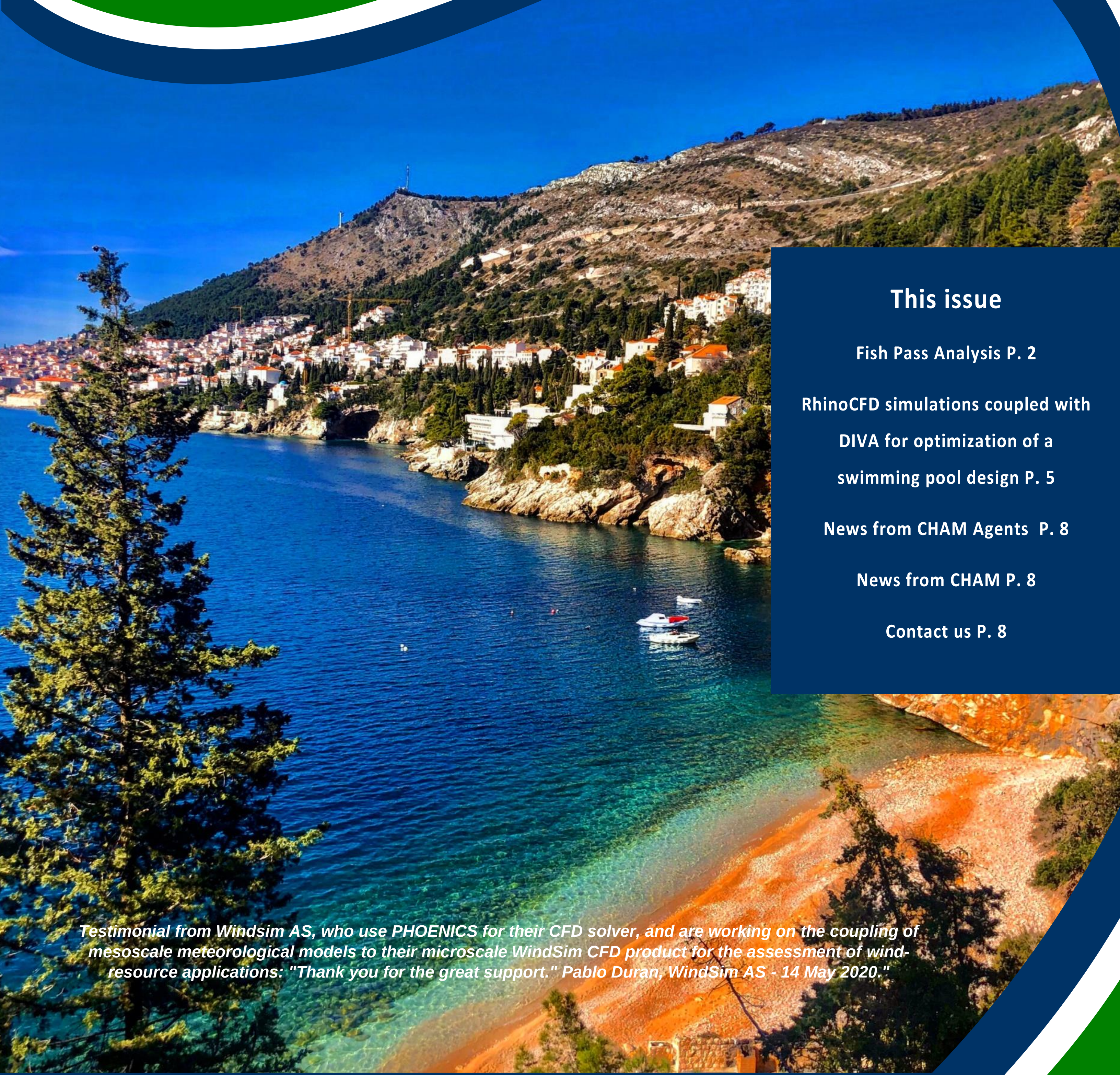
PHOENICS News

CHAM



This issue

Fish Pass Analysis P. 2

RhinoCFD simulations coupled with DIVA for optimization of a swimming pool design P. 5

News from CHAM Agents P. 8

News from CHAM P. 8

Contact us P. 8

Testimonial from Windsim AS, who use PHOENICS for their CFD solver, and are working on the coupling of mesoscale meteorological models to their microscale WindSim CFD product for the assessment of wind-resource applications: "Thank you for the great support." Pablo Duran, WindSim AS - 14 May 2020."

Concentration, Heat and Momentum Limited (CHAM)

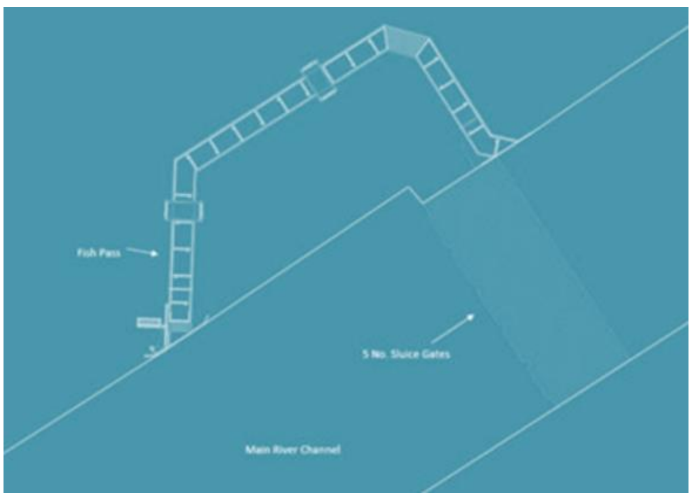
Bakery House, 40 High Street, Wimbledon Village, London, SW19 5AU, England

Tel: +44 (0)20 8947 7651 Email: phoenics@cham.co.uk Web: www.cham.co.uk

Spring 2020

Holme Sluice Fish Pass Analysis – CFD Simulation of Water Flow through a Fish Pass using Volume Of Fluid (VOF) model, by Timothy Brauner, CHAM, and Katarzyna Bozek, RHDHV Scientist, Water Europe, July 2019.

Fish passes are specialised structures designed to help fish swim upstream and are needed on rivers to enable salmon, sea trout and eels to circumvent man-made obstacles such as dams, weirs and sluice gates. In the UK their designs must be approved by the government's Environment Agency. Haskoning DHV UK Limited (RHDHV), a division of the Royal Haskoning DHV Group, contacted CHAM for assistance in predicting the operation of a new 200m-long, 20-slotted-weir fish pass system being designed for operation on the River Trent near Nottingham.



Holme Sluice – River Trent – Proposed layout

The objective of the CFD simulations was to model the flow of water entering the fish pass from the main river channel upstream of a sluice, along a gradual descent through the fish pass and subsequently flowing back into the river downstream. The purpose of the exercise was to confirm that the flow through the fish pass remains constant under varying river conditions and to ensure that the flow depth and velocity stays within a fish-tolerant range

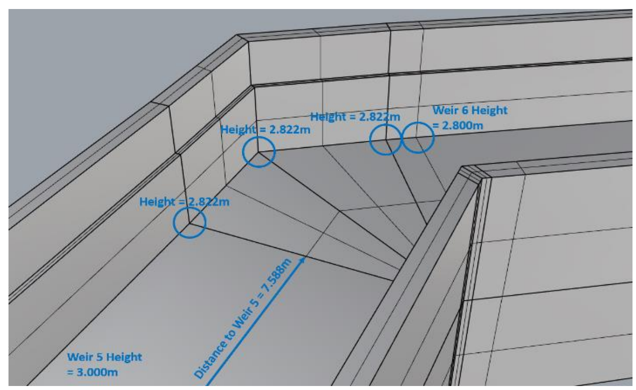
CHAM assisted with the creation of the CFD model which was then used by RHDHV personnel to investigate a number of different flowrate and environmental conditions to determine the operational range for the fish pass using different rates of abstraction.

The simulations were used to predict the flow rate through the fish pass and to assess the environmental conditions for the fish at the slotted weirs and at the commencement of their ascent.

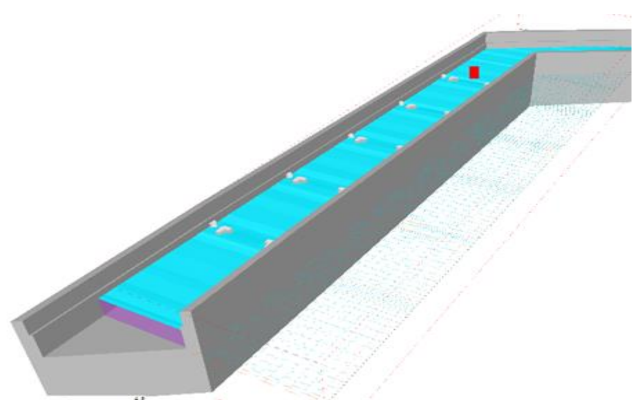
Three CFD models were created for the RHDHV, each focussing on a different region of the fish pass:

1. the upstream river topography and flow conditions upstream of the fish pass
2. the fish pass itself
3. the downstream river topography and conditions downstream of the fish pass and sluice gate

The geometry for CFD model was created by CHAM from drawings supplied. In additional to the fish pass's incline along its length, particular attention was paid to capture the detail of the corner sections and the intermittent structures.

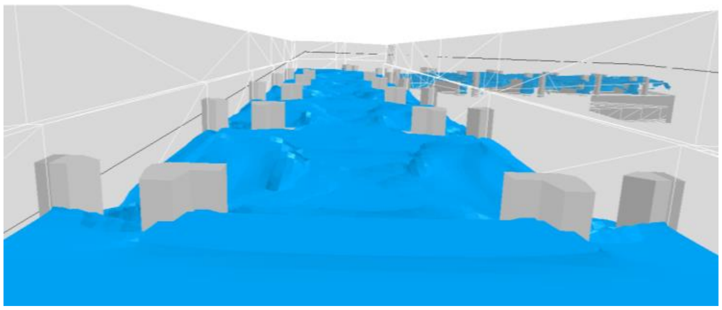


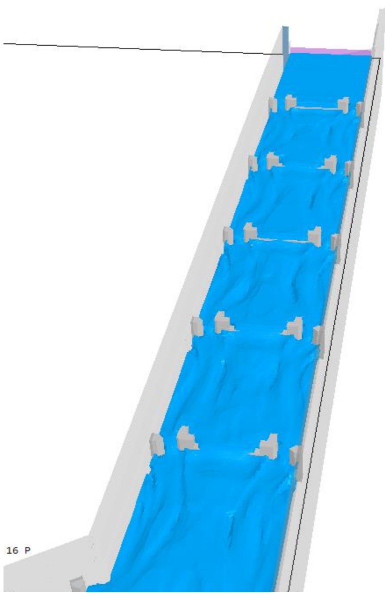
Detail of banked sections at fish pass corners



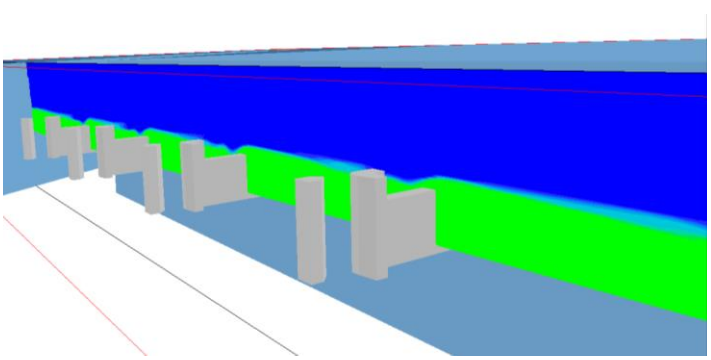
Position of first 5 sluices gates

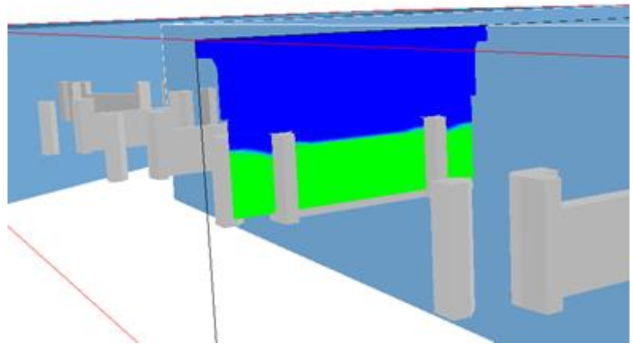
The fish pass cases were run as transient, 3D, free-surface models using the upstream water level and velocity data taken from earlier steady-state river-bed simulations. They employed the Volume Of Fluid (VOF) model to capture the free-surface of the descending water over and around the fish pass's internal weirs / sluice gates. (More information can be found in the Volume of Fluid POLIS entry.)





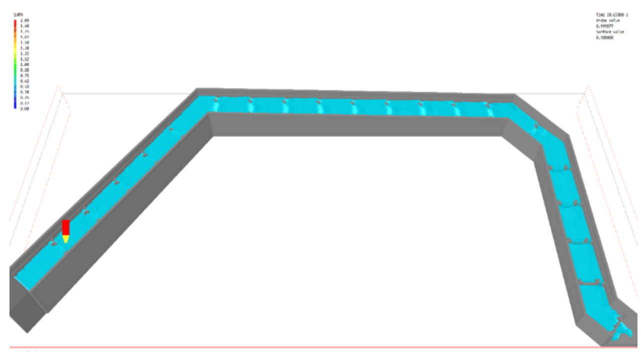
Free surface through gates





Free surface cross sections

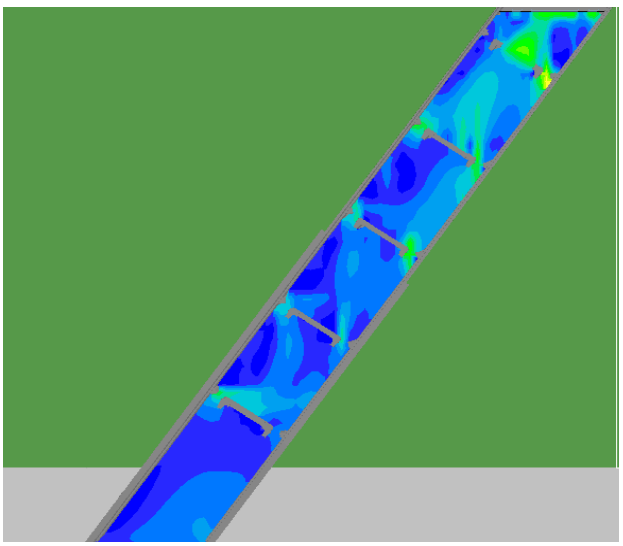
The flow down the fish pass involves flow past twenty slotted weirs, each comprising of an internal weir structure with a slot across its top and slots on either side. The slots allow water to flow past the weir and are intended to produce the desired flow conditions for the typical species that will swim up the fish pass. The fish pass was modelled at different rates of water abstraction from the river to determine its operational range.

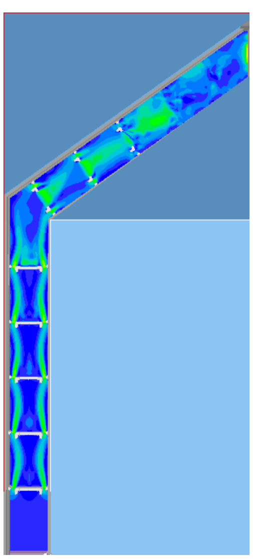


Holme Sluice – Whole Channel Geometry Integrity Test

Case 1 shown below looks at the region upstream of the sluice gates and around the fish pass' intake. This model includes the first 5 (out of 20) weirs of the fish pass. It is a transient case where all mass leaving the domain is summed up and put back into to upstream boundary. When run long enough, a state of equilibrium is reached from which the flow rate into the fish pass is deduced. This was investigated for a fixed upstream water height with different configurations for the number and location of open sluice gates.

Case 1: Upstream river velocity – fish pass intake – plan views



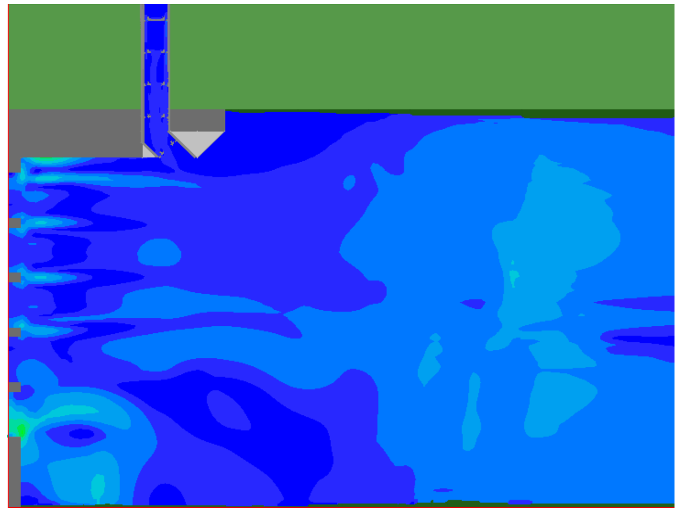


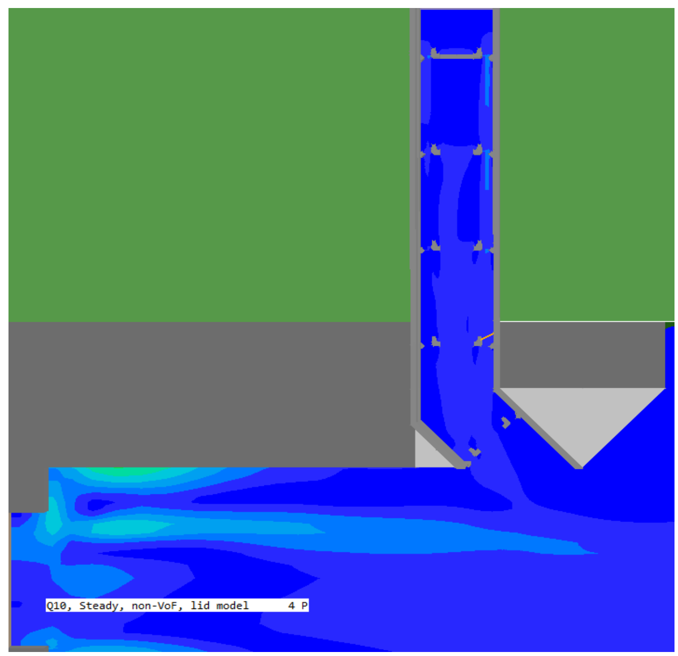
Case 2:

Fish Pass

first bend

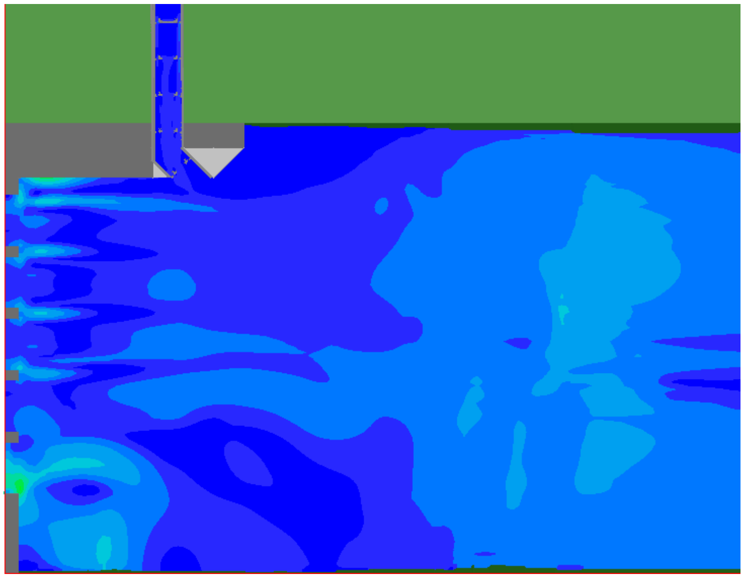
Case 2 looks at flow only through the fish pass structure starting at the upstream intake and ending after the 10th weir, which is located after the first bend of the fish pass. It is a transient case with the purpose of investigating the flow field in each pool between weirs and velocities through the weir slot gaps.

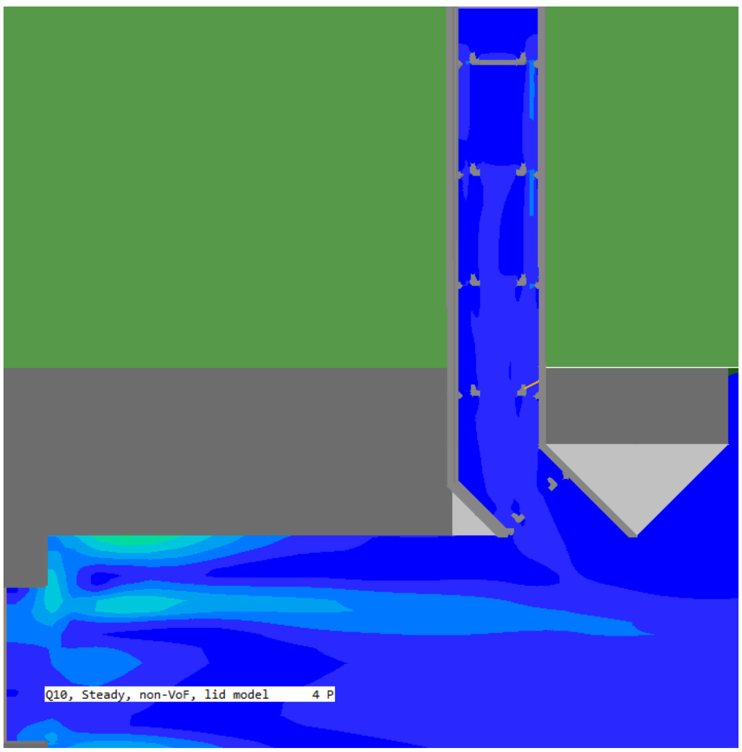




Case 3: post-weir river velocity – fish pass exit – plan view

.Case 3 looks at the region downstream of the sluice gates and around the fish pass' outflow. The model includes the last 5 (out of 20) sluice gates of the fish pass. It is a steady-state simulation, run for several water heights with different configurations for the number and the location of open sluice gates. It was investigated to establish if the velocities at the base of the fish pass were conducive to attract fish.





Case 3 looks at the region downstream of the sluice gates and around the fish pass' outflow. The model includes the last 5 (out of 20) sluice gates of the fish pass. It is a steady-state simulation, run for several water heights with different configurations for the number and the location of open sluice gates. It was investigated to establish if the velocities at the base of the fish pass were conducive to attract fish.

The project spanned the upgrade period from PH-2018 to PH-2019. A notable feature of PH-2019 is that no solution for 'un-used', blocked cells (many in this case) is made by its AMG solver option that reduced the run times.

The simulations helped RHDHV to investigate and visualise the inflow and outflow conditions for the fish, to establish the effectiveness and operational range of the fish pass under varying environmental conditions and to consider whether design improvements were desirable prior to its construction.

Royal HaskoningDHV
Enhancing Society Together

RhinoCFD simulations coupled with DIVA for optimization of swimming pool design at UC Berkeley course: "Advanced Study of Energy and Environment" by Haripriya Sathyanarayanan and Prof. Luisa Caldas. Department of Architecture, University of California, Berkeley.

Minimizing energy use is a cornerstone of designing and operating sustainable buildings, and attention to energy issues can often lead to greatly improved indoor environmental quality. For designers, using computer-based energy analysis tools is important not only to qualify for sustainability ratings and meet energy codes, but also to develop intuition about what makes buildings perform well. This graduate level course presents quantitative and qualitative methods for assessing energy performance during design with students getting hands-on experience with state-of-the-art software - ranging from simple to complex - to assess the performance of building components and whole-building designs.

In Spring 2019, the required *MArch course Advanced Study of Energy and Environment* (ARCH 240), taught by Professor Luisa Caldas, had as its Graduate Student Instructor Haripriya Sathyanarayanan (PhD Student in Building Science, Technology and Sustainability), who handled the labs and simulations for a class of 38 students. The project was of a swimming pool design located in a San Francisco neighborhood with an area of approximately 24,000 sq.ft.

Students were required to analyze the local climate and site context, design a swimming pool based on the proposed programme, conduct daylighting simulations, thermal simulations and energy simulations including analysis of building components to arrive at an optimized design for energy. The software used for the course included Rhino[1] for 3D modeling, Climate Consultant[2] and DIVA[3] for climate and site analysis. DIVA was used for daylighting performance and COMFEN[4] for thermal and energy performance. Through a collaboration with CHAM for this edition of the course, the students had for the first time the option of using RhinoCFD[5] to study natural ventilation using CFD simulations in the Rhino user environment in addition to the hand calculations usually performed for the course.

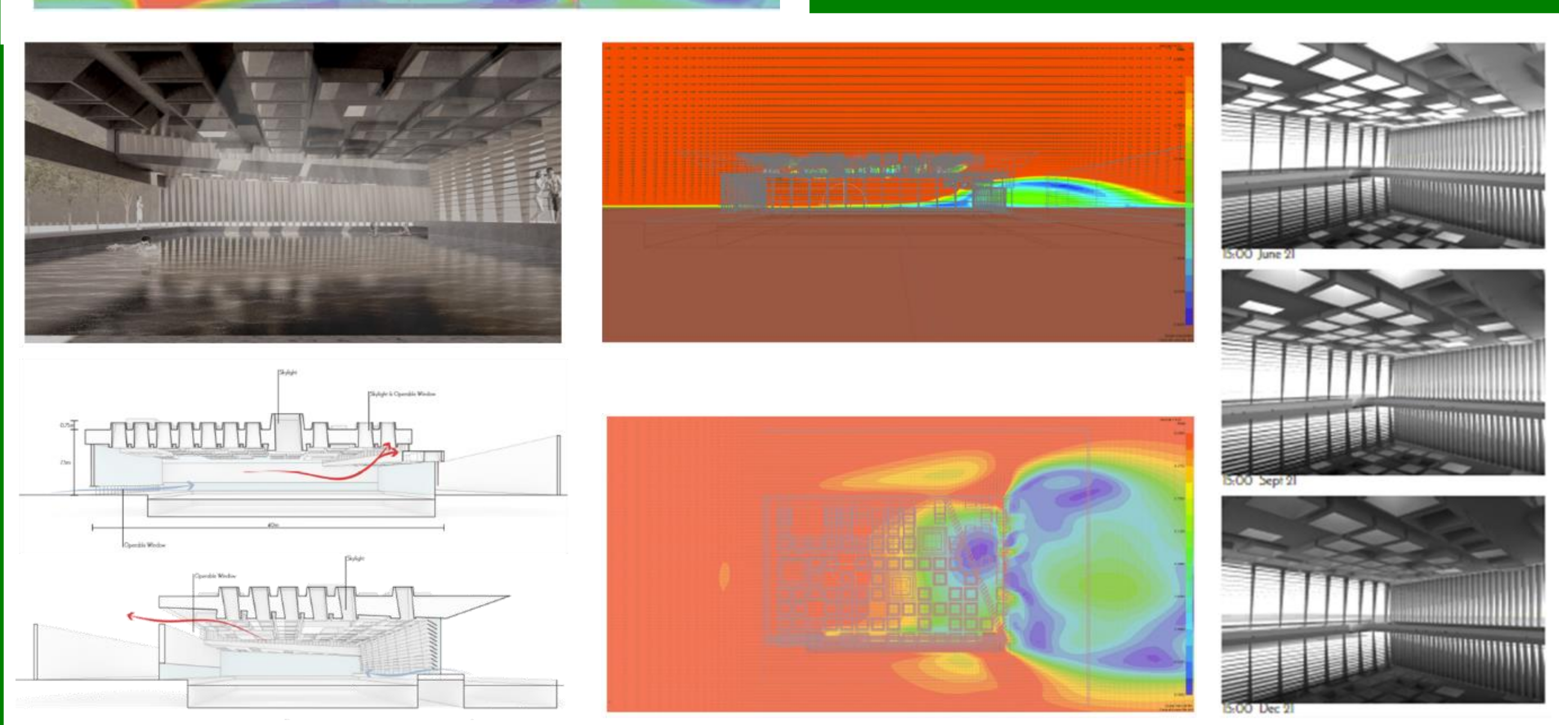
The student groups had worked for two months on optimizing their designs for daylighting and thermal performance using DIVA and COMFEN. They had to further improve the performance of the swimming pool for natural ventilation. This involved an understanding of opening area needed for natural ventilation, inlet and outlet design, pressure and velocity at the occupied level. The objective of the exercise was more to understand the process than the actual results of the simulation, considering the training and resources needed for CFD.

Students were given a hands-on demonstration of RhinoCFD along with principles for natural ventilation design including rules of thumb that they compared to the CFD results. They first went through the process of building a simplified geometry for a CFD simulation of solids and voids, including setting up the computational domain, computational grid, simulation parameters and running the simulation, including understanding convergence, results and analysis.

The experience was successful in providing the students with an understanding of the CFD methodology, results and analysis, including learning the power of CFD simulations in informing early design. This was the first time that CFD simulations were included in the course. The exercise helped students further in reiterating on their envelope design to meet requirements for operable windows.

Samples of student works are shown below in Figure 1.

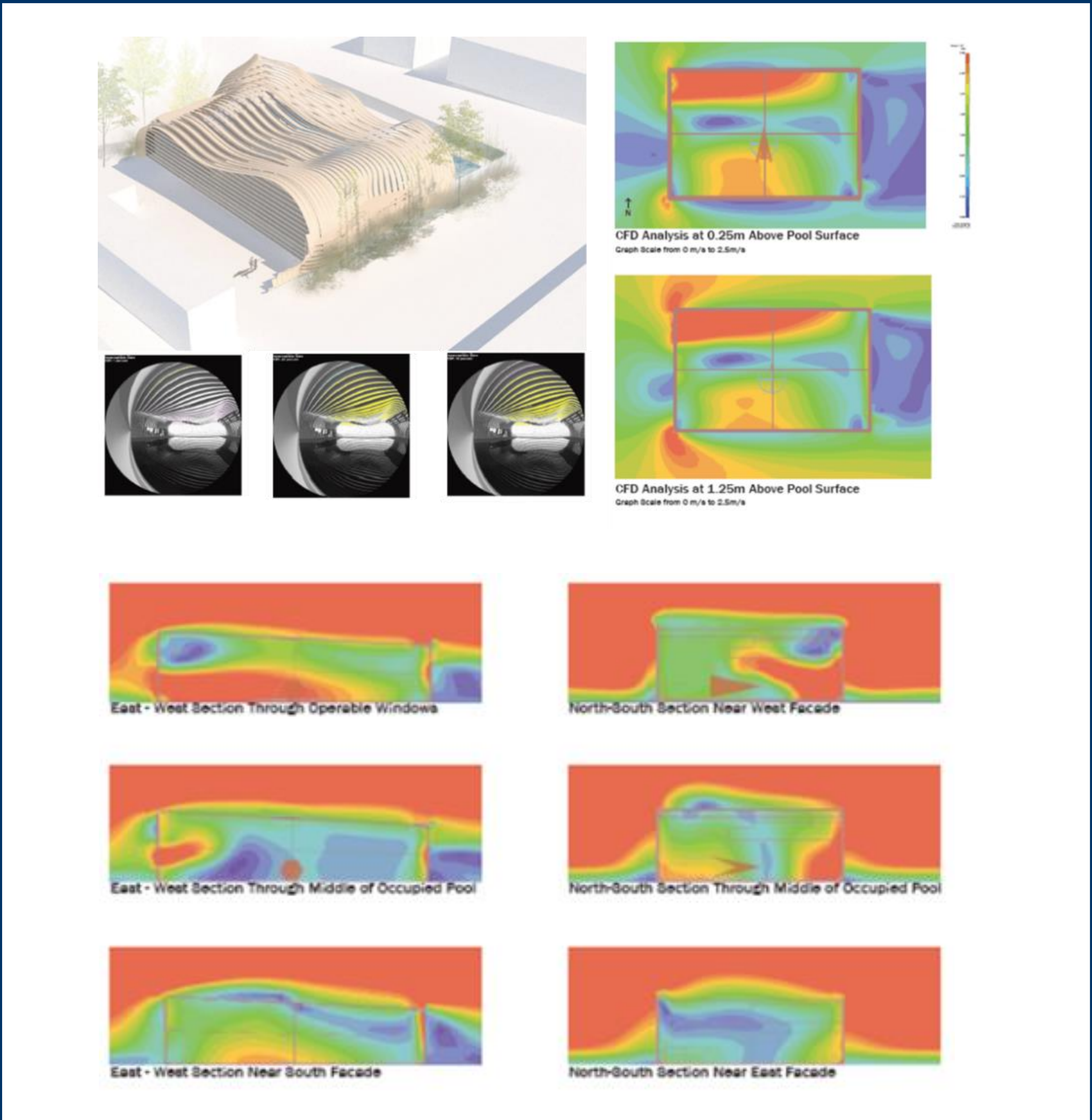
Group 1.



Group 2

Group 3

Figure 1. Student group projects, including CFD and daylighting simulations



References

1. Rhino 6 for Windows and Mac. https://www.rhino3d.com/. Accessed March 10, 2020.
2. Energy Design Tools. http://www.energy-design-tools.aud.ucla.edu/. Accessed March 10, 2020.
3. Solemma LLC. https://www.solemma.com/. Accessed March 10, 2020.
4. COMFEN | Windows and Daylighting. https://windows.lbl.gov/software/comfen. Accessed March 10, 2020.
5. RhinoCFD | Food4Rhino. https://www.food4rhino.com/app/rhinocfd. Accessed March 10, 2020.

News from CHAM Agents

1. ACFDA (Canada and the USA)

Staff at ACFDA are staying at home after 'social distancing' was introduced in Canada on March 16. Vladimir Agranat will, however, be approaching Clients with information on the new release of PHOENICS – PHOEINCS 2020 – outlining what new features will be available.

2. ArcoFluid (France)

Jalil Ouazzani writes that ArcoFluid is partner in two ESA (European Space Agency) programs which started in 2020: MAP EDDi (Emulsion Dynamics and Droplet Interfaces) and MAP Evaporation (Convection and Interfacial Mass Exchange).

The general aim of the map EDDI program is:

- Better understanding of the role of surfactants in emulsion production and stability targeting;
- Reduction/optimization of the amount of additives utilized in emulsion-based technologies and products.

The initial meeting of participants on April 21 2020 was via Skype due to lockdown in each country.

The general aim of the MAP Evaporation program centres on the scenario definition of the experiments "Drop Evaporation," "Marangoni in films," and "Enhanced Evaporator" approved for performance on ISS; as well as on analysis of the results of the sounding rocket experiment "ARLES." The initial meeting was on February 19-20 2020 at the European Space Research and Technology Centre n Noordwijk, Netherlands. ArcoFluid's presentation related to use of the VOF method in PHOENICS and its ability to cope with such complex problems.

Work with Dr Paul Chen from University of Marseille, on evaporation problems, led to a publication in 2020 in International Journal of heat and mass transfer based on numerical work, using PHOENICS, done in Marseille (France) and experiments done at the Institute of Mechanics of the Academy of Science in Beijing (China).

3. Applied Computational Engineering (ACE) (Norway)

Arne Holdo advises that he has been in touch with users to offer home working licences and talked with potential new users. He is sending out information regarding RhinoCFD and is planning skype meetings with potential Users. He believes that, in Norway, "the end of May or the start of June will see a lessening of restrictions which shoulld make some businesses start projects which need simulation."

News from CHAM

John Smith joined CHAM at the beginning of April 1991 and retired at the end of March 2020. He was with us for 29 years and, when he left, was 75 which is pretty impressive.

John's job changed over the years. He was responsible for providing PHOENICS software to users worldwide. In 1991 that meant making up, and sending out, packages containing tapes or discs (of varying shapes and sizes) along with hard copy manuals. The software was prepared for a variety of hardware some of which we had in house and some of which we did not. In the latter case John had to create relationships with institutions in possession of the requisite hardware and visit them to create masters which could be stored with copies being made as necessary.

By the time he left, all installations were on a PC, most of them were made via ftp, manuals were transferred electronically, things were stored in clouds rather than in our offices - life had changed. That is not the only change. We were unable to mark John's retirement with a Company gathering - as would normally have been the case - we were all locked down and having to work remotely. The positive aspect of this is that it gives us the opportunity to gather once we are allowed back into the office - hopefully in the not-too-distant future.

Contact Us

Should you require any further information on our offered products or services please give us a call on +44 (20) 89477651. Alternatively you can email us on sales@cham.co.uk.

Our website can be viewed at www.cham.co.uk and we are on the following social media:

Concentration Heat and Momentum Limited (CHAM)
Bakery House
40 High Street
Wimbledon Village
London SW19 5AU, England