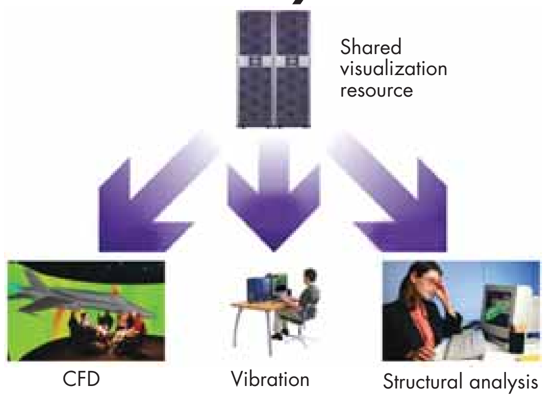
Computers in engineering

Visualizing improved aviation safety



Lockheed Martin uses a Visual Area Networking system from SGI to analyze and investigate aviation events.

Henry Ford's single greatest contribution to industry was the moving assembly line, which took the Industrial Revolution to the next level of innovation. The assembly line allowed individual workers to stay in one place and work on multiple vehicles that passed by them. Ford realized that increasing efficiency was the key to escalating production, allowing him to surpass his competitors while keeping his costs substantially lower.

Manufacturing has come a long way since 1903, but industry continues to adopt new technologies to increase operational efficiencies. Visual Area Networking (VAN) is one such technology.

From two different perspectives, VAN is the assembly line of the 21st century. From an engineer's perspective, it delivers the efficiency benefits of an assembly line by allowing creators and consumers of manufacturing information to remain in their offices and visually interact with data, applications, and colleagues located at another site—increasing efficiency by eliminating travel, and shortening design cycles with distributed design reviews, and therefore shorter delivery times.

From an IT perspective, VAN delivers assembly line benefits by allowing large data sets to remain in a single location while computational and visualization tasks move around them—increasing efficiency by eliminating time-consuming data copying and maximizing resource use.

VAN enables a single set of resources to support multiple organizations. The environment can support the large data visualization needs of multiple groups in the same way that a computer server or supercomputer supports the simulation needs of CFD, structural analysis, and vibration engineers within a company.

The technology can also be used to analyze past events to prevent their recurrence. **Lockheed Martin** uses **SGI**'s VAN solutions to analyze aviation events and construct physics-based models of the circumstances leading to them. The company has offices throughout the Fort Worth, TX, metropolitan area, each housing experts in different disciplines, and they are connected via high-speed networks.

When an expert reconstruction of an event is called for, the company convenes virtual teams of scientists and engineers located at different physical facilities to work on different aspects of the investigation. VAN enables a modeler in one facility to show his results to an engineer in another facility or to a senior executive in Washington D.C. without ever having to leave the office. Illustrating that it is much more than video conferencing, Lockheed Martin takes advantage of the multi-user capability to allow remote participants in a meeting to take control of the simulation, change parameters, and visualize the results—reaching conclusions faster and with less expense than ever before.

To maximize the benefit achievable from VAN, manufacturing companies need to have the proper resources in place. It is crucial that a scalable visualization system like the Silicon Graphics Onyx4 UltimateVision be used as the core visualization server.

An Onyx4 system supports up to 64 CPUs and 32 graphics pipes, and these resources can be dynamically allocated to groups and users on a scheduled or on-demand basis. Small groups can start out with small systems and increase capability as problem sizes or the number of users increase—like speeding up an assembly line. Using this technology also allows existing desktop workstations and personal computers to access more powerful servers.

VAN increases the value of large data sets by making them available to many users throughout an organization, and also extends the economic life of desktop systems by eliminating the need to upgrade them to handle the occasional analysis of larger data sets or the use of advanced software capabilities.

This article was written for *Aerospace Engineering* by **Michael Brown**, Visualization Software Product Line Manager for SGI.

Reconstructing custom fan blades

Beyond a physical likeness, the design and mechanical features of a blimp, or airship, are closer to a submarine than an airplane. Such a melding of concepts introduces design elements unlike those in any other aircraft—something **American Blimp** realized firsthand when the manufacturer of its custom fan blades went out of business.

"Airships are strange beasts and are totally different from 'normal' aircraft," said Lance Nordby, Project Engineer at American Blimp. "They have a number of systems on board that have no counterpart in the airplane world."

One distinctive design aspect of American Blimp airships are the fan blades, modeled after Moulton Taylor's Aerocar of the 1950s. The car/airplane incorporated a cooling fan that American Blimp thought suitable for cooling the airship engines. Fan design is particularly important because

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ESA-ESTEC, the European Space Research and Technology Centre of the **European Space Agency**, has purchased a perpetual license of the FEA software SAMCEF, developed and marketed by **SAMTECH,** a Belgian company. ESA-ESTEC has also issued a contract to SAMTECH for new developments in SAMCEF software addressing the design and advanced analysis of inflatable space structures.

Lockheed Martin has selected NX Nastran from **UGS** as its preferred FEA solver. The agreement will enable numerous sites within the company to leverage common terms and conditions to reduce internal costs.

Perm Engine, a Russian manufacturer of aircraft engines, has implemented eMPower Quality software, from **Tecnomatix**, to automate and improve quality and tolerance-management operations. The tools will provide Perm inspectors with inspection data generated directly from CAD models.

Turkish Aerospace Industries (TAI), an **Airbus** industrial partner, has purchased FiberSIM software from **Vistagy** for the analysis of large-scale composite parts. TAI will use FiberSIM within its CATIA V5 modeling environment (from **Dassault Systemes**) to design ailerons and spoilers for the Airbus A400M military cargo plane. FiberSIM's simulation capability will be used to verify that the fiber deviation from draping composite material over complex curvatures falls within limits that ensure uniform part strength.

Two Italian aerospace companies have invested in the MSC.MasterKey licensing system to get access to the full range of virtual product development tools from **MSC.Software**. **Alenia Aeronautica** plans to use MSC. Nastran 2004 and MSC.Robust Design for stress and stochastic analysis of composite wing boxes and horizontal tails. **Avio** will expand its use of SimOffice products by integrating new tools such as MSC.Marc DMP and MSC.ADAMS into its product development process.

When its suppliers went out of business, American Blimp had to reverse-engineer its custom fan blades with the help of ADC and software from Raindrop Geomagic.

the relatively low airspeeds of airships make their engines difficult to cool.

For nearly a decade, American Blimp purchased the blades from Taylor's aircraft manufacturing business, **Aerocar**. Unfortunately, when Taylor passed away in 1995, his business closed down and the supply of blades eventually ran out. With no access to the original molds, American Blimp had a third-party vendor use a CNC machine to manufacture the blades out of acetal from a scan of an original blade. Eventually that source dried up as well.

"The vendor had ownership of the scan file," Nordby said. "Suddenly they went out of business with no notice and we had no way to buy the scan file."

The shape of the blade—now incorporated into all of the company's airship designs—had to be exact to provide the appropriate cooling characteristics and to fit on existing hardware, which made designing a new blade from scratch difficult. Given the reduction in cost for short-run injection molding, American Blimp had already been contemplating having molds made for manufacturing the blades, so it sent an original fan blade to **Advanced Design Concepts** (ADC), who scanned it with a **Perceptron** laser scanner. The blade was fixtured using one of its existing holes, so the scanner could see all of the part's surfaces.

"Perceptron allows you to orient the head in many different positions to capture every necessary angle," said Greg Groth, Senior Designer at ADC. "The scanner can capture more than 23,000 points per second with 50-micron accuracy. No 2-D data had to be recorded because the high resolution of the scanner allowed us to capture everything we needed to reverse-engineer the part."

From the original fan blade, a Perceptron laser scanner generated a 3-D point cloud that was converted into math surfaces using Geomagic Studio software. A new injection mold was created to manufacture the blades from glass-filled acetal.

Once the data was collected, the point cloud with around 2.2 million points was brought into Geomagic Studio software from **Raindrop Geomagic** to create an accurate digital model and generate surfaces. The model was imported into **PTC**'s Pro/ENGINEER software where the mechanical features were added and an injection-molding tool was designed. IGES data of the tool components were exported to **Surfware**'s Surfcam system to manufacture the injection mold on a CNC machine.

In the final step, the aluminum mold was mounted on a **JSW** injection-molding machine, and injected with acetal to make the blade. ADC used Geomagic Qualify computer-aided inspection software to automatically align and compare measurement data from cross sections of the physical part with the digital model, verifying that the molded blade matched the original design.

Using the new injection-mold process, it now costs American Blimp less than $6 to make each fan blade, compared to about $50 when the parts were manufactured directly on a CNC machine. The new process allows the blades to be molded from glass-filled material, which improves fatigue properties and resistance to ultraviolet light, as well as providing high stiffness, low warpage, and low creep.

"The parts have a much better surface finish and are more consistent," said Nordby. "The smoother surface and greater stiffness should also improve the blade's efficiency."

This article was written for *Aerospace Engineering* by **Jill Aitoro**.