Using CFD to Investigate the Personal Micro-Environment

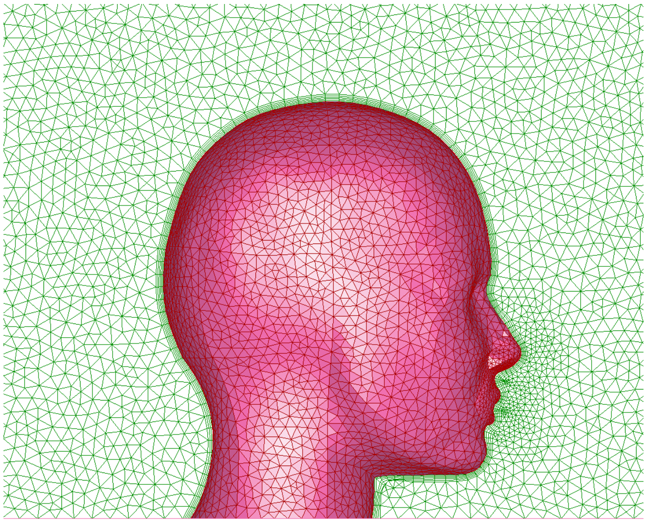

Figure 1: Prism layers have been extruded around the mannequin geometry.

Researchers at Syracuse University's EQS STAR Center are using Gridgen to create grids around a detailed human mannequin to study the personal micro-environment (PME). The PME can be thought of as the immediate environment affecting an occupant's breathing zone. The flows created by the interaction of HVAC systems, indoor appliances and human occupancy are particularly complex. Using CFD, these processes can be isolated and studied individually.

The first step was to validate the computational fluid dynamics software. To accurately predict the heat and mass transfer from a person, the grid near the mannequin surface needed to resolve the boundary layer. Employing a strictly tetrahedral topology for the entire volume would have required a prohibitive amount of cells to resolve the mannequin boundary layer. Using Gridgen, several layers of prismatic cells were created by extruding the unstructured surface cells, as seen in Figure 1.

While it was estimated that a grid well in excess of 10 million cells would be required to resolve the boundary layer ($y+ < 1$) using tetrahedra alone, total cell count using prism layers was 4.5 million.

To understand the impact of transient occupant activities, simple motions such a head and body rotation, were introduced into the simulations. In the case of head rotation, two blocks were needed: a cylindrical volume around the head and the remaining room volume.

The cylinder was created so that a fluid zone containing the head could rotate around the axis. Creation of a two-block grid using the original database was greatly expedited because Gridgen treats the geometry and grid in a decoupled manner. Figure 2 shows a snapshot in time of the fluid particle motions, released during the exhale phase, computed from the resultant CFD solutions.

The EQS STAR Center's CFD group is continuing to make use of Gridgen by leveraging features such as solid modeling and anisotropic tetrahedra for their projects to reduce the time spent going from the initial CAD model to the final computation mesh. The EQS STAR Center's work highlights the need for advanced meshing capabilities as the sophistication of CFD grows to follow new areas of indoor environmental research.

Courtesy of Chris N. Sideroff and Thong Q. Dang, EQS STAR Center, Syracuse University, Syracuse, New York, USA. Reprinted from an article in the Spring 2008 Focal Point.

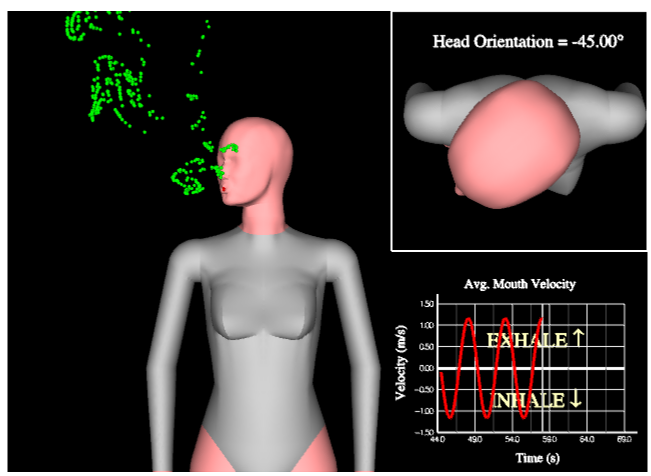

Figure 2: The motion of fluid particles while turning the head.

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