

# RING OF FIRE

**Whirlpool Brazil reduces time to develop a new cooktop by 35 percent with direct modeling and fluid simulation.**



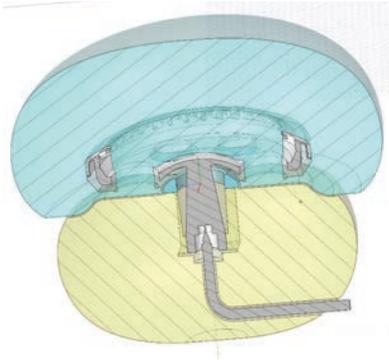
By Pablo Filgueira Rodeiro, Senior Manager — Simulation-Based Design, Whirlpool Corporation, São Paulo, Brazil

**T**he design of gas burners for cooktops is challenging because of the many design parameters involved. The geometry of the port where the flame is produced, the injectors that provide gas and air to the ports, and the grates that support the ports — as well as the relationship between the ports and the metal surface of the appliance — all play roles in determining how well a burner will perform.

Whirlpool Brazil relies heavily on simulation to design gas burners for freestanding ranges, built-in ovens and cooktops. Simulation helps engineers to lower fuel consumption and cook time and reduce development time by predicting the performance of proposed burner designs prior to the prototype phase. Whirlpool Brazil engineers use ANSYS computational fluid dynamics (CFD) software to evaluate proposed burner designs for flame stability, energy efficiency, surface temperature and carbon monoxide generation. However, the engineers required a tool to prepare models for simulation so that they could quickly explore a range of designs to come up with the best burner that would meet all criteria.

Whirlpool overcame this challenge by using ANSYS SpaceClaim Direct Modeler, which allows easy geometry cleanup and generation of closed volumes required for CFD simulation. With the SpaceClaim approach, Whirlpool engineers could directly edit any geometry feature without worrying about parametric constraints, reducing the time required

**ANSYS SpaceClaim Direct Modeler allows easy geometry cleanup and generation of closed volumes required for CFD simulation.**



▲ Simulation domain



▲ Simulation domain exploded view

to prepare a concept design for analysis by up to 90 percent. The ability to much more quickly define and evaluate new design iterations has reduced the overall time required to develop a new cooktop model by 30 to 40 percent.

### STREAMLINING THE DESIGN PROCESS

Whirlpool engineers had been creating burner designs using a parametric CAD system. CAD systems generate the highly detailed models that are vital to meeting rigorous manufacturing requirements — one of the final steps in the design cycle. However, early in the design phase, engineers needed a tool that allowed them to make multiple design interactions easily. They could then virtually test these designs using simulation. A single CAD model took a week to prepare, and at least 100 days were required to complete a new burner design.

Integration of ANSYS SpaceClaim Direct Modeler within ANSYS Workbench enables engineers to make and investigate design modifications in a fraction of the time required in the past. Whirlpool Brazil engineers used these tools recently

**Engineers increased primary air entrainment from 36 percent to 52 percent. This generated a stable flame with nearly complete combustion, high levels of efficiency and low levels of carbon monoxide.**

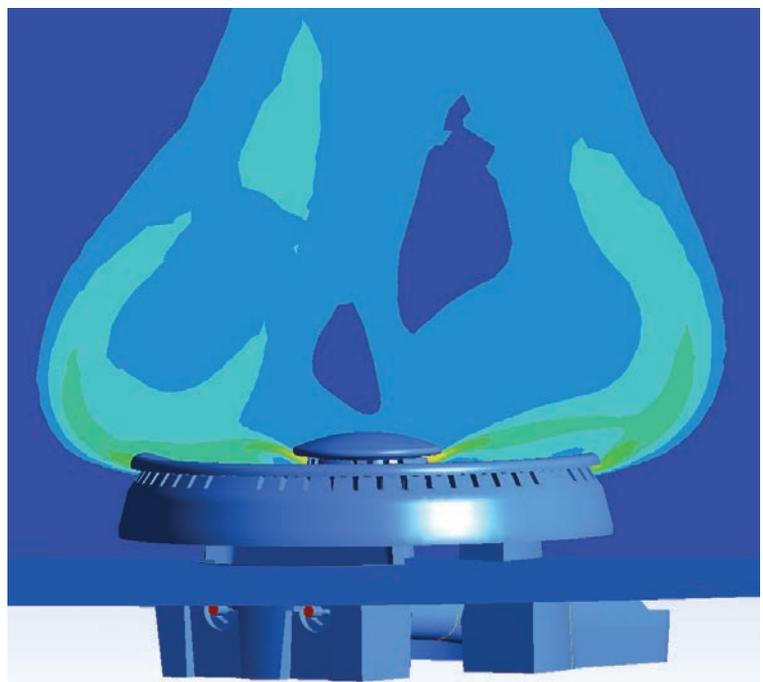
to design a new cooktop for the consumer market. Engineers first created a baseline design with the company's parametric CAD system. Then they stripped out the parametric constraints by exporting a STEP file into the ANSYS Workbench design environment.

SpaceClaim Direct Modeler's advantage is that it uses pattern recognition on an imported model to determine the user's intention when making an edit, so the model can be manipulated as if it were fully parametric. For example, even though a pocket has not been defined as a feature, the user can select it and the software will recognize in real time that it is a feature and allow the user to change its size or move it without breaking it down into its individual entities, such as lines and arcs.

### COOKTOP BURNER EXAMPLE

In the case of the cooktop burners, Whirlpool Brazil engineers began by using a SpaceClaim tool that automatically finds and fixes gaps and overlaps between the surfaces of the model. This tool addressed the majority of the problems with the original model. Engineers corrected additional areas with other SpaceClaim tools, such as one that cleans up small features and fills holes. Further edits were made simply by selecting faces and edges and pulling or moving them into the proper positions. The model was ready for meshing and simulation in only four hours.

The mesh had 2.5 million nodes and 10.2 million tetrahedral, hexahedral, wedge and pyramid elements. Whirlpool engineers ran an ANSYS Fluent CFD



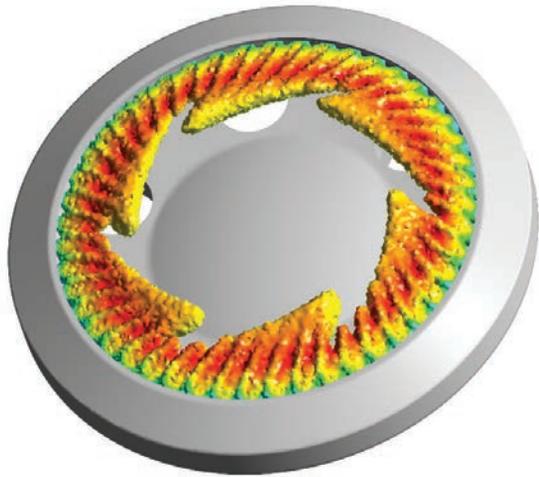
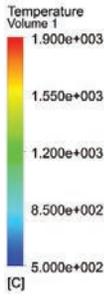
▲ ANSYS CFD simulation of new burner design. Simulation was conducted to study air/fuel ratio at different locations in and out of the gas burner. The image shows natural gas concentration at a cross section of the burner.



**ADVANCED GEOMETRY REPAIR WITH ANSYS SPACECLAIM FOR CFD PRE-PROCESSING**  
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combustion simulation using the EDC combustion model and SST turbulence model. The simulation took 36 hours to run on a high performance computing (HPC) platform with 20 cores. Results showed the mass flow of fuel and primary air, carbon monoxide concentration and surface temperatures on the cooktop. Whirlpool Brazil engineers also wrote a script to calculate burner efficiency. The simulation revealed significant areas for improvement in the initial design.

Engineers generated a total of 16 iterations with SpaceClaim to investigate changes in port and injector geometry. They focused on increasing the primary air entrainment, which is a measure of how effectively air is taken up by the burner during operation, expressed as a percentage of stoichiometric supply. Over the course of design iterations, engineers increased primary air entrainment from



▲ Iso-volume of percentage of fuel with temperature plot

36 percent to 52 percent. This generated a stable flame with nearly complete combustion, high levels of efficiency and low levels of carbon monoxide.

The complete design process took only about 65 days, 35 percent less time than would have been required using previous methods. This application demonstrates the

time- and cost-savings that can be achieved by enabling simulation engineers to quickly and easily prepare design geometry for simulation as well as how an efficient design can be determined using simulation. ▲

*Whirlpool Brazil is supported by ESSS, ANSYS elite channel partner in South America.*

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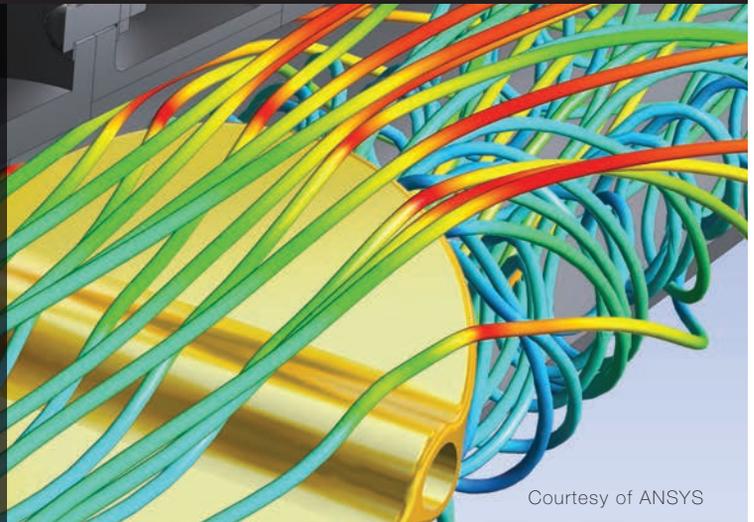
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