier-Stokes equations (DNS) is simple by finite-differences, that are satisfactory to reproduce the dynamics of turbulent flows. A large part of the book is devoted to the study of homogeneous and wall turbulent flows. In the second chapter the elementary concept of finite difference is given to solve parabolic and elliptical partial differential equations. In successive chapters the 1D, 2D, and 3D Navier-Stokes equations are solved in Cartesian and cylindrical coordinates. Finally, Large Eddy Simulations are performed to check the importance of the subgrid scale models. Results for turbulent and laminar flows are discussed, with particular emphasis on vortex dynamics. This volume will be of interest to graduate students and researchers wanting to compare experiments and numerical simulations, and to workers in the mechanical and aeronautic industries.

Nowadays mathematical modeling and numerical simulations play an important role in life and natural science. Numerous researchers are working in developing different methods and techniques to help understand the behavior of very complex systems, from the brain activity with real importance in medicine to the turbulent flows with important applications in physics and engineering. This book presents an overview of some models, methods, and numerical computations that are useful for the applied research scientists and mathematicians, fluid tech engineers, and postgraduate students.

Numerical Simulation in Fluid Dynamics A Practical Introduction SIAM

Modelling and Simulation of Reactive Flows presents information on modeling and how to numerically solve reactive flows. The book offers a distinctive approach that combines diffusion flames and geochemical flow problems, providing users with a comprehensive resource that bridges the gap for scientists, engineers, and the industry. Specifically, the book looks at the basic concepts related to reaction rates, chemical kinetics, and the development of reduced kinetic mechanisms. It considers the most common methods used in practical situations, along with equations for reactive flows, and various techniques—including flamelet, ILDM, and Redim—for jet flames and plumes, with solutions for both. In addition, the book includes techniques to accelerate the convergence of numerical simulation, and a discussion on the analysis of uncertainties with numerical results, making this a useful reference for anyone who is interested in both combustion in free flow and in porous media. Helps readers learn how to apply applications of numerical methods to simulate geochemical kinetics Presents methods on how to transform the transport equations in several coordinate systems Includes discussions of the basic concepts related to reaction rates, chemical kinetics, and the development of reduced kinetic mechanisms, including the most common methods used in practical situations Offers a distinctive approach that combines diffusion flames and geochemical flow problems

Ready access to computers has defined a new era in teaching and learning. The opportunity to extend the subject matter of traditional science and engineering curricula into the realm of scientific computing has become not only desirable, but also necessary. Thanks to portability and low overhead and operating cost, experimentation by numerical simulation has become a viable substitute, and occasionally the only alternative, to physical experimentation. The new framework has necessitated the writing of texts and monographs from a modern perspective that incorporates numerical and computer programming aspects as an integral part of the discourse. Under this modern directive, methods, concepts, and ideas are presented in a unified fashion that motivates and underlines the urgency of the new elements, but neither compromises nor oversimplifies the rigor of the classical approach. Interfacing fundamental concepts and practical methods of scientific computing can be implemented on different levels. In one approach, theory and implementation are kept complementary and presented in a sequential fashion. In another approach, the coupling involves deriving computational methods and simulation algorithms, and translating equations into computer code instructions immediately following problem formulations. Seamlessly interjecting methods of scientific computing in the traditional discourse offers a powerful venue for developing analytical skills and obtaining physical insight.

This volume presents a selection of survey and research articles based on invited lectures and contributed talks presented at the Workshop on Fluid Dynamics in Porous Media that was held in Coimbra, Portugal, in September 12-14, 2011. The contributions are devoted to mathematical modeling, numerical simulation and their applications, providing the readers a state-of-the-art overview on the latest findings and new challenges on the topic. The book includes research work of worldwide recognized leaders in their respective fields and presents advances in both theory and applications, making it appealing to a vast range of audience, in particular mathematicians, engineers and physicists.

With the advent of super computers during the last ten years, the numerical simulation of viscous fluid flows modeled by the Navier-Stokes equations is becoming a most useful tool in Aircraft and Engine Design. In fact, compressible Navier-Stokes solvers tend to constitute the basic tools for many industrial applications occurring in the simulation of very complex turbulent and combustion phenomena. In Aerospace Engineering, as an example, their mathematical modelization requires reliable and robust methods for solving very stiff non linear partial differential equations. For the above reasons, it was clear that a workshop on this topic would be of interest for the CFD community in order to compare accuracy and efficiency of Navier-Stokes solvers on selected external and internal flow problems using different numerical approaches. The workshop was held on 4-6 December 1985 at Nice, France and organized by INRIA with the sponsorship of the GAMM Committee on Numerical Methods in Fluid Mechanics. Accurately predicting the behaviour of multiphase flows is a problem of immense industrial and scientific interest. Modern computers can now study the dynamics in great detail and these simulations yield unprecedented insight. This book provides a comprehensive introduction to direct numerical simulations of multiphase flows for researchers and graduate students. After a brief overview of the context and history the authors review the governing equations. A particular emphasis is placed on the 'one-fluid' formulation where a single set of equations is used to describe the entire flow field and interface terms are included as singularity distributions. Several applications are discussed, showing how direct numerical simulations have helped researchers advance both our understanding and our ability to make predictions. The final chapter gives an overview of recent studies of flows with relatively complex physics, such as mass transfer and chemical reactions, solidification and boiling, and includes extensive references to current work.

Reactive flows encompass a broad range of physical phenomena, interacting over many different time and space scales. Such flows occur in combustion, chemical lasers, the earth's oceans and atmosphere, and in stars. Because of a similarity in their descriptive equations, procedures for constructing numerical models of these systems are also similar, and these similarities can be exploited. Moreover, using the

latest technology, what were once difficult and expensive computations can now be done on desktop computers. This new edition of a highly successful book presents algorithms useful for reactive flow simulations, describes trade-offs involved in their use, and gives guidance for building and using models of complex reactive flows. It takes account of the explosive growth in computer technology and the greatly increased capacity for solving complex reactive-flow problems that has occurred since the previous edition was published more than fifteen years ago. An indispensable guide on how to construct, use, and interpret numerical simulations of reactive flows, this book will be welcomed by advanced undergraduate and graduate students, and a wide range of researchers and practitioners in engineering, physics, and chemistry.

In this translation of the German edition, the authors provide insight into the numerical simulation of fluid flow. Using a simple numerical method as an expository example, the individual steps of scientific computing are presented: the derivation of the mathematical model; the discretization of the model equations; the development of algorithms; parallelization; and visualization of the computed data. In addition to the treatment of the basic equations for modeling laminar, transient flow of viscous, incompressible fluids - the Navier-Stokes equations - the authors look at the simulation of free surface flows; energy and chemical transport; and turbulence. Readers are enabled to write their own flow simulation program from scratch. The variety of applications is shown in several simulation results, including 92 black-and-white and 18 color illustrations. After reading this book, readers should be able to understand more enhanced algorithms of computational fluid dynamics and apply their new knowledge to other scientific fields.

Large Eddy Simulation (LES) is a high-fidelity approach to the numerical simulation of turbulent flows. Recent developments have shown LES to be able to predict aerodynamic noise generation and propagation as well as the turbulent flow, by means of either a hybrid or a direct approach. This book is based on the results of two French/German research groups working on LES simulations in complex geometries and noise generation in turbulent flows. The results provide insights into modern prediction approaches for turbulent flows and noise generation mechanisms as well as their use for novel noise reduction concepts.

This book gathers contributions to the 21st biannual symposium of the German Aerospace Aerodynamics Association (STAB) and the German Society for Aeronautics and Astronautics (DGLR). The individual chapters reflect ongoing research conducted by the STAB members in the field of numerical and experimental fluid mechanics and aerodynamics, mainly for (but not limited to) aerospace applications, and cover both nationally and EC-funded projects. Special emphasis is given to collaborative research projects conducted by German scientists and engineers from universities, research-establishments and industries. By addressing a number of cutting-edge applications, together with the relevant physical and mathematics fundamentals, the book provides readers with a comprehensive overview of the current research work in the field. The book's primary emphasis is on aerodynamic research in aeronautics and astronautics, and in ground transportation and energy as well.

This textbook presents numerical solution techniques for incompressible turbulent flows that occur in a variety of scientific and engineering settings including aerodynamics of ground-based vehicles and low-speed aircraft, fluid flows in energy systems, atmospheric flows, and biological flows. This book encompasses fluid mechanics, partial differential equations, numerical methods, and turbulence models, and emphasizes the foundation on how the governing partial differential equations for incompressible fluid flow can be solved numerically in an accurate and efficient manner. Extensive discussions on incompressible flow solvers and turbulence modeling are also offered. This text is an ideal instructional resource and reference for students, research scientists, and professional engineers interested in analyzing fluid flows using numerical simulations for fundamental research and industrial applications.

Exploring new variations of classical methods as well as recent approaches appearing in the field, Computational Fluid Dynamics demonstrates the extensive use of numerical techniques and mathematical models in fluid mechanics. It presents various numerical methods, including finite volume, finite difference, finite element, spectral, smoothed particle hydrodynamics (SPH), mixed-element-volume, and free surface flow. Taking a unified point of view, the book first introduces the basis of finite volume, weighted residual, and spectral approaches. The contributors present the SPH method, a novel approach of computational fluid dynamics based on the mesh-free technique, and then improve the method using an arbitrary Lagrange Euler (ALE) formalism. They also explain how to improve the accuracy of the mesh-free integration procedure, with special emphasis on the finite volume particle method (FVPM). After describing numerical algorithms for compressible computational fluid dynamics, the text discusses the prediction of turbulent complex flows in environmental and engineering problems. The last chapter explores the modeling and numerical simulation of free surface flows, including future behaviors of glaciers. The diverse applications discussed in this book illustrate the importance of numerical methods in fluid mechanics. With research continually evolving in the field, there is no doubt that new techniques and tools will emerge to offer greater accuracy and speed in solving and analyzing even more fluid flow problems.

This volume continues previous DLES proceedings books, presenting modern developments in turbulent flow research. It is comprehensive in its coverage of numerical and modeling techniques for fluid mechanics. After Surrey in 1994, Grenoble in 1996, Cambridge in 1999, Enschede in 2001, Munich in 2003, Poitiers in 2005, and Trieste in 2009, the 8th workshop, DLES8, was held in Eindhoven, The Netherlands, again under the auspices of ERCOFTAC. Following the spirit of the series, the goal of this workshop is to establish a state-of-the-art of DNS and LES techniques for the computation and modeling of transitional/turbulent flows covering a broad scope of topics such as aerodynamics, acoustics, combustion, multiphase flows, environment, geophysics and bio-medical applications. This gathering of specialists in the field was a unique opportunity for discussions about the more recent advances in the prediction, understanding and control of turbulent flows in academic or industrial situations.

Computational Fluid Dynamics (CFD) is an important design tool in engineering and also a substantial research tool in various physical sciences as well as in biology. The objective of this book is to provide university students with a solid foundation for understanding the numerical methods employed in today's CFD and to familiarise them with modern CFD codes by hands-on experience. It is also intended for engineers and scientists starting to work in the field of CFD or for those who apply CFD codes. Due to the detailed index, the text can serve as a reference handbook too. Each chapter includes an extensive bibliography, which provides an excellent basis for further studies.

Ready access to computers at an institutional and personal level has defined a new era in teaching and learning. The opportunity to extend the subject matter of traditional science and engineering disciplines into the realm of scientific computing has become not only desirable, but also necessary. Thanks to port ability and low overhead and operating costs, experimentation by numerical simulation has become a viable substitute, and occasionally the only alternative, to physical experiment at ion. The new environment has motivated the writing of texts and monographs with a modern perspective that incorporates numerical and computer programming aspects as an integral part of the curriculum: methods, concepts, and ideas should be presented in a unified fashion that motivates and underlines the urgency of the new elements, but does not compromise the rigor of the classical approach and does not oversimplify. Interfacing fundamental concepts and practical methods of scientific computing can be done on different levels. In one approach, theory and implementation are kept complementary and presented in a sequential fashion. In a second approach, the coupling involves deriving computational methods and simulation algorithms, and translating equations into computer code instructions

immediately following problem formulations. The author of this book is a proponent of the second approach and advocates its adoption as a means of enhancing learning: interjecting methods of scientific computing into the traditional discourse offers a powerful venue for developing analytical skills and obtaining physical insight.

Computational mechanics is a scientific discipline that marries physics, computers, and mathematics to emulate natural physical phenomena. It is a technology that allows scientists to study and predict the performance of various products--important for research and development in the industrialized world. This book describes current trends and future research directions in computational mechanics in areas where gaps exist in current knowledge and where major advances are crucial to continued technological developments in the United States.

The book gives the reader the basis for understanding the way numerical schemes achieve accurate and stable simulations of physical phenomena. It is based on the finite-difference method and simple problems that allow also the analytic solutions to be worked out. ODEs as well as hyperbolic, parabolic and elliptic types are treated. The book builds on simple model equations and, pedagogically, on a host of problems given together with their solutions.

Compared to the traditional modeling of computational fluid dynamics, direct numerical simulation (DNS) and large-eddy simulation (LES) provide a very detailed solution of the flow field by offering enhanced capability in predicting the unsteady features of the flow field. In many cases, DNS can obtain results that are impossible using any other means while LES can be employed as an advanced tool for practical applications. Focusing on the numerical needs arising from the applications of DNS and LES, *Numerical Techniques for Direct and Large-Eddy Simulations* covers basic techniques for DNS and LES that can be applied to practical problems of flow, turbulence, and combustion. After introducing Navier–Stokes equations and the methodologies of DNS and LES, the book discusses boundary conditions for DNS and LES, along with time integration methods. It then describes the numerical techniques used in the DNS of incompressible and compressible flows. The book also presents LES techniques for simulating incompressible and compressible flows. The final chapter explores current challenges in DNS and LES. Helping readers understand the vast amount of literature in the field, this book explains how to apply relevant numerical techniques for practical computational fluid dynamics simulations and implement these methods in fluid dynamics computer programs.

This volume collects the contributions of a Conference held in June 2005 at the laboratoire Paul Painleve (UMR CNRS 8524) in Lille, France. The meeting was intended to review hot topics and future trends in fluid dynamics, with the objective to foster exchanges of various viewpoints (e.g. theoretical, and numerical) on the addressed questions. It comprises a collection of research articles on recent advances in the analysis and simulation of fluid dynamics.

The book provides highly specialized researchers and practitioners with a major contribution to mathematical models' developments for energy systems. First, dynamic process simulation models based on mixture flow and two-fluid models are developed for combined-cycle power plants, pulverised coal-fired power plants, concentrated solar power plant and municipal waste incineration. Operation data, obtained from different power stations, are used to investigate the capability of dynamic models to predict the behaviour of real processes and to analyse the influence of modeling assumptions on simulation results. Then, a computational fluid dynamics (CFD) simulation programme, so-called DEMEST, is developed. Here, the fluid-solid, particle-particle and particle-wall interactions are modeled by tracking all individual particles. To this purpose, the deterministic Euler-Lagrange/Discrete Element Method (DEM) is applied and further improved. An emphasis is given to the determination of inter-phase values, such as volumetric void fraction, momentum and heat transfers, using a new procedure known as the offset-method and to the particle-grid method allowing the refinement of the grid resolution independently from particle size. Model validation is described in detail. Moreover, thermochemical reaction models for solid fuel combustion are developed based on quasi-single-phase, two-fluid and Euler-Lagrange/MP-PIC models. Measurements obtained from actual power plants are used for validation and comparison of the developed numerical models.

This book covers a wide variety of topics related to advancements in different stages of mass transfer modelling processes. Its purpose is to create a platform for the exchange of recent observations, experiences, and achievements. It is recommended for those in the chemical, biotechnological, pharmaceutical, and nanotechnology industries as well as for students of natural sciences, technical, environmental and employees in companies which manufacture machines for the above-mentioned industries. This work can also be a useful source for researchers and engineers dealing with mass transfer and related issues.

Numerical Simulation of Non-Newtonian Flow focuses on the numerical simulation of non-Newtonian flow using finite difference and finite element techniques. Topics range from the basic equations governing non-Newtonian fluid mechanics to flow classification and finite element calculation of flow (generalized Newtonian flow and viscoelastic flow). An overview of finite difference and finite element methods is also presented. Comprised of 11 chapters, this volume begins with an introduction to non-Newtonian mechanics, paying particular attention to the rheometrical properties of non-Newtonian fluids as well as non-Newtonian flow in complex geometries. The role of non-Newtonian fluid mechanics is also considered. The discussion then turns to the basic equations governing non-Newtonian fluid mechanics, including Navier Stokes equations and rheological equations of state. The next chapter describes a flow classification in which the various flow problems are grouped under five main headings: flows dominated by shear viscosity, slow flows (slightly elastic liquids), small deformation flows, nearly-viscometric flows, and long-range memory effects in complex flows. The remainder of the book is devoted to numerical analysis of non-Newtonian fluids using finite difference and finite element techniques. This monograph will be of interest to students and practitioners of physics and mathematics.

This handbook covers computational fluid dynamics from fundamentals to applications. This text provides a well documented critical survey of numerical methods for fluid mechanics, and gives a state-of-the-art description of computational fluid mechanics, considering numerical analysis, computer technology, and visualization tools. The chapters in this book are invaluable tools for reaching a deeper understanding of the problems associated with the calculation of fluid motion in various situations: inviscid and viscous, incompressible and compressible, steady and unsteady, laminar and turbulent flows, as well as simple and complex geometries. Each chapter includes a related bibliography

Covers fundamentals and applications Provides a deeper understanding of the problems associated with the calculation of fluid motion

Numerical Simulation of Pneumatic and Cyclonic Dryers Using Computational Fluid Dynamics.

Fluid Dynamics: Theory, Computation, and Numerical Simulation is the only available book that extends the classical field of fluid dynamics into the realm of scientific computing in a way that is both comprehensive and accessible to the beginner. The theory of fluid dynamics, and the implementation of solution procedures into numerical algorithms, are discussed hand-in-hand and with reference to computer programming. This book serves as an introductory course in fluid mechanics, covering traditional topics in a way that unifies theory, computation, computer programming, and numerical simulation. The approach is truly introductory, in the sense that few prerequisites are required. The audience includes not only advanced undergraduate and entry-level graduate students, but also a broad class of scientists and engineers with a general interest in scientific computing. Two distinguishing features of the discourse are: solution procedures and algorithms are developed immediately after problem formulations are presented; and numerical methods are introduced on a need-to-know basis and in increasing order of difficulty. A supplement to this book is the FORTRAN software library FDLIB, freely available through the Internet, whose programs explicitly illustrate how computational algorithms translate into computer code instructions. The codes of FDLIB range from introductory to advanced, and the problems considered span a broad range of applications; from laminar channel flows, to vortex flows, to flows in aerodynamics. Selected computer problems at the end of each section ask the student to run the programs for various flow conditions, and thereby study the effect of the various parameters determining or characterizing a flow. This text is a must for practitioners and students in all fields of engineering, computational physics, scientific computing, and applied mathematics. It can be used as a text in both undergraduate and graduate courses in fluid mechanics, aerodynamics, and computational fluid dynamics.

Computational fluid flow is not an easy subject. Not only is the mathematical representation of physico-chemical hydrodynamics complex, but the accurate numerical solution of the resulting equations has challenged many numerate scientists and engineers over the past two decades. The modelling of physical phenomena and testing of new numerical schemes has been aided in the last 10 years or so by a number of basic fluid flow programs (MAC, TEACH, 2-E-FIX, GENMIX, etc). However, in 1981 a program (perhaps more precisely, a software product) called PHOENICS was released that was then (and still remains) arguably, the most powerful computational tool in the whole area of endeavour surrounding fluid dynamics. The aim of PHOENICS is to provide a framework for the modelling of complex processes involving fluid flow, heat transfer and chemical reactions. PHOENICS has now been in use for four years by a wide range of users across the world. It was thus perceived as useful to provide a forum for PHOENICS users to share their experiences in trying to address a wide range of problems. So it was that the First International PHOENICS Users Conference was conceived and planned for September 1985. The location, at the Dartford Campus of Thames Polytechnic, in the event, proved to be an ideal site, encouraging substantial interaction between the participants.

Computational fluid dynamics solutions of the Navier-Stokes equations have been applied to both nonreacting and reacting in-bore flowfields for a ram accelerator projectile launch system. In this system, a projectile is injected at supersonic velocity into a stationary tube filled with a pressurized mixture of hydrocarbon, oxidizer, and inert gases. After ignition, the shock system generated by the projectile can result in sustained combustion around and aft of the projectile. This energy release process, which travels with the projectile, also generates high pressures and imparts thrust to the projectile. Experimental observations indicate that the porous obturator may play a significant role in the initiation of combustion after projectile injection. Numerical simulations have been used to investigate the role of the obturator in both the 38mm and 120mm (bore diameter) systems. Fluid dynamics, Hypervelocity guns, Navier Stokes equations, Ramjet engines, Supersonic combustion, Reacting flows.

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