Embraer Turns VR Potential Into Reality

by Bob Cramblitt

Since its conception, virtual reality has stoked imaginations for its potential to allow people to see and experience phenomena that couldn't easily be created in the real world.

Embraer, one of the world's largest aircraft manufacturers, is turning VR's potential into reality. The company is stretching VR's long-time role as a presentation platform for large-scale digital mock-ups and virtual prototypes. In Embraer's hands, VR is also an important tool for engineering analysis, simulation and virtual testing. The technology is playing a key role in speeding development time, helping engineers design better test campaigns, and increasing the safety of real-world testing.

Tools of the trade

The most visible part of Embraer's VR center in Sao Jose dos Campos, Brazil, is the PowerWall from Fakespace (www.fakespace.com). The large display system is based on high-resolution rear-screen projectors that provide crisp, stereoscopic images when viewed with 3D shutter glasses. Computing power is provided by an SGI (www.sgi.com) visualization supercomputer. The center also uses VR devices that include stereoscopic glasses, electromagnetic sensors, a head-mounted display, and a pinch glove for interacting with 3D models.

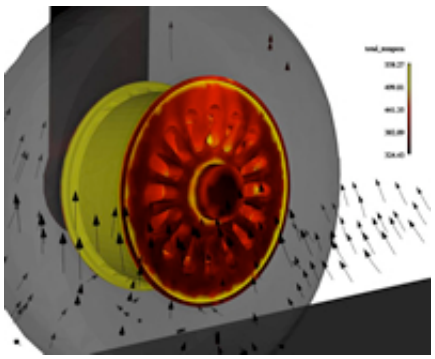
Fluent (www.fluent.com), Metacomp Technologies' CFD++ (www.metacomptech.com) and other commercial and in-house codes are used for CFD analysis. CEI's EnSight and EnSight Gold software is used to visualize results and prepare interactive presentations.

The push for new applications

Hardware and software are essentials for VR, but they don't necessarily lead to new or more extensive applications for the technology. That takes dedication like that of Marcelo Fabricio Prim, a technology development engineer responsible for CAE visualizations at the VR center.

"We're always looking for new possibilities for using VR at Embraer," says Prim. "We work like enzymes - we find people who need help and do our best to solve their problems."

Sometimes those problems are ones that cannot be solved by physical testing, or are too expensive to undertake using solely conventional means. An example is the phenomena of natural air convection.



Product development engineers could not understand why the Embraer Legacy's landing gear had faster heat dissipation on the inside than the outside. The cause of the phenomenon was not readily understandable from computer simulations and flight tests.

"It was hard to interpret trends from the experimental and numerical CFD results," says Ramon Papa, product development engineer at Embraer.

EnSight visualizations displayed in stereo on the

PowerWall helped verify the behavior of the air around brakes, tires and the wheel.

"Transparency, oil-flow and scripting features in EnSight, along with the ability to combine different variables in the same plot, helped us understand what was happening," says Papa.

Bringing images to the big screen

Bringing these revealing graphics and animations to the big screen in stereoscopic vision is not as easy as it might seem. Stereoscopic images must be rendered for the viewer's left and right eyes separately, using a slight angular offset in either direction. The resulting pair of images are displayed or projected onto a viewing surface, alternating at a high rate between the left- and right-eye images.

Since immersion - becoming one with the virtual environment and interacting with it - is important to the VR experience, visualization software needs to provide a way to manipulate models and interactively interrogate data. EnSight Gold, the software used in Embraer's VR center for CAE visualization, provides support for 3D input devices that enable movement with six degrees of freedom (6DOF). A heads-up macro within the software provides user interface panels on the display that can be used to change the viewing scene or attributes of models on the screen.

Additional visualization capabilities required to handle Embraer's VR needs include the ability to display very large models, multi-frustrum viewing to display multiple-projector or multiple-screen images and animations, and parallel rendering on multiple graphical processors to accelerate rendering for a scene. Engineering Simulation and Scientific Software (ESSS), the EnSight distributor in Brazil, has been instrumental in helping Embraer integrate advanced CFD visualization into its VR environment.

"The complexity of the analyses at Embraer are always increasing," says Prim. "We need to be able to visualize those analyses with good performance. Visualization features such as parallel rendering, user-defined inputs that allow us to use sensors, special gloves and other 3D input devices, and the ability to support immersion and interactivity make a difference in the operation of the VR center."

Better testing through VR

A recent evaluation of reverser systems for the new Embraer 170 jet demonstrates how CFD, advanced visualization and VR can combine to reduce testing costs, speed development time and improve safety.

Most modern jets have thrust reverser systems that decelerate the aircraft more quickly and efficiently. The systems are designed to provide as much reverse thrust as possible, but they are limited by constraints such as re-ingestion of airflow, damage from foreign objects, loss of efficiency of control surfaces and spoilers, increased vibration, and pressure on the bottom of the fuselage that can cause buoyancy.

Embraer used Fluent and its in-house CFD programs to analyze the effects of different design configurations on the thrust reverser systems. Specific features within EnSight enabled Embraer to depict different types of CFD results, according to Luis Gustavo Trapp, who joined with Guilherme L. Oliveira to write a paper on the project for the annual meeting of the American Institute of Aeronautics and Astronautics (AIAA).

Restricted-surface particle traces generated in EnSight were used to show the overall flow topology on the surface of the Embraer 170. Isosurfaces were used to visualize the areas affected by reverse flow at different speeds. Streamlines that were color-coded according to velocity enabled engineers to visualize re-ingestion, the effect of a configuration on buoyancy, and how air flows over spoilers. Isocontours were used to examine

temperature changes nearby the engine.

Displaying results with stereographic animations on the PowerWall enabled Embraer engineers to better understand and compare the complex interactions for the different thrust reverser cascade configurations.

"Performing CFD analysis and visualizations to check the reversers' aerodynamic behavior before flight test reduced costs and helped ensure the safety of our test pilots, since we knew in advance about controllability issues they might face," says Trapp.

The "wow" factor

VR at Embraer extends the company's design, engineering and analysis capabilities well beyond what can be done with traditional CAD/CAM/CAE systems. The victim of unrealistic expectations and hype in the early days, VR is becoming a tool for increasing productivity and making new approaches possible.

But don't think because it is becoming a part of the mainstream at a company such as Embraer that VR has lost its ability to impress.

"Customers are amazed when they see engineering animations running in stereo on a VR display," says Ramon Papa. "The animations really help us show simulations and results in a convincing way."

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CEI Press contact: Amanda Baley, 919-363-0883