PHOENICS NEWS

Editorial

Autumn 2011

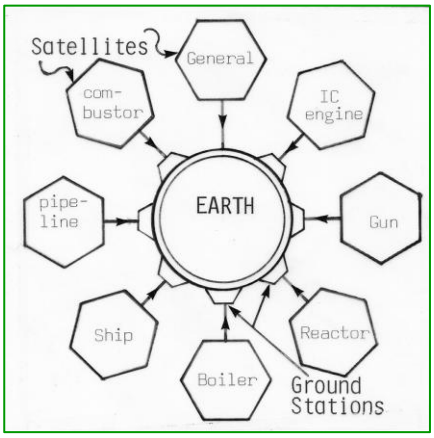
PHOENICS at 30

Before PHOENICS there were computational fluid dynamics codes generated, in the main, within academe.

PHOENICS was the first ***commercial*** general-purpose CFD software to appear on the market. It was created by Professor Brian Spalding, who has been at the forefront of computational fluid dynamics for as long as the field has existed, and by his Development Team.

PHOENICS is not only the forerunner of all other general-purpose software; it is also one of the very few still being developed, and marketed, by its originators and not absorbed into a larger conglomerate. PHOENICS has always been marketed via CHAM (Concentration, Heat & Momentum Limited), Professor Spalding's Company, from its head office in Wimbledon Village, London, England

PHOENICS is celebrating its 30th year of continued existence in October this year and this Newsletter incorporates memories and photographs of the past three decades and some new materials.



A diagram of the early structure of PHOENICS

Professor Brian Spalding

2) HISTORY

2.1 CHAM Memories

2.1.1 Background

by Colleen King, CHAM

CHAM started in 1969 and was based at Imperial College for the first years of its existence. It separated from the College in 1974 and moved to New Malden and thence to Bakery House in Wimbledon Village where we remain to the present day.

Professor Spalding remained at the College as Head of the Heat Transfer Section and later the Computational Fluid Dynamics Unit as he moved into the field of CFD which he, in the main part, created.

Heat Transfer Section Party 1977 at IC where it started

In 1978 he was appointed Reilly Professor of Combustion at Purdue University in West Lafayette Indiana. One of the factors of the move was that he no longer had access to his own assistant. He had to learn to program for himself as a result of which he could implement his ideas directly and equally directly amend or extend them.

Chaffee Hall, Purdue University where Professor Spalding was based

During this period CHAM was consulting across a spectrum of industries concerned with fluid flow using a wide variety of industry specific computer codes. Thus CALM (Calculation of Layer Movement) modelled Rivers, Bays, Lakes and Estuaries, CHARM (Computer Heart Model) was used in medicine, CORA (Combustion and Radiation Analyser) modelled Combustors and Furnaces, ESTER (Electrolytic Smelters) did what the name indicated as did FLASH (Flow Around Ships' Hulls). GENMIX (General Mixing) was a general–purpose program, HESTER (Heat Exchanger Steady and Transient Analyzer) was used by the Process Industry, PLANT (Pipe-Line Analyzer *Two* –Phase) was used for under-ocean pipe lines and LOCA in Nuclear Plant and TACT (Thermal Analysis of Cooling Towers) analyzed Cooling Towers. Then there were GANDALF, TIBALT, TOPSI and more. There was also CHAMPION (CHAM Program Collection) for general use. It was CHAMPION that Brian turned his attention to in West Lafayette. A General-Purpose Code (not just a code collection) appealed.

Development took time. In 1979 he returned to Imperial College where there were lectures to give and students to supervise. Cooperation with others on the General Purpose Code had to be fitted around academic, commercial and other commitments. The work was done in conjunction with members of the CHAM Development team.

Dr David Tatchell, Professor Spalding, Harvey Rosten

The code took shape. In 1980 Brian delivered a paper at the International FEM Congress in Baden Baden the abstract of which says:

"General Computer programs have been available for many years which solve the equations describing the distributions of stress and strain in solid structures. The engineering community has become used to relying upon them; and the originators and custodians of these programs have steadily increased the reliability, their ease of use, and their economy.

The development of general computer programs for fluid-flow, heat-transfer and chemical-reaction processes has been far slower. It is not that computer programs do not exist for simulating particular processes of this kind; for the aerospace, nuclear and energy industries have all given rise to process-simulation demands which the numerical analyst has successfully met. Three dimensional, time dependant and strongly non-linear equations are being solved daily.

It is the provision of a general computer code system that has proved difficult, both technically (because of the large number for which provision must be made) and organizationally (because funds are obtainable, as a rule, only for the development of special-purpose codes).

In the last few years, the author and his colleagues have been able, however, to bring a general *program for fluid-flow, etc, into existence; and it is now used in all their work. It is a computer-code system which is in question; and is consists of speci8al-purpose satellites. The whole system is called PHOENICS, which stands for Parabolic, Hyperbolic Or Elliptic Numerical-Integration Code Series; the satellites, which are small programmes which communicate data to 'earth' for processing, have names such as FLASH (simulating Flow Around Ships' Hulls), CORA (for Combustion and Radiation simulation), TACT (for Thermal Analysis of Cooling Towers), and many others.".*

At this juncture PHOENICS was being used in-house at CHAM, being beta tested and then tried out on consultancy projects. It was to be another year before the software was launched as a fully fledged commercial product at the London University Computer Services premises in Gordon Square in London in October 1981.

After its launch PHOENICS was used not only in commerce but, extensively, in academe via the PHOENICS User Club which, by 1988, had its own Newsletter – the precursor of the PHOENICS Newsletter of today. Some of those PUC members are still using the code as can be seen in the article from Penn State University on page 8 of this Newsletter.


PHOENICS
USER CLUB NEWSLETTER
Issue No 14/15 June/September 88

EDITORIAL
by Colleen I King

A New Team at The Top....

After many years with the same Management Team there has been a change of personnel at CHAM resulting in the appointment of seven new Managers. All except one of these have been promoted from other positions within the Company and have long experience both of CHAM and of the PHOENICS code. The new team is looking at problems from a different viewpoint, and intends that there will be many improvements to all aspects of the Company over the next months.

The new team comprises:

Managing Director
The Managing Director of CHAM is still Professor Brian Spalding; but his October 1 1988 retirement from Imperial College enables him to devote all his time to CHAM affairs, instead of the previous small fraction.

Professor Brian Spalding | Mrs Anne Robson

Managers
Mrs Anne Robson has joined CHAM in the role of Administration Manager from a similar position at the House of Fraser. It is her task to create and run an efficient 'business machine'.

Dr John Ludwig has moved from the Consultancy Team to take over the Research and Development Group. John has been with the Company for many years and has great experience of PHOENICS as a user. He has been impatient in the past at the lack of interest seemingly shown by R&D in making the code user friendly and in responding to users requests and suggestions. He is now in the position to rectify this. His team is being strengthened by the transfer from Imperial College of several highly-experienced members of Brian Spalding's Computational Fluid Dynamics Unit; and Brian himself has resumed work on the PHOENICS EARTH program.

Dr John Ludwig

Dr Patrick Phelps | Dr Coulis Pericleous

Drs Patrick Phelps and Coulis Pericleous are still running the Consultancy team. They have both had many years with the Company and have successfully taken joint charge of the largest section of CHAM which, in addition to providing consultancy to outside clients, is also the training ground for new CHAM recruits. Patrick is also responsible for spreading the project-control techniques which have worked well for Consultancy to other departments of the Company.

Dr Mike Reynell is the Coordinator of CHAM's Marketing Team which will be launching major sales campaigns during the Autumn in respect of Version 1.5. There is an article by Mike, on this subject, in Section 2 of this Newsletter.

Dr Mike Reynell | Colleen King

Colleen King has taken over administrative responsibility for the Deliveries and Installations Team. She has been with CHAM for 15 years and has been responsible for Academic Users since the system of preferential rates for these sites was introduced. She will continue to handle academics but is also intending to streamline the delivery process so that orders can be met quickly and with minimum installation difficulty.

John Parry | Mrs Sylvie Stevens

John Parry is handling User Support and, additionally, is responsible for Courses (both internal and external) and PHOENICS User Groups. He will be building up a team over the next few months and will also be contacting all PHOENICS Users to encourage them to take out User-Support Contracts so that he can assist with their problems on request.

A new Section has been set up to handle publications, which are an increasingly important aspect of Company activities. It is headed by Mrs Sylvie Stevens who has assisted Professor Spalding with his work on various international Journals over the past 11 years. Mrs Stevens has been responsible for production of the new PHOENICS Journal (for which she would welcome contributions from all readers of this article). She will handle the growing library of reprints using PHOENICS which is based at CHAM and the production of CHAM Technical Reports and PHOENICS Enhancement Reports.

Inside This Issue:

Other CFD codes have been created and launched, subsequent to PHOENICS, by companies most of which are now part of international conglomerates. PHOENICS remains independent.

Some of those present at the time of our launch 30 years ago are still with us and others were not born when the launch took place. PHOENICS continues to be developed, tested, and expanded to provide solutions to new and different problems. Its creator has received countless awards for his contribution to the subject and still uses his scientific skills to amend, and extend, his creation.

2.1.2 Memories by Michael Malin, CHAM Limited

For this special issue of the Newsletter, I thought that it might be of interest to set down something about the origin and development of CHAM, as well as my own early involvement with the company and PHOENICS. CHAM was formed as Combustion, Heat and Mass Transfer Ltd by Professor Brian Spalding in 1969, and renamed Concentration Heat and Momentum Ltd in 1974. There is little doubt that by this action Brian also founded the commercial CFD industry. From the outset commercial CFD services were provided to industrial and governmental clients based on the pioneering technology that had emerged from Brian's research group at Imperial College in the late 1960s. Thus, well before the advent of PHOENICS, CHAM was the world's only commercial CFD Company, and remained so until 1983 when Creare began marketing the FLUENT code.

The first contracts undertaken by CHAM were conducted by members of the academic staff of the Heat Transfer Section (HTS) of the Mechanical Engineering Department of Imperial College. During 1973, CHAM's records[1] show that the academics associated with the company were:

- Prof D B Spalding Professor of Heat Transfer.
- Dr B E Launder Reader in Fluid Mechanics.
- Dr J H Whitelaw Reader in Convective Heat Transfer.
- Dr F C Lockwood Lecturer specialising in Combustion.
- Dr A D Gosman Lecturer specialising in Numerical Analysis.

The other CHAM members at that time were a number of full-time post-doctoral research workers at Imperial College, namely: Dr S V Patankar, Dr A K Runchal, Dr A W Date, Mr M Koosinlin, Mr D Sharma and Mr D G Tatchell. The initial growth of CHAM was such that by 1974 the company had left Imperial College for new premises in New Malden, Surrey. Two years later it moved to its present location in Wimbledon.

Between 1969 and 1980, CHAM developed numerous application-specific CFD computer codes for clients across a wide range of sectors, including the aerospace, automotive, defence, chemical, environmental, fire & safety, marine, manufacturing & process, nuclear-power, and fossil-fuel power industries. These CFD codes also provided the means for CHAM to undertake CFD consultancy contracts aimed at solving practical problems and creating design aids for industry. For anyone who is interested, a comprehensive but not exhaustive description of these activities can be found elsewhere[1-2]. In this pre-PHOENICS era, contracts typically involved adapting a basic, standard CFD code to a specific application for a particular client. These two- and three-dimensional standard codes handled parabolic systems, partially-parabolic systems, or fully elliptic systems with the option for steady or time-dependent simulations.

My own involvement in CFD began in 1976 when I joined Brian's research group at Imperial College to undertake an MSc in Heat Transfer Engineering. It is now easy to see that this was essentially the world's first post-graduate degree course in CFD. The course was delivered almost single-handedly by Brian, with some very competent assistance provided by Dr Sam Pun and turbulence expert Dr Mike Gibson. The most impressive course component was Brian's excellent lecture series "Mathematical Modelling of Fluid-Mechanics, Heat-Transfer and Chemical-Reaction Processes: A Lecture Course"[3]. This was essentially an all-encompassing, everything-you-need-to-know lecture series about the basic equations of fluid-flow, heat & mass transfer, combustion and radiation, and how to solve them by means of the CFD finite-volume method. This lecture series provides a valuable reference source to this day.

One year later I joined CHAM and began working on consultancy contracts concerned with the development and application of CFD codes for turbomachinery and marine-hydrodynamics cases, using partially-parabolic and fully-elliptic methods with non-orthogonal body-fitted meshes. At that time CHAM's technical staff included David Tatchell (Deputy Managing Director), Mark Koosinlin (Contracts Manager) and a number of industry-specific Section Leaders of whom I can recall Harvey Rosten, Nikos Markatos, Pratap Vanka, Chippy Thyagaraja, Ashok Singhal, and Shesh Srivatsa. It was not long before Harvey was promoted to Development Manager and Nikos to Consultancy Manager. My time was then shared between the two teams either performing consultancy contracts on numerous, wide-ranging industrial applications, or developing and testing application-specific CFD codes. This continued until the release of PHOENICS in 1981. During this period it was my good fortune to work with, and be trained by, four technically-talented people in Brian, David Tatchell, Harvey Rosten and Nikos Markatos. The highlights for me were working with Nikos in pioneering the use of CFD for predicting fire and smoke movement in buildings, and working with Brian, Harvey and David on the development and application of a three-dimensional, non-orthogonal elliptic CFD code for the prediction of steady, turbulent flow in centrifugal impellers, with allowance for cavitation.

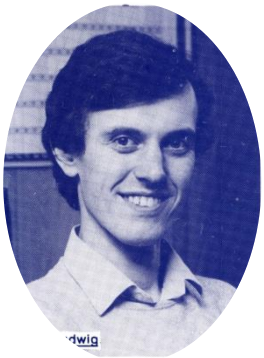
In 1978, Brian conceived the idea of a single CFD code capable of handling all fluid-flow processes. Consequently, CHAM abandoned the policy of developing individual application-specific CFD codes, and late in 1978 the company began creating the world's first general-purpose CFD code, PHOENICS, (Parabolic, Hyperbolic Or Elliptic Numerical Integration Code Series). The initial creation of PHOENICS was largely the work of Brian and Harvey Rosten, and the code was launched commercially in 1981, and so here for the first time, a single CFD code was to be used for all thermo-fluids problems. My involvement in the development of PHOENICS did not begin until a year or so later when I was seconded from Consultancy to work under Brian and Harvey's direction with the challenging task of equipping PHOENICS with a general-purpose, body-fitted-coordinate system, the so-called BFC option of PHOENICS[5]. My most enduring memory from this work was Harvey's impressive ability to rapidly convert Brian's innovative ideas into a working set of equations complete with detailed coding-implementation strategies and sample hand-written FORTRAN listings. It was my job to translate all this into working code and devise test cases to validate the implementation. The task of providing BFC graphical post-processing capabilities was carried out largely by David Glynn in the Consultancy Team. The BFC option was released in 1984, by which time my ongoing development activities had been complemented with the role of Consultancy Section Leader in External Aerodynamics.

1. *D.B.Spalding*, "CHAM Information Booklet", CHAM TR/6, (1973).
2. *V.Artemov et al*., "A tribute to D.B.Spalding and his contributions in engineering and science", Int. J. of Heat & Mass Transfer 52, 3884–3905, (2009).
3. *D.B. Spalding*, "Mathematical Modelling of Fluid-Mechanics, Heat-Transfer & Chemical-Reaction Processes: A Lecture Course", HTS/80/1, Computational Fluid Dynamics Unit, Imperial College, University of London, London, (1980).
4. *H.I.Rosten & D.B.Spalding*, "The mathematical basis of the PHOENICS Computer Code", CHAM TR/58b, London, (1981).
5. *M.R. Malin, H.I. Rosten, D.B. Spalding, D.G. Tatchell,* "Application of PHOENICS to flow around ship's Hulls", in: L. Larsson, C. S. Ohlsson (Eds.), Proceedings, 2nd International Symposium on Ship Viscous Resistance, Gothenburg, Sweden, pp. 16:1–16:23. (1985).

2.1.3 Early Days at CHAM

by John Ludwig, CHAM Limited

I joined CHAM an astonishing 33 years ago in 1978. Even more astonishingly, Mike Malin and David Glynn were already here – and still are! I had been studying at Imperial College for a PhD in Nuclear Reactor Safety. At the start of my final year, I thought it might be wise to look for a job, and came across an interesting advertisement in a magazine. I applied, was asked for an interview, and somehow was successful even though my knowledge of CFD at that time was non-existent.



Looking back now, I must have walked past Brian Spalding's office nearly every day of my three years at Imperial – his office was next door to the computer centre, where I used to take my decks of cards – without knowing who he was or what was going on there.

At that time PHOENICS did not exist, but there were a number of more or less successful 2D and 3D codes for various applications. I recall that the greater part of a Consultancy project was often spent removing unneeded features from a previous application, leaving little time to add what was needed for the task at hand. The state-of-the-art minicomputer we were using had less (much much less) computing power than an average modern telephone. The largest production runs had to be initiated from the operators console with the Operating System shut down!

There were only two terminals which had to be shared by everyone, so there was much queuing for one's turn. Coding was written out by hand on coding forms, and had to checked, often by Harvey Rosten, before one was allowed to type it in. When things went wrong, debugging was by means of performing hex arithmetic on addresses in compiler listings and load maps to find the line of code, and then much head scratching to figure out why it wasn't working.

There was no graphics, only line printer contour and line plots and of course reams of numbers. Even once graphics was available, some clients still insisted on receiving the full line printer plots for a project. One such client, having been sent several boxes of printout rang back a couple of weeks later complaining that in such-and-such a cell the porosity defining the geometry was wrong!

It increasingly became obvious that the way forward was to separate the common numerics from the application-dependent physics and thus PHOENICS was born. The first version, PHOENICS 81, used a Fortran BLOCK DATA subroutine as the means of input. By PHOENICS 84 the Q1 had arrived and to those who wish to think so, nothing much has changed since. Obviously a lot of improvement has taken place with new features and more advanced models, but many of those original Q1 files would still run today with very little change.

During my time at CHAM I have been involved with nearly all aspects of the CFD business – Consultancy, Development, Support and Training. I hesitate to mention that I have never been involved with Installations ... I have also never, in true CHAM style, been involved with any projects for the Nuclear industry. Now would be far too late, as I have forgotten anything I might have known about that subject.

2.1.3 PHOENICS 30 Years Ago

by David Glynn, Consultant

I first arrived at CHAM in 1978, with an unfinished PhD in CFD, but no experience of SIMPLE methods and the "Imperial College approach". I was straightway plunged into the creation of a CFD code for a glass-making client. At that time there was no general-purpose PHOENICS; instead there was a collection of codes for specific purposes, generally with similar architecture. A consultancy project involved finding the most appropriate code to act as a starting point, and then modifying it for the project in hand. I found myself dealing with all the subroutines (now part of EARTH) that performed the numerics of the fluid-flow solution.

Part of the joy of consultancy is the wide experience it gives. I soon found myself concerned with modelling flame travel during ignition in stratified-charge internal-combustion engines, and reflooding the core with water following a loss-of-coolant accident in a nuclear pressurised water reactor. The latter was very topical in the lead-up to the Public Enquiry for the Sizewell B nuclear power station. Modelling was extremely complex and involved numerous empirically based correlations for two-phase heat transfer. As a result, the accuracy of the results was variable. I recall that in similar work for another client, we simulated four reflooding scenarios for which experimental data were available. Three cases gave really rather good results; the fourth was quite the contrary!

Brian Spalding had the then revolutionary idea that using separate codes for each application was a most inefficient procedure. Since they all operated in a similar way, how much better it would be if the numerical solvers could be combined into a common "EARTH" program, while the aspects that made each model individual would be characterised as a separate input for each application. Thus PHOENICS-81 was born.

All of us consultancy engineers played our part in this transformation, while continuing to work on our respective projects, the whole being managed with great competence by Harvey Rosten.

While much of the central numerics of the original PHOENICS would be quite recognisable to a software-developer of today, many aspects of the code would appear rather primitive. There was of course no graphical user interface; the VR editor lay years into the future. Originally, there was not even a Q1 file. The specification data for each project were set up as statements within a Fortran "BLOCK DATA" routine.

Hardware was equally primitive. The processing power and RAM of our "mainframe" Perkin-Elmer computer was of course a mere fraction of today's capabilities. For input, we had "teletype" terminals. These seemed an enormous upgrade from the decks of punched cards which were still used for larger models which would be run at an external computer bureau. There were shelves full of card decks of the individual codes. And of course - amazingly, to the modern CFD modeller - there was no graphics of any kind. The terminals were text-only, and so was output, which consisted of reams and reams of line-printer paper. The computer room was filled all day by the clatter of the printer, and the shelves all around CHAM groaned under the weight of the printout. When modelling a three-dimensional flow, it was a major task to try to interpret flow patterns by poring over pages and pages of velocity component values at all the individual cells.

Geometries were essentially "square-world". Walking back one day with Brian Spalding from a meeting at the Nuclear Installations Inspectorate, I was astonished when he expounded his latest ideas for the introduction of curvilinear coordinates into PHOENICS, so that curved geometries could be handled properly. This was the start of "Body-Fitted Coordinates", which figured prominently in my life at CHAM. My first essay using BFCs, with PHOENICS-81, was modelling flow around a submarine. Construction of the grid was a masterpiece, which I was exceedingly proud of. Unfortunately, the model would never converge! Things improved with the new incarnation of BFCs in the much more advanced PHOENICS-84, and I went on to spend a lot of my time simulating external aerodynamics flows around aircraft shapes and car bodies. I would have been astonished at the thought that BFCs were destined for replacement as a practical tool by PARSOL.

Eventually CHAM acquired graphics terminals, but they were useless without graphics software to display the flow predictions. Bit by bit, during various consultancy projects, I gradually constructed the prototype of the postprocessor PHOTON, for plotting BFC models, and John Ludwig and I created; both of these still exist with the PHOENICS suite. We take graphical visualisation of fluid flows for granted nowadays, but then it was revolutionary.

Working with PHOENICS over the years has been educational and enjoyable (even if inevitably occasionally frustrating!). I look forward to many more years of using it, and to the new developments that they will bring.

2.2 Branch & Agent Memories

2.2.1 CHAM-Japan, Japan

by Mr Z W Kong, Mr H Suzuki & Mr Tachino

The history of PHOENICS in Japan

1980 CRC started to use the CRAY-1
1981 CRC started to sell PHOENICS in Japan
1984 NIPPON Steel Corporation was the first PHOENICS User in Japan:
1985 First PHOENICS user conference was held in Dartford UK, Mr Hiroji Suzuki of CRC attended
1986 CRC started to use the CRAY-XMP
1987 At CRC, the CFD team started to use the Apollo DOMAIN
1990 Most users started to use Workstations: DEC, HP, SUN, etc
1994 CHAM-JAPAN established
The first PHOENICS Japan user conference was held in British Embassy in Tokyo and was attended by Professor Spalding

1996 Sixth PHOENICS user conference was held in Japan, Waseda university
1998 CHAM-JAPAN set up the first Windows and Linux parallel systems
2000 Most users started to use the Windows version of PHOENICS and some users started to use Parallel PHOENICS
2002 Prof Spalding attended the Japanese PHOENICS user conference
2002 CRC transferred user supporting business to CHAM-JAPAN
2003 CHAM-JAPAN started to sell SWIFT
2004 CHAM-JAPAN released TWO-PHASE package of PHOENICS
2005 CHAM-JAPAN started to sell APUS-CFD
2006 Most users started to use Parallel PHOENICS with PARSOL
2007 CHAM-JAPAN released the first CFD Parallel Package for a Windows Computer Cluster Server and it became a solution case study for Microsoft Japan
2008 Users started to use the Windows version of the 64bit Parallel PHOENCS
2009 CHAM-JAPAN celebrated its 15th birthday at the Japanese user conference
2010 ASMO, a PHOENICS User, used a 40 million mesh on an 8 core CPU to do their simulation of a Wiper design
2011 The earthquake happened in 11 March and Japan PHOENICS user conference will be held on 25th November

2.2.2 ACADS-BSG Pty Ltd, Australia

by Murray Mason, Principal Engineer/Director

Whilst October (2011) marks the 30th Anniversary of PHOENICS, October (1995) is the month that ACADS-BSG Pty Ltd became agents for CHAM's PHOENICS program. In those days it was PHOENICS and FLAIR which have now been merged into one program.

The Building Services Group (BSG) integrated as a division of a not for profit organisation called ACADS (The Association of Computer Aided Design) in 1980. Then in 1994 it separated from ACADS and was set up as a separate company hence the name ACADS-BSG.

Murray Mason of ACADS-BSG

Initially when the building services group was set up within ACADS, two air conditioning load estimation programs and a duct design program were made available to a hand full of users via a computer bureau. In those days they were DOS based. Copies of the programs were also licensed and supplied to users on magnetic tape.

Since then ACADS-BSG has developed, or acquired a comprehensive range of building services programs, including software for piping and sprinkler systems design and energy simulation, and is the agent in Australia, SE Asia and New Zealand for PHOENICS. We have well over 500 companies using our software, including users of PHOENICS.

Staffed by 2 very experienced engineers and 3 support programmers, ACADS-BSG provides an unrivalled service to the construction and fire protection industries in Australasia.

In 2004, ACADS-BSG ran the first and only PHOENICS User Conference in Australia and in 2008 hosted a workshop in Sydney run by John Ludwig. ACADS-BSG regularly has a stand at the bi-annual ARABS (Air conditioning, Refrigeration and Building Services) Trade Exhibition where the programs, including PHOENICS, are demonstrated. In 2010 this exhibition attracted over 7000 local and international visitors with 225 exhibitors and numerous seminars and workshops. ACADS-BSG will have a stand at the 2012 exhibition to be held in Melbourne from May 7th - 9th 2012.

2.2.3 ACFDA, Canada and the USA

by Vladimir Agranat, Managing Director

I met with PHOENICS in 1991 when I was working in CFD Group of Advanced Technologies Centre (Dimona, Israel) and there was a need to simulate the mixed convection flows in solar receivers developed by Weizmann Institute of Science (Rehovot, Israel). At that time, such modern PHOENICS capabilities as INFORM, PLANT, PARSOL, VR-Editor and VR-Viewer were not available yet. However, GROUND coding was available and it was one of the reasons that PHOENICS was selected for this modelling work, which continued till 1993. Since 1994, I have been involved in many PHOENICS applications while working in Canada at the University of Toronto, Stuart Energy Systems, Hydrogenics Corporation and Applied Computational Fluid Dynamics Analysis (ACFDA). The applications have covered different areas such as flows in chemical reactors, nuclear reactors, kraft recovery boilers, hydrogen generators, rivers, forest fires, etc.

Over the last 20 years, PHOENICS has become user-friendly and such advanced features like INFORM, PLANT, VR Interface and others have been developed. This continuous development of the code has kept me using PHOENICS despite presence of many other commercial CFD packages on the CFD market. The most attractive PHOENICS features to me have been its openness and easy customization (for non-standard applications), its PARSOL technique, the existence of library of input files, comprehensive documentation and highly professional user support. In particular, the use of INFORM and PLANT enable users to avoid the complexities of direct FORTRAN coding and make required customizations for complex applications.

Since 1998, I have been promoting PHOENICS while managing ACFDA, CHAM's North American Agency (www.acfda.org), and providing PHOENICS sales, training, user support and consulting services in Canada and USA. Over the last 13 years, I have talked to many PHOENICS users and realized that they like mostly its easy-to-use Virtual Reality Interface and the easy customization of the code. These and other advanced features of the code might be responsible for keeping various companies and research organizations in the list of current PHOENICS users for many years. For example, Northrop Grumman Corporation, Tennessee Valley Authority (TVA), Natural Resources Canada, Concordia University, US Steel Research and Gas Cleaning Technologies (GCT) have been using PHOENICS for more than 10 years. I would like to thank all our clients for their continuous use of PHOENICS and special thanks are expressed to our long-term PHOENICS users such as Drs. Alex Shlifshteyn, Pascale Biron, Mohamed Ouzzane, Zine Aidoun, Sam Matson, Boualem Hadjerioua and Asish Sinha for their more than 10-year loyalty to PHOENICS. Technical interactions with them have enriched my personal PHOENICS experience significantly.

Dr. Boualem Hadjerioua has used PHOENICS at TVA from 1993 to 2010 (for seventeen years!) and written many publications and technical reports. In his opinion, "PHOENICS has greatly enhanced TVA's modeling capabilities, which helped the company to address and evaluate many environmental and design projects. The CFD modeling capability helped save millions ($) and averted many unnecessary expenses." Boualem thinks that " In early to late 90's, it was very difficult and time consuming to use PHOENICS, but starting early to mid-2000's, with the newer interface, PHOENICS became much easier and user friendly."

Dr. Sam Matson, who was working for many years in GCT and is currently CMC Americas Technical Energy Manager, is saying "PHOENICS has been useful in my work evaluating industrial ventilation options, furnace configurations, and mixing of off-gas in industrial ductwork. Using PHOENICS, we have been able to verify the behavior of existing ventilation conditions and then develop the best and most cost-effective improvements."

In conclusion, I would like to thank all CHAM's staff for their support over the last 20 years. I am sure that 30-year old PHOENICS will continue to be competitive, attractive to both CFD newcomers and experienced CFD users and helpful in solving real-life fluid flow problems.

2.2.4 ACS Consulting, USA

Dr. Allen Badeau Jr. ACS Consulting

ACS Consulting has been a partner with CHAM since 2002 as its United States distributor of PHOENICS. As ACS Consulting has been working diligently to re-establish PHOENICS as a key player in the CFD market, success has been limited because of existing market pressures from competitors. However, slowly, we have started to break-through to the acquisition community in both the commercial and government spaces, and customers have included the Department of Energy, The US Navy, and Rubbermaid. We have also provided consulting services, in cooperation with CHAM, to customers such as BCCLT, RS&H, and Solar Suspensions. Additionally, as we try to continue to expand market share in a budget conscience environment within the US, we are pushing cost savings and ROI to potential customers, which led to signing a long-term contract with the City University of New York.

ACS Consulting is continuing to market PHOENICS to users as an enterprise solution, which seems to be taking hold within the US Army Corps of Engineers and the US High Performance Computing Modernization Office. We will be continuing our marketing efforts to this agency, other potential customers, and the High Performance Computing user base at the Supercomputing 2011 Conference November 14 – 18th, in Seattle, WA. Also, we will be sponsoring the 2012 NDIA Physics Based Modelling and Users conference to be held in Washington DC in June of 2012 and attending the DoD Scientific User M&S Conference in San Diego, CA. We hope to utilize these new markets, and our new marketing/advertising campaign within the US and on-line to drive home the cost benefits of PHOENICS.

2.2.5 Arcofluid, France

by Dr Jalil Ouazzani, Scientific Director ArcoFluid

ArcoFluid – Solutions efficaces en mécanique des fluides numérique

Since 1995, our company Arcofluid is a distributor of PHOENICS in French speaking countries, and particularly in France. Our partnership with CHAM is based upon the great challenge to provide researchers and engineers with CFD solutions that can meet the complexity of their applications and problems.

To mark the thirtieth anniversary of PHOENICS, I want to emphasize the dual requirement tackled by the company CHAM: i) the innovation and ii) the openness of the tool. Strength to be underlined is the continuous development of PHOENICS through its user's contributions far away from the "black box" software. As an agent of CHAM, I appreciate the trust relationship which has been built over the last 16 years. Confidence in CHAM's company that has retained its human character, with whom relations are cordial and informative, which has always supported us in giving the best answers to the various kind of users in this complex area of heat and mass transfer. "Big thanks to our French users".

During my university studies, I followed the "French school" of numerical methods focused on high-precision methods (spectral methods), and disdaining the low-order methods as finite volume. This distinction could be valid as long as we were dealing with simplified “academic” cases. But in the real "world" of fluid mechanics where geometries are often complex, the singular phenomena often present, with multiple physical interactions from different fields (solid, electromagnetic, electric, conjugated heat transfer, variables physical properties and even in some cases discontinuous, as well as having multiple phases), the high precision methods could behave very poorly as compared to finite volume methods. In fact, I quickly encountered this complexity described above upon entering the crystal growth laboratory headed by Professor Franz Rosenberger in Salt Lake City and then in Huntsville, Alabama in 1986. It is in Huntsville where I contacted CHAM North America to obtain the software PHOENICS. PHOENICS was the only software available in 1986 on the market allowing us to address the various issues raised by crystal growth modeling such as: solidification from melt (Czochralski or Bridgman techniques), CVD (Chemical Vapor Deposition), PVT (physical vapor transport), coupled Monte Carlo/fluid flow for the growth of surfaces combining surface growth and bulk flow, 3D curvilinear geometries, complex boundary conditions, chemical reactions, variable properties...). Since using PHOENICS I have been able to start working with it on problems of combustion, dispersion of pollutants in the air and river water, fire, explosions, critical fluids and two phase flows. But all this could have remained purely technical, if I do not evoke the men and women who contributed to this great tool. In particular, being able to meet and exchange ideas with Professor Brian Spalding was one of my greatest joys. At these meetings, I was always moved by how the complexity of the problems could be addressed with simple straightforward manner, how the real issues rise naturally out of his thinking. His sharp mind and rightful vision are really impressive. Working with other members of the team at Wimbledon CHAM has always been and is also very friendly and professional, especially with Peter Spalding, Mike Malin, John Ludwig, Millie Lyle and Colleen King.

The latest innovations of Professor Spalding have transformed the software PHOENICS in a multi-physics tool, with the simplification of complex meshes by the approach of virtual reality and the introduction of In Form which extends considerably the users coding capabilities. PHOENICS now has become a complete laboratory for experimental fluid dynamics without the exorbitant cost of experimental equipment.

The wealth of possibilities for using this software is far from being fully explored.
Happy thirtieth anniversary...
And here we go again for another round...

2.2.6 Coolplug, Germany, Austria, Switzerland

By Frank Kanters

30 years of PHOENICS! Then I must getting old as well. My first experience with a CHAM product was around 1984. During my study for mechanical engineer at the Eindhoven University (www.tue.nl/en/) I met Geert Janssen (currently PHOENICS agent in the Benelux), who was doing his graduate work with a piece of software, called CORA from a company, called CHAM. It increased my interest in computational fluid dynamics and a couple of years later I decided to also do my graduate work in this field.

My professor was good at getting paid side jobs for his students and so I got involved in performing flow simulations of an ethylene reactor for DOW Chemical using software, called PHOENICS, in 1987. I was told PHOENICS was a successor of CORA. I don't remember a lot of that work, but there was no graphical interface at that time, so it must have been much harder than today.

Six years later in 1993 during my work as product developer for a boiler company, I had a problem developing a gas-air mixer. PHOENICS did a great job in assisting with the design and the resulting product is still being produced and sold. Already over 2 million pieces!

It took until 2006 to meet PHOENICS again. Having moved to a place near the German border, it was Geert again who asked me if I was interested in the CHAM agency for Germany, Austria and Switzerland. After having had several technical management positions I believed it was the right moment to go back to an old love: CFD and especially PHOENICS. Looking back it was the right decision. I have met a lot of interesting clients and helped them to successfully complete their projects. It is always amazing to see how CFD can help understanding your problem and helps to improve the product or process performance.

The corporation with the CHAM staff has been and is very pleasant. I don't believe I will manage to stay for the next 30 years with CHAM and PHOENICS, but I hope it will be for a long time.

Happy birthday and congratulations to all the people at CHAM! Best regards/Mit freundlichen Grüßen,

3) User Memories

3.1 PHOENICS 81 Tales *by Dr Bob Hornby*

I started to use PHOENICS soon after joining NNC (the National Nuclear Corporation) in 1980. At the time NNC was committed to the design and construction of the British designed Advanced Gas-cooled Reactor (AGR) and collaborative research into a commercial Fast Breeder Reactor. The Prime Minister Margaret Thatcher had proposed an ambitious AGR construction programme so NNC turned out to be an exciting place to work!

I remember at that time computer codes used by NNC were 2-D and application specific. When PHOENICS appeared in 1981 it enormously enhanced our capability. It allowed users to simulate 3-D fluid flow in domains with complex geometry and to incorporate complicated (non-linear) source terms into these equations. The former was achieved (with easily defined Cartesian or Polar grid cells) using the cell porosity concept which allowed cells to be partially blocked. The latter was accomplished by having the fluid flow solver visit a subroutine called Ground at specific points in the solution procedure. At these points virtually any source term could be constructed. In contrast, other general purpose fluid flow codes in operation or being designed tended to have a fairly limited user interface for flow geometries and source terms.

We fairly soon had access to PHOENICS on a Cray supercomputer using a bureau service offering surprisingly reasonable rates! This enabled realistic 3-D simulations to be carried out. One of the greatest successes of the code was its involvement in the safety case for operational UK AGRs. I utilised the PHOENICS porosity concept in a novel way to allow the complicated reactor fuel pin geometries of damaged fuel elements (figure 1) to be represented and for individual fuel pin temperatures to be calculated taking account of convective and radiative cooling. The results agreed well with experiments and allowed a robust safety case to be constructed, enabling continued operation of the reactor plant and consequent saving of money.

I believe current PHOENICS users would identify the technique I used as an early form of PARSOL!

Figure 1. A young Dr Robert Hornby displaying a damaged fuel pin bundle on a Tektronix graphics terminal. A model of the British AGR is shown in the background. To the right of the display terminal is a model of a full size (undamaged) AGR fuel element incorporating 36 fuel pins in a graphite sleeve.

Dr Bob Hornby.
email:bob@hornby007.wanadoo.co.uk

3.2 Penn State Students Use PHOENICS for Class Projects on CFD in Building Design

by Mingjie Zhao, M.Sc. and Jelena Srebric, Ph.D.
The Pennsylvania State University

Every spring semester at the Pennsylvania State University, students use PHOENICS for a class project on using CFD in Building Design. During Spring 2011, thirteen students had the chance to work on different CFD building design problems related to indoor or outdoor airflows. They had to first write a proposal that defined the goals of their project; they were then required to structure project deliverables within a four week period. Examples of student projects include:

(1) Evaluation of laboratory fume hood face velocities,

(2) Selection of a wind turbine location for a university campus, and

(3) Feasibility of exhaust-fan-assisted ventilation. The selected projects show students' skills and abilities to deal with practical architectural engineering problems that required reducing complex design issues to tractable CFD simulation activities.

1. Evaluation of laboratory fume hood face velocities for contaminant containment

This project evaluated the containment effectiveness of a fume hood at different face velocities. The simulation used a real laboratory environment, while the fume hood flow rates and physical size were based on manufacturer's data. There were two main goals for the CFD modelling in this project: (1) to assess whether the existing setup can achieve the desired face velocities of 80 and 100 fpm (0.4 and 0.5 m/s), and (2) to verify contaminant concentrations that indicate the leakage rate of a tracer gas in this setting. The results show that the energy saving resulting from the reduced face velocities of 80 fpm (0.4 m/s) are worthwhile due to the containment effectiveness that is comparable to the effectiveness resulting from 100 fpm (0.5 m/s) fume hood velocities.

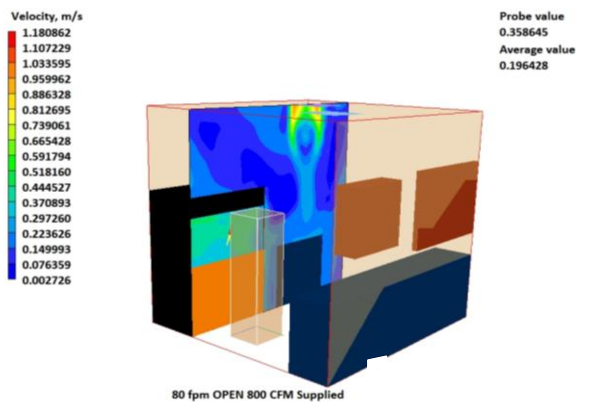


Figure 1: Simulated results for 80 fpm (0.4 m/s) face velocity with 800 cfm tracer gas

2. Selection of a wind turbine location for a university campus

Another project simulated the outdoor airflow for the Pennsylvania State University's main campus by using the standard k-ε Chen turbulence model. The optimal location for wind turbines was selected based on the locally high wind velocities that are caused by the wind channelling effect. Furthermore, data from the Typical Meteorological Year (TMY) were used to determine the frequency of high wind velocities. Finally, turbines from two different manufacturers were evaluated for the potential installation, and one of the two turbines was selected due to its ability to have a larger number of turbines on the same roof.

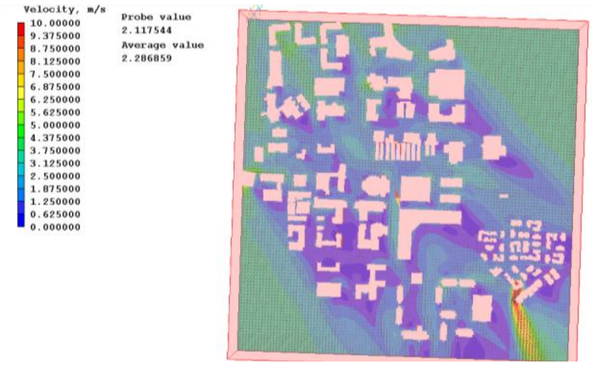


Figure 2. Plane velocity of the outdoor airflow on campus

3. Feasibility of exhaust-fan-assisted ventilation

The goal of this CFD analysis was to evaluate the effects of introducing outside ventilation air through the pressure difference driven by exhaust fans for an entire section of a building. Upon running simulations under isothermal and non-isothermal conditions, there were a few noticeable differences that highlighted the importance of simulating room loads modeled as heat fluxes from internal objects. Through calculations of point and average values for velocities and temperatures, requirements for thermal comfort were evaluated. This particular design solution avoided air drafts and an excessive vertical temperature difference for building occupants. These CFD simulations concluded that exhaust-fan-assisted ventilation is a viable design solution for an overall mechanical redesign, even for the core spaces in this particular building.

Summary

Students were very happy to work on their individual projects because they had a chance to apply the fundamental concepts learned in the first half of the class. Furthermore, students were challenged to turn real building design problems into realistic, yet simplified PHOENICS CFD models. The process of solving practical design problems enabled students to connect the knowledge they acquired not only from this particular CFD class, but also from other relevant courses in their architectural engineering curriculum. For example, several students compared the simulated results with the requirements laid out in the standards developed by the American Society of Heating Refrigerating and Air-conditioning Engineers. Several students also developed simulated building files in other software packages then exported their files into PHOENICS. These creative combinations of CFD analyses and other design tools are typical ways to successfully solve real design problems.

4) Past & Future Comments

4.1 The Distant Past by Colleen King

Lewis Fry Richardson (October 1881 – September 1953)

Whereas most of those in the Scientific world would credit Brian Spalding with being one of the main founding fathers of CFD, Brian has reminded me that "PHOENICS was launched on the centenary of the birth of the true originator of computational fluid dynamics namely Lewis Fry Richardson".

Richardson's interests were varied and eclectic. He was a mathematician, meteorologist, physicist, psychologist and pacifist. He pioneered the mathematical techniques, based on the solution of differential equations, which are still used in weather forecasting today and then applied similar techniques to studying what caused wars and how they could be prevented. He worked on fractals and produced a method for solving linear equations.

His solutions methods predated computers as we know them. References to computers in Fry's 1922 book *Weather Prediction by Numerical Process* meant people who did the calculations or computations and not the machines of our day. The first weather forecast by the first modern computer (ENIAC) was produced in 1950, and was a great scientific advance even though it took nearly 24 hours to generate.

He studied atmospheric turbulence (creating the Richardson number) and summarized his work, in the above mentioned book, as follows:

Big whirls have little whirls that feed on their velocity,
and little whirls have lesser whirls and so on to viscosity.

Richardson attempted to forecast the weather on a single day (20 May 1910) by direct computation. He used a mathematical model of the principal features of the atmosphere, and data taken at a specific time (7am), to calculate the weather six hours later. At the time it seemed the forecast failed but subsequent analysis indicated the failure was caused by not applying smoothing techniques to the data. When these were applied the forecast turned out to be essentially accurate. This was quite an achievement given that the calculations were done by hand while Richardson a conscientious objector) was serving with the Quaker ambulance unit in northern France.

Richardson applied his mathematical skills to try and understand the roots of international conflict. As a result of this he is considered a founder of the scientific analysis of conflict tries systematically to investigate causes of war and conditions of peace. He analyzed war using mainly differential equations and probability theory based on armament supply sense of grievance and posited that the propensity for war between two nations was a function of the length of their common border.

At the time much of Richardson's research was ignored by the scientific community. Today it is seen as an element in the birth of the modern study of fractals.

4.1 Comments by Brian Spalding

I was told this story in Hungary in 1984: Karl Marx was found, amazingly, still to be alive, so the Communist Party invited him to address their Conference. At first he declined; but after pressure he consented to say just two words.

What were those words?

"I apologize"

Having read what Colleen and others have put together here, and being asked to make a contribution myself, it was Karl Marx's words which first suggested themselves.

After reflection I decided to add a few words of my own, namely:

"for still finding new ways to improve PHOENICS".

It has been an interesting three decades. I look forward to seeing what the next decades will bring.

4.1 Conclusion by Colleen King

It has been interesting and enjoyable to compile this Newsletter. My thanks go to all of those who contributed memories from the past: to John, Mike and David from CHAM, to the team at CHAM-Japan led by Zuwei Kong, to Murray, Vladimir, Allen, Jalil and Frank representing our Agents and to Bob Hornby who is a valued long-term PHOENICS User and source of Newsletter contributions. Thanks also to Jelena Srebric and her team from Penn State an institution which was one of the earlier members of the PHOENICS User Club.

Technical contributions are now sought for the Winter Edition of the PHOENICS News which will return to its more usual format.

5) Coming PHOENICS Events

Name	Event	Date	Information/Contact
CHAM	9th Australian Heat &Mass Transfer Conference Monash University Melbourne	Nov 2-4 2011	Professor Spalding will lecture Nov 2 on "Mapping Turbulence and Combustion; Populational CFD"
CHAM	PHOENICS Training Course	Nov 22-24 2011	sales@cham.co.uk
CHAM Japan	PHOENICS User Conference	Nov 25 2011	Tokyo International Forum Building 6F Entry free. Contact customer@phoenics.co.jp
ACFDA	PHOENICS Training Course	Dec 12-14 2011	info@acfda.org
ACS	Supercomputing 2011	Nov 14-18 2011	Seattle Washington State
ACS	NDIA Conference	June 2012	Washington DC
ACS	DoD Scientific User Conference		San Diego California
ACADS -BSG	ARBS (Air conditioning, Refrigeration and Building Services)	May 7 – 9 2012	Melbourne Australia

CFD Online

A free online centre for Computational Fluid Dynamics. Share news and experiences with other PHOENICS Users at www.cfd-online.com/forums/phoenics.

All PHOENICS Users are cordially invited to contribute to this Newsletter. Please email articles to cik@cham.co.uk. We look forward to learning about your current PHOENICS work and experiences. Thank you.