

Mastering the flow



We often select computer systems that provide a generic solution to our engineering problems. We choose CAD systems such as Catia, ProEngineer, or SolidWorks because they help us design our systems. We generally do not choose a CAD system that was developed to design aircraft or spacecraft. The same is generally true for engineering analysis packages: We choose Ansys or NASTRAN because we know how to use these tools, not because they provide the specific engineering solution for hydraulic systems, for example.

An alternative approach is to choose analysis, design, or engineering tools that solve specific aerospace problems. One example, MoldFlow, was detailed in last month's column. This month we look at solving specific problems in the area of aerospace fluid and thermodynamic simulation and design applications. The company and product are called Flowmaster.

Flowmaster: The company

Flowmaster (Glenville, Ill.) [<http://www.flowmaster.com>] is the brainchild of D.S. Miller's research on internal flow systems. He conducted this work and started on the development of the commercial computer code that would eventually become Flowmaster in 1980. The initial development effort that culminated in the first version of Flowmaster was completed in 1987, with Vicker Shipbuilding and Engineering becoming the first customer.

Developers at Flowmaster have continued to improve their product and have created specific analysis and simulation code that is now known as Flowmaster V7 Aerospace.

Flowmaster has created a solution that enables organizations to integrate system simulation software with their existing CAE and CFD tools, providing an integrated approach and a robust core for fluid system design processes.

V7 Aerospace is a dedicated thermo/fluid system simulation software tool developed specifically to meet the challenges of the aerospace industry. The product brings major improvements in

the modeling of fuel systems with the introduction of a 3D coordinate analysis system. This enables the user to rotate an aircraft on its axis and simulate the effects of external body forces on fuel systems while in flight.

In addition, environmental control systems engineers benefit from V7 Aerospace's Psychrometric Modeling functionality, which tracks and modifies changes in moisture and humidity through an environmental control system. Frequency domain postprocessing aids the optimization of hydraulic systems.

Included in V7 Aerospace is a catalogue of many industry-tailored components. Users can build and customize their own component catalogues, reducing project time and improving the quality and repeatability of initial designs. By using a central database structure and adding powerful security and accessibility controls, V7 Aerospace ensures that simulation data and component models can be safely shared and tracked across an organization and supply chain.

V7 Aerospace focuses on a few system-level areas that involve the need to solve fluid/thermal problems: propulsion/turbine systems, hydraulic systems, environmental control systems, and lubrication systems.

Propulsion

In the area of propulsion/turbine systems, V7 Aerospace addresses the needs of secondary air and fluid mixing applications. With an integrated swirl solver, engineers are able to calculate the swirl generated by rotating components in a gas turbine engine and geometrically induced swirl such as that generated by pre-swirl nozzles. Through the use of complex cavity components and the cavity wizard, Flowmaster uses the swirl solver to simulate the secondary air systems of gas turbine engines. This capability is also flexible enough that it allows individual companies to customize the software and use their proprietary correlations for the flows through these rotating passageways.

In addition, the software enables engineers to model the mixing of multiple

liquids or gases, calculating the fluid properties of the mixture during the analysis. This is particularly useful in modeling steam injection in the combustors and fuel systems of power generation turbines that use syngases.

The product also incorporates a catalogue of industry-tailored components, including labyrinth seals, rotating cavities, annular passages, and specialized orifices, all of which are customizable. Engineers can build and customize their own component catalogs, reducing project time and improving the quality and repeatability of initial designs.

Hydraulics

Hydraulic systems are typically a complex assembly of electronic, hydraulic, and mechanical components that use pressurized liquid to transmit energy from one place to another. For an efficient hydraulic system design, these components must be chosen in an optimum way that requires exact information about system loads and component capabilities. V7 Aerospace enables systems engineers to build computer models of their entire aircraft hydraulic systems, complete with components such as pumps, pressure regulating valves, directional control valves, hydraulic cylinders, T and Y junctions, and supply and return lines.

The module also provides a library of hydraulic system components. Behavioral prediction of mixed liquids and gases are included, as are both transient and steady-state analyses. These components include primary control boosters, retraction and extension of the landing gear, and mechanisms for all control surfaces (flaps, elevators, and rudders).

Environmental controls

Environmental control systems involve the cooling down or heating up of a given amount of air for the comfort of passengers and the safety of electrical equipment. A typical airliner must furnish an adequate supply of fresh air while maintaining the cabin at a tolerable pressure and temperature.

Changes in atmospheric conditions

(temperature, pressure, altitude, relative humidity) necessitate the careful design of environmental control systems. Systems engineers use Flowmaster V7 Aerospace to design and carry out simulations for an aircraft's entire environmental control system, from the cooling pack to the aircraft distribution system, in a single model. Conclusions from the analysis allow changes early in the design phase.

Aerospace examples

Engineers at GE Aircraft Engines were able to predict the oil temperature range over the service life of the component, which was critical to achieving the reliability goals of the generator. Flowmaster's open interfaces helped engineers at GEAE to link the Flowmaster software with existing in-house software to automate the time-consuming analysis tasks.

The use of Flowmaster in this process yielded an accurate and efficient way to perform the many fluid and thermodynamic simulations needed to derive the required analysis charts for management reviews. This way the engineers were able to determine the maximum and mini-

mum oil temperature operating range over a 10-year life cycle.

Sikorsky used Flowmaster to model and study the emergency fuel jettison system and hover-in-flight refueling systems for the J-92 Superhawk. With Flowmaster it was possible to generate a pressure loss versus flow curve that represented the system at the different line sizes, and compare it back to the supplied pressure versus flow from the selected pumps. Sikorsky engineers were able to choose the appropriate system components successfully and observe their impact on smaller line sizes.

Airbus engineers used Flowmaster to perform fuel system analysis that provided helpful information before flight testing. They used tank volume and fuel height center of gravity parameters as a starting point for building fluid mechanical performance models to investigate the system performance for the refuel, defuel, jettison, center of gravity and transfer, venting, and engine feed subsystems.

This becomes important when these models are used as part of an integrated fuel simulation that includes system con-

trol logic to perform realistic flight scenarios. These subsystems that are modeled in Flowmaster do not need extensive testing prior to aircraft test, thus saving thousands, if not hundreds of thousands of dollars.



More and more application and analysis software is saturating the markets. One of the key strategies for increasing sales is to develop industry-specific applications. This is one of the key drivers for Flowmaster. The trend is demonstrated by Flowmaster's V7 Aerospace set of modules. I believe that these specific applications will become more robust over time, and that they will also interface to other key software packages. The applications are starting with the key modeling software packages; the next step will be the integration with system-level design packages such as Simulink or VisSim.

Stay tuned, the analysis software industry is just beginning to heat up and flow forward.

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NOTED IN BRIEF

Inmedius [www.inmediusdita.com] announced the availability of Inmedius DITA (Darwin Information Typing Architecture) **Storm Developer version 2.0**. Inmedius is a Web-based, embeddable XML editor that integrates into virtually any Web application or CMS. The XML solution lets authors create and edit DITA-compliant content in WYSIWYG mode, regardless of their expertise. The Web-based editor is entirely implemented in Java-Script and simply embeds into virtually any Web application or content management system, ensuring that the entire DITA documentation life cycle is supported.

Alibre (Richardson, Texas) [<http://www.alibre.com>] announced **Alibre CAM**, an integrated 3D parametric personal CAD/CAM solution that is accessible for manufacturers and machine shops of any size. This family of CAM products is integrated within Alibre's Design 3D parametric CAD software, which offers the functionality of products such as SolidWorks, Pro/ENGINEER, and Auto-desk Inventor. Its CAM products provide two-and-a-half- to five-axis CNC milling fully integrated into the Design interface, with complete parametric solid modeling of parts and assemblies and automated creation of 2D drawings and bills of materials. All components of the integrated solution are associative to the solid model, so any update to a model automatically updates all related components. Toolpaths created for a part also will automatically update.

Mercury Computer (Chelmsford, Mass.) [<http://www.vistanav.com>]

released **VistaNav 3.0**, the latest offering in the VistaNav Synthetic Vision system. It offers an enhanced approach plate viewer, notes feature, and enroute guidance. It also supports the Samsung Q1 Ultra Mobile SSD tablet PC for the CIS-1000 synthetic vision system. The product line includes the CIS-1000 Class I EFB and CIS-2000 Class II EFB cockpit information systems, designed to bring portable synthetic vision into the cockpit, along with support for traditional chart viewing, flight planning, and FLIR display. The system provides the pilot with a complete portable navigation solution, including 3D synthetic vision, highway-in-the-sky flight path guidance, 3D terrain views, and 3D approach display. In addition, VistaNav can display 2D navigation in either full- or split-screen formats.

Algor and SpaceClaim [<http://www.algor.com> and <http://www.spaceclaim.com>], as part of Algor V21.1 and SpaceClaim Professional 2007+, are now offering a fully integrated solution providing users with a complete design-to-analysis product and a unique computer-aided engineering (CAE) workflow. Users can control the workflow regardless of the native CAD environment, reducing the time it takes to iterate through multiple CAE scenarios. This solution provides benefits in preparing models for analysis and in building intelligence by enabling users to edit geometry for design optimization and multiple iterations. SpaceClaim can import virtually any solid model geometry and create a neutral file format for input to Algor. The geometry modification is ideal for "what if" conceptual design or modification of existing designs.