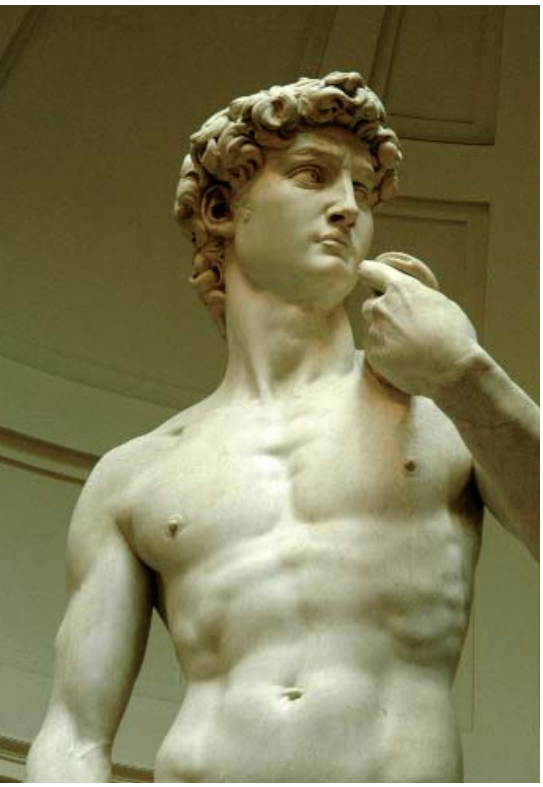

A Curtain of Air for the Statue of David

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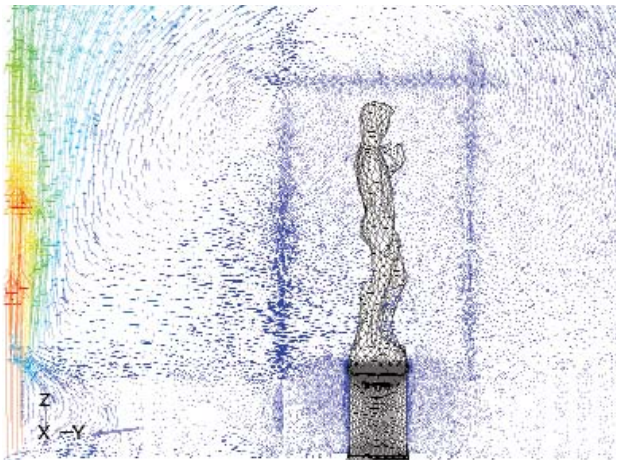
Every year millions of people visit works of art in museums around the world. Ironically, the museum visitors who most appreciate the cultural heritage found in museums and galleries are often the primary source of pollutants to the artwork on display. Air curtains are a promising method for protecting works of art in such situations. They have no harmful impact on the art objects and do not restrict the visibility to the crowd.

CFD is a useful tool for the design of air curtains because it gives coherent answers within a timeframe shorter than that needed for lab or field tests. This is one of the principal reasons that CFD is such an advantageous instrument during the design phase of any project. It allows possible solutions to be studied for different initial configurations, geometries, and boundary conditions.

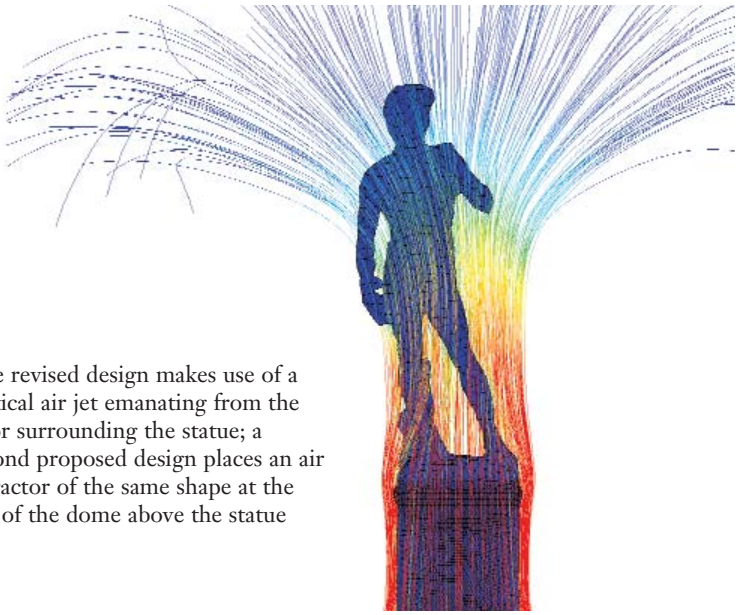
As an example, consider the interior space of the Galleria dell' Accademia in Florence. The principal nave hosts Michelangelo's *David* along with other paintings and sculpture, such as the Pieta Palestrina and Prigioni. Two lateral rooms house the work of Florentine painters.

The existing HVAC system in the gallery provides a compact vertical inflow from the floor of the apsis area directly behind the statue of *David*. The inlets push air at high velocity up and over the statue toward the visitors, diffusing pollutants in the surrounding environment. When visitors stand near the inlet units to observe the paintings, the rising air picks up pollutants from their bodies. These pollutants are carried aloft into the upper reaches of the dome where they rapidly lose velocity. This phenomenon represents a danger for the statue which stands in the area below, since the dust and pollutants are free to fall from the stagnant upper air and deposit onto the surface.

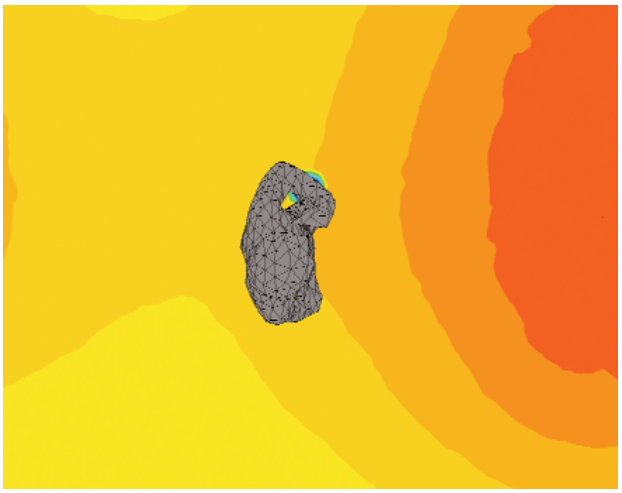
Using CFD, a research group at the University La Sapienza in Rome have tested a number of alternative HVAC system designs for the gallery. The best one developed provides a 150mm wide air terminal in the shape of an annulus, placed around the base of the statue to introduce air from the floor. The velocity of the airflow is high enough to reach the top of the statue without the risk of too much outward spreading.

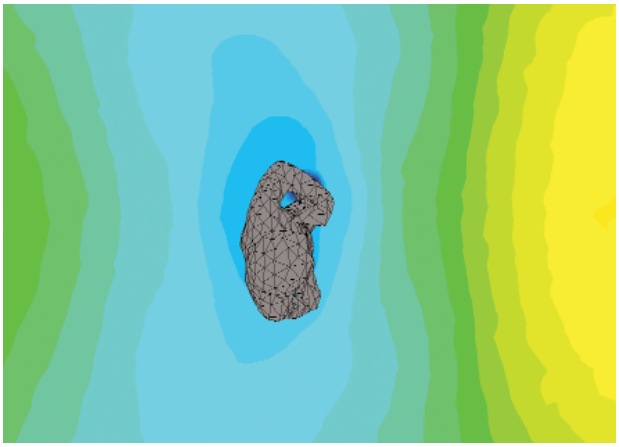


The existing air curtain design involves a high-speed vertical jet of air directed upwards from behind the statue; pollutants introduced to this air stream can separate from stagnant air above the statue and fall onto it



The revised design makes use of a vertical air jet emanating from the floor surrounding the statue; a second proposed design places an air extractor of the same shape at the top of the dome above the statue





Displayed using the same scale, the concentration of CO_2 in the vicinity of the statue is shown with the original (top) and revised (bottom) ventilation system; the revised system creates a greatly improved environment for the statue

A second proposal would be to place an air extractor near the top of the dome for exhaust air, corresponding to that at the base of the statue. Together, these would generate a vertical flow field rising from the base of the statue, improving the protective action of the air curtain by pushing up and out the pollutants coming from the nearby area where visitors stand.

Performing different design simulations using CFD, the research group has been able to identify the appropriate design geometry of the air curtain, optimizing the velocity, temperature, and relative humidity in the gallery. In addition, the filtration characteristics of the airflow have been identified, and a dedicated air handling unit has been specified that adheres to the most restrictive prescriptions for works of art in museums. ■

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Suggested Reading

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2. L. de Santoli, F. Mancini, M. Mariotti, Air curtains as a protection for indoor cultural heritage: a proposal for Michelangelo's *David* in Florence, Proceedings of Indoor Air 2005, Beijing 4-9 September 2005.

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