Payette

The Accurate CFD Software that Throttles Up Building Design and Energy Modeling Processes

Payette, an award-winning architectural design firm located in Boston with 165 employees, specializes in high technology building design for science institutions, healthcare, and research facilities. With the emphasis on technology the firm's projects often feature energy efficiency, naturally ventilated spaces, or a thermal corridor. Payette's projects include the Duke University's Environment Hall (Picture 1), George Washington University's School of Public Health, and many more, all of which were recognized for design excellence. Payette has used scSTREAM CFD software since 2013.

Payette
http://www.payette.com

Founded	1932
Business	Architectural design
President	Kevin Sullivan, FAIA
Location	Boston, MA, USA
Size	165 employees

Picture 1: Duke University's Environment Hall designed by Payette
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One of Payette's strengths is that, unlike typical design firms, its designers work directly with staff scientists: Dr. Alejandra Menchaca (Picture 2) is one of the building scientists. As a visiting faculty at the Harvard Graduate School of Design and Massachusetts Institute of Technology (MIT) with experience serving as a building physics consultant for Hulic Co., Ltd. in Japan, Dr. Menchaca took a role as a building scientist at Payette, where she provides design guidance and direction from a sustainability and energy performance standpoint. Her involvement begins early with schematic design, and continues all the way to detailing and specifications. She uses a wide range of tools to address specific aspects of building design. These tools range from quick back-of-the-envelope calculations, to more elaborate daylighting or energy simulations to full CFD computations.

scSTREAM, a Remarkable CFD Tool for Architectural Design

Dr. Menchaca has extensive experience in natural ventilation. She has helped develop natural ventilation and passive cooling performance simulations, where she had an instrumental role in the development and implementation of a physical model to predict the thermal stratification of air in naturally ventilated rooms. When Dr. Menchaca was looking for a CFD tool for her work, scSTREAM caught her attention because of its accuracy and its full, general purpose CFD capability. Dr. Menchaca's most critical criterion was accuracy. She recalls that "we did not consider any software that did not pass our validation tests. This meant that the software was able to model convective and radiative heat transfer at room scale accurately, as well as external airflow." For the budget Payette had available, scSTREAM was the most viable option after testing of the candidate tools was completed. "scSTREAM was the only software within our price range that was able to accurately replicate room airflow simulations with convective and radiative heat transfer. Our validation study consisted of comparing scSTREAM's output to experimental results of flow inside

Picture 2: Dr. Alejandra Menchaca, a building scientist at Payette.
She obtained Master's and Ph.D. Degrees in Aerospace and Mechanical Engineering from MIT.

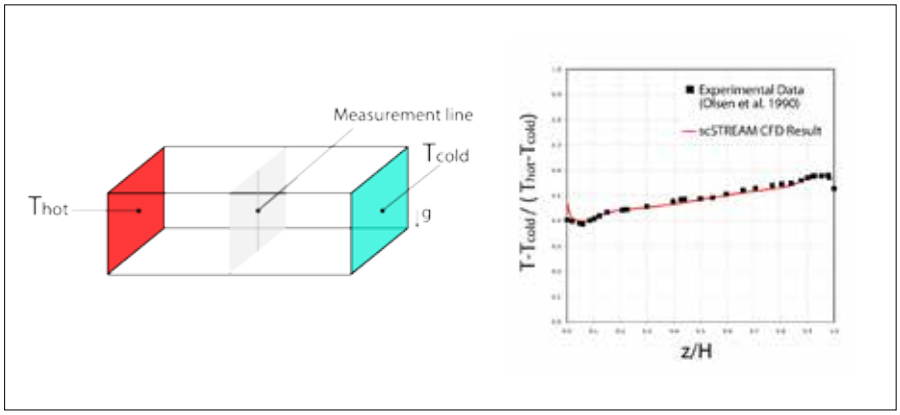

Figure 1: Case example of air temperature validation inside a building (validation setting on left, result on right)

an enclosure with a hot and a cold wall (Figure 1). We compared the temperature and velocity output for simulations accounting for and neglecting radiation, and found that scSTREAM's results were closer to experimental results than any other package we had tested," said Dr. Menchaca.

Easier, Quicker and Better Features

She also pointed out that the ease of geometry and mesh generation was one of the strengths of scSTREAM. "The ability to easily import Rhino and SketchUp geometries was a big advantage that we were not even originally considering. This saves me a lot of time, and allows us to model exactly what architects need to be modeled. The several meshing options offered by scSTREAM are something we had not seen in other software within our price range. Meshing has never been easier," she said. Furthermore, one of the features Dr. Menchaca really liked was the scSTREAM GUI. "This is where scSTREAM was probably the most superior compared to other CFD packages. The scSTREAM interface is very intuitive and defining boundary conditions – often the most painful part of setting up a simulation – is extremely simple. I tend to skip 'wizards' in most software, but scSTREAM's external airflow simulation wizard is a true time saver." The external airflow simulation wizard sets the boundary conditions for all six computational boundaries with only a couple of clicks and typed inputs.

When Dr. Menchaca talks about simulation time she says "we cannot afford to run week-long simulations, although while we are still waiting for the perfect day when CFD simulations take one minute to complete, scSTREAM simulation times are relatively short." Because of scSTREAM's reasonable cost and efficient performance Dr. Menchaca could run a simulation on her laptop if needed. This enabled her to continue running jobs when she was away from her office.

The way scSTREAM processes the data from an analysis makes it easy to visualize the results. Dr. Menchaca first mentioned scSTREAM's user-friendly interface and explained that user-friendly, high quality post-processing capabilities are critical for architectural firms like Payette. scSTREAM's post-processor enables users to instantly create surfaces, planes, volumes, streamlines, animations, dynamic views and much more. "Post-processing options seem to be endless," she said. "I often use streamlines with semi-transparent arrows, overlaid on contour plots (Figure 2). I also like the particle animations and all animations in general, which make it easy to convey results to people in the office. My students discovered the ability to record videos of their animations, which was mind-

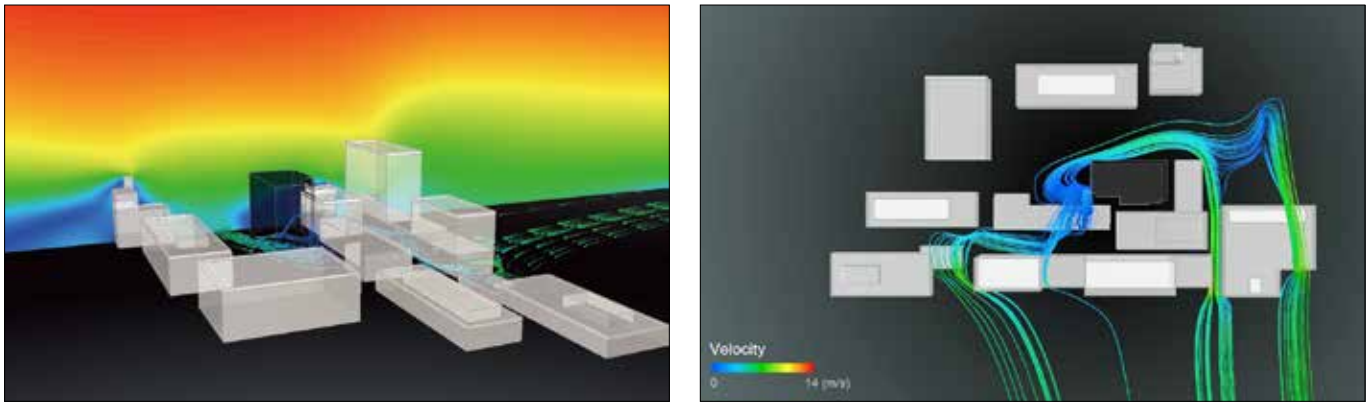

Figure 2: Results of an external wind flow study post-processed in scSTREAM - perspective view (left) and top view (right)

blowing." She continued, "another priceless feature is that I can visualize several outputs and compare them, side by side or as an animation." Of all the scSTREAM post-processing features, Dr. Menchaca thought one of the most helpful was Status File, which saves post-processing settings including viewpoint, geometry modification, image plots and graphs. It can then retrieve them into any post-files.

One last thing Dr. Menchaca liked about scSTREAM was Cradle's dedicated technical support, which ultimately convinced her to select scSTREAM. "The quality, and most importantly, quick response offered by Cradle's technical support has allowed us to overcome problems and bugs in a matter of hours, compared to the several days that one needs to wait with other firms."

CFD Analysis at a Design Firm and the Future of CFD for Architecture

CFD analysis is known to help designers and engineers understand and improve their architectural designs. However, practitioners in the architectural field often say they are hesitant to commit to CFD. Dr. Menchaca provided her thoughts on this matter. "I think the current usage of CFD in the architecture industry has not reached its full potential. Because of cost, time and expertise required, running a CFD simulation means waiting for at least a month to get an answer to any questions." The time required to perform a CFD analysis is certainly an issue that affect the role of CFD in the design processes. According to Dr. Menchaca, time is an even greater constraint when the architectural firm outsources the CFD work to a supplier. "By the time the CFD results are received, the building is likely to have changed dramatically. This means that, in general, we will only outsource CFD studies for building elements that are less critical." In contrast, the situation is entirely different at Payette where building scientists conduct energy modeling and CFD analysis alongside their design team. Dr. Menchaca described the benefit of having CFD capabilities in-house. "Having CFD capabilities in-house allows us to speed up the simulation process to a week or so, and also allows us to tweak and explore more options as the design evolves."

She also explained some of the differences between the current design process and the past. "Our office used to hire outside consultants to evaluate indoor thermal comfort conditions or to conduct wind studies, studies which usually require about one month to get results. Now we do most of the early design simulations in-house, which has allowed us to use the results to modify the building design. This saves us both money and valuable time."

CFD will make greater contributions to the architectural industry as technology continues to improve "the easier and quicker it becomes to run accurate CFD simulations, the more CFD will be used as a tool that impacts building design, rather than an afterthought." Dr. Menchaca compared this to the way energy modeling has slowly become more common in the early design stages and now impacts the design process.

Lastly, Dr. Menchaca was asked about one feature she would like to test with scSTREAM. "I have not had the chance to really test particle dispersion, which is extremely relevant for us, particularly in the healthcare practice. Also, I would like to run parametric tests with scSTREAM, to evaluate several design options without having to set each case up, just like the Wind Tool does when it tests several wind directions."

Dr. Menchaca's application example of scSTREAM indicates that scSTREAM will play even more significant role in building design in future.

Featured Software

scSTREAM

scSTREAM uses a structured mesh to model general purpose thermal/fluid applications where tiny details and curved surfaces are not critical for an accurate simulation. scSTREAM can both create the mesh and calculate the solution quickly and efficiently using the finite volume method. A one million element model only consumes 350MB of RAM. In addition to highly capable models for simulating complex physics, scSTREAM also includes a set of Visual Basic interfaces and table/function inputs that make it customizable.

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