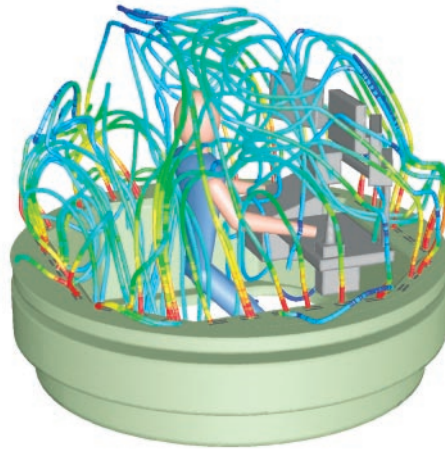


At Boeing, an investigation has been performed to predict the ventilation and temperature characteristics of the International Space Station Cupola, and to ensure the adequacy of crew comfort and safety during certain usage scenarios. The Cupola is the Space Station's pressurized observation and work area. It is used to support the Remote Manipulator System (RMS), which is the station's robotic arm. It also houses a Robotic Workstation (RWS), which is used to control the RMS. The Cupola permits the astronaut to view the Earth, celestial objects, and visiting vehicles as well.

Fluent's CFD software has been used to evaluate the Cupola's ventilation with and without the RWS operating. The entire geometry and mesh were created using GAMBIT. There is a requirement that an effective air velocity in the Cupola habitable volume must be maintained within the range of 15 to 40 feet per minute. The first round of FLUENT results indicated that the Cupola ventilation meets this specification when the RWS is not powered. However, when the RWS is operating, the air velocity is too high due to the elevated flow rate created by the RWS fans. Furthermore, a low velocity region is present where the crewmember is usually positioned, at the center of a vortex created by the flow pattern.

In addition to examining Cupola ventilation, crew comfort has been evaluated by investigating the air temperature around the crewmember. When the RWS is not operating, it was found that, due to good air mixing and low heat loads, the temperature around the crewmember stays at a comfortable level. When the RWS is activated, however, there is reduced air mixing and higher heat loads that cause uncomfortable temperatures to develop.

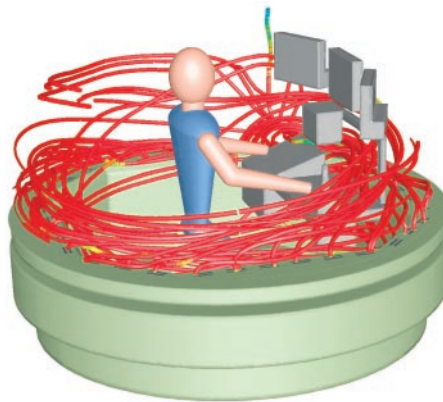
After analyzing these results, it was found that a laterally located vent on the RWS is the culprit for the vortex air pattern during RWS operation. FLUENT was used to find a resolution to this problem. A deflector was placed over the vent to hopefully bring the ventilation closer to specification, improve the air mixture, and lower the temperature around the crewmember. The results of these simulations show that the deflector works by diverting the air from the laterally located vent directly out of the Cupola hatch, thereby hindering the formation of the vortex. This, in turn, results in lower air velocities, an improved air mixture, and more comfortable temperatures for the astronaut. ■



Pathlines, colored by velocity magnitude, illustrate the flow field in the cupola when the RWS is not operating

Looking Out for Crew Comfort in Space

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When the RWS is turned on, a vortex forms in the cupola, causing discomfort for the crewmember



By adding a deflector near a laterally mounted vent, pathlines show that the flow is now acceptable