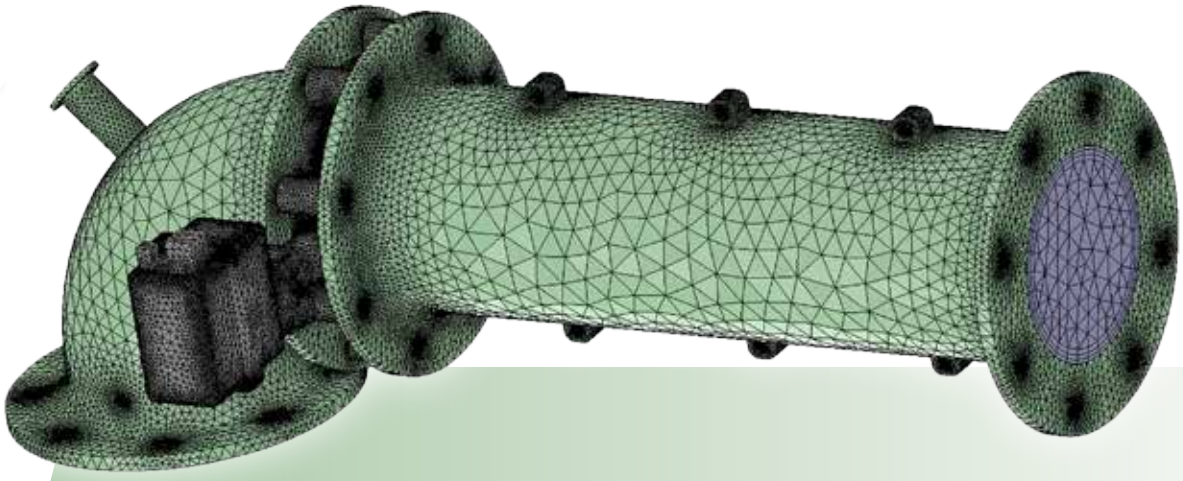
Digital Exploration with ANSYS AIM



By **Steve Scampoli**,
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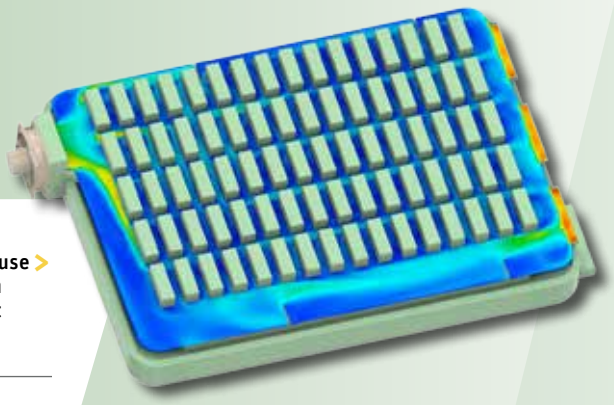
Innovative companies continually seek new ways to improve product design and reduce product development costs. Because most development costs are determined by decisions made early in the design process, many companies leverage digital exploration, often called upfront simulation, to reduce costs. By digitally exploring design concepts and testing critical design choices early in the design process, upfront simulation provides the guidance required to make informed design decisions, reduces the need for physical prototypes and avoids unworkable design concepts. ANSYS AIM makes it easy to perform digital exploration by combining unmatched ease of use, accurate simulation results and design optimization in one simulation tool.



Velocity magnitude for an automotive fuse box where the inlet boundary condition is specified using a solution-dependent expression representing a fan performance curve

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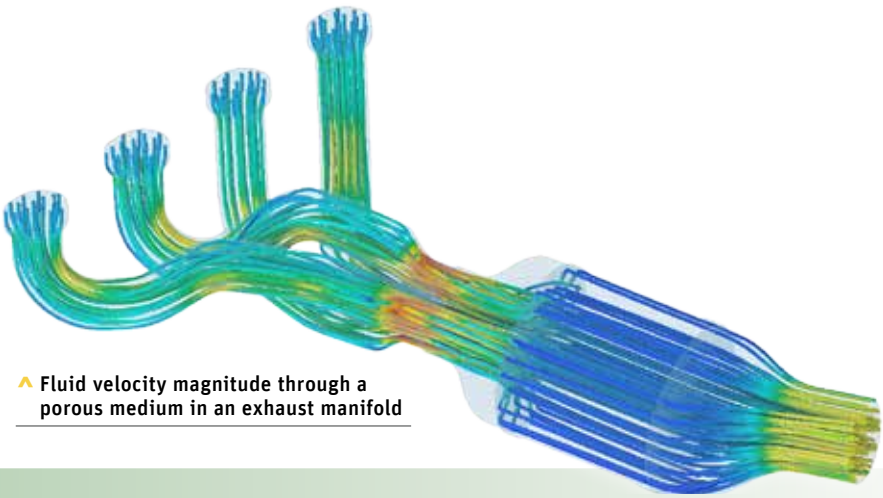


Fluid velocity magnitude through a porous medium in an exhaust manifold

UPFRONT SIMULATION FOR PRODUCT DESIGN

ANSYS AIM integrates proven ANSYS technology. Geometry modeling (based on ANSYS SpaceClaim capabilities) enables users to quickly create new concept models or edit existing designs. By leveraging ANSYS's world-leading solver technology, AIM provides design engineers with results they can trust, whether a simulation includes fluid, thermal, structural and/or electromagnetic effects. Depending on the product, it is often necessary to consider the flow and thermal performance, the structural integrity and/or the electromagnetic performance of the design. With AIM's single user interface, the workflow and the user experience are consistent for all types of simulation, which makes AIM easy to learn and remember, so that design engineers can rapidly meet any simulation challenge.

ANSYS continues to expand ANSYS AIM capabilities to cover an even broader range of product design applications. Some of the new capabilities to evaluate the physical performance of product designs, along with advancements in collaboration and customization, follow.

EVALUATING FLUID PERFORMANCE

A number of new features enable design engineers to quickly evaluate fluid and thermal performance. Significant enhancements include solution-dependent expressions and porous media. With solution-dependent expressions, users can easily define real-world boundary conditions acting on their designs. In many applications, fluid boundary conditions depend on the results of the simulation itself. For example, in electronics and HVAC applications, fans provide forced-convection cooling, and designers routinely evaluate a fan's ability to deliver the desired airflow and amount of cooling. Using solution-dependent expressions, design engineers define a pressure inlet boundary condition as a function of the mass flow at an outlet to represent the manufacturer's fan performance curve. Accurate fan modeling allows design teams to determine the amount of airflow delivered and the amount of cooling. Solution-dependent expressions can also be used for many other applications where fluid boundary conditions depend on solution variables.

In addition, design engineers can now better understand the behavior of fluid flow through a porous medium using ANSYS AIM. Using the porous media model, users can specify a flow resistance in the porous region of the model

Multiple Physics in a Single GUI with ANSYS AIM
ansys.com/AiM-gui

^ **Equivalent stress from sequential bolt pre-tension simulation of an automobile rim**
Image courtesy SVS FEM.

to characterize the momentum loss. Many industry applications, such as flow through a filter, packed bed or perforated plate, require incorporating flow through porous media to accurately characterize the fluid performance of the design.

These and many other new fluids features in AIM can accurately evaluate key design parameters, such as fluid velocity and pressure drop, to rapidly evaluate design changes and determine optimal designs.

EVALUATING STRUCTURAL INTEGRITY

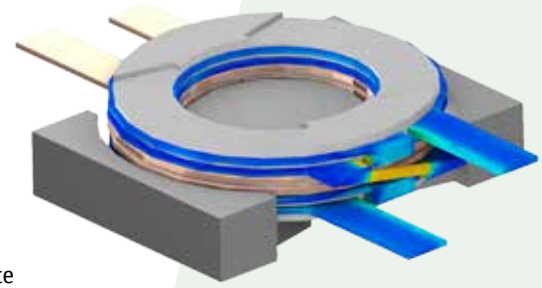
In addition to fluids enhancements, new features in ANSYS AIM include bolted connections and nonlinear contact capabilities that enable design engineers to rapidly evaluate the structural integrity of product designs. Bolted connections are very common in construction and machine design, and are used in steel buildings, automobiles and industrial equipment. Accurately simulating bolt tightening sequences, and the resulting contact pressure and frictional stresses between the parts, is required to accurately predict the structural integrity of bolted connections and connected components. AIM's bolt pre-tension capability allows a bolt pre-load to be specified to simulate the bolt clamping force. The subsequent shortened grip length of the bolt, the region between the bearing face of a nut and the bolt head, can be locked in place to determine the response of the bolted connection to additional structural loads. Pre-tension bolts, nonlinear contact and many other new features empower users to rapidly evaluate structural performance early in the design cycle, reducing the need to build costly physical prototypes.

EVALUATING ELECTROMAGNETIC PERFORMANCE

ANSYS recently introduced a number of new enhancements to ANSYS AIM for the evaluation of electromagnetic performance. There is a high demand for energy efficiency in the power conversion industry. Companies also need to reduce manufacturing costs by designing electromagnetic devices that use less steel, copper and permanent magnets. Design engineers must account for increased power density and need to understand electromagnetically induced thermal losses while making these trade-offs. New capabilities in AIM include the ability to simulate magnetic frequency response and one-way magnetic–thermal coupling. With these capabilities, users can determine induced eddy/displacement currents and associated induction heating of power conversion components such as transformers, converters, insulated-gate bipolar transistors (IGBTs) and busbars. An automatic adaptive solution for magnetics ensures accuracy and allows users to focus on the design, since manual iterations to refine the mesh density are not required. AIM's guided workflow and automated adaptive solution make it easy for those who may not be experts in electromagnetic simulation to rapidly evaluate both the magnetic and the thermal performance of their designs.

ENABLING ENGINEERING COLLABORATION

Innovative companies require upfront simulation as part of the product development process. Simulation guidance must be integrated into the early phases of the product development process when the cost of making design changes is low, and to free up simulation experts so that they can perform product validation analysis, which often requires advanced physics. In these companies, design engineers often need to send their models to simulation analysts for final product validation simulation, or simply to confirm their upfront results. AIM includes enhancements that facilitate engineering collaboration by enabling the transfer of simulation model data from AIM to either ANSYS Mechanical or ANSYS Fluent via an ANSYS Workbench project schematic connection. The reliable data transfer between AIM and



^ **Current density from a magnetic frequency response simulation of a planar transformer, including temperature-dependent material properties**

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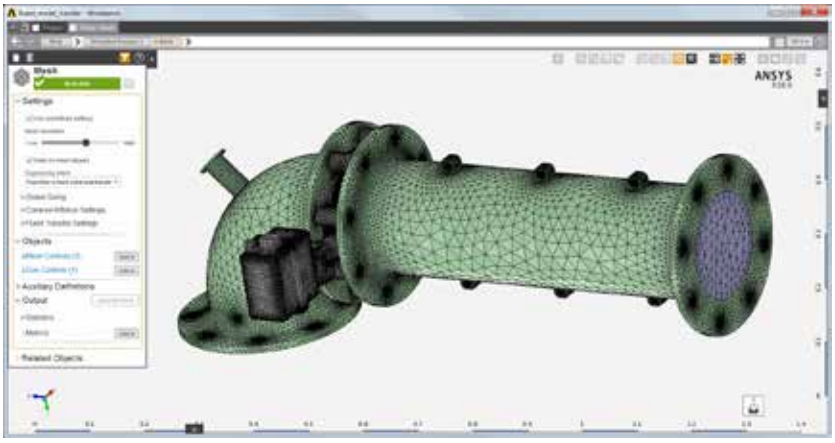
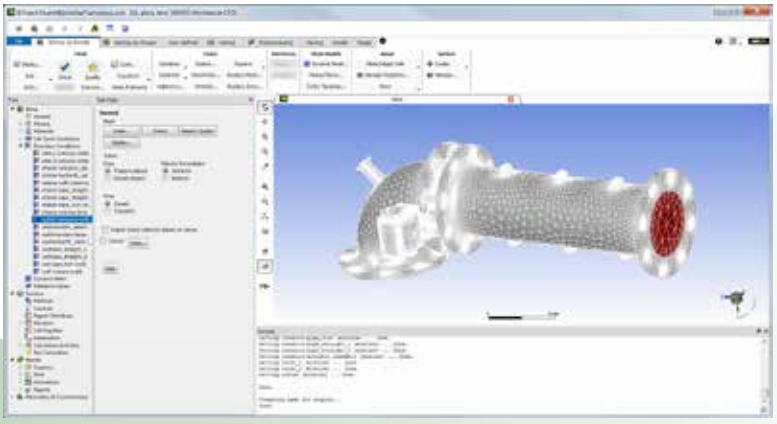
ansys.com/tryAIM





Mesh and selection sets for butterfly valve model setup in ANSYS AIM and transferred to ANSYS Fluent

ANSYS flagship solver products allows designers to quickly and accurately transfer model data to analysts, which fosters engineering collaboration and streamlines the product development process.

CUSTOMIZING SIMULATION WORKFLOWS

In many companies, simulation methods groups define standard simulation processes, which are deployed to the broader design organizations. AIM's customization capabilities enable methods groups to develop custom applications, which can be tailored to follow an organization's specific simulation process and engineering best practices. Since the initial release, AIM also includes many customization enhancements, including multi-step custom applications and in-context apps to further automate the simulation process. Customization enhancements enable methods groups to provide expert simulation guidance to design engineers who leverage upfront simulation early in the design process.

UPFRONT SIMULATION BECOMES ROUTINE

ANSYS AIM's new features and enhancements enable simulation across a broad range of industry applications, such as the fluid, thermal and structural performance of valves and flow control devices; wind and fluid loads on structures; temperature and stress in heat exchangers, engine components and electronic devices; and electromagnetic and thermal performance of transformers, converters, IGBTs and busbars. These examples represent just a few of the many applications that can be addressed with upfront simulation to determine how product designs will perform in real-world environments. ANSYS AIM's extreme ease of use, combined with industry-leading solver technology, empower design engineers to routinely take advantage of upfront simulation across a wide range industries — making digital exploration a routine part of the product development process.

Anticipating the Next Revolution in Engineering Simulation
ansys.com/revolution