PHOENICS Newsletter

CHAM

Dear Reader

This Newsletter contains articles relating to the ongoing scientific activities of CHAM and the latest update of PHOENICS.

In addition, there are brief memories of the Company itself – founded by Professor Spalding in 1969.

CHAM started at Imperial College at a time when small commercial entities, involving academic staff members, were seen as beneficial and were encouraged.

Shortly afterwards it was thought there may be conflicts of interest. Companies were encouraged to move from the University into a more commercial environment.

CHAM was one such. It moved from South Kensington to Burlington Road in New Malden. From thence it transferred to its current Head Office in Wimbledon Village where it has remained for over 45 years and now shares its space with an excellent, independent, Bookshop.

This is the last Newsletter I will edit. See page 8 as to what is happening next. It is thanks to all who have supplied articles over the years that our Newsletter exists. It has been good to work with you.

Kind Regards

Colleen Spalding
Managing Director

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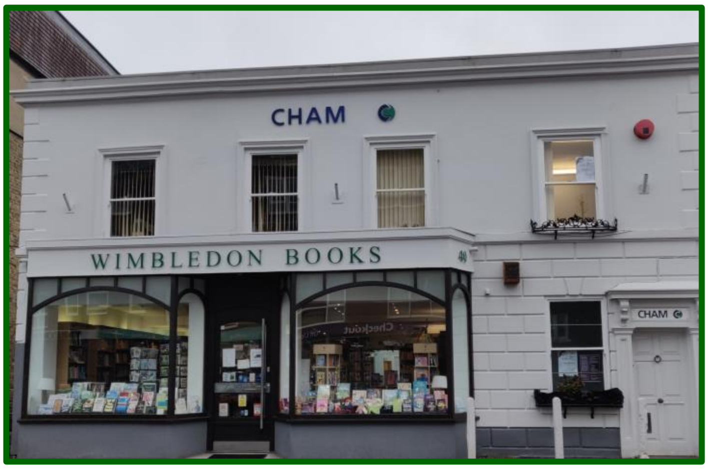
Summer 2023



If you worked at CHAM, have memories of the space, or place, whilst we have been here (or indeed before when part was a bakery and then a laundrette) and would like to share your memories, please send them (in Word) to newsletter@cham.co.uk for use in a subsequent Newsletter. Thank you.

General

CHAM's main asset has always been colleagues who have worked in the company. Brian was the original Managing Director from its inception in 1969 until his death in 2016 (47 years). None of us can match his start date but some can surpass his longevity. I have been with the company for 50 years this June. Peter Spalding was with it for 49 (with a break in the middle) until his retirement end April this year. Mike Malin joined in 1977 (46 years) and John Ludwig in 1978 (45 years). Both of them are still active here.

When I joined, CHAM operated within the Heat Transfer Section (later the Computational Fluid Dynamics Unit) of the Mechanical Engineering Department of Imperial College (Exhibition Road). Most of the work was of an R&D nature involving computer software (often the GENMIX Code). Brian saw the benefits of computers early on which led him to create Computational Fluid Dynamics (CFD) as a discipline – it is now a multi-billion-dollar industry. He also began to create (or have created as he did not code at that time) a series of task-specific codes all of which had acronyms ranging, alphabetically, from AVA to TOPSI.

AVA (Agitated Vessel Analyzer) was of use to the Chemical and Pharmaceutical Industry, TOPSI (Two-Phase-with-Slip-Integrator) was designated "General". In-between, and of more longevity, were CORA (2 & 3), (Combustion and Radiation Analyzer 2D & 3D) to model combustors and furnaces. CVD (Chemical Vapour Deposition) is, in a different format, in use today; as is ESTER (Electrolytic Smelter) used by the Aluminium Industry. FLAIR (Flow Analyser Internal) had its acronym appropriated and became a most popular CHAM subset modelling Flow of Air.

There were FLASH (Flow Around Ships Hulls), HESTER (Heat Exchanger Steady and Transient Analyzer), PLANT (Pipe-Line Analyzer Two-Phase), Stella (Steam Generator Elliptic Analyzer), TACT (Two- and Three-Dimensional Analyzer for Cooling Towers), and more. There was, of course, GENMIX (General Mixing) the source code of which Brian published in a book of the same name.

When Brian was offered the position of Reilly Professor of Combustion in 1978 he moved to Purdue University, West Lafayette, Indiana where he had no programmer. Rather than wait he taught himself to code and started work on what became the first commercial, general purpose, CFD software which, designated PHOENICS, was offered to the market in 1981.

PHOENICS - 2023:
Dr J C Ludwig, CHAM

Steady State Volume of Fluid (VOF)

This will allow certain classes of free-surface flows to be solved steady-state as opposed to the current requirement that all VOF cases are run transient. This should reduce computer time drastically for such steady state flows.

WIND-object upgrade to include Pasquill Stability conditions

This will allow external wind calculations with stratified boundary layers to be performed. This applies to density-differences due to temperature changes and also due to concentration changes, as in the release of a dense gas.

Log-scale Contours in Viewer

For many scalars, eg smoke, the range of values is so large that it becomes hard to plot sensibly. InForm can be used to create a variable which is the log of the solved scalar, but then the contour scale looks strange, as it is the log of the value. The VR Viewer now takes the log itself and still displays the correct scale.

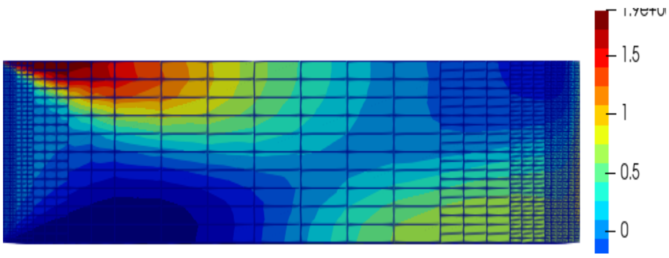
Earth Convergence Monitor – Save layouts

The new ECM allows the various monitor windows to be positioned and sized by the user. This upgrade allows the changes to be saved and used again for another run.

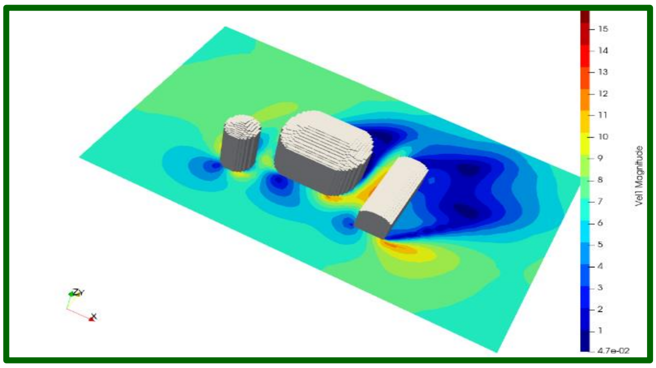
IPSA Extension to include Kinetic Theory of Granular Flow (KTGF)

IPSA has been extended to account for particle-particle interactions by implementing models for the solids stress tensor that are based on the kinetic theory of granular flow. The latter involves solving an equation for the granular temperature, which represents the kinetic energy of the fluctuating particle velocity field. The IPSA-KTGF model will extend PHOENICS-2023 to handle important applications including dense-regime pneumatic lines, riser-, and fluidised-bed reactors. This feature can be operated from the GUI.

UnStructured PHOENICS (USP) Revisions



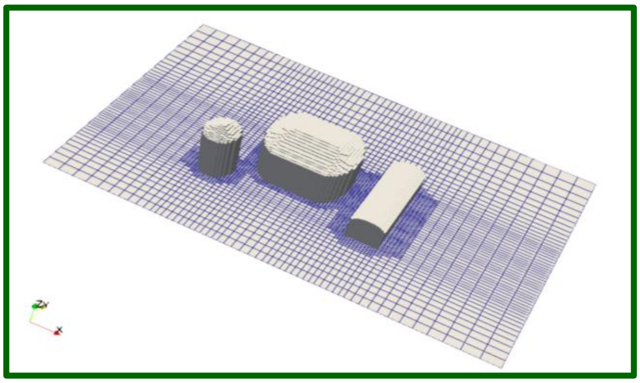
Compressible / High Speed Flow in USP



USP Wind Object Flows

Un**S**tructured **P**HOENICS is being revised to include:

- Physical property formulae used in PROPS file.
- FLAIR Comfort Indices
- Heat source on outside of 198 blockages
- Compressible / high speed flow
- Fire object
- Full reporting of sources in the Result file as in SP
- Wind object. (in progress)
- Display of USP mesh in VRE. (in progress)
- Display of USP solutions in VRV. (in progress)
- Allow for parallel operation. (in progress)
- Realisable K-ε, and k-ω SST turbulence models
- Angled-in / out or equivalent
- Combustion – mixed-is burnt and eddy-breakup.



Phase-Change Material Object for FLAIR

Generalisation and implementation of the PCM model described in the Autumn 2022 Newsletter article by Peter van den Engel of TU Delft.

Improved Pressure-Drop Formulations for Porous Media

It will be possible for Users to select a formula and input the relevant constants to implement more complex pressure-drop correlations (such as the Ergun Equation) rather than having to write InForm.

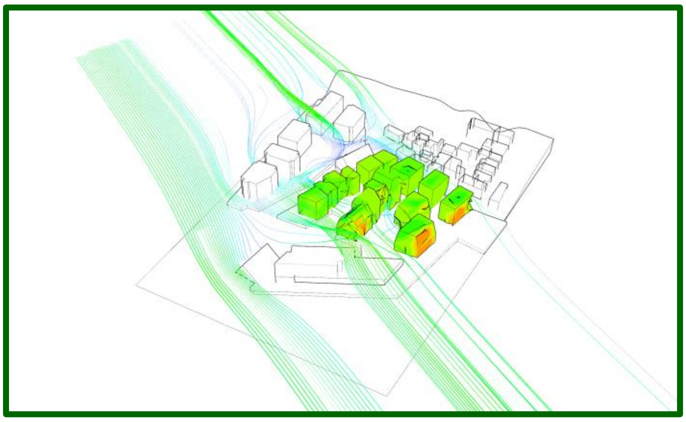
Using RhinoCFD for Pedestrian Wind-Comfort Studies:

Shakil Ahmed, CHAM

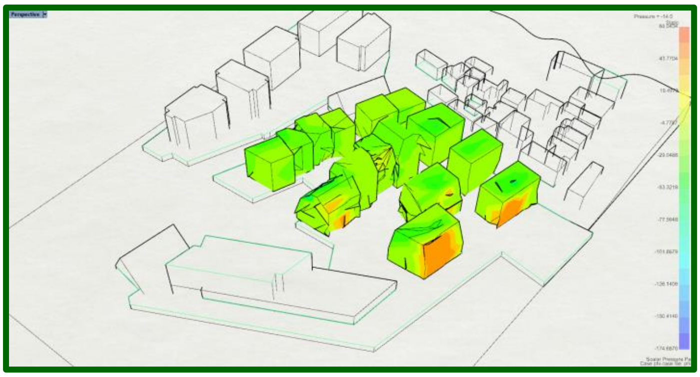
Introduction

In the demonstration scenario shown in the images below wind is passing over a small neighbourhood near a river and RhinoCFD is used to analyse how the wind flows within the street canyons.

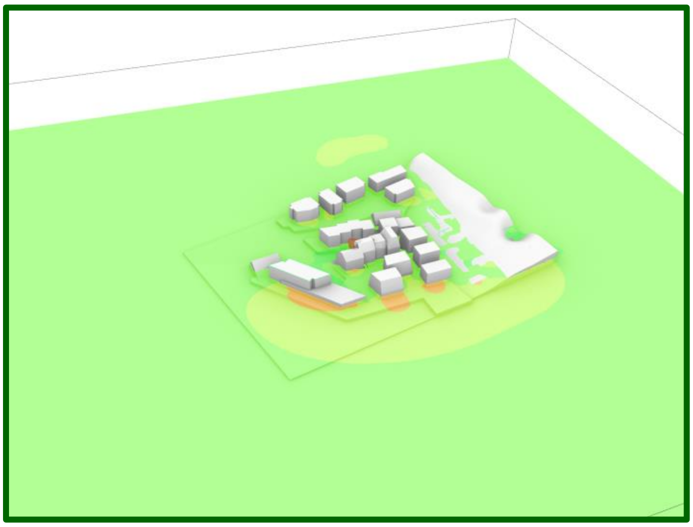
This is a simple demonstration which indicates how, with more detail applied, it would be possible to determine wind comfort for pedestrians, formation of areas with stale air or areas of overly high velocities in the streets.



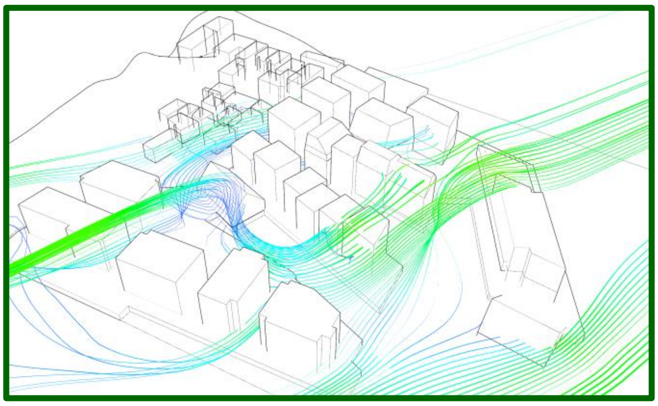
Velocity Stream Lines and Surface Contours



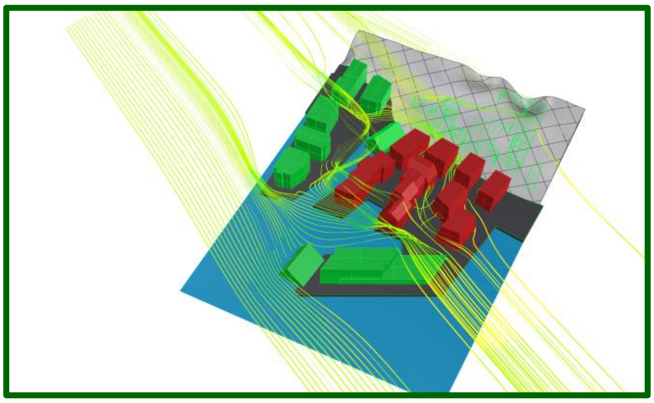
Pressure Surface Contours



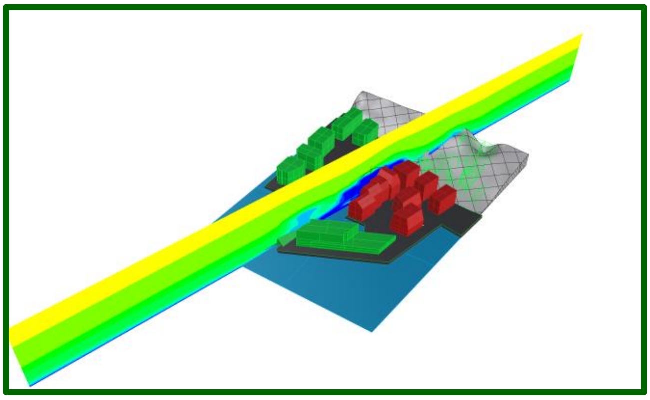
Pressure Cut Plane Rendered



Velocity Stream Lines



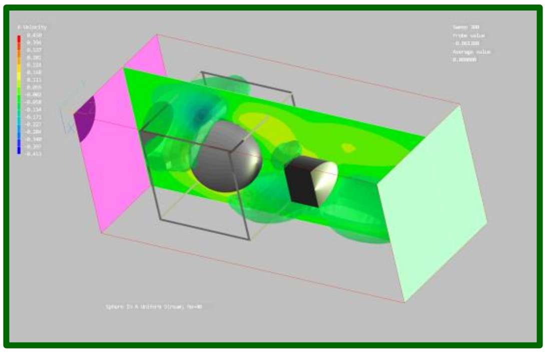
Velocity Stream Lines Shaded



Velocity Cut Plane Shaded

VTK Results

Displaying VTK results in VRE/VRV is being improved.



CFD analysis of different wind shelter configurations for a luxury apartment Building: Frank Kanters, Coolplug, Benelux

For the balconies of a luxury apartment building (15 floors) the most favorable arrangements for the fixed and movable panes in terms of wind protection are to be determined. The influences of gusts, vortex-excited vibrations and aeroelastic instabilities are not the subject of these investigations.

Figure 1 shows a CAD model of the apartment building.

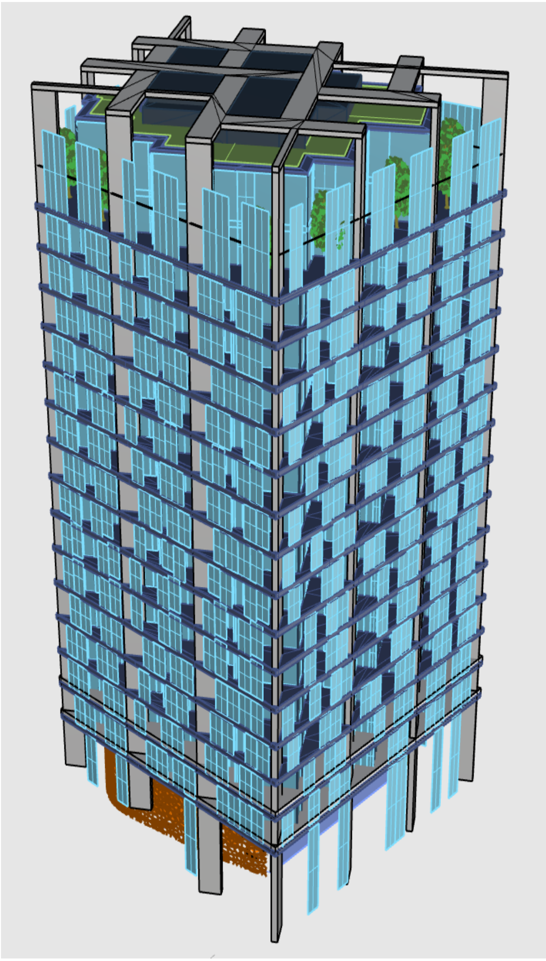


Fig. 1. CAD model of the apartment building.

To minimize the calculation effort, the procedure of calculating protection factors is chosen. A simplified model is created, in which the respective pane arrangement for a balcony with 8 wind directions is considered (see Figure 2).

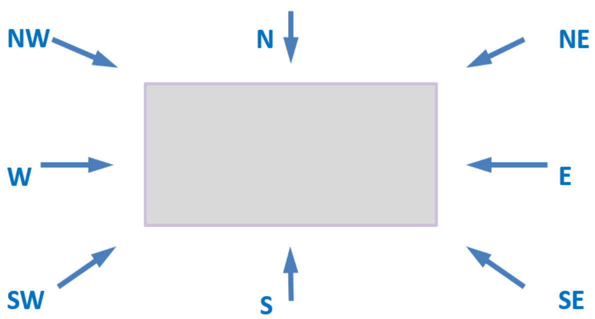


Fig. 2. Wind directions for the test calculations. Wind speed wm = 4.9 m/s

This procedure only serves to compare the different windbreak variants and does not exclude the possibility of deviations in the overall model due to the influence of the surrounding buildings. The assessment of the wind protection results from the comparison of the wind protection factors.

For each wind direction, the protection factors were calculated by deriving the mean air velocities in the occupied zone of the balcony and forming the mean value for the respective wind direction. The protection factor is then calculated as:

$$f_{protection} = v_{m,balcony} / v_{m,Wind}$$

where:
Vm,balcony is the mean value of the air velocity in the occupied zone of the balcony in m/s
Vm,Wind is the value of the wind profile speed at the height of the loggia considered in m/s.

Three variants were examined:
Variant 1: Without any wind protection, neither fixed nor movable elements. Only a balustrade.
Variant 2: the positions of the sliding element available in the model arranged to the right or left of the fixed element, depending on the wind incidence angle (Figures 3 and 4). This corresponds to normal user behaviour.
Variant 3: As variant 1, but with a sliding element at the corners of the building to close the gap between the supporting column and the apartment.

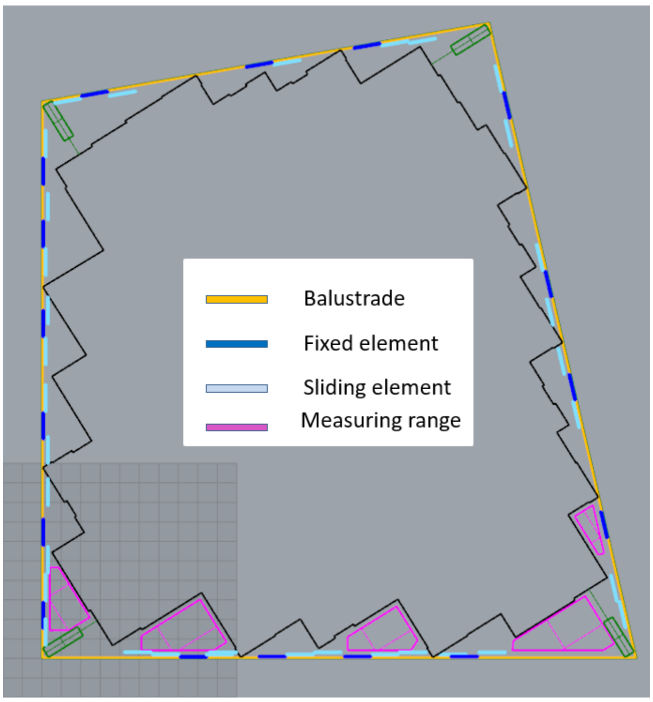


Fig. 3. Example of a floor layout. Every floor has a slightly different layout.

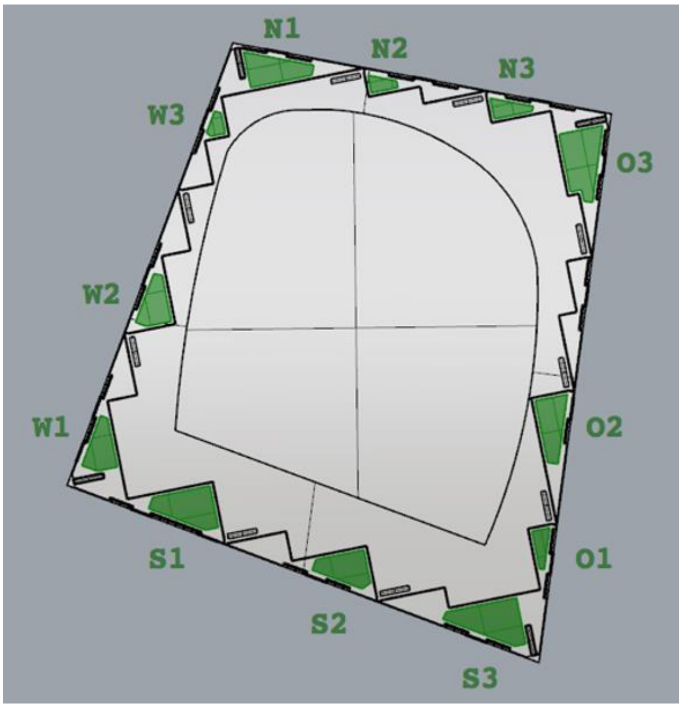


Fig. 4. Numbering of the balconies. Every floor has a slightly different layout.

The PHOENICS model measures 210x210x100m^3 and has twenty-five million cells. The cells in the region of interest were about 10 cm in size. The Chen-Kim K-ε turbulence model was used. Two thousand iterations were needed for convergence on a PC using four cores. The computation time was 16 hours.

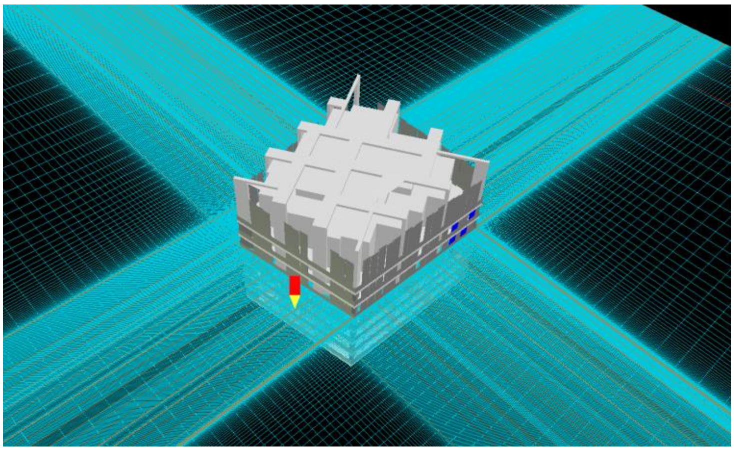


Fig. 5. PHOENICS model with grid.

After running the CFD simulations with PHOENICS for each wind direction, the protection factors for the 3 variants were compared for all balconies. An example of this analysis is shown in Figure 6.

In addition, images were created using the PHOENICS Viewer with scalar and vector velocity distributions around the balconies. This allowed a good visualization of why variants worked well for one wind direction and poorly for another.

The study concluded that there is not one best solution for all wind directions. It did enable the architect to choose the best compromise considering the most common wind direction.

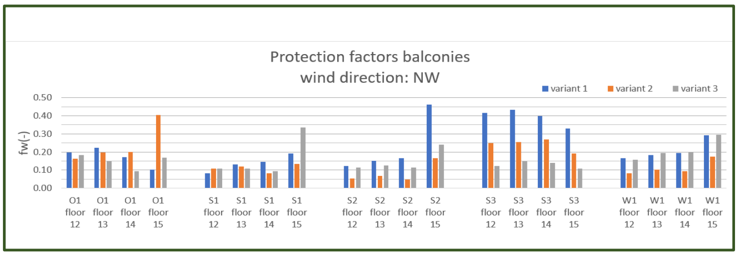


Fig. 6. Comparison of protection factors for different balconies on different floors for the 3 variants.

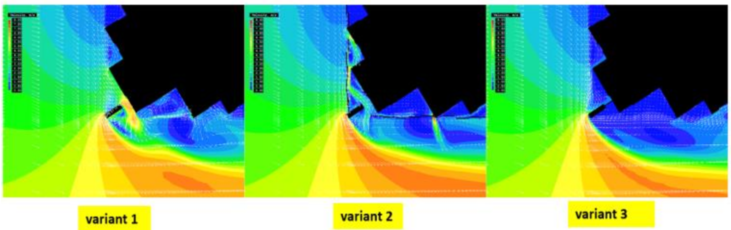


Fig. 7. Velocities at the SW corner of the building for floor 13.

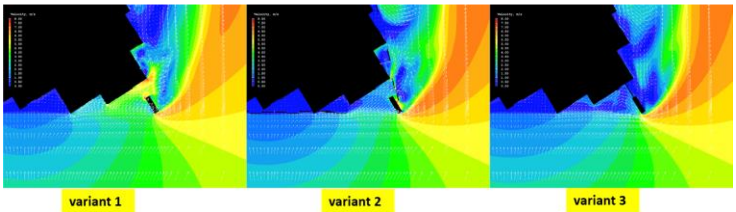
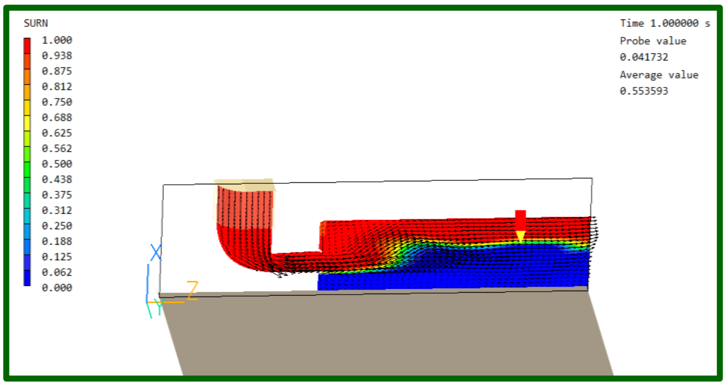


Fig. 8. Velocities at the SE corner of the building for floor 13.

Steady VOF development
Jalil Ouazzani, ArcoFluid, France



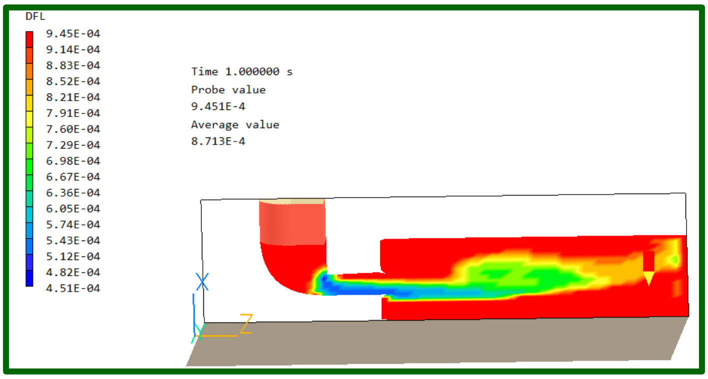
In numerous applications, particularly in the marine industry, where a stationary state of a free surface is sought, the transient VOF method often requires a significant amount of time.

This prolonged duration can be attributed to stability criteria for the color function and the time it takes for surface waves to damp out and produce a steady configuration of the free surface.

To address this issue, we propose a technique that accelerates achievement of the steady state, while minimizing CPU time consumption. Three potential directions were explored to attain this goal in PHOENICS:

1. Solve all equations in a steady manner, except for the colour function, which is solved during each sweep (or every N sweeps) using a false transient approach. This involves introducing a false time step that adheres to CFL and surface-tension restrictions. The temporal discretization and various VOF approximations (such as SEM, THINC, CICSAM, etc) can be applied to the colour function. We investigated whether the existing "gxsurf.for" coding can be utilized, with modifications, or if a new subroutine, similar in nature, needed to be created. The focus is on appropriately discretizing the colour function. The feasibility of this approach can be tested initially using "ground.for" with the existing "gxsurf.for" coding. If successful, a "gsurfsteady.for" subroutine will be created or the current "gxsurf.for" modified. It should be noted that the graphical user interface (GUI) should allow use of the VOF method when the steady-state option is selected, which is currently not the case.
2. Introduce local time stepping for the colour function. The main equations will have a different time step from the colour function, which will possess a local time-stepping variable in space; this necessitates special smoothing techniques.
3. Combine elements from approaches (1) and (2) involving a steady-state formulation for all equations, except for the colour function, which will utilize local time stepping.

The second approach has been developed based on local time stepping. Pressure, velocities, and other scalar quantities are solved using time steps determined by their respective CFL conditions; the colour function adopts a local time-stepping approach depending on characteristics present in each cell. Computation of this local time stepping is implemented in the "gxsurf.for" subroutine. Subsequently, a smoothing technique is employed (similar to that used for the colour function) to smooth out local time stepping, and ensure that the time step does not exhibit significant variations between cells.



News from ACFDA, Canada

Applied Computational Fluid Dynamics Analysis (ACFDA), CHAM's agent since 1998, provides basic and advanced online training courses on the following Computational Fluid Dynamics (CFD) applications: indoor air quality (IAQ) improvement and infection risk reduction, wildfire spread and its interaction with urban structures, outdoor pollution dispersion, two-phase plumes, complex gas-liquid flows, and hydrogen production via electrolysis.

Some customized CFD models for these applications are illustrated at www.acfda.org and briefly described on the webpages:

1. Improving air quality and minimizing infection risks in built environments www.acfda.org/results/Aerosol_Dental1.pdf;
2. Physics-based multiphase modeling of wildfire spread and its interactions with urban structures www.acfda.org/results/Agranat_Perminov_EMS_2020.pdf;
3. CFD modeling of outdoor pollution via two-phase plumes www.acfda.org/docs/Paper_ICONE22-30010_ Agranat_et_al.pdf;
4. Modeling of complex gas-liquid flows www.acfda.org/docs/GLFLOW_Capabilities.pdf including electrolysis stacks for hydrogen production www.acfda.org/docs/ASME2006-98355.pdf;
5. Modeling of gas releases and dispersion for environmental and safety analyses www.acfda.org/results/2014_ASSE-MEC_CFD.pdf.

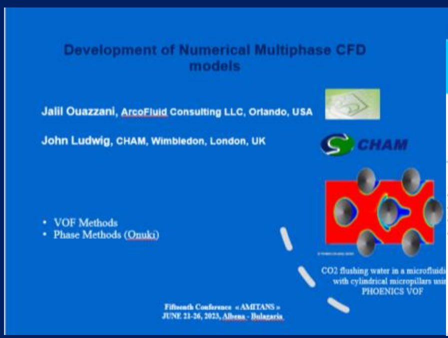
For these applications, ACFDA offers working CFD model templates, training and consulting services. The models are open to users and can be modified using the built-in PHOENICS In-Form capability: https://www.cham.co.uk/phoenics/d_polis/d_enc/in-form.htm. Free webinars are arranged briefly to describe a model of interest. Details are provided during training and from info@acfda.org and vlad@acfda.org.

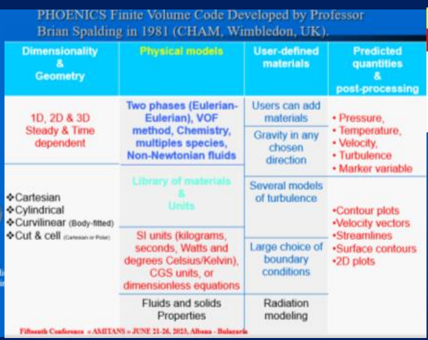
Wimbledon Village has an annual display of windows associated with tennis. This is Wimbledon Books 2023.

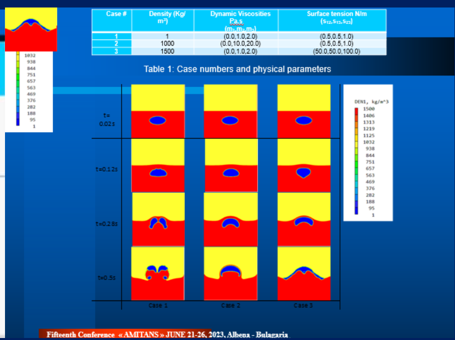
News from Agents:

Dr Jalil Ouazzini gave a presentation at the Fifteenth Conference of the Euro-American Consortium for Promoting the Application of Mathematics in Technical and Natural Sciences (AMITANS), Albena, Bulgaria, June 21-26, 2023.

Three slides from the presentation, co-authored by Dr John Ludwig from CHAM, are shown below. The entire presentation can be accessed at https://youtu.be/XKSEvyizvWQ.







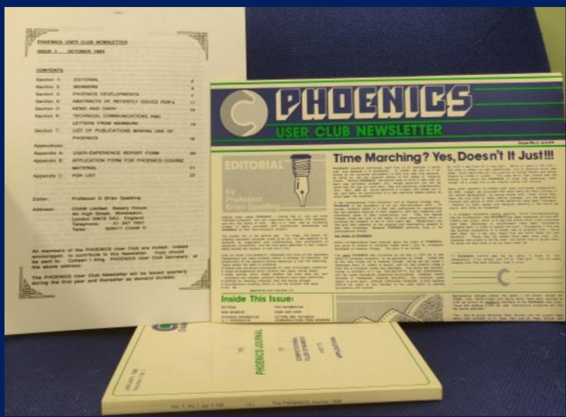
News from CHAM:

This is the last Newsletter I will edit. Having started the original Newsletter for what was, at the time, the PHOENICS User Club (Academic users) it became more general and, from the Autumn Issue, will be edited by William Spalding.

Thank you to all who have sent material for use in Newsletters up to, and including this edition. I Please keep sending contributions to newsletter@cham.co.uk or to William (wbs@cham.co.uk).

I have much enjoyed working with you and editing the Newsletter.

I look forward to reading future copies.



Contact Us:

CHAM's highly skilled, and helpful, technical team can assist in solving your CFD problems via proven, cost-effective, and reliable, CFD software solutions, training, technical support and consulting services. If YOU have a CFD problem why not get in touch to see how WE can help with the solution?

Please call on +44 (20) 89477651, email sales@cham.co.uk or check our website www.cham.co.uk. For PHOENICS on the Cloud (PHOENICS-OTC) call us or contact phoenics.cloud@cham.co.uk

See us on social media sites shown below:

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