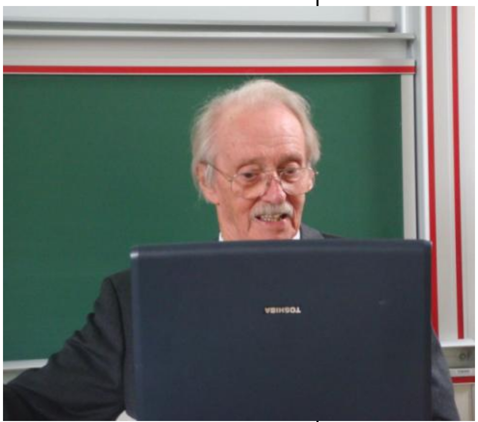
PHOENICS News

Winter 2008/9

Editorial

One of the facilities offered by PHOENICS is its "Relational Input Capability". What does this mean and what is its importance?

When designing the layout of a room, for example, it is often necessary to ensure that the positions and sizes of objects conform to certain rules; for example doors must fit aperatures in the walls and chairs need to be in contact with the floor. Thus, if one moves an aperature, or a chair, one needs these rules to continue to be adhered to.



The PHOENICS Virtual-Realiy Editor has a "grouping feature" which enables relative-position connections to be expressed but it does not allow objects in a group to change relative size or position. This meant that if a group were recorded in a Q1 file, and if that Q1 file were to have its geometry modified, all relationships have to be re-defined.

This deficiency has been remedied by using the VR-Editor in "protected mode" and, more fully, by use of the new Graphical User Interface (GUI), **"PRELUDE".** PRELUDE is more advanced than the facilities allowed via the VR-Editor. It:

- uses object names as arguments of its functions;
- allows expressions of unlimited complexity to be typed into its dialogue boxes;
- provides error-checking and undo capabilities;
- has a more flexible position / size / rotation language;
- handles many more CAD formats;
- can launch multiple runs with systematic data-input variations;
- create parametrised object by accessing Shapemaker;
- sorts its output in multiple-instance Q3 files instead of single-instance Q1's.

More information can be obtained by accessing presentations made by Brian Spalding in Paris in September: www.cham.co.uk/phoenics/d_pc/htms/english/ppts/relatinl.ppt

(See News & Events on page 8).

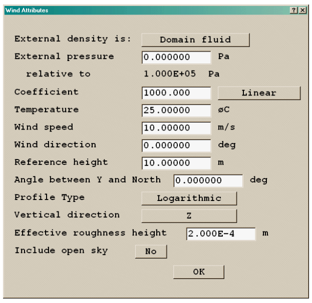
What's New in PHOENICS 2008

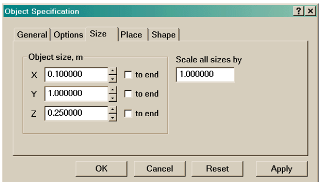
PHOENICS-2008 has improvements across the board, including the PRELUDE option (described in the Editorial), an enhanced parallel-processing solver, and new additions to PHOENICS/FLAIR. Some of these new features are outlined below.

PHOENICS 2008 has been provided with a new front-end module, PRELUDE; and this, in conjunction with special-sector **'Gateways'**, enables users to introduce easily the data which they understand from their special knowledge to be necessary, without having to attend to matters not of their concern.

For PHOENICS/FLAIR we have added a new WIND Object that creates atmospheric boundary layer inflows at up-wind domain edges, and fixed pressure boundaries at down-wind edges.

There is an option to have a pressure boundary at the upper, sky boundary, and allowance for a change of wind direction without moving objects or having to use a calculator.





The size of an object can be tagged to be 'to end' so that the object will stay at the domain end regardless of domain size.

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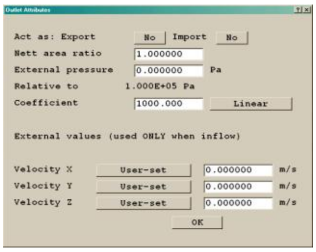
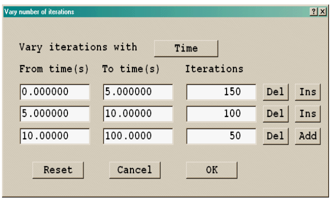
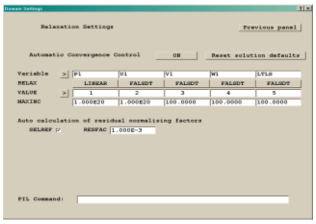
The FLAIR DIFFUSER objects can be freely rotated about any axis. If they are rotated out of the plane of the grid, they must lie on the face of a blockage, as they use the ANGLED_IN code for implementation. For all OUTLET, OPENING or ANGLED_OUT objects, a loss coefficient can be specified.



The loss coefficient represents the loss of dynamic head through the exit.

The Main Menu Numerics panel has been updated to allow change of LSWEEP with time.





The Main Menu Relaxation panel has been updated to make change of relaxation type easier.

The INFORM command processor has been made more tolerant of stray spaces in commands. It also checks for the correct number of open/close brackets before starting an Earth run. If INFORM errors are found, the Earth run is not started.

Visibility reduction can be estimated from the Beer-Lambert law. The intensity reduction ratio LR in % is computed from:

LR = 100.*Iz/I0

= 100.*exp (- S C_s*r*K_m*dz)

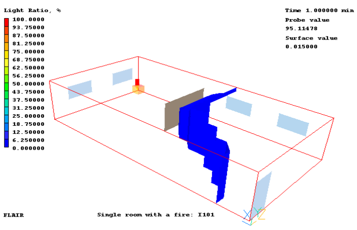
where

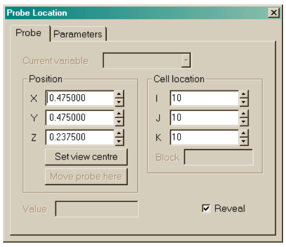
K_m = smoke extinction coefficient (7600 m^2/kg),

r = fluid mixture density (kg/m^3),

C_s = particle smoke concentration (kg/kg).

If light reduction is greater than 0.015%, the looked-at location is not visible.

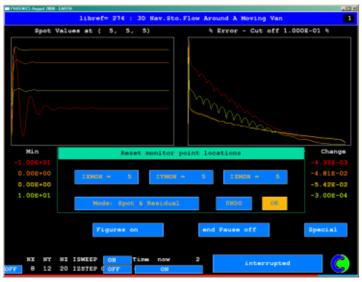




The View Centre can be jumped to the probe, minimum location or maximum location. Similarly, the probe can be jumped to the minimum location or maximum location.

There is an Update Monitor to allow change of:

- LSWEEP
- CONWIZ maximum increment
- linear and
- false- timestep relaxation
- monitor mode



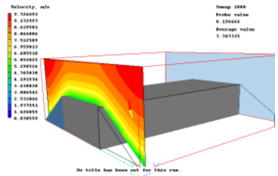
The Nett source in RESULT includes a mass-averaged scalar value, e.g. average exit temperature or smoke mass fraction at mass flow boundaries.

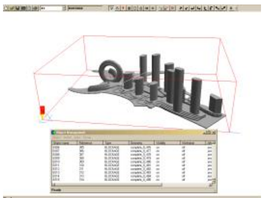
```
Nett source of R1   at patch named: OB1      (INLET   ) = 1.189000E-04
Nett source of R1   at patch named: OB2      (OUTLET  ) =-1.189000E-04
pos. sum= 1.189000E-04 neg. sum=-1.189000E-04
nett sum= 2.910383E-11

Nett source of TEM1 at patch named: OB1      (INLET   ) = 3.477290E+01 (Average TEM1 =  1.799989E+01)
Nett source of TEM1 at patch named: OB2      (OUTLET  ) =-3.528582E+01 (Average TEM1 =  2.229244E+01)
Nett source of TEM1 at patch named: OC3      (ROD     ) = 5.137433E-01
pos. sum= 3.528664E+01 neg. sum=-3.528582E+01
nett sum= 8.163452E-04
```

Average Temperature = $Q_{out}/(Cp*M_{out})-273$

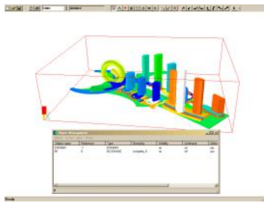
Note that this only gives reliable answers if there is no recirculation through the boundary.

For WIND_PROFILE objects (also used by the new WIND object), the profile starts at the first open cell.

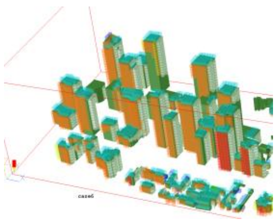




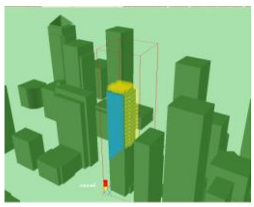
A single STL object repaired by FacetFix can sometimes give detection problems.



When divided into individual objects, each will be detected correctly. Import by Group can also read DAT files.



Using PRELUDE, the positioning of buildings in terms of longitude and latitude permits the automatic extraction of sunlight orientation for any given time of year and time of day. In the examples shown, the first image shows the incidence of solar irradiation onto a group of buildings.



The second example shows a building taken in isolation (for a different time of year.)

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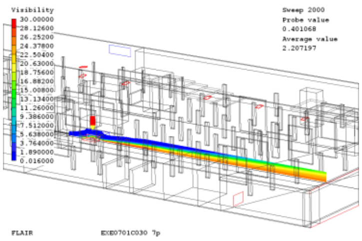
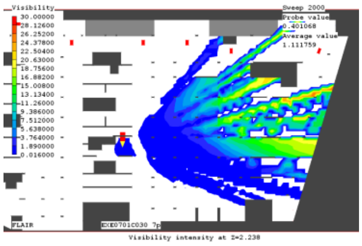
Reduction of Light

A recent addition to FLAIR is the "**Reduction of Light**". This feature predicts the effect on visibility under, for example, fire/smoke scenarios. The pictures below show the visibility intensity reduction on various planes, when looking at a point in the middle of the central fire source. A modification of the streamline tracking module is used to integrate the visibility reduction from each cell to the point being looked at. This is actually the probe, so by moving the probe (and then recalculating) the visibility reduction to any point can be obtained.

The user-interface is currently basic, with just a 'GO' button. Desired enhancements include the automatic re-calculation when changing time steps, which is a requirement before inclusion in the forthcoming release.



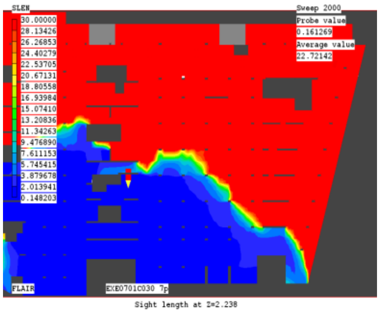


The spikes are because various obstacles block the view. The integration is carried out from each cell centre to the point being looked at (the probe).

Whenever a blocked cell, or cell face, is encountered the integration stops and the intensity is set to zero as the probe is not visible from that cell. The spikes are the shadows of the columns and other internal walls. The entire left side is blue, as the fire location cannot be see at all from that side. One way of visulising this this might be to have a contour line in a circle around the fire. The contour line would be, say, on the 0.016% reduction distance round the fire.

The lower limit of the contour plot is 0.016, so the outer edge of the blue where it goes to white is the appropriate viewpoint. As an alternative, the contour range can be made very small, say from 0.016 to 0.0161, and make everything below blue and above red, as in the image shown.

In the red zones, the fire can be seen; in the blue zones it cannot.

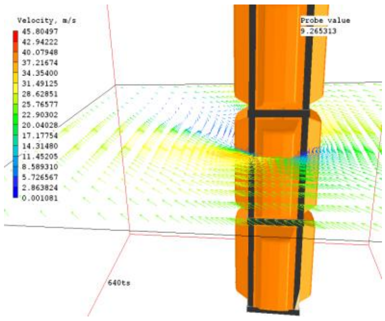


Alternatively, a 3D iso-surface of 0.016 can be provided, (see page 2): Anywhere inside the surface, the fire can be seen; outside the surface it cannot.

The 0,016 methodology will be used in future Dutch regulations for car parks that will become applicable by the end of 2008.

CFD for Digital TV

NationalGrid Wireless investigates the use of CFD to model drag from large arrays of panel antennas to be installed on various masts and towers in readiness for the Digital Terrestrial TV switchover. Regional Engineer, David Howell contacted CHAM to see an example of how PHOENICS could be used to evaluate drag coefficients of various antenna arrangements.

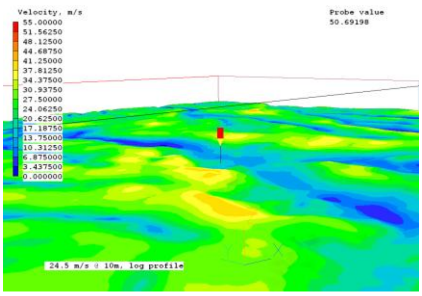


Air-flow past section of an individual antennae mast fitted with surface radomes.

Whilst the measurement of drag coefficients for antennae is expected to be most useful for a large multi-panel main UHF-transmit array, cantilevered at the top of a mast, wind loading on smaller individual antennae and dishes is also anticipated. Until now, NationalGrid Wireless has depended upon empirical data for standard blockage shapes usually with a drag coefficient for front and side aspects.

Wind velocity profile at 10m height over hilly terrain.

Antenna mast located centrally.



The priority was to look at wind profiles for individual sites particularly those in hilly terrain. NationalGrid Wireless use BS8100 to generate a wind profile to import to its tower analysis software. David's interest was stimulated having viewed the Wind Energy Simulation case study for Wind-farm Micrositing part of which compares a logarithmic profile with CFD and actual mast measurements. (See:www.cham.co.uk/PUC/PUM_London/papers/CHAM_Case_Study_Wind_Energy.pdf)

NationalGrid Wireless is also looking at having some actual wind-tunnel-testing conducted. This involves full scale model testing of actual portions of mast / tower structure, with many permutations of loading - i.e. different arrangements of antennae / dishes / feeder cables and associated blockages. Ultimately, this will be both time consuming and expensive; hence, following a few wind tunnel cases, the intention is to undertake further investigations using CFD.

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Development of a Numerical Wave Tank using the PHOENICS code

The development of a numerical wave tank is offered as a cost-effective and practical alternative to physical modelling at the laboratory scale. ENIT's proposed model for linear and non-linear wave generation in the internal flow region is now implemented in the PHOENICS code.

This is a 2D numerical wave model in the vertical plane and is based on two added source terms for the mass conservation and the momentum transport equations:

1. The expression of the mass source term depends on the specified generated wave such as a linear monochromatic wave and a non-linear solitary wave.
2. A friction force term is added to the vertical velocity component to reduce the wave amplitude at the end of the active domain.

The free-surface evolution is calculated in terms of Volume Of Fluid (VOF) fraction representative of the cell occupied by the fluid. Coupled with this supplementary pure convective transport equation used to compute the free surface evolution, PHOENICS is able to predict fully overturning waves with fluid "re-attachment". The VOF transport equation is modified to take into account the non-zero divergence mass conservation equation.

After validation of the general methodology in simple cases, the extension of the method into the third dimension and the investigation of wave-structure interaction, becomes straightforward. The comparison of numerical and analytical results showed that the free surface and vertical distribution of the velocity components are accurately predicted for small amplitude waves, propagating at a constant water depth, (figure 1).

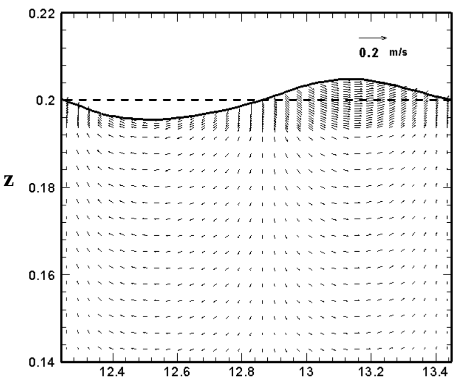

Figure 1: Numerical free surface elevation and velocity field for unit wavelength at t = 5 T.

The proposed model generates the free-surface profiles induced by solitary waves correctly, with a small discrepancy in the tailing edge of the wave. The propagation of the solitary wave at a constant water depth indicates that the wave preserves its permanent form and the same wave velocity.

This model is then used to simulate the non-breaking 'run up' and 'run down' caused by the solitary wave passing over an impermeable steep-plane beach. The numerical results are compared with experimental data of Lin and al. (1999) and show that the free-surface profiles are accurately predicted during the run up and run down process (figures 2 and 3).

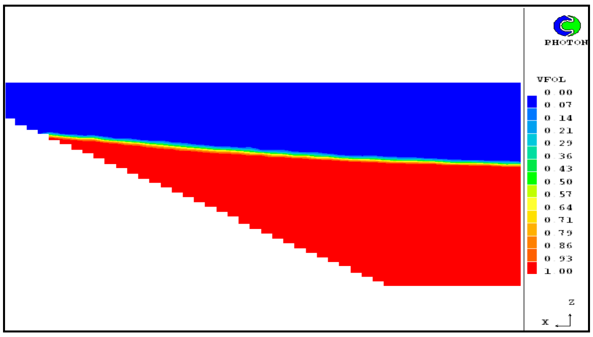

Figure 2: Numerical free surface profile in the vicinity of the beach at the maximum run up (t = 3,17 s).

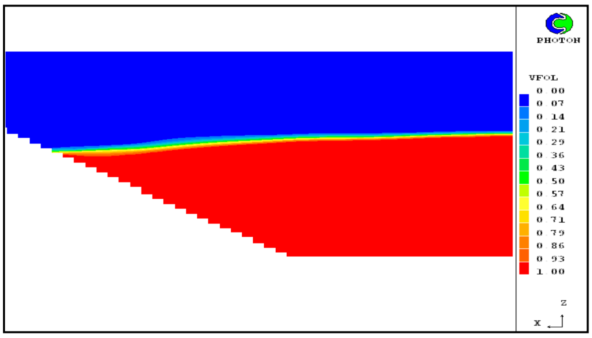

Figure 3: Numerical free surface profile in the vicinity of the beach at the maximum run down (t = 3,77 s).

Based on previous research work from the specialized literature, an extensive validation process will be performed to demonstrate the accuracy of the numerical wave generator model.

This general methodology is also very useful for the practical computations in coastal engineering where reflection is present and to investigate the wave and current interaction.

Dr Zouhaier Hafsia, *ENIT Laboratoire d'Hydraulique, Tunisia.*
E-mail: Zouhaier.Hafsia@enit.rnu.tn

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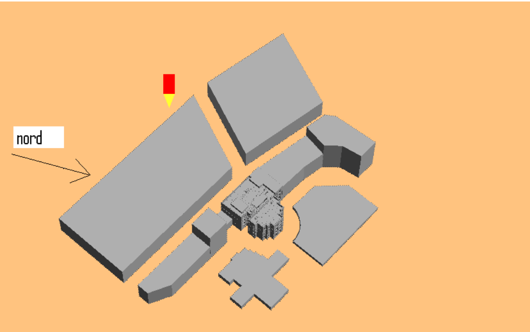
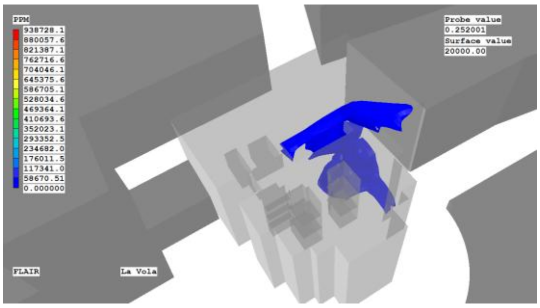
What's cooking in the Courtyard?

Spanish consultants, La Vola Ingenieria, described a ventilation problem of some "nasal" delicacy.

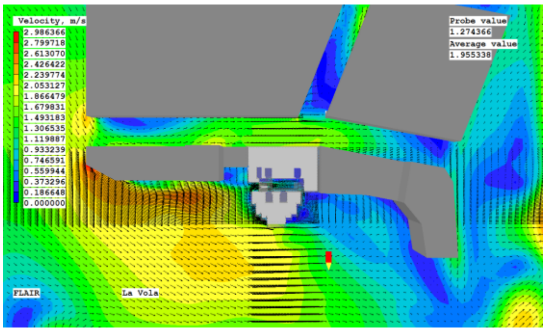


They modelled a new building housing several flats. The model was imported as an STL file, containing the immediately-neighbouring buildings, as wind direction plays an important factor. The central buildings are very detailed, with each floor section with different room distribution. The analysis focused on the kitchens, from which smoke and smells potentially can be generated and released to a "patio" without chimneys to evacuate the gases.

La Vola Ingenieria employed PHOENICS to establish (1) whether the smells of kitchens from lower floors would enter upper flats under various wind conditions, and (2), what would happen in case of fire in one of the kitchens.



Iso-surface of 'smell' concentration



Overall wind profile – Plan View

Prevailing conditions: The wind blows from the North ten months per year from the South one month per year, and from the Southwest one month per year. For a roughness of 0.4, wind speed is 1.8 m/s at 10m and 3.09 at 100m. The kitchens are equipped with fans which evacuate 350 m3 per hour.

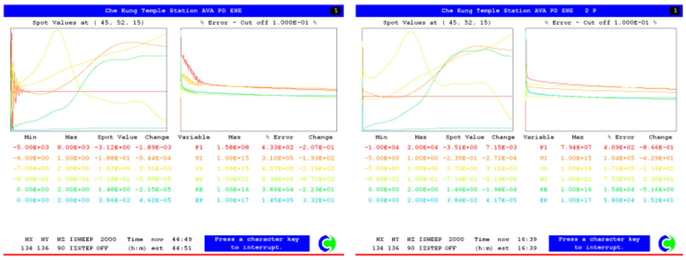
We can only speculate whether the aroma proved to be agreeable.

PHOENICS-2008 Parallel Solver shows remarkably-improved performance

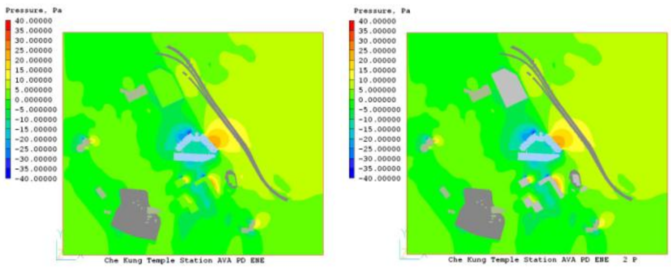
Tests on behalf of ENVIRON Hong Kong recently provided a first indication of the improvements made to the parallel solver by CHAM's Development Team in Moscow.

A case involving wind simulation across a complex terrain and urban environment was undertaken to investigate the environmental impact of a new flyer system near the Che Kung Temple Station.

The example involved 1.65 million cells and was run for 2000 sweeps, both with the sequential solver and the parallel solver with two processes on a PC with an AMD dual core processor. The convergence patterns for the two runs were similar.



The speed up for the parallel run is remarkable. Although tested on a relatively slow computer, a sequential run time of 44:51 hours reduces to 16:39 hours - **a speed up of 2.69.**



The contour patterns are also remarkably similar at this stage of the solution. [The 2P in the title indicates the number of processes used in the parallel run.]

CHAM is now running much larger cases with 8 million, 12 million and 20 million cells using the new parallel release on both dual-core and quad-core configurations. Further results will be reported in the next newsletter.

Contributions

We are always interested in receiving contributions for the Newsletter from Agents, PHOENICS Users and Students. Please email to PHOENICS@cham.co.uk. Full attribution will be given to all contributions used.

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Development of a Methodology for Toxic & Flammable Gas-Sensor Positioning in Oil Platforms

A major safety item for oil installations is the use of concentration sensors for flammable and/or toxic gases to minimise the obvious dangers resulting from leaks (fires, explosions, intoxications and others).

A new methodology of easy application and in agreement with the industry "norms" and specifications is being developed by CHEMTECH Ltda. in partnership with the Laboratory of Heat and Mass Transfer and Fluid Dynamics (LTCM) of the Federal University of Uberlândia (UFU).

According to technical specifications usually employed in the oil and gas industry, alarms in the central control room should go off whenever levels from 20% to 60% of Lower Flammable Limit (LFL) for combustible gases are detected, where LFL is the minimum concentration of gas capable of causing combustion. In a similar form, the Upper Flammable Limit (UFL) is the maximum gas concentration dispersed in the air capable to cause combustion (Figure 1).

3D gas dispersion simulations are undertaken with geometric aspects, meteorological conditions and gas properties at leak conditions taken into consideration.

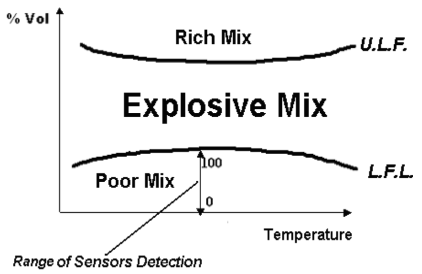

Figure 1: Strips of inflammability of a mixture gas-fuel
Source: Own elaboration

Leaks are modelled with varying wind speed and direction. Meteorological conditions are important as atmospheric instability favors dispersion of the gaseous pollutant in the atmosphere.

Using CHEMTECH-UFU's model, the user enters data referring to leak conditions and meteorological data. The probabilities of occurrence are calculated which take into consideration the leak and wind speed and direction, synthesizing in a unique value for these two variables.

After calculation of the probabilities, based on Bayes's Theorem, the next step is to load the output from PHOENICS simulations separating the values of concentration (variable C1). A new file is then generated (C2) with the computational volumes that contain concentrations among 20% and 60% of L.F.L. In the computational volumes out of this range, the value "zero" will be attributed. At the end of this stage a file will be generated one C2 file for each file.

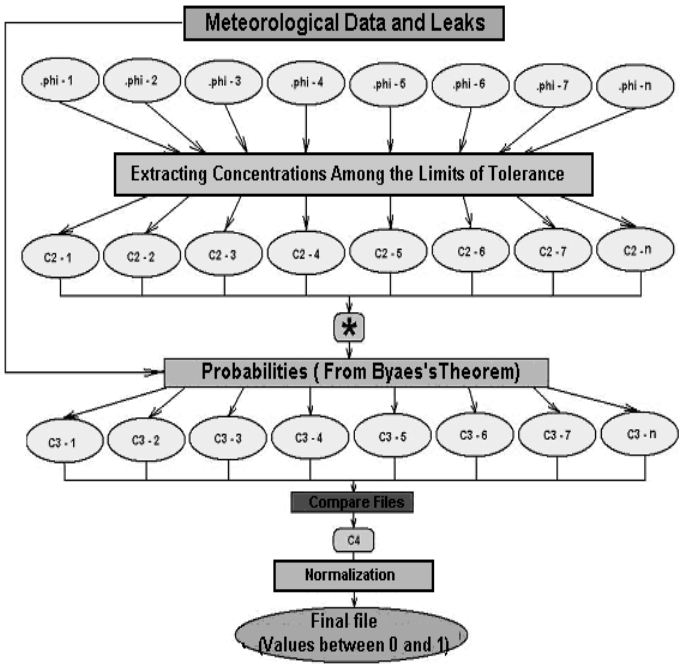

Figure 2: Flowchart of the computational tool.
Source: Own elaboration.

Thereafter, each C2 file is multiplied for the respective occurrence probability, generating C3 files. Then, all the files are compared, selecting the highest value for each volume, saving them in an unique file (C4). These values are normalized so that their range varies between 0 and 1. This final file is processed in the VR Viewer to highlight the important locations where sensors should be put. Figure 2 summarizes these stages through a schematic flowchart of the sequence of files created using this methodology.

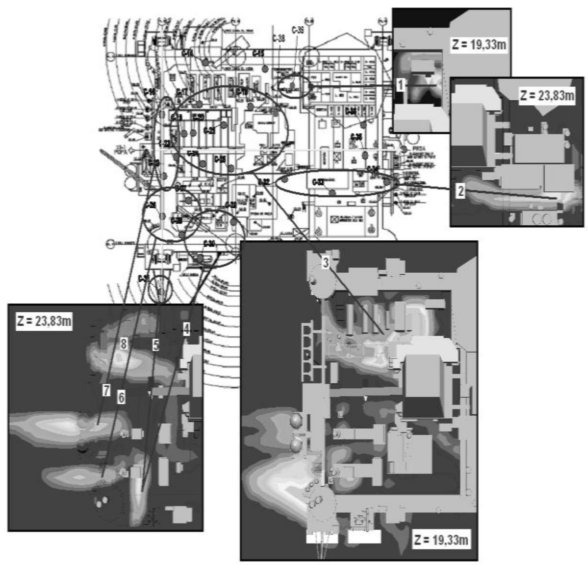

Figure 3: CHEMTECH 2003 versus the new methodology
Source: Own elaboration

Figure 3 shows that the results provided by the new methodology are similar to results obtained in 2003. The scale indicates the best regions for the installation of detectors, where "z" is the elevation in meters.

Using this tool, it is now possible to analyse many plumes with gas concentration between 20% and 60% of LFL much more quickly. Existing qualitative methodologies analyse only plumes in the threshold gas concentrations for positioning sensors (20% and 60% of LFL) due to many scenarios to be studied.

This methodology presents improvements in relation to others studies of gas dispersion and positioning of sensors, forming an alliance between CFD simulation results and coherent mathematical treatment. Development of the computational tool described in this document will reduce the time for conception of the projects, besides supplying more necessary and less intuitive results.

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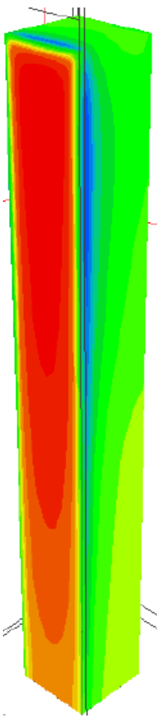
Solidônio Rodrigues Carvalho, D.Sc., Federal University of Uberlândia -FEMEC/LTCM, Uberlândia, MG, Brazil, srcarvalho@mecanica.ufu.br
Valter César de Souza, D.Sc., Consultant, CHEMTECH, Brazil, valter.souza@chemtech.com.br
Patrícia Carneiro dos Santos, Process Engineer, CHEMTECH, Brazil, patriciaequfrj@gmail.com

Independent PHOENICS validation meets German Industry Standards



Zimmermann-Becker GmbH, advisory engineers for the construction industry, have undertaken a series of successful comparisons between experimental data and PHOENICS to meet the German Industry Standard DIN 1005-4 in relation to calculations of air-flow around and forces on buildings.

The full PowerPoint presentation – in German – can be found at:
www.cham.co.uk/docs/Validierung_Windlasten.ppt

A summary, in English, will be added soon.

Comparison of PHOENICS results with wind tunnel measurements for NIST 6371. Comparison is made for both shear and uniform wind profiles.

Events Calendar

On 25th September 2008, the **French User Meeting** was held at the **Ecole Supérieure de Physique Chimie de Paris, Paris**, organised by Dr Jalil Ouazanni (shown above) of Arcofluid Srl, www.arcofluid.fr.

Whilst the audience of 33 were enthusiastic recipients of Professor Brian Spalding's presentation of the new PRELUDE relational 'Gateways' for PHOENICS, they seemed slightly less impressed with his ad-hoc attempt at the disappearing-object magic trick... which clearly can be seen flying over his right shoulder!

Other recent CHAM events included:-
16th to 18th September 2008 – **PHOENICS Training Course,** CHAM, London, UK.

23rd September 2008 – **Benelux User Meeting,** Aristo, Eindhoven, organised by A2TE, www.a2te.nl at which Dr John Ludwig made a presentation of some of the new features of PH-2008 described on Page 2.

14th to 16th October 2008 – 1st PHOENICS/FLAIR Training Workshop – SEAS, Singapore, organised by ZEB Technology.

15th November 2008 – Japanese User Meeting, Tokyo, organised by CHAM Japan, Email: cham-j@phoenics.co.jp, Web: www.phoenics.co.jp

Forthcoming Events:
9th to 11th December 2008 & 9th to 11th March 2009 – **PHOENICS Training Course,** CHAM, London, UK – See: www.cham.co.uk/training.php

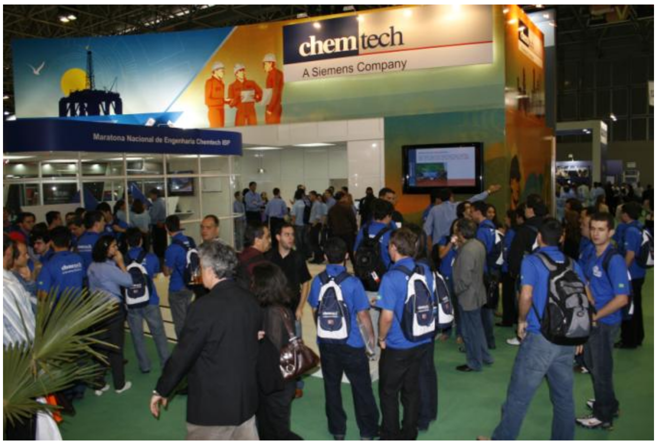
2008 National Engineering Marathon – CHEMTECH – Rio de Janeiro – Brazil

The National Engineering Marathon is an unprecedented initiative developed and supported by CHEMTECH that aims the spread of high technological knowledge through undergraduate students from the best universities in Brazil. The 2008 event occurred during the Rio Oil & Gas Conference, the most important event of the oil and gas area in Latin America, from September 15th to 18th in Rio de Janeiro, Brazil.

250 students from 18 universities were trained by the CHEMTECH staff in CFD and process control. The training lasted for 6 weeks and was conducted through the internet, using e-learning tools. The 2 best students from each participating university were selected to represent their university in the next round of the Marathon, run over the 4 days of the conference. Challenging engineering problems involving CFD and process control subjects were posed to and solved by the participants. The best teams from the first 3 days were selected to dispute the final round to select the winner of this exciting event. Besides the prizes, CHEMTECH offered internship opportunities in several offices spread through the country.

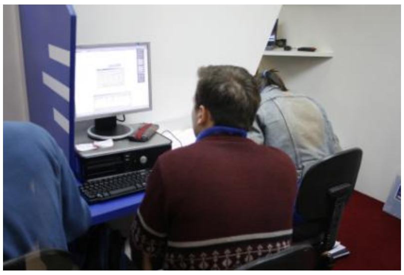
What made the challenge possible was the partnership with CHAM, who supplied the universities and the students with PHOENICS licences for free. With these licences, they could establish their first contact with CFD tools, a not-so-common subject in undergraduate courses. Moreover, this opportunity showed them all the possibilities of this field and how powerful this tool is. The students were trained in the software by CHEMTECH's staff thorough the e-learning mechanism, with on-line chats and technical lectures about the subjects beyond computational fluid dynamics. Through such activities, CHEMTECH and CHAM contribute to the professional development of our next generation of engineers.

Sponsors of the National Engineering Marathon



CHEMTECH's stand in the National Marathon Area. In focus, the students engaged in the event

Test area in CHEMTECH's stand



Students from UFSCar using PHOENICS

More PHOENICS use during the 2008 National Engineering Marathon