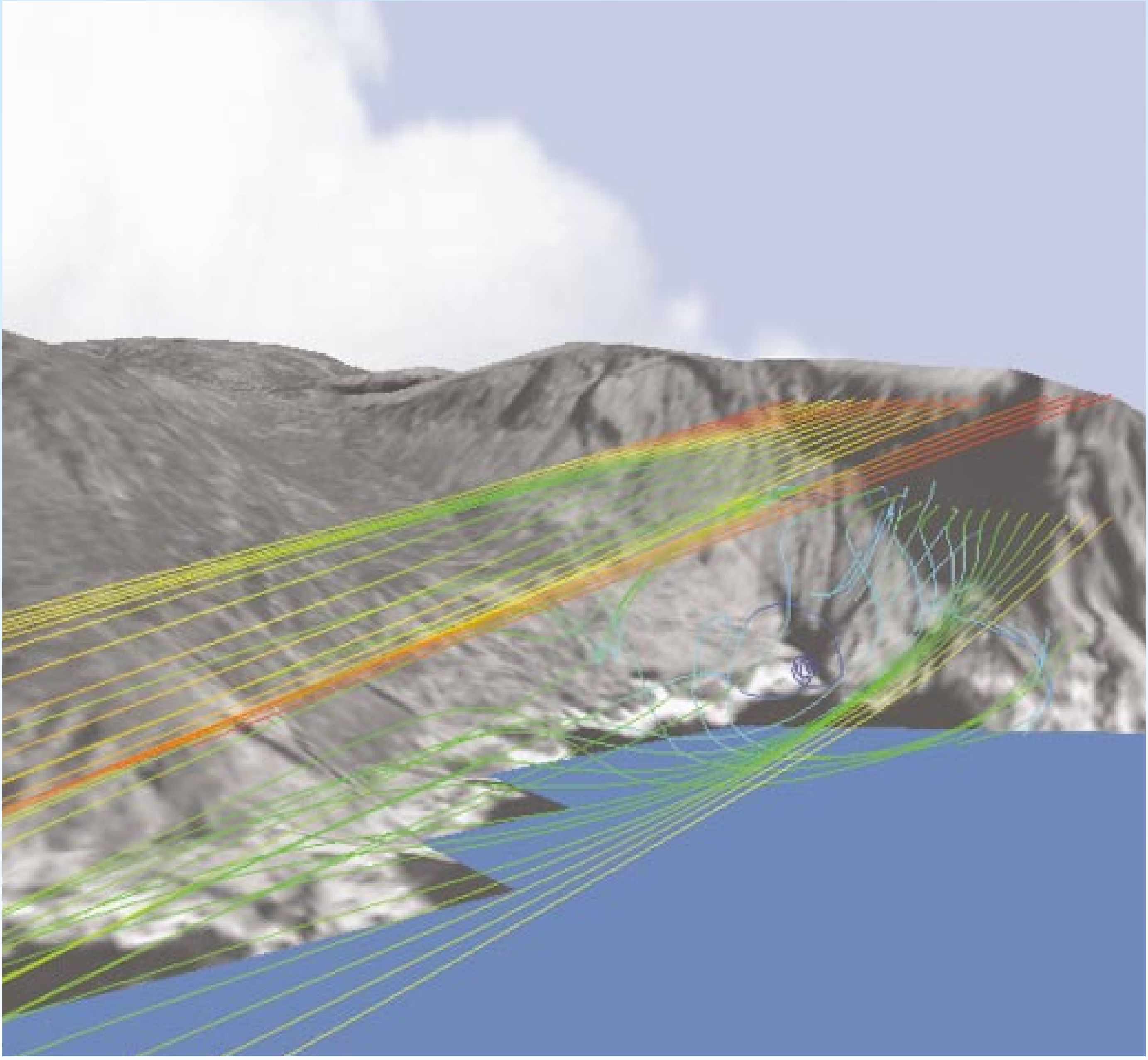
PHOENICS news

Winter 2001

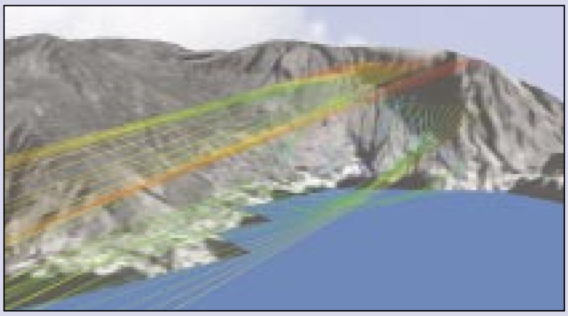


NEWS FROM THE WORLD OF COMPUTATIONAL FLUID DYNAMICS

PHOENICS News

Designed & Edited by Peter Spalding
Comments and articles for future publication may be sent to :-
CHAM Ltd 40 High Street, Wimbledon Village, London SW19 5AU
or emailed to:*pls@cham.co.uk*

Contents



Contacts

CHAM-UK

Bakery House
40 High Street, Wimbledon Village,
London, SW19 5AU, UK.
Tel / Fax:+44 (0)20 8947 7651 / +44 (0)20 8879 3497
Email: phoenics@cham.co.uk / sales@cham.co.uk
Web: http://www.cham.co.uk
Managing Director
Professor D Brian Spalding / Email: dbs@cham.co.uk

CHAM-Japan

406 Kojimachi Intelegent Bldg 4F,
3-5-4 Kojimachi, Chiyoda-ku,
Tokyo 102, Japan.
Tel / Fax: +81 (0) 352 10 93 56 / +81 (0) 352 10 93 59
Email: info@phoenics.co.jp /customer@phoenics.co.jp
Web: http://www.phoenics.co.jp
General Manager
Mr Z Kong / Email: cham-j@phoenics.co.jp

CHAM-MEI

Science-Service-Center (SSC)
Moscow Power Engineering Institute,
14 Krasnokazamennaya Street,
111250 Moscow, Russia.
Tel / Fax: +7(0) 95 362 6821 / +7(0) 95 918 1469
General Director
Dr Alexey Ginevsky / Email: alex@mons.mei.msk.ru
Web: http://www.ssc.ru

CHAM-for North American clients

ACFDA Inc,
81 Rejane Cresent,
Thornhill, Ontario,
Cananda, L4J 5A5.
Tel / Fax: +1 905 709 6821 / +1 905 709 5910
General Director
Dr V Agranat / Email: vladimir.agranat@utoronto.ca
Email: acfda@canada.com

Agents

ACADS-BSG, Glen Iris, Victoria, Australia
Tel / Fax: +61 3 98 85 65 86 / +61 3 98 85 59 74
Email: acadbsg@ozemail.com.au

ACT2000, Seoul, Korea
Tel / Fax: +82 2 21 81 60 94 / +82 2 21 81 60 95
Email: acteng@act-eng.co.kr

Arcofluid, Aix En Provence, France
Tel / Fax: +33 4 42 16 10 20 / +33 4 42 16 10 11
Email: arcofluid@pacwan.fr

BCC, Berlin, Germany
Tel / Fax: +49 30 / ++49 30
Email: if.mueller@berlin.de

C-DAC, Pune, India
Tel / Fax: +91 212 332461 / +91 212 357551
Email: chetan@cdac.ernet.in

CHAM Shanghai, Shanghai, China
Tel / Fax: +86 21 6495 6833 / +86 21 6483 6584
Email: phoenics@public8.sta.net.cn

CHAMPION, Tapei, Taiwan
Tel / Fax: +886 2 2711 0228 / +886 2 2711 0515
Email: jasmine_li@ms54.url.com.tw

Chemtech, Rio de Janeiro, Brazil
Tel / Fax: +55 2 15 32 31 84 / +55 2 12 62 31 21
Email: chemtech@chemtech.com.br

CRC Solutions, Tokyo, Japan
Tel / Fax: +81 3 56 34 58 33 / +81 3 56 34 73 37
Email: a-suzuki@crc.co.jp

Cybron Technology, Selangor, Malaysia
Tel / Fax: +60 37 93 69 20 / +60 37 93 69 84
Email: kinetik@tm.net.my

GEM Systems, Espoo, Finland
Tel / Fax: +358 94 52 28 13 / +358 94 559 47 80
Email: gem.systems@gemsystems.fi

LM Flow Consult, Torshov, Norway
Tel / Fax: +47 2204 0900 / +47 2237 1164
Email: terjet@larsmyhre.no

Logica-PDV, Bochum, Germany
Tel / Fax: +49 234 959 3252 / +49 234 959 3255
Email: m.megahed@pdv-online.de

PMO, Belgrade, Yugoslavia
Tel / Fax:+38 1 1145 8222 / +38 1 1145 3670
Email: zare@rt270.vin.bg.ac.yu

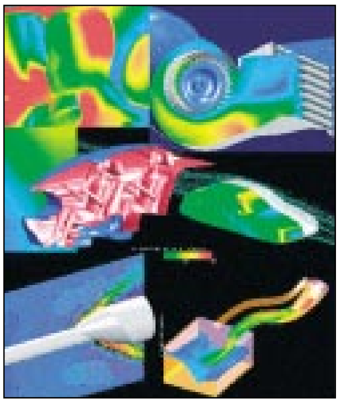
Sybilla, Athens, Greece
Tel / Fax: +30 1 614 1244 / +30 1 614 1245
Email: sybilla@internet.gr

Vortex De Mexico, Tlaltan, Mexico
Tel / Fax: +52 5 622 3320 / +52 5 616 2164
Email: vortex@vortex.iingen.unam.mx

AVL & CHAM
announce collaboration agreement

A technical collaboration agreement has been signed between the Austrian company AVL List GmbH, and CHAM Limited for the development and marketing of CFD software and methods.

AVL, best known for its software and services within the automotive industry through its FIRE code, now plans to expand its operation into the wider CFD marketplace using its new SWIFT general-purpose flow solver. SWIFT uses a finite-volume integration technique and unstructured polyhedral grids. SWIFT's general-purpose CFD capabilities are complemented by the FAME pre-processor and the IMPRESS post-processing packages, with interfaces to a number of other third-party products.



AVL and CHAM intend to build a long-term relationship for the development and marketing of their respective simulation software. For this purpose, the companies are combining techniques and know-how for the benefit of their customers and the advantage of both businesses. In addition to strengthening the simulation capabilities, the efficiency and user-friendliness of both SWIFT and PHOENICS, there will be communication modules between the two packages.

A cross-propagation of technology is envisaged whereby SWIFT can benefit from CHAM's technical expertise through the integration of features such as its unique Multi-Fluid models of turbulence and, amongst other items, the IMMERSOL radiation model.

In turn, AVL will share with CHAM its know-how with respect to arbitrarily unstructured grids, multiphase capabilities for spray formation, propagation and evaporation, and so forth.

AVL personnel will be based at CHAM's Wimbledon HQ during the technology exchange programme.

Alongside this technical exchange, the parties are building a marketing collaboration whereby CHAM will represent AVL's CFD services and products under a 'broad-band' OEM arrangement. CHAM's Deputy Managing Director, Dr Jeremy Wu, says *"These new initiatives will ultimately provide our customers with the highest-flexibility and quality of CFD analysis available anywhere in the world. It is my job to ensure that each and every one receives an integrated and cost-effective solution."*

The 3-year agreement, recently signed between CHAM's Managing Director, Professor D Brian Spalding, and AVL's President of its Advanced Simulation Technologies group, Dr Rainer Gotthard, represents the first stage of an anticipated long-term integration programme.

For further information contact: sales@cham.co.uk

AVL AVL List GmbH, Hans-List-Platz 1, A-8020 Graz, Austria
http://www.avl.com

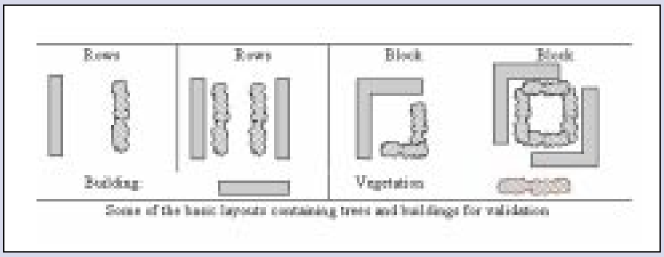
Landscape gardening at Heriot-Watt?

External comfort is increasingly becoming an issue in urban design and masterplanning particularly for open community spaces, such as parks, playgrounds and recreation fields. On many occasions, landscape architects and environmental engineers expect a wind study to be carried out to test their designs, assess the proposed options and optimise a particular one. Conventionally this is done in atmospheric boundary layer wind tunnels, which is always expensive and time consuming.

HERIOT WATT UNIVERSITY

CFD, which is used by design engineers in many consulting firms to model airflow inside buildings, has traditionally resolved wind problems separately for buildings as solid bluff bodies, and simplified vegetation shelterbelts as ideal porous media. However, these two elements and their interaction are always the central concern in environmental design in landscape or masterplanning. Hence it is desirable that computational modelling should integrate the simulation of wind over areas that contain both buildings and vegetation.

Dr F Wang in the Department of Building Engineering and Surveying, Heriot-Watt University has won a three-year EPSRC funded project (GR/R21929/01) with Co-investigator - S Bell, Department of Landscape Architecture, Edinburgh School of Art. This research will explore how vegetation and buildings can be modelled together in a flow domain using a CFD code, using a turbulence model suitable for both bluff bodies and coarse porous media.



Some of the basic layouts containing trees and buildings for validation

A protocol for CFD models is to be developed to simulate the wind over porous media and bluff bodies mounted onto a turbulence boundary layer and will be validated in a range of common urban layouts, including choices of types of vegetation and buildings layouts.

Along with the protocol, a set of guidelines will also be produced for CFD users to operate such a modelling study using one of several major CFD codes.

It is expected that the modelling approach established in this study will be a quick and economical alternative to the conventional wind tunnel test approach for practical use in optimising layout planning by firms with adequate computing expertise.

Dr Fan Wang, email: fan.wang@h-w.ac.uk

Modelling of an end-fired regenerative glass-melting furnace

Alain GRANGERET - Laidlaw Drew Ltd

Two modelling techniques (physical and mathematical) have been used in a collaboration between ARC International and Laidlaw Drew Ltd. for designing an end-fired regenerative glass-melting furnace. The furnace study focused on the combustion space design, port design and burner location. This furnace was larger than previously built by ARC, and hence benefited from modelling before construction.

The acid/alkali physical model is not investigated in this extract - Likewise, although the CFD analysis involved two codes, only PHOENICS is referenced in this extract. A copy of the complete analysis can be obtained from Mr Alain Grangeret at Laidlaw Drew, Email: sales@laidlaw-drew.co.uk

The aerodynamics inside a glass tank are affected by several factors. By experience, the dominant factors are:

- Furnace geometry (crown position, port slope and location)
- Ratio of fuel jet momentum and the combustion product momentum

The second factor is relatively important for the heat release and the flame length.

For a glass furnace, the fuel momentum from the burners is relatively small in comparison with the main air stream momentum. For this reason, the confinement effect is dependent on the geometry and the air momentum. This approach, albeit very simplistic, gives a good result for many practical problems. The velocity profile shows that if the flow is fully developed then it gives a better flame coverage.

The application of CFD is based on the assumption that only the air stream is modelled. By adopting fixed criteria for the air stream (density and viscosity) and a turbulent transport model (K-epsilon model), a set of simple CFD cases can be presented. Based on the results, advanced modelling such as combined combustion and heat transfer is beneficial to determine the crown temperature profile. This takes longer to investigate.

ARC International's first proposal was a furnace with a relatively low crown. PHOENICS hot air stream model clearly shows a short-circuiting flame as shown on Figure 1. The physical model confirmed the predicted results - Figure 2.

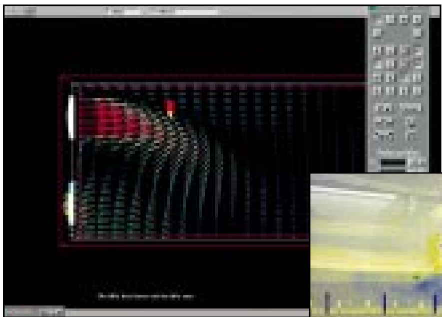


Figure 1 - Lower crown position - Phoenics model

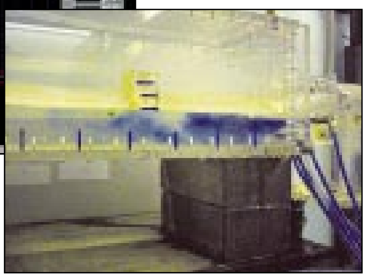


Figure 2 - Lower crown position - acid/alkali model result

The physical model validates the CFD results. The crown is too low and the flame is confined. The combustion space will make it impossible to have a longer flame in this configuration.

Laidlaw Drew proposed to raise the crown. The modelling techniques confirmed that the flame was much improved by such a modification. PHOENICS calculations quickly showed a smooth flow pattern across the furnace - Figure 3. The acid/alkali technique proved that a bigger volume of the combustion chamber was required - Figure 4.

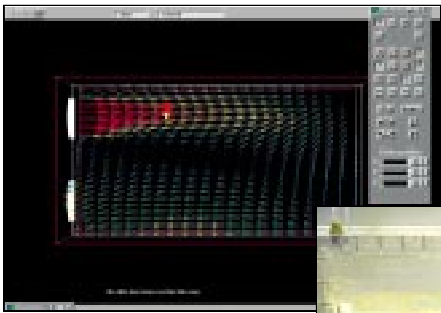


Figure 3 - Crown at the ideal position - Phoenics model

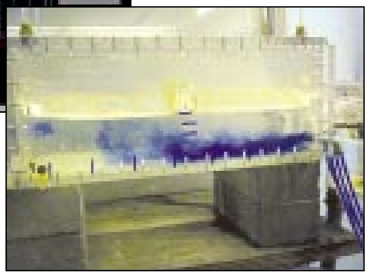


Figure 4 - Crown at the ideal position - acid/alkali model result

The physical model validates the CFD results. The flame is long and reaches the end of the furnace.

Other improvements like burner locations and port design were clearly pointed out by these models. Real furnace operating conditions confirmed all these experiments a few months later with a great success.

Advantages of modelling

CFD requires the simultaneous solving of a vast number of mathematical equations, covering both empirical & fundamental relationships. It also requires experienced users to make judgements upon the validity of the data and this requires the users to have extensive experience of real-life equipment. CFD gives quantitative information at an “average” steady state about combustion chemistry and heat transfer, important factors in the design of furnaces and the prediction of emissions.

Physical modelling has a high level of reliability in representing reality and can therefore be used to validate CFD.

The acid/alkali technique is basically a way of visualising the mixing process. This technique is sometimes ignored in light of CFD modelling. Moreover, modelling by acid/alkali technique can be a good method of investigating stability problems (transient phenomenon). The model should be made with the maximum of flexibility to allow future modifications without additional cost (adjustable crown, port neck moveable and flexible burner location and design). The writer believes that to obtain an optimum design both techniques of modelling should be used to ensure reliability of any results obtained.

Conclusion

The furnace geometry has a great impact on the combustion efficiency. If the flame is better balanced with a better glass coverage then the result will be an increase in glass quality and fuel efficiency with lower gas emissions. The combination of mathematical and physical modelling is a reliable design strategy. Based on the experience and collaboration of glassmakers and combustion engineers, high quality furnace design can be achieved.

Laidlaw Drew Ltd, 1 Lister Road, Kirkton Campus, LIVINGSTON EH54 7BL, SCOTLAND, www.laidlaw-drew.co.uk

Wind Energy
When the terrain gets rough

Dr Arne Gravdahl, Vector AS

Announcing a new PHOENICS-based Special-Purpose-Product (SPP)

Among the new renewable energy technologies wind energy seems to have taken a strong position. The high penetration of wind energy in Denmark and northern Germany is well known, and the growth rate in some of the new markets, as the Spanish market, is impressive. The wind energy technology faces new challenges when moving towards new markets. Typically, turbines are more and more often erected in complex terrain. As the energy content in a wind field is proportional to the wind speed in the third cube, the terrain induced speed-up gives a significant contribution to the energy production. Accurate simulations make it possible to optimise the energy production, and also to reveal unwanted effects, such as areas with high turbulence intensity.

WindSim, developed by Vector AS in Norway, is a tailor-made simulator for predicting local wind fields and dispersion of air-borne pollution. WindSim uses the PHOENICS solver and has interfaces to well-established project tools within the wind energy market. WindSim is designed for complex terrain situations with equally complex local climatology and dispersion scenarios.

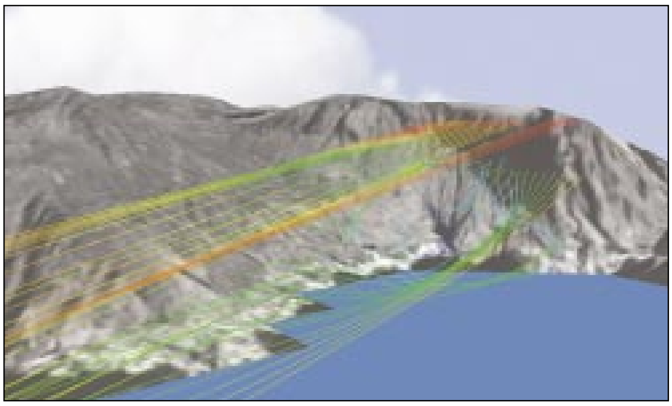


Fig 1 - Circulation zone on the lee side of a mountain (extract from a micro model at Krakenes, Norway)

WindSim is offered by Vector AS as an internet simulation service - http://www.windsim.com. Shortly, WindSim will become a PHOENICS-SPP, a special-purpose product, which can be purchased under licence as a stand-alone system.

Norwegian Wind Atlas

Assessment of wind resources is accomplished by both experimental and numerical means. Typically, experimental data from a limited area are used in a numerical model to assess the wind resources within larger areas.

WindSim has been used in the assessment of wind resources along the entire 2,700 Km Norwegian coast. The project has been undertaken in co-operation with the Norwegian Meteorological Institute. More than 100 detailed models from the southern tip up to the Russian border have been simulated. The simulations are adjusted according to long-term measurements from the climatology stations. Some of the climatology stations had to be represented with very refined models, so called micro models, in an attempt to filter out small-scale effects from the measurement, before being used as input in the coarser models covering the coast. In Fig 1, a typical circulation zone is envisaged on the lee side of a mountain as found in the micro model at Krakenes.

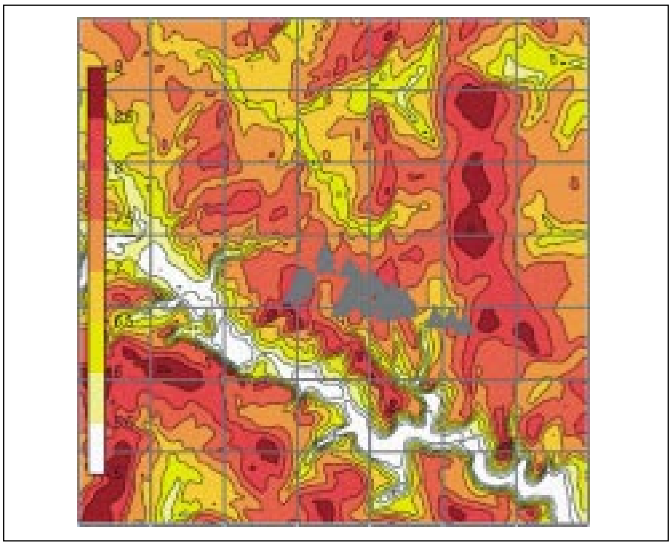


Fig 2 - Wind resource map for an area with complex terrain - Cumbria, UK

The Norwegian Wind Atlas has been financed by he Norwegian Water Resources and Energy Directorate and the Norwegian Research Council. Results can be found at windsim.com under the link “Norwegian Wind Atlas”.

Validation

WindSim has been validated against measurements and other simulation packages at several sites worldwide, both in moderate and in complex terrain. (Fig 2 shows a site with complex terrain located in Cumbria, UK - part of a validation test undertaken for Renewable Energy Services Ltd, UK.

WindSim uses various digital terrain data in the wind and field calculations and for visualisation purposes. The code has been validated against meteorological data on both meso and micro scales.

More information and validation examples can be found by browsing the Vector AS web site, www.windsim.com, or by contacting CHAM’s Sales Dept: sales@cham.co.uk, or finally through to Dr Arne Gravdahl directly via email: gravdahl@vector.no

What's New in PHOENICS-3.4

D Brian Spalding outlines the features of the latest release

PHOENICS 3.4 is now available for delivery. Some of the highlights of this latest release are:-

1) IN-FORM PHOENICS was the first CFD code to allow users access to Fortran subroutines which they could edit. For those preferring just to express their wishes by formulae in the Q1, CHAM created 'PLANT' which turned formulae into accurate Fortran, compiled it, re-built the EARTH executable, and carried out the simulation.

PHOENICS 3.3 added a 'PLANT-menu' to make formula-writing easy. However, a compiler and a re-compilable version of PHOENICS were still needed which meant an additional cost.

In-Form does what PLANT did, and more, but without Fortran, compilation, re-building or cost. In-Form has enormously increased the simulation capabilities of PHOENICS. For information and examples, see www.cham.co.uk/phoenics/d_polis/d_enc/in-form.htm.

2) SHAPE-MAKER Since the beginning of VR, PHOENICS has been supplied with objects (described by .dat files) which users could employ in their virtual modelling. But there were never enough; and users had to turn to solid-modelling packages, or to home-made Fortran programs, to create what they wanted. This is no longer the case. PHOENICS 3.4 contains a stand-alone Shape-Maker program which enables users to create objects, and to see them as soon as they are created. Shape-maker handles both the creation and display of objects unlike the VR-GEOM program in version 3.3.

3) MANAGEMENT BY BUTTONS PHOENICS-3.4 provides a radical new means of activating PHOENICS modules: the PHOENICS Manager. This offers window-panels containing large labelled buttons, with 'hover-help' to describe their functions. Red buttons elicit information', grey buttons initiate actions, and green buttons bring new panels to the screen. Consequently, there is no longer any need to remember, and then key in correctly, any PHOENICS commands. Just press the button. Moreover, the Manager is easily customisable. Users have only to add sub-directories to the tree and place in each a few line buttons.txt files; then whatever display or action they desire is 'buttoned up'.

4) VR-ENHANCEMENTS TO EDITOR AND VIEWER The VR-Editor and Viewer enhancements are too numerous to be listed; the highlights are:

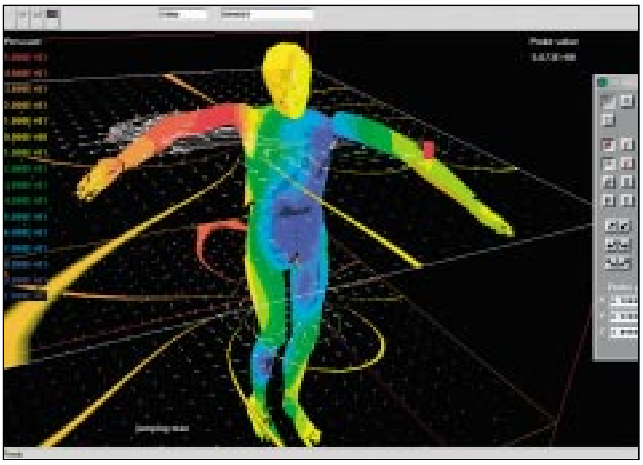
- The ability to plot contours, eg of pressure or temperature on the surface of a VR object;
- The ability to draw streamlines through fine-grid regions embedded in coarser grids.

In addition, there have been many behind-the-scenes improvements, such as the sealing of 'memory leaks' which sometimes caused the program to 'hang' when started and stopped frequently.

CHAM is confident that many users will conclude that the update to PHOENICS 3.4 is worth making for the VR-enhancements alone.

5) GOAL-SEEKER: THE INPUT OPTIMISER PHOENICS-3.4 is being delivered with a new 'goal-seeking' feature which enables so called 'inverse problems' to be solved, such as the search for the constants in a formula which will best fit prescribed experimental data.

What happens is that PHOENICS performs 'multi-runs' and at the end of each the goal-seeking part of EARTH compares the predictions with the experiments, and then adjusts the constants in such a direction as will make the agreement better.



Moving bodies - Dancing Mannequin Example - a fun demonstration of the moving bodies feature within PHOENICS

Goal seeker is new, therefore CHAM cannot yet report extensive achievements. However, its potential is great so it is being provided for interested users to try.

6) PARSOL PARSOL, the means of handling solid bodies which intersect cell edges between cell corners, has been made more robust and accurate. The developments have been driven, in part, by CHAM's concern with flows in and around moving humans where the smoothness of the contours is achieved despite the coarseness of the grid. CHAM's progress is rapid in this sector.

7) PARALLEL PHOENICS Two-processor PC's are not much more expensive than single-processor ones. CHAM has therefore paid particular attention to ensuring that the parallel version of PHOENICS performs well whether the operating system is Linux or Windows-NT.

If a 2-processor machine is not asked to do anything else at the same time, Parallel-PHOENICS runs for many problems almost twice as fast as sequential PHOENICS on one of them. The small price differential must surely make 2-processor parallel PHOENICS a good bargain for many users.

8) DBOS When PHOENICS for PC's first became popular, the preferred compiler was ftn77. Although PC-PHOENICS has been supplied in recent years with Digital (now Compaq) FORTRAN compilers PHOENICS 3.4 is being supplied in two versions, Digital/Compaq and Salford/DBOS. It is recommended that whoever wants to enjoy the different advantages of both should order both. The former has the better graphics; the latter has better text and speed of compilation but will not work with NT.

9) MIGAL The larger the grid size the longer the computer time, as all CD users are aware; and it is also known that multi-grid solvers can significantly limit the increase. That is why CHAM and Michel Ferry R&D have collaborated to attach the latter's MIGAL multi-grid solver to PHOENICS. MIGAL has been demonstrated, for large problems, to effect great time reductions see: www.cham.co.uk/phoenics/d_polis/d_enc/migal/enc_mig.htm

Parallel PHOENICS by Dr Nikos Baltas

Parallel PHOENICS3.4, is now available on 2-processor PC's and PC-clusters running under LINUX and Windows 2000. It is now possible to take advantage of the low-priced 2-CPU PC's, by running Parallel PHOENICS and achieve a speed-up factor of almost 2 for many problems.

Benchmark results are shown in the Figure, for the turbulent flow around a ship hull. This is a BFC problem with a 150K grid size. The benchmarks were performed on a 3-node Win2000 heterogeneous cluster, consisting of INTEL Pentium III processors with varying clock speeds (866 MHz, 900 MHz and 1GHz). Each node consists of 2-CPUs and they were connected via a fast Ethernet switch to form a computing cluster. Communication between nodes/processors is done using the message passing interface MPICH.NT.1.2.1.

contiunes on page 7

Grid-Generation Update

Dr Peter Bailey reports

Peter Bailey reports upon the latest upgrade to CHAM's Body-Fitted-Cordinate (BFC) mesh-generator to Windows-style menus and user-friendly data import.

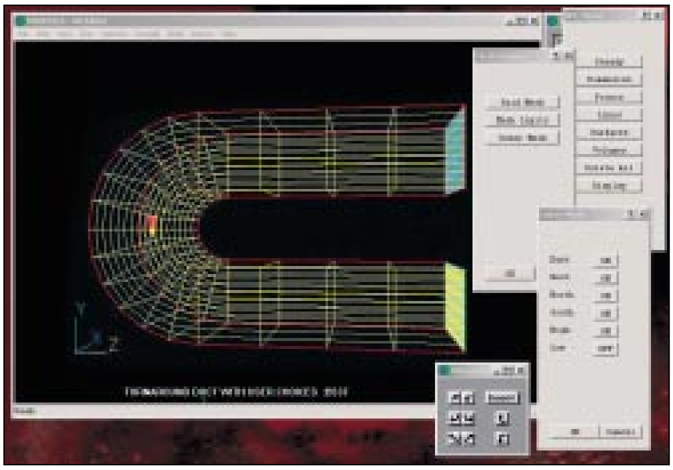
The PHOENICS interactive modelling software and graphics for the BFC method of modelling has been extensively modernised and improved. As of Winter 2001, the work is nearing completion.

The BFC method, long-established in PHOENICS, has now been revamped to use modern Windows-style menus, OPENGL graphics for better hidden lines and surface removal plots of the model, plus many user friendly improvements and bug fixes.

Users can also still generate and import BFC meshes using third-party packages, such as ICEM, GeoGrid-CSI and FEMGEN; however the inbuilt PHOENICS BFC feature has been revitalised .

The improvements to the PHOENICS BFC modelling code include the following:

- **WINDOWS MENUS** to run with WINDOWS operating systems on a PC.
- **WINDOWS-style MENUS** to run with non-WINDOWS operating systems on machines other than PC, e.g.DOS, UNIX, LINUX, etc.
- **MOVABLE POP-UP MENUS**
- **USER FRIENDLY DIALOGUE BOX TYPE MENUS**, + QUICK-CLICK ICONS for DYNAMIC ROTATION, PAN and ZOOM of PLOTS.
- **OPENGL GRAPHICS** used with WINDOWS operating systems on a PC.
- **MORE ACCURATE** Hidden Line and Surface Removal effects with plots of the model, making viewing complex 3-D models clearer to understand.
- **LIGHT SHADING** option. This makes plots of the model look more realistic, which is not only useful for presentation in reports, but also when viewing complex 3-D models.
- **ON-LINE HELP MESSAGES** are now provided at the click of the mouse for each option in the BFC menu.
- **EXTENSIONS for MORE COMPLEX, LARGER MODELS** PHOENICS has long been able to handle large, complex models involving millions of cells. This is true of both the BFC and PARSOL methods, but some of the geometry-modelling tools for the BFC method had some limits which became awkward in some cases. The previous limit of 999 Points, Lines and Frames with many of the related options, has now been raised up to 2.56 million.
- **EXTENSIVE NEW CHECKS for BAD DATA** entered by the user, together with EXPLANATORY ERROR MESSAGES.
- **BUG CORRECTIONS and OVERHAUL** The opportunity has been taken to remove one or two identified during a recent quality control review. These have now been corrected in a thorough overhaul of the coding.
- **TERMINOLOGY and OPTION NAMES** revamped to be more understandable. The terminology of some of the operations and option names has been changed to be more consistent with modern CAD and Engineering conventions.
- **NEATER, SIMPLER, SPLIT UP MENU LAYOUT** A number of the old menus were rather complex and cluttered to look at, with too many options and information. These have been sub-divided into simpler, smaller menus, each with fewer options.
- **A VAST NUMBER OF DIFFERENT APPLICATIONS** can now have their boundary conditions set up and plotted.
- **SOME EXTRA OPTIONS and FEATURES** Whilst the development emphasis concentrated upon "re-styling" BFC's, the opportunity was taken to add extra options, including:

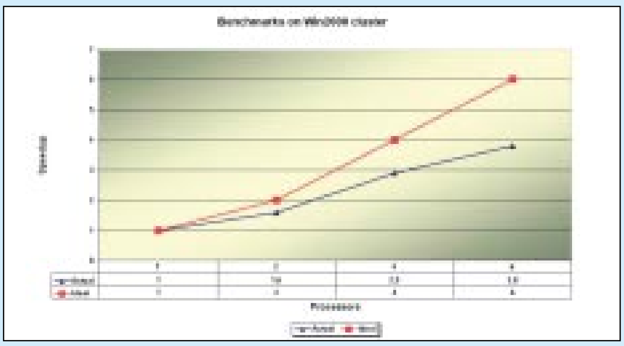


The new-style BFC menu

DATA SHOWN in MENU FORM, for the MODIFY SUB-BLOCK option. Before, when a user wished to modify a Sub-Block operation, the Sub-Block operation was shown as a rather complicated command line on the screen. Now the data is shown in a Windows-style menu form.

NEW SPLIT LINE OPTION The user can now split a line at a specified parameter, e.g. 0.5 for halfway along the line, or 0.25 for a quarter of the way along the line. This can be useful when breaking down geometry imported from a CAD system, or if the user changes his/her mind about how to do the modelling. Straight Lines, Circular Arcs, or Spline Curves can be split in this way.

For a full breakdown of the improvements within the BFC upgrade to be included with PHOENICS-3.4.2, contact Dr Peter Bailey, email: pb@cham.co.uk



It is very easy to add more PCs on the cluster, by connecting them via the ethernet switch and installing the MPICH.NT software.

Parallel PHOENICS scales well on larger systems, and this has been demonstrated on a LINUX Beowolf cluster with 32 nodes.

Dr Nikos Baltas, email: nb@cham.co.uk

1, 2 & 3 dual-processor system performance figures

Studying stratification in ventilated enclosures

K.Pikos and R.K.Calay report on their experiences with simulation vs modelling

Stratification effects are dominant in single cell buildings and influence the efficiency of ventilation and air-conditioning systems. Efforts are generally made to de-stratify the flow to achieve a uniform air temperature and to reduce the heating load of the building.

However, stratification effects can be used by design in air-conditioning systems to reduce the cooling load of the building; and in the design of ventilation systems to achieve better air quality. Understanding the influence of the stratification is also important for displacement ventilation systems. In enclosure fire problems, the spread of rising smoke at a certain height above the floor is affected by stratification.

Very little information on stratification is available in relation to buildings. CFD offers an efficient way to study such stratification, but there are issues that carefully need to be considered relating to: choosing appropriate boundary conditions, mesh resolutions and turbulence models, for flows dominated by buoyancy and stratification.

Fig 1 Cross-sectional geometry of the test model

The present study simulates buoyancy-dominated flow using PHOENICS, which leads to stratification in an enclosure. The geometry of a simulated room environment is depicted in Figure 1. Temperature differential is created across the height of the room to model stratification. Air supply is through inlets, floor and ceiling levels and an exhaust duct is located on the right wall. Different arrangements of the exhaust height, inlet velocity and temperature potential are studied to evaluate its effect on velocity and temperature distribution and formation of stratified layers in the room

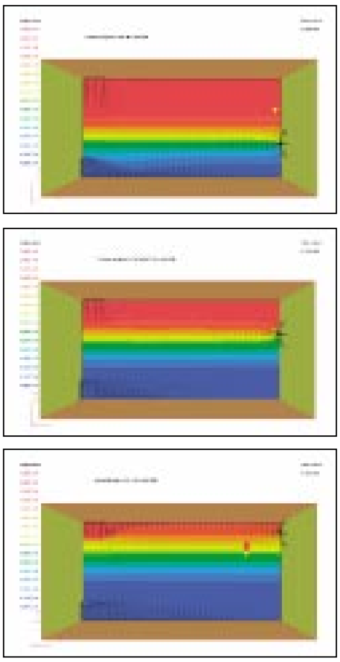


Fig 2a, 2b, 2c Temperature distribution & velocity vectors in Z-X plane at y=2.5 for different exhaust heights

Initially, a standard k-e turbulence model is used to predict distribution of air velocity and temperature and turbulent kinetic energy in the room. In stratified shear flows the modelling of vertical disturbances is most important in the evolution of turbulence. Figures 2 a, b and c show simulated flow-field and temperature distribution for three extract heights, 0.8, 1.6 and 2.2m. The influence of the extract location on the formation of stratified layers is clearly observed and is directly correlated to the height of the extract. Figure 3 shows the effect of increasing the supply velocity from 0.2m/s to 0.8m/s. Comparing Figure 2b and Figure 3 it is clearly seen that stratified layer becomes unstable in certain locations across the room when velocity is increased. Figure 4 shows the effect of increasing the temperature difference.

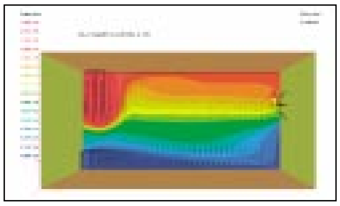
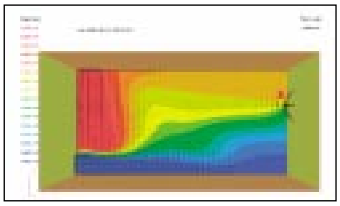


Fig 3 Temperature distribution & velocity vectors in Z-X plane at y=2.5 for a different inlet velocity



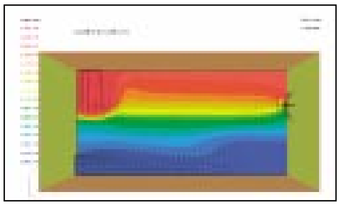


Fig 4 Temperature distribution & velocity vectors in Z-X plane at y=2.5 for different inlet temperature

Further work will include time dependent simulations to model the collapse/evolution of turbulence; and the standard approaches used in room ventilation modelling will be evaluated. It was concluded that the different buoyancy extended k-e models should be used to model stable and unstable stratified flows. It is very important to validate experimentally any new model that is implemented in the code.

The Fluid Mechanics Research Group has access to an excellent experimental facility situated in the ACME department that will be used for validating some of the CFD results. The environmental chamber (5.6m x 8m and 2.52 m high) is one of the largest in the country and provides ideal conditions where experiments require controlled environmental conditions. The room can be configured for many inlet and extract locations, flow rates and temperatures. The plant is equipped to reach temperatures within the chamber of less than -40C, and in excess of 50C, with a full air handling system with chilled water-cooling plant and 100kW electric heater battery. Thermostatically controlled electric, under-floor heating is also provided. A sustained, stable operational temperature within 2C can be achieved within the environmental chamber.

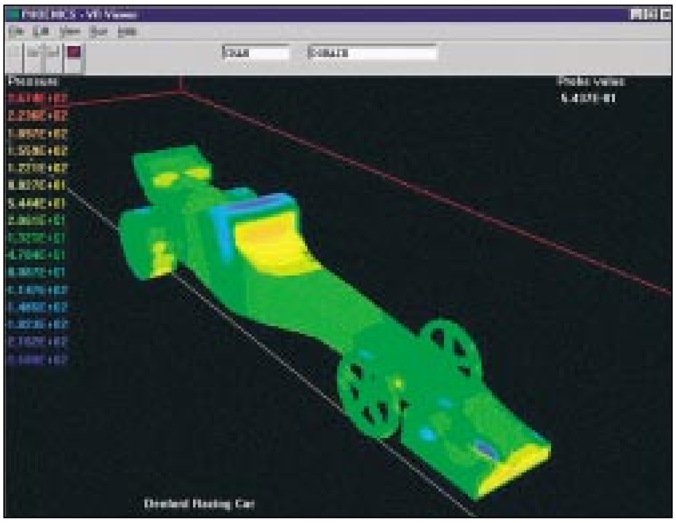
A two-axis computer controlled, robotic, traversing system currently carrying 16 analogue data channels, allows the instrumentation to be remotely positioned in any part of the chamber. Solid state temperature sensors and constant current thermistors for velocity measurements are available. The experimental facility can be used to validate and compare CFD simulations for HVAC applications in buildings, aerospace and automotive fields.

K.Pikos and R.K.Calay, Fluid Mechanics Research Group, University of Hertfordshire.

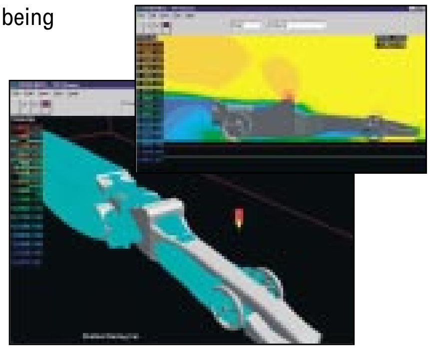
For more information contact: Dr R.K.Calay,
Email: r.k.calay@herts.ac.uk

PHOENICS – the winning formula for schools

PHOENICS will be adopted as part of the "F1 in Schools Challenge" for 2002. The Challenge, sponsored by amongst others, Denford, BAE and Jaguar, was created in 2001 to raise the profile of engineering and manufacturing within secondary schools and colleges.



All schools in the UK are being invited to participate in the creation of mini-F1 CO_2-powered model racing cars, for entry into a Grand Final at the end of each year. The entrants are particularly encouraged to use CAD and VR software tools during the design process prior to construction.



Flows around an example F1 design

Utilising CAD-design software for these mini-racing machines, they will be beta-tested in the PHOENICS "Virtual Wind Tunnel" before the favoured prototypes are constructed and physically tested.

The F1 in Schools programme is being coordinated by Heather Hawthorne of Denford Ltd, email: hhawthorne@denford.co.uk and further details of the Challenge can be found on www.f1inschools.com. See us on Stand Z90 at the BETT 2002 exhibition at Olympia from 9-12th January 2002.

CHAM participates in CODE Technology Programme

In July, CHAM met with representatives of the Finnish "CODE" Programme concerned with technological research and development funding in Finland.

The CODE delegation included members from Abo Akademi University, Kvaerner, and "Tekes". Tekes, the National Technology Agency of Finland, operates under the Ministry of Trade and Industry and sponsors joint research activities. One aim of the CODE Programme is to strengthen international co-operation between Finnish developers and top researchers.

The prime objective of the CODE Programme is to devise comprehensive and accurate mathematical models of furnace processes in order to get better tools for combustion process design and development. Accurate modelling of combustion is considered to be the key to achieving good boiler and furnace design and to resolving any potential or actual operational problems in equipment.

The furnace processes being researched include fluidised bed and pulverised fuel combustion, recovery boilers and grate furnaces, and metallurgical ovens as well as liquid and gas burner combustion. PHOENICS will feature as part of the development work within CODE for modelling fluid dynamics.

Several areas of co-operation were identified and a mutual letter of understanding has been signed by the parties.

It is intended that CODE researchers will implement their own sub-models into PHOENICS with CHAM's assistance. Secondly CODE researchers will formulate the problem for modelling using inbuilt features within the code and utilising specialist modelling techniques such as CHAM's unique MFM (Multi-Fluid Models of turbulence) methodology.

Other comprehensive submodels will be constructed including those for:

- radiative heat transfer
- turbulence-chemistry interaction
- fluidised bed hydrodynamics
- furnace slagging & fouling
- emission issues (especially for difficult fuels and fuel mixtures).

In October, Professor D Brian Spalding addressed the CODE Steering Committee and the CODE membership during its annual meeting held in Teisko, near Tampere, in Finland.

Further details can be obtained from the CODE Programme Co-ordinator: Kari Koskinen email: kari.k.koskinen@fortum.com or from Peter Spalding at CHAM, email: pls@cham.co.uk

PHOENICS AWARD

The Year 2001 PHOENICS Award for the best CFD project of the year goes to Mr Joel Davison, for his major project report "CFD Simulation of Flow in an Engine Duct".

Joel receives a BEng in Aerospace Engineering with 1st Class Honours. He remains at the University of Hertfordshire as a Research Student sponsored by Skanska Cementation (UK) Ltd.

"An excellent piece of work", says Professor Brian Spalding. The report has been submitted for publication into the PHOENICS Journal.

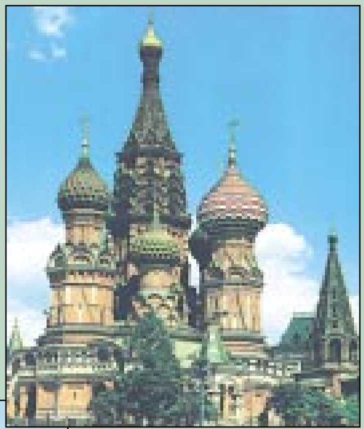
Further details about this, and other initiatives at the University of Hertfordshire, can be obtained from Professor A E Holdo, Email: a.e.holdo@herts.ac.uk

Conference News

May 2000 saw a gathering of 100 or so PHOENICS users from all over the world. The 4-day conference sponsored by HP Invent was a great success, and we hope to repeat the experience in 2002. Offers were received from many institutions to host this next meeting and we deliberated a long time before making our decision.

The 2002 conference will be held in Moscow, and co-hosted by our friends in the Science Service Centre located in Moscow's Power Engineering Institute.

Locating in Moscow should permit a greater number of our more remote users to attend than has previously been the case, and we therefore hope to welcome participants from all over Russia in particular.



St Basil's church

Lenin's Library

The conference language will be English as the programme will include presentations from PHOENICS Users from all over the world, as well as papers presented by CHAM on features of PHOENICS regarded as being of special interest to the delegates. There will be the opportunity for "hands-on" experience during instruction course sessions (in both Russian & English). There will also be a poster session alongside oral presentation sessions, as well as an exhibition area with stands displaying related third-party software products.

As a venue, Moscow offers many attractions and for those of you with "accompanying persons", a social programme will be arranged for those who do not wish to attend the technical sessions.

As usual, we will endeavour to keep the costs down, and a block booking will be made for air travel from the UK. But some of last year's participants may be grateful to learn that no international coach journey is planned this trip... we want our clients to arrive before midnight this time! A day-trip is planned, however, so you can't quite get away from coaches.

Further details of the conference will be announced shortly. If you have any questions in the meantime contact the conference organisers below:

For Russian Participants:
Professor A S Dmitriev, SSC, email: das@ssc.ru

For participants from other countries:
Mrs Sylvie Stevens, email: sks894460@aol.com

Preliminary Call For Papers

This is the first announcement for the next International PHOENICS Users Conference to be held in Moscow in September 2002, in conjunction with the Science Service Centre in the Moscow Power Engineering Institute. A draft programme, and details of the parallel exhibition of related software products, will be released before the end of December 2001. If you would like to make a presentation, please register your interest with Mrs Sylvie Stevens, email: sks894460@aol.com as soon as possible, or request general information using the form below.

FAXBACK: +44 (0)20 8879 3497

I am interested in participating at the next International PHOENICS Users Conference to be held in Moscow from 23rd to 27th September 2002.

I understand I will receive a draft programme and details of the conference fees, travel and accommodation arrangements before end-December 2001.

Contact:

Organisation:

Address:

Telephone:

Fax:

Email:
(Very important)

☐ **Send me Conference Details**

☐ **I intend to present a paper**

☐ **I intend to submit a poster**

☐ **I intend to exhibit**

☐ **I cannot attend, but I would be interested to attend a user meeting in my region**

Tick here only if you wish to be removed from CHAM's mailing list ☐

Your FAQ's

by Dr Mike Malin, CHAM User Support

There has been some confusion among several users on how to model fire and smoke movement in enclosures by means of a scalar variable. In this issue of the newsletter an explanation of the modelling strategy is made together with some advice on how to interpret the field values of the scalar variable.

In PHOENICS, the scalar variable C1 (or alternatively SMOK in FLAIR) can be solved to represent the smoke concentration. The obvious ways to introduce a fire are:

1. to have a blockage of the fluid material, usually air, with a heat release and associated source of smoke; or

2. to have an inlet of fluid, carrying with it a smoke concentration and an appropriate temperature (or having a fixed flux of heat instead for any combustion release).

In either case, the units for the C1 variable are to some extent up to the user. The conserved quantity is C1*density, so a natural choice is C1 = mass fraction of smoke, with units of kg/kg, but this is not essential: 'anything'/kg will do, provided that all sources are consistently treated.

Many users choose the first modelling approach above, and use the 'Fixed Value' setting to specify the value of C1 to 1.0 in the fire: C1 values elsewhere therefore give the smoke 'density' (smoke/kg) relative to that in the fire. An alternative is to use the 'Fixed Flux' setting to specify a rate of smoke creation, either for the whole fire or per unit volume. In this way the C1 value can represent a variable for which a creation rate is known (although the absence of a mass source makes this somewhat artificial). Of course, if there are several fires they can have different sources to represent their different behaviour. The C1 value elsewhere in the domain will then represent the cumulative effect of the different contributions. (If necessary, different scalars can be used for the smoke from each fire, say C2, C3 etc. In that way, it is possible to tell how much each one contributes in different locations.)

In the same way, with the second approach the value of C1 carried into the domain by the fluid (combustion product) is often set to 1.0; in that case, C1 field values should be interpreted relative to that (possibly arbitrary) value. Alternatively, a more realistic value can be set so that 'mass inflow rate times incoming C1 value' represents the mass flow rate of smoke created by the fire. (Note that the value of C1 in the fire will be rather lower than the incoming value, because the air in the domain will dilute the smoke as soon as it appears.)

If C1 is defined as a mass fraction (units of kg of smoke per kg of gas mixture), it is possible to derive the local smoke density (units of kg of smoke per unit volume) by multiplying C1 by the fluid density. In general, this requires storage of the density (DEN1) and another concentration variable (say CSMO); then, in Group 19 Section 6 of GROUND, the smoke density is calculated by introducing the FORTRAN statement:

```
CALL FN21(LBNAME('CSMO'),C1,DEN1,0.0,1.0)
```

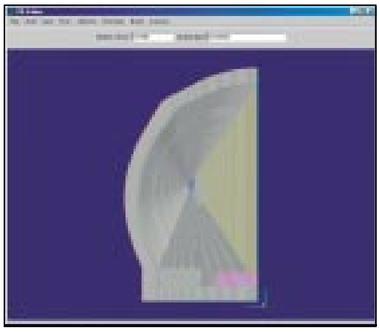
CHAM's user support pages are available to all maintained customers via the web. These can be accessed by clicking on: www.cham.co.uk/website/new/support/level2.htm. You will need an access code which can be obtained from CHAM's Support Team via support@cham.co.uk.

ADELFI

Dr Jeremy Wu reports on the final outcome

The EU-funded "ADELFI" project successfully terminated at the end of May 2001. The project has developed a generic software tool, the PHOENICS-HPC solution, on the Internet and its corporate Intranet for the deployment of web-based, computationally intensive (CFD) applications.

The two and half year collaboration involved 7 partners, Concentration, Heat and Momentum Limited (the project Coordinator), Imperial College of Science Technology and Medicine (UK), Centro Sviluppo Materiali (Italy), Institute National d'Environment Industrial et des Risques (France), GeneData AG (Switzerland), Logware Informationssystem (Germany), and Wella Intercosmetic Gmbh (Germany)



One of INERIS' test case (Fire in a tunnel)

The success of ADELFI stems from the fact that these tools have been evaluated on real applications by users, in particular CSM and INERIS, and tested on a developing commercial service (SIMUSERVE) the moment they became available.

CHAM, through SIMUSERVE, provides the Remote Computing Service (RCS) based the PHOENICS-HPC system. Users may access RCS by connecting to CHAM's website, www.simuserve.com

Simuserve Remote Computing Service

Simuserve RCS using the ADELFI technology

The RCS now offers users a choice of input style. The HTML-style remains available, but a new Desktop System has been introduced for Java-based browsers.

This has also removed the earlier restrictions associated with the HMTL-style, permitting submission of users' own GROUND coding, property data and geometry clip art.

Similarly, whilst the option remains freely to download the pre- and post-processing elements of PHOENICS, users are now able to use these interactive aspects over the web.

Further details about the ADELFI project and access to the RCS can be obtained from Dr Jeremy Wu, email: jzw@cham.co.uk.

Notices & Events 2001/ 2002

CHAM

Mr Peter Spalding, UK
Tel: +44 (0)20 8947 7651

9-12 Jan, 2002	BETT Exhibition, Olympia, London, UK see page 9 for details
TBA Mar, 2002	UK PHOENICS Users Meeting, London, UK
27-29 Jun, 2002	GRACM2002 Congress & Exhibition, LFME, University of Patras, Greece - see http://gracm2002.upatras.gr/
23- 26 Sept, 2002	PHOENICS International Users Conference Moscow, Russia - See page 10 for details

New Appointments at CHAM

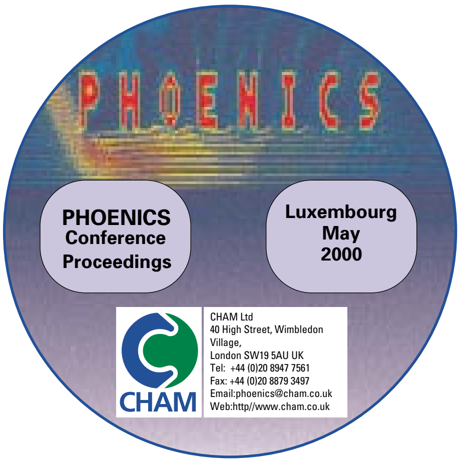
CHAM has appointed several new personnel this year to boost the technical development effort for PHOENICS-3.4 and beyond.

These include Dr Peter Bailey, Dr Nuray Kayakol, Dr Geoff Michel, Dr Wei-Shan Zhang, together with the welcome return of Dr Nick Baltas.

Discover the PHOENICS Discussion Forum at

CFD Online

Why not exchange ideas,
news, information and views via
the PHOENICS Discussion Forum at
www.cfd-online.com/forum/phoenics.cgi)



Order your Luxembourg Conference Proceedings CD Today from Petula Smith, email: ps@cham.co.uk

CHAM for North American clients

Applied Computational Fluid Dynamics Analysis (ACFDA), CHAM's North American Agency, is offering in 2001/2 the following services for Canadian and US PHOENICS users:

Technical support for 'maintained' PHOENICS users

Monthly training courses for new and existing clients

Customized one-on-one training courses

Extended CFD consulting services.

ACFDA

Dr Vladimir Agranat, ACFDA, Toronto
Tel: +1 905 709 6402

ACFDA provides services at discounted prices for clients signing collaborative agreements with ACFDA. Also, clients benefit from joining the 'North American PHOENICS Users Club', where their applied CFD problems are analyzed in detail with the PHOENICS version used by ACFDA in collaboration with the University of Toronto and other North American universities.

For further details and registration information, contact Dr Vladimir Agranat, email: acfda@canada.com / vladimir.agranat@utoronto.ca

Logica-PDV

Dr Mustafa Megahed, Germany
Tel: +49 234 959 3252

Wolfgang Ottow

Logica-PDV welcomes Mr Wolfgang Ottow who has recently joined their CFD department. Wolfgang completed his studies in September 2000 - his diploma thesis dealt with the development of coal devolitisation models and their implementation into commercial CFD codes.

From 1st September 2001 Logica-PDV GmbH's address has changed to: GB20/ Industrial Consulting & Services, Universitaetstrasse 76, D-44789 Bochum. http://www.a-cfd.de.

The telephone, fax and email contacts remain the same as before.

logica pdv

The PHOENICS Journal

is a quarterly publication to promote and exchange knowledge and skills amongst PHOENICS user world-wide. Data input files and FORTRAN routines, for GROUNDstation implementation, are published alongside mathematical models and computational results. Contributions to the journal are subject to review by independent referees.

Price: £140 per year (UK)
£165 / $265 (Elsewhere).
Journal Manager: Mrs Petula Smith
email: ps@cham.co.uk

The PHOENICS Journal is now available to 'maintained' customers.free of charge. It can be supplied to all others via subscription or purchased through the cfdShop at www.simuserve.com/cfd-shop/journal.htm

CHAM Ltd. Bakery House, 40 High Street, Wimbledon Village, London, SW19 5AU, tel: +44 (0)20 8947 7651, fax: +44 (0)20 8879 3497, email: phoenics@cham.co.uk