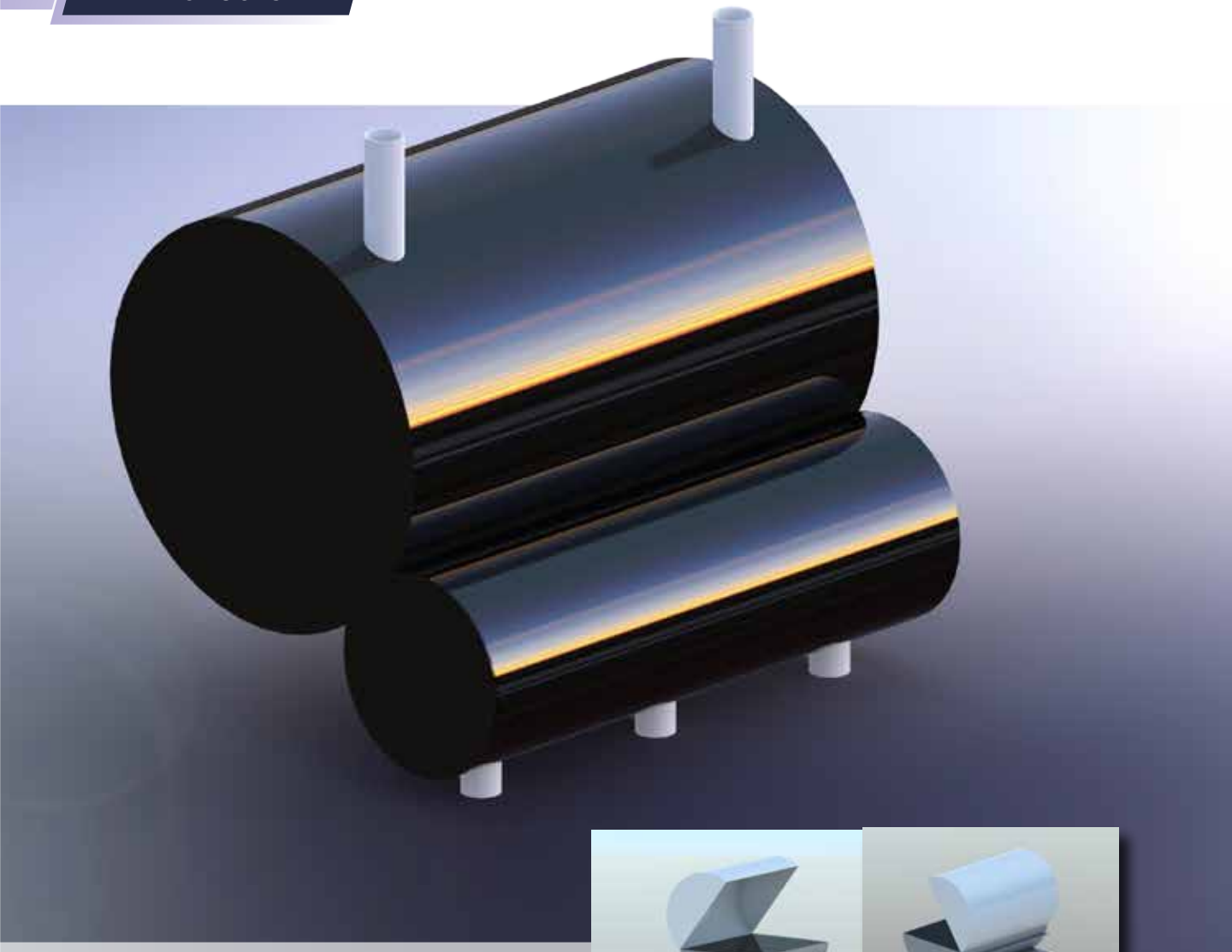


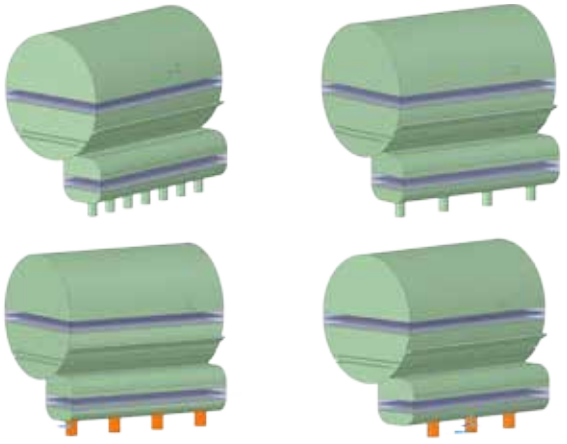
Cooking with ANSYS SpaceClaim

By **Travis Jacobs**,
President,
Jacobs Analytics,
Denver, USA

When Jacobs Analytics started designing a barbecue smoker, it took two weeks using traditional solid modeling to create a single design iteration ready for computational fluid dynamics (CFD) simulation. Since switching to ANSYS SpaceClaim, the company can now edit the design to create a new iteration in only five minutes. After generating and simulating about 500 designs, the design and engineering company finalized a version that offers substantially higher performance than existing smokers.

"Jacobs Analytics streamlined the design process by using ANSYS SpaceClaim and simulation to generate new design iterations early in the design process, in a fraction of the time required in the past."

Under ideal conditions most barbecue smokers work very well to cook delicious meat. But, when the wind blows strongly, the smoke is sucked out and the temperature inside the smoker varies drastically from too hot to too cold. The result is meat that is either over or undercooked with not enough flavor. Jacobs Analytics is a startup design and engineering company where president and engineer Travis Jacobs performs all functions. As a barbecue enthusiast, Jacobs was inspired to use CFD to design a smoker that could cook meat to perfection in any weather. When the project began, he used a popular parametric solid modeling package to define the geometry of each design iteration. This was time-consuming because he needed to work around feature dependencies in the model, repair artifacts produced as a by-product of the translation to a neutral file format for analysis, and create a fluid volume for each design iteration.



Jacobs Analytics digitally explored many designs before determining the best configurations. Only a portion of the designs for the number and shape of inlets is shown.

He was inspired to use ANSYS SpaceClaim to modify the fluid volume for ANSYS CFD and so enrolled in the ANSYS Startup Program. As a small company, Jacobs Analytics does not have the funds to create a large number of physical prototypes; digital exploration through SpaceClaim can create many new design iterations to determine the best design long before the prototype stage. Modifying fluid or solid geometry is much faster with SpaceClaim than with a conventional solid modeler because any feature can be edited without contending with the network of interdependencies in a parametric solid model. Using digital exploration guided by CFD results, Jacobs iterated to a design that maintains a high level of smoke and a uniform internal temperature regardless of weather conditions.

ANSYS SpaceClaim: Try It Now
ansys.com/tryspaceclaim

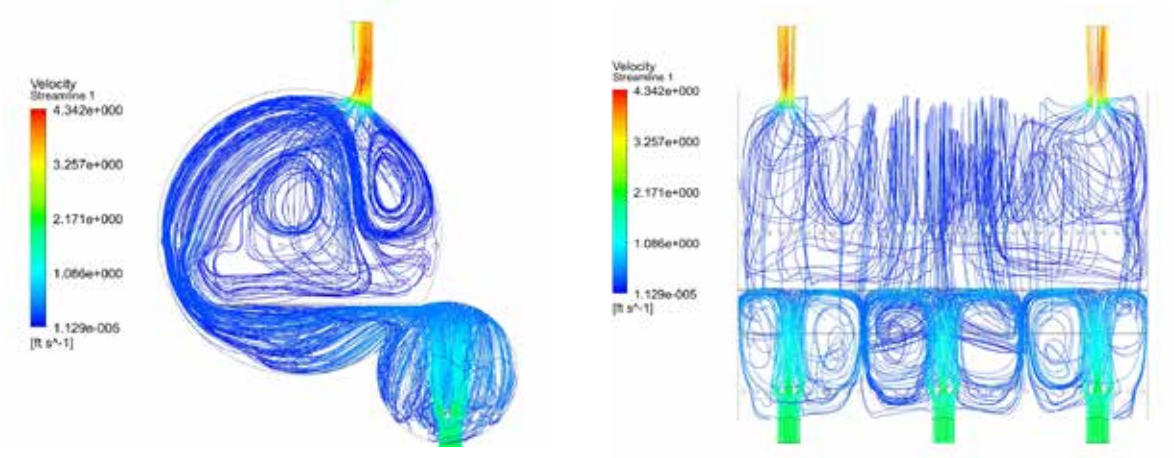
LIMITATIONS OF EXISTING SMOKERS

The typical barbecue smoker consists of a 4-foot-long, 2-foot-diameter cylinder with a removable pan at the bottom to insert wood or charcoal. Racks are distributed vertically through the smoker to hold meat while it cooks. Air enters through vents in the bottom and exits through outlets near the top of the smoker. This design works well in calm weather, but under high winds too much air enters the inlets and swirls through the smoker, removing the smoke and causing severe temperature variations. Some dedicated cooks build enclosures around their smoker, but this is expensive and takes up considerable space.

Jacobs wanted to include flow restrictors in the inlets and outlets to maintain the internal flow regime regardless of the weather. The company also planned to incorporate a double wall in the smoking box to provide insulation to maintain the internal temperature. Getting this much more complex design right in a reasonable amount of time required using simulation to explore many different design iterations.

IMPROVING DESIGN PROCESS

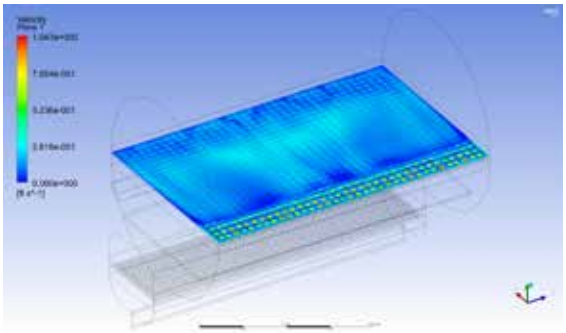
In the past, Jacobs created designs as solid models and exported the geometry in neutral file format for CFD simulation. The process of editing the solid geometry was slowed by the difficulty of changing geometry that was not originally configured as a parametric variable; it could only be changed indirectly by changing its parent geometry. Limitations in the accuracy of the process of translating from CAD to the neutral file format often resulted in the creation of many tiny fragments that had to be manually combined or removed in the CFD preprocessor. This entire process,



^ Side view (left) and front view (right) of CFD flow streamlines for a smoker design iteration with three inlets at the bottom and two outlets at the top

which took about two weeks, had to be repeated for each design iteration.

Jacobs reduced the time required to create a new design iteration by editing the design geometry in ANSYS SpaceClaim instead of a parametric modeler. SpaceClaim uses direct modeling technology to create and modify any element of the design. The network of constraints is replaced by feature recognition that intelligently determines which individual entities the user wants to edit. For example, the engineer can select the end of a pipe and pull it to lengthen or shorten the pipe. SpaceClaim also generates geometry in the native



^ Velocity profile over horizontal cross-section for the final smoker design. The final design has one long skinny inlet on the bottom and one long skinny outlet at the back angled at 30 degrees upward.

format used for simulation, avoiding translation errors. This helped Jacobs reduce the time required to create a new design iteration to only two days.

After about a dozen iterations, the engineer decided to further improve the design process by editing the fluid geometry directly in SpaceClaim, thus avoiding the need to deal with the solid geometry after the first design iteration. This process change reduced the time to create a new design iteration to about five minutes.

SIMULATION GUIDES DESIGN IMPROVEMENTS

After creating each design iteration, Jacobs used ANSYS Meshing to create a tetrahedral mesh with inflation layers around the smoker and about 30 million nodes. The smoker was simulated within a much larger design space so that air currents could be created in the surroundings to simulate the effect of wind on the smoker. Jacobs created a flow velocity inlet on one face of the cube and a pressure outlet on the opposite face so he could evaluate the effect of changes in wind velocity on the flow patterns inside the smoker. He modeled the effects of different wind directions by changing the orientation of the smoker with respect to the wind.

With the analysis workflow optimized, Jacobs Analytics focused on optimizing the geometry of the smoker to achieve constant vertical flow velocity, uniform flow velocity across each horizontal cross section, and uniform temperature inside the smoker regardless of ambient wind velocity, wind direction or temperature. Jacobs experimented with different types of flow restrictors and tried them under a wide range of wind conditions. He saved time in evaluating flow restrictors by simulating only the inlet and flow restrictor, which took 15 minutes compared to the six hours it would have taken to run the complete model. The best flow restrictor designs were then simulated with the full model. Through the ANSYS Startup Program, Jacobs Analytics streamlined the design process by using ANSYS SpaceClaim and simulation to generate new design iterations early in the design process, in a fraction of the time required in the past. This made it possible to create a design that delivers optimized cooking performance regardless of the ambient weather conditions. The company is currently testing the new design and preparing to bring it to market.