

## Interactive computer graphics

Both the hardware and software sectors of the computer graphics and visualization industry have reached the point where any improvements in their basic products are usually second-order—a few new features here, a little increase in performance there. The first-order enhancements that have generated excitement this year have come from integration efforts that create new capabilities or streamline critical tasks. These include products that integrate models, standards that integrate applications, systems that integrate processes, and technologies that integrate the skills and talents of the people who use them.

Several products now create an integrated visualization environment where the graphic output structures (such as CAD models and VRML files) from various applications or from different work groups can be brought together in the same scene. Though typically used as review and markup tools in the design phase, integrated environments are also being used for analysis, because most analytical software can now output results in some 3D solid-model format. (Recently released products from several vendors can be found via the Web search keywords, “CAD viewers models formats.”)

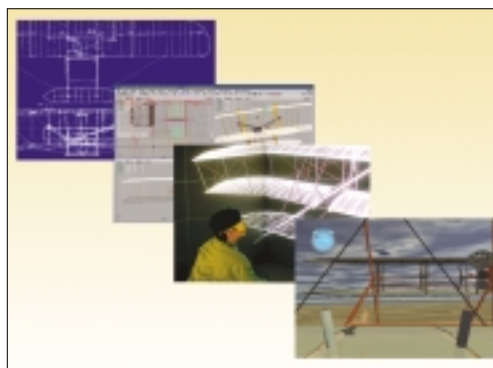
There have also been recent efforts to achieve a tighter integration between the mesh-generation, numerical simulation, and visualization applications, both as simultaneous and as pre- and postprocesses. This is becoming more important since the numerical simulation tasks need the ability to modify the geometry or fidelity of the underlying meshes. Several initiatives, themselves a result of the integration of industry, academia, and government, announced major releases this year. The Unstructured Grid Consortium [<http://www.pointwise.com/ugc>] continued its standards-development efforts with the Geometry and Grid Modeling for Numerical Simulation project. Funded by the Air Force Research Laboratory and contracted to Pointwise, the project will develop an application programming interface to assist program developers in the complex task of unstructured meshing.

An approach more tailored to computational fluids is being taken by the developers of the CGNS (computational fluid dynamics general notation system [<http://www.cgns.org>]), which can bind analytical data to the grid information that is passed between applications. Version 2.2 of the implementation of the CGNS

standard was released as open-source code in May. Also released this year was a free software development toolkit for the HOOPS Stream Format (HFS), a proposed standard for inter-application sharing of 2D/3D visualization and engineering data being promoted by the industry-wide OpenHFS Initiative [<http://developer.hoops3d.com/openhsf>].

In addition, many commercial visualization and simulation applications provide mechanisms for creating a client-server architecture to facilitate monitoring and code-steering or to alleviate the need to transfer enormous quantities of data between the computation and visualization systems.

Product life-cycle management (PLM) and knowledge management systems, although not directly considered interactive visualization tools, have major implications for graphics software and standards. Such systems increase the need for data exchange mechanisms and for forward- and backward-version interoperability (for hardware as well as software). They also provide for recording and archiving analytical



*From concept to engineering to virtual flight testing, fully integrated visualization tools will advance the next century of flight.*

insights derived from visualization. In addition to several commercial systems [Web search keywords: “PLM aerospace engineering”], the National Institute of Standards-supported Federated Intelligent Product Environment project seeks to integrate both legacy and state-of-the-art tools in an advanced Web-based design and analysis environment [<http://www.fiperproject.com/fiperindex.htm>].

During the past year, integrating the expertise of individuals and teams was the aim of several commercial software developers whose latest releases incorporate network-based mechanisms for interactive collaboration. It is now possible to view and interact with objects in a real-time visual environment shared by remote individuals spread not just across the continent, but across a wide range of display devices—from wireless PDAs to fully immersive virtual reality systems. ▲

by Jay G. Horowitz