PHOENICS Case Study: HVAC
Natural Ventilation in a Concept Home

Regulations set by government agencies – no doubt coupled with the desire to minimize energy usage due to ecological social consciousness and cost reduction reasons - are leading an ever-increasing use of natural, rather than mechanical, ventilation and heating schemes.

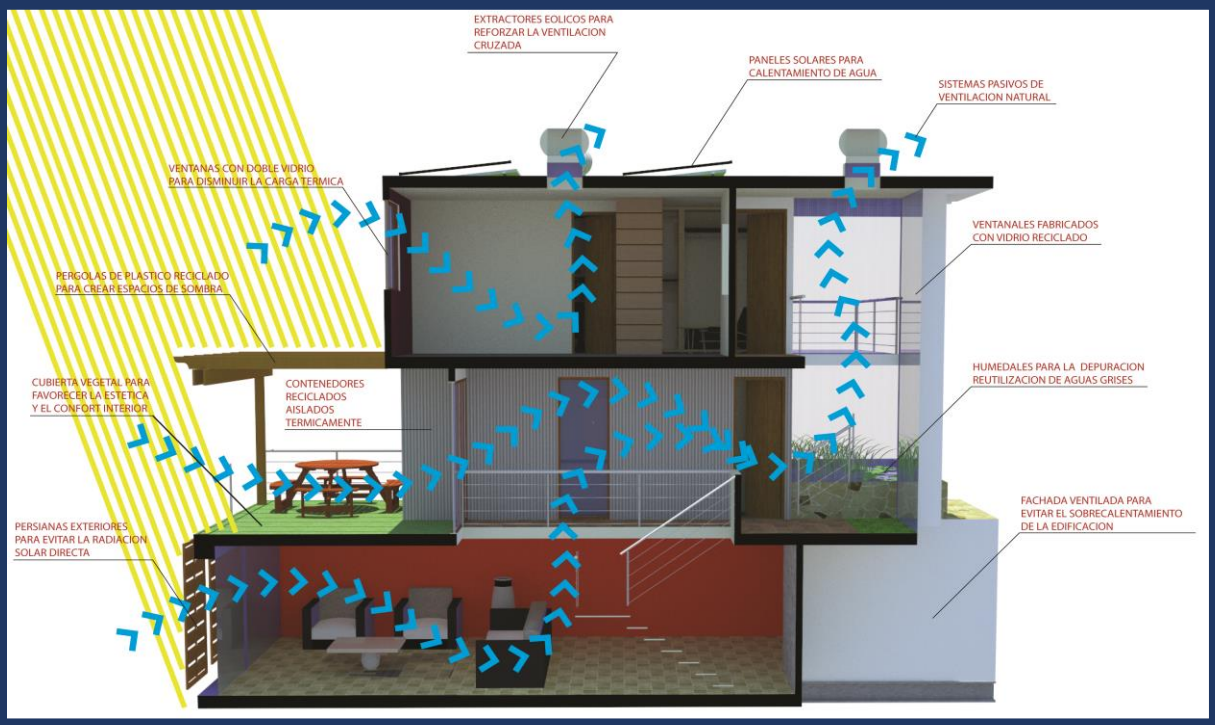

Figure 1. Design expectations
>>> indicates the expected air flow path through the structure.

In this demonstration, PHOENICS/FLAIR is used to analyse the natural ventilation of a concept home, comparing it to initial expectations. The building is a private house, to which full recycling and bioclimatic concepts have been applied. The building consists of re-cycled shipping containers and was designed by ASOLBA Enginyeria & Arquitectura, a firm of sustainable design and energy efficiency engineers located in Guayaquil, Ecuador and Barcelona, Spain.

Setup

The initial conditions and model setup for the analysis were as follows:

Wind Speed	3m/s at 10m (using Log Law Wind Profile)
Mesh Size	~ 2 million cells
Number of Iterations	4000

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The wind profile took into account the roughness height of the surrounding environment which was set to 0.1m to represent low crops and occasional large obstacles. The house itself is a simplified version of the real model and excludes elements such as furniture and the stairwell. The louvres on the lower floor were represented as partial blockages. No account of solar gain was needed for this ventilation-only model.

Results

Figures 2 and 3 show two different cross-sectional views of flow through the house. In the scenario considered, most of the air flow enters past the louvre doors on the lower floor, proceeding upwards through the house and exiting through the windows and roof vents.

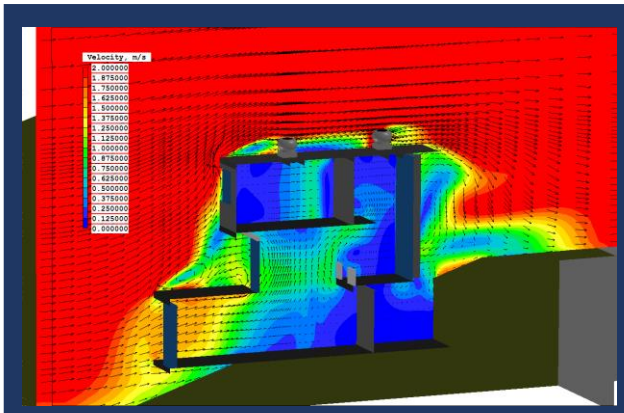

Figure 3. ***Velocity profile in x-plane***

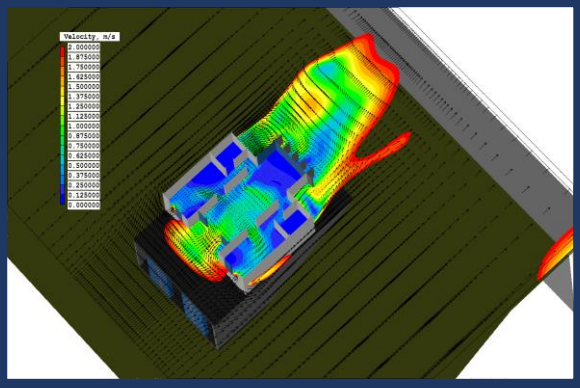

Figure 2. ***Velocity profile in z-plane***

A streamline representation (Figure 4) confirms the findings which contradict, slightly, initial expectations of a more even distribution of air entering through windows on the middle and upper levels (Figure 1).

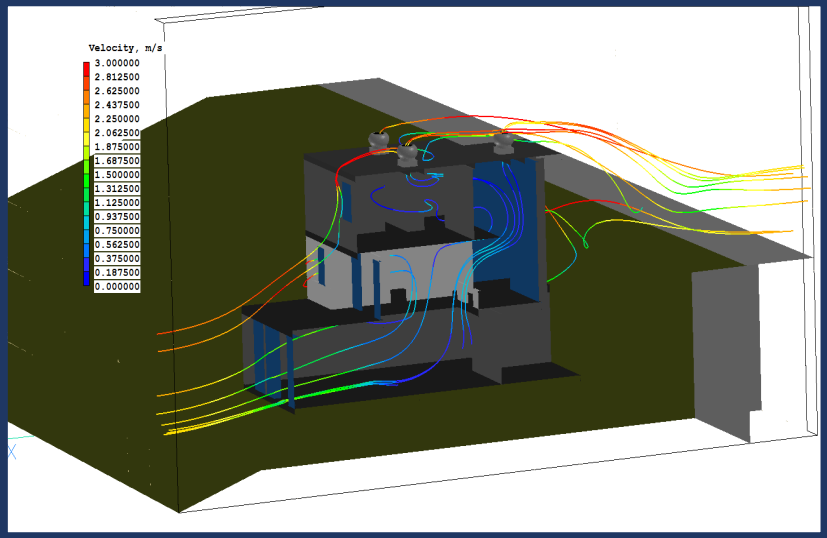

Figure 4. ***Streamline airflow in x-plane***

The CFD model can be used to ascertain, quickly and inexpensively, whether more-restricted openings through the lower region would balance flow on each floor to the required degree, or if other remedial action might be needed.

Conclusion

Using CFD techniques in this manner greatly enhances design capabilities of engineers and architects to improve and demonstrate the efficiency of particular housing designs.

PHOENICS/FLAIR can be used to predict the comfort levels needed for those occupying buildings, through further analysis of, for example, solar radiation, humidity, internal heat sources and varying environmental conditions.