[Volume 2]—Summer 2002

sgi®

Eye on Innovation

Manufacturing Edition: SGI News

Helping Build America's Backbone

SGI® High-Performance Computing and Visualization Technology

"We felt that in order to remain the world's most advanced shipyard we needed to up our competitive edge. To achieve our goal, and based on our previous successes using SGI products, we selected the SGI Reality Center facility."

— Bill Kunz, Visualization Engineering Solutions, Northrop Grumman Newport News

The backbone of U.S. defense is the aircraft carrier and its battle group. It is the largest warship in the world, runs on nuclear power, and is the world largest assembled product, with over one billion parts. Construction of an aircraft carrier, from design to delivery, takes 12 years, the latter five just to build it. Its life cycle is 50 years—two 25-year tours of duty—with a three-year break for refueling and complex overhaul.

Newport News

Northrop Grumman Newport News, a sector of Northrop Grumman located in Newport News, Virginia, is the only company that designs, builds, refuels, and overhauls nuclear aircraft carriers, and it is one of only two to do the same for nuclear submarines. When a carrier's life cycle is complete, Newport News handles the decommissioning and disposal. SGI workstations, high-performance computing systems, and advanced visualization technology play an important role in helping Newport News build a better, stronger backbone for the U.S. Navy.

Aircraft Carrier Facts: Nimitz Class

- Length: 1,092 feet
- Width: 251 feet, flight deck at widest point
- Height: 20 stories, waterline to mast
- Displacement: 91,209 tons
- Propulsion: Nuclear
- Flight deck: 196,000 square feet
- Air wing: 9–10 squadrons, 80 aircraft
- Personnel: 6,000+

Today, Newport News employs more than 4,000 design and construction engineers, each integrally involved in the design, testing, and construction of aircraft carriers for the Navy. Their job is to develop, evaluate, and insert new technologies that reduce the total cost of ownership while enhancing the capability, flexibility, survivability, and combat effectiveness of the ship.

The merging of Northrop Grumman, a defense electronics powerhouse in its own right, with Newport News, created an organization ideally suited to serve as the Navy's one-stop shop for nuclear aircraft carriers. The company's ability to provide concept-to-completion shipbuilding provides a twofold benefit to the Navy—lower acquisition costs and lower total cost of ownership throughout the life cycle of the aircraft carrier.

SGI workstations and high-performance computing systems have long been instrumental in helping Newport News reduce the total cost of ownership for Navy ships, specifically in areas of 3D solids modeling, finite element analysis (FEA), and the management of complex data.

Bow to Stern

The Seawolf-class submarine was the first Navy ship to be entirely designed by Newport News using 3D solids modeling. The move to full-blown 3D product model

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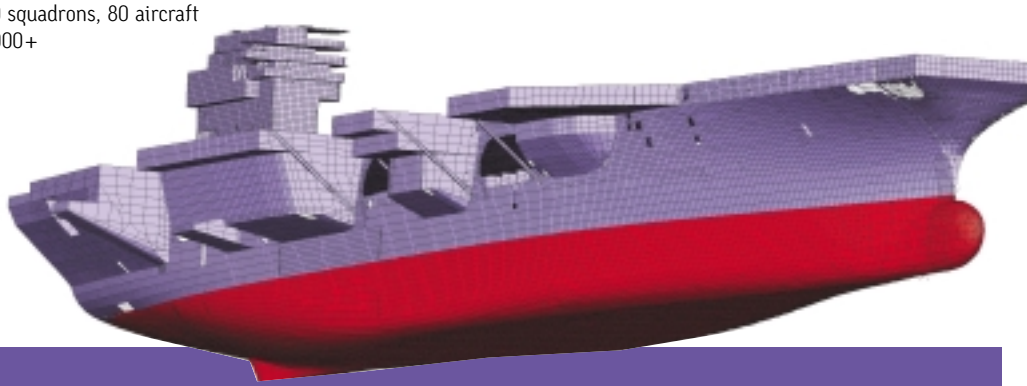

IN THIS EDITION

Immersed in Engineering

Dr. Carolina Cruz-Neira, vice president and cofounder, Glass House Studio, LLC, and associate director, Iowa State University, Virtual Reality Applications Center

Today's manufacturing teams face the challenge of creating quality products while working under shortened development timeframes and increased cost constraints. These teams involve designers, engineers, factory personnel, contractors, and suppliers, all of whom must interact with each other at different stages of the product development cycle. Part of the challenge requires knowing how to leverage advanced computer technologies for the purpose of efficient and cost-beneficial product design, analysis, and evaluation.

The Virtual Reality Applications Center (VRAC) at Iowa State University is an exemplary multidisciplinary center devoted to computing and visualization resources for virtual environments. The research there involves the integration of humans and computers with advanced interfaces that enable interaction between users and computer-generated environments.

Immersive visualization techniques create virtual prototyping/virtual manufacturing environments that support interactive design, analysis, and evaluation tasks prior to physical prototyping and tooling of a product and its components. Conventional visualization systems have proven useful in displaying and manipulating complex 3D engineering designs, but limit interaction to 2D projections on a standard computer monitor. Research indicates that engineers are significantly more accurate with the data and significantly quicker in reaching conclusions within an immersive system instead of a traditional desktop environment.

Virtual reality goes beyond desktop visualization capabilities by making it possible and cost-effective to create and manage a data environment that supports three-dimensional display and direct interaction with the data. Engineers can "step into" their designs and perform evaluations as if manipulating physical prototypes, and in ways not possible with physical prototypes.

Today, many industries have accepted virtual reality as a key tool in their daily work. For example, car manufacturers are using virtual reality to analyze, test, and evaluate new car concepts. Oil and gas companies are exploring virtual representations of oil reservoirs to make decisions about drilling and well management. Architectural firms build their designs as virtual environments that can be walked through as if they were real. More and more industrial sectors are realizing the benefits of virtual reality and finding new and creative ways to apply this technology to their sites.

As we continue the work on applying virtual reality technology in many areas of engineering, we will see a growing demand for technology that is more stable, more scalable, easier to use, and that costs much less. On the hardware end, visual quality integrated with complex simulation will continue being the driving force to design computer systems. Combined with the visual simulations, networking will play a key role, as virtual reality erases the geographical distances between engineering team members. Immersive collaborative environments need to become routine in many industries to succeed in the current competitive markets. The technology supporting collaborative virtual environments will be transparent to the end users, as we are unfortunately not yet at that point. A significant effort must be made in the area of middleware and high-level software to hide the complexities of real-time visual simulations in a collaborative setting. Current technologies, although becoming more and more powerful, still require that users have an in-depth background of technical computer skills. As a community, we need to enable nontechnical users to make full use of virtual reality—not only to run the simulations, but also to develop their own virtual environments.

The long-term goal we need to achieve to be successful in virtual reality application is to make all of its powerful capabilities available to a wide range of users without encumbering them with the technological details. I believe we are in the very early stages of this technology, but at a point in which we understand its value and benefits.

Dr. Carolina Cruz-Neira, the renowned codeveloper of the CAVE™ system and author of the CAVE Library, is cofounder and vice president of Glass House Studio, LLC. She also serves as associate director of the Virtual Reality Applications Center at Iowa State University, where she is an associate professor in the Electrical and Computer Engineering Department and leads research projects funded by such institutions as Deere & Company and Procter & Gamble. BusinessWeek has featured Dr. Cruz-Neira as one of the nation's top young computer scientists.

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Eye on Innovation

CUSTOMER

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design for submarines and, later, for select aircraft carrier components, enabled Newport News to fully implement steel fabrication automation, maximize preoutfitting and neat-build processes, transfer digital design data to drive work-execution systems, and improve accuracy control, design quality, design validation, and configuration management.

When the Seawolf project was getting underway, Newport News was migrating its main FEA application, I-DEAS, from the mainframe to a workstation-only platform. SGI® Indigo® workstations were selected, in part, because of their support for I-DEAS and because they could also be used to handle 3D modeling of various project components.

Moving Forward

In the years since the Seawolf project began, I-DEAS and VIVID tools and files were migrated to a single CAD tool—CATIA® software, a commercially available and continually upgradeable solution from Dassault Systemes that supports industry-accepted best practices. Moving to CATIA enabled Newport News to realize an overall reduction in software maintenance costs. The first of the next class of aircraft carriers, CVNX (carrier, vessel, nuclear, experimental), will be modeled using CATIA for all new design work.

Newport News' engineering visualization software of choice is PTC's dvMockup, which enables visual analysis, simulation, and real-time design collaboration of 3D CAD models across multiple machines in both LANs and WANs. Also now widely used at Newport News for supporting proof-of-concept studies and other R&D projects is Alias|Wavefront™, a comprehensive suite of 3D industrial design software applications.

Newport News' compute and visualization power recently grew when the shipbuilder refreshed its Silicon Graphics® Octane® workstations with 47 high-powered Silicon Graphics® Octane2™ visual workstations and an SGI® Origin® 3000 series system with 24 processors, eight of which are dedicated solely to FEA work. The remaining 16 processors handle 3D modeling and simulation. The SGI Origin 3000 series system's high-performance shared memory enables Newport News to perform complex computational tasks. By including SGI® InfiniteReality® series graphics, the system also enables advanced visualization. The ability to do these concurrently is unique among supercomputers and provides Newport News with a single-platform price/performance solution that can grow with the shipbuilder.

FEA Structural Analysis

The integrity of the structure of an aircraft carrier is infinitely essential to its survival. That means using SGI high-performance computing to conduct rigorous FEA analyses on every component of the carrier structure. Newport News puts carrier components through structural analyses (static, modal, transient) to test how the ship will react to every conceivable stressor once deployed. This includes load conditions such as hurricane-force winds, vibrations from routine maneuvers, explosions above and below the waterline, and a range of other war-type events. Everything possible is done to ensure that the FEA work results in the best structural engineering solution being applied to the final product.

The analyses are conducted in computer simulations to determine their validity. If the simulations are small enough (under 200,000 degrees of freedom) they are performed on the Silicon Graphics Octane2 workstations. The FEA-dedicated portion of the SGI Origin 3000 series system handles large-scale simulations, turning out results virtually around the clock. The results of each simulation are then given to the product modeler who, in turn, uses the new information to update the 3D model of the entire ship.

"You can expect to perform evaluations on several iterations of a typical model, depending on where you are in the design process," said Kevin Arden, senior project engineer for Northrop Grumman Newport News. "However, with the next class of aircraft carrier, CVNX, still in the earlier stages of development, the project engineers are conducting as many as five simulations a day just to keep up with the product modeler changes and then using the FEA results to make further design refinements almost daily."

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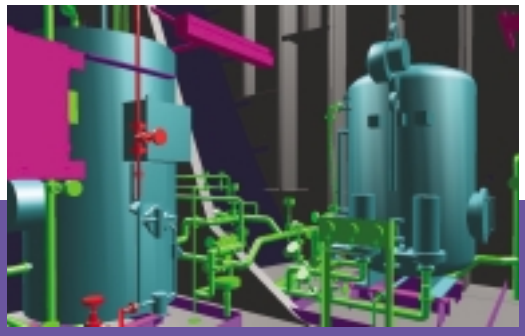

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Typical FEA structural analysis applications used by Newport News include MSC.Nastran (MSC.Software), ABAQUS (ABAQUS, Inc.), and LS-DYNA™ (Livermore Software Technology Corporation).

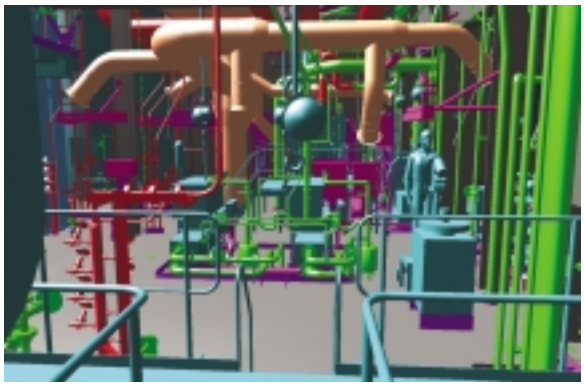
Visualization Technology

In 1998, Newport News committed fully to integrating visualization technology into its shipbuilding business model. According to Bill Kunz, Visualization Engineering Solutions project lead at Northrop Grumman Newport News, "We felt that in order to remain the world's most advanced shipyard we needed to up our competitive edge. To achieve our goal, and based on our previous successes using SGI products, we selected the SGI Reality Center facility. SGI was the only company that met all of our functional requirements. We also were quite impressed with the price/performance quotient." SGI was responsible for the installation of the Silicon Graphics® Onyx2® workstation and the overall systems integration. Display provider Panoram Technologies was selected for all display and control equipment for the SGI® Reality Center™ theater.

SGI and Newport News then conducted a full-fledged trade study before finally selecting PTC DIVISION dvMockUp as the company's large-scale visualization tool, which could be optimized on SGI hardware. Kunz said, "Besides liking the 64-bit capability and large address memory space, dvMockUp's ability to import all CAD formats was a real plus. And it was highly customizable." At the end of the selection process, everyone involved felt that having and getting to work on the best visualization tools available would serve as a powerful incentive to the engineers.

"Our best example of putting visualization technology to work for us has been on CVNX," said Kunz. "In this program, visualization is an integral part of all Integrated Product Team (IPT) design/build meetings. The team also uses visualization collaboratively with our design partners and external customers, using it to bring them into the design process from the very beginning. Our IPTs use visualization to make movies of erection and build sequences as well as facility layouts that support preproduction planning. Future plans will support physics-based simulations as well as work and operational simulations. Ultimately we see visualization playing a huge role in lifecycle support for the ships we build."

Newport News also is very interested in the recently introduced SGI® InfinitePerformance™ scalable graphics subsystem and how it can further enhance the shipbuilder's visualization capabilities. InfinitePerformance graphics, with 16-way scaling available in fall 2002, will deliver a much-elevated class of geometry performance



and will enable Newport News to visualize, interact with, and collaborate on even the largest of models and most complex simulations. The enormity of an aircraft carrier and the number of files required to create a single, complete 3D model has, to date, kept view rates to about one to two frames per second. SGI InfinitePerformance graphics, with 16-way scaling and interactive graphics performance of up to 283 million triangles per second, will enable Newport News to achieve better frame rates and visualize its largest models in even greater detail.

Having a distributed visualization system also was part of the vision. Today, the SGI Origin 3000 series system located within the Newport News complex is connected directly to visualization centers located in four separate buildings. The facilities range from a large auditorium, a visualization center, and a design/build theater to a series of five small-scale visualization rooms.

From a marketing and public relations standpoint, the SGI Reality Center installations help Newport News confirm its leadership role in the shipbuilding industry.

The Rewards

With the addition of the SGI Reality Center installations and through the use of SGI and other visualization software applications, Newport News looks to reap further time and cost savings in the area of physical prototyping.

While there are obvious time- and cost-savings opportunities to be realized through using digital prototyping, there are still some concerns that need to be overcome. Bryan Marz, enterprise project analyst for Newport News, had this to say: "Customer acceptance of a digital, design-only approval process isn't likely to happen as rapidly in shipbuilding as in other manufacturing arenas, due to customer concerns surrounding human interaction with the model."

"To facilitate acceptance, simulations in which ship personnel staff operations stations, perform casualty drills, and engage in operations that the ship is designed to perform must be created. Every design review is a proving ground for the validity and reliability of digital mock-ups."

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Visual Area Networks for Manufacturers: Universal Access to Advanced Visualization

A review of today's market dynamics is quick to reveal that time to market is paramount. It is the single most competitive advantage a company or industry can possess. Faster decision making further accelerates time to market.

SGI advanced visualization technologies support faster decision making by providing multidisciplinary teams with more accurate and complete information upon which to make more informed decisions early on in the product-development cycle. Visual Area Networking extends the power of advanced visualization and collaborative decision making beyond a single room and into the world of local- and wide-area networks that span campuses, communities, and continents.

Ultimately, the universal access to complex visualization graphics that Visual Area Networking enables will serve as the cornerstone for collaborative environments in which discussion, innovation, and decision making are more spontaneous and the ability to resolve engineering problems faster and with a greater degree attention to detail is significantly enhanced.

The Marketplace

The globalization of industries, in its effort to reduce product cost and realize greater economies of scale, has put design, engineering, and manufacturing far afield from one another. And while the disbursement of resources has been beneficial financially, it will now be the linking together of these resources that most impacts a company's future ability to remain competitive. To that end, collaboration is key. Doing so in real-time is essential.

For some time now, industries have relied on computer-based modeling and visual simulation—often on SGI platforms and equipment—to design and develop their products. Workstations have been successful in facilitating peer-to-peer and interdepartmental collaboration as well as localized decision making during detail design, but such interaction has been limited to individual parts and smaller subsystems.

The advent of the SGI Reality Center facility further enhanced the ability to use SGI high-performance computing and advanced visualization technologies to extend to multidisciplinary groups collaborative real-time visualization in a fully immersive environment. At this level of visualization, participants were able to visualize and interact with the complete product and evaluate its functional behavior. As a result, they could make more informed product-development decisions and do so in far less time than was previously possible.

SGI Reality Center facilities bring people together in one location to collaborate on a design. However, with today's physically distributed design and engineering teams, it is not always easy to bring together the right people when needed. Scheduling demands, time commitments, and fluctuating travel itineraries can make it difficult for top designers to always be in the right design studio at the right time, such as when critical design and styling decisions must be made.

Visual Area Networking

Visual Area Networking is the conduit by which a larger universe of designers and engineers can gain access to and interact with the most complex simulations, imaging, and other 3D renderings, such as those used in design and styling reviews, MCAE visualization, and digital mock-up. The data is stored, managed, and processed on a centralized SGI® Onyx® family graphics system. Designers and engineers, regardless of their locations and proximity to each other, can visualize and interact with the data using any client device—from tablets, laptops, and workstations to SGI Reality Center facilities—over existing standard networks.

Visual Area Networking extends the decision-making benefits of multidisciplinary collaboration fostered within SGI

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Reality Center facilities to the world at large—not just to select locales—and allows the immediate involvement of experts in the decision-making process, regardless of time and location.

Visual Area Networking enhances engineering productivity by allowing workgroups to access the graphics and compute power of an SGI Onyx family system using their existing desktop PCs or workstations as client devices, all without leaving the office.

OpenGL Vizserver™

The chief software component of Visual Area Networking is SGI® OpenGL Vizserver. OpenGL Vizserver enables an SGI Onyx family system to distribute visualization sessions to virtually any client device, whether it's a laptop, workstation, wireless tablet, or even a PDA. Graphics processing is handled entirely on the SGI Onyx family system; OpenGL Vizserver transports pre-rendered, compressed graphics over existing network infrastructures (Gigabit Ethernet, 100Base-T, ATM, T3, T1, and the Internet); the client machine simply decompresses and displays the image. The raw data remains secure on the SGI Onyx family system.

OpenGL Vizserver is application transparent—it runs any existing OpenGL® API-based application without modification. OpenGL Vizserver contains collaboration functionality, such as shared application control, that instantly turns existing stand-alone applications into collaborative applications.

According to Kent Misegades, president of CEI, "Our experience with OpenGL Vizserver has been impressive, and our software is well matched to the concept of remote visualization. SGI technology and VAN permit easier access to EnSight's powerful visualization feature set. As most of our customers are large scientific and engineering organizations with offices in different geographic locations, remote visualization is an important part of our product offering."

Collaborative Power of Visual Area Networking

Manufacturers can utilize the collaborative power of Visual Area Networking during scheduled review sessions by using OpenGL Vizserver to link an SGI Reality Center facility with a second SGI Reality Center facility or with another local or remote client device. This solution makes it infinitely easier for key engineering experts and top-level decision makers to be available when critical decisions must be made. Overall, it reduces travel costs, saves time, facilitates better and more informed decisions, and helps accelerate time to market.

Visual Area Networking also allows for spontaneous collaboration between individuals in and among different engineering groups. With OpenGL Vizserver, initiating a collaborative session between geographically dispersed users can be done as quickly as making a phone call. In this way, engineers can communicate while visualizing the same data from the same viewpoint, thereby enhancing their ability to identify and resolve design and manufacturing problems and optimizing their designs in less time.

Visual Area Networking for Engineering Workgroups—A Break With Tradition

Engineers don't usually have a daily need for real-time visualization. They spend up to 80% of their time on other tasks, including e-mail, writing reports, meetings, traveling, etc. They often have two systems on their desk: a standard PC or laptop and a high-performance workstation. Not only are they expensive to maintain, workstations still lack the ability to satisfy the most complex visualization needs. Engineers have to leave their office to access the power of an SGI Onyx family system to visualize their most technically challenging problems.

Visual Area Networking eliminates costly and continuous workstation upgrades by allowing companies to deploy less-powerful desktop systems that can gain access (via LANs and WANs) to a central SGI Onyx family graphics system when needed. With OpenGL Vizserver, engineers use their existing PCs and workstations as clients to interact with and view the data on the central system. This type of access also ensures the integrity of the data by eliminating redundant copies, version-control problems, and unauthorized access, all of which could negatively impact the product development cycle.

Overall, Visual Area Networking lowers the total cost of ownership, allows an SGI Onyx family system to be 100% utilized, and, because it's highly scalable, readily meets

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PARTNER

LSTC and SGI

Drive Industry Innovation

Manufacturers increasingly rely on high-performance computing (HPC) technology and finite element analysis (FEA) applications to drive innovations in product development. This enables them to grow their competitive advantage by achieving faster time to market, improved product quality, and lower product development costs. For more than 15 years, Livermore Software Technology Corporation (LSTC) and SGI have sustained a business and technology relationship that provides design tools that are essential to helping the industry achieve these goals.

LSTC, developer of LS-DYNA general-purpose FEA software for structural analysis and impact simulation, and SGI, with its HPC and visualization technology, are working together to optimize the performance and scalability of LSTC software when used by manufacturers to perform FEA simulations in an SGI systems environment.

In recent years, the automotive industry in particular has made sizeable investments in scalable systems from SGI and software from LSTC. During 1999 alone, estimates show that Detroit's Big Three automakers more than doubled their total GFLOPS compute capacity. Much of the increase was brought about by efficient parallel implementations of commercial mechanical computer-aided engineering (MCAE) software such as LS-DYNA, which is used extensively for applications in vehicle crashworthiness, occupant safety, and metal stamping.

LS-DYNA Overview

LS-DYNA is the latest generation of what began as DYNA3D, developed originally by then Lawrence Livermore National Laboratories research engineer and current LSTC founder and president, Dr. John Hallquist.

Considered one the most advanced nonlinear finite element programs available today, LS-DYNA has proved an invaluable multiphysics simulation tool for industry-leading companies and research organizations, including those developing products for automotive, aerospace, power-generation, and consumer products, and defense applications, among others.

"SGI continues to lead in supporting the ISVs and customers."

—U.S. automotive manufacturer

LS-DYNA enables manufacturers to conduct a wide range of simulations:

- High-velocity impact
- Elastic-plastic deformation
- Drop-shock
- Explosive phenomena
- Explosive forming
- Machining operations
- Concrete and building structures
- Accident reconstruction
- Nuclear safety
- Transient thermal analysis
- Novel spacecraft landing systems (Mars Pathfinder)
- Underwater shock
- Vehicle dynamics

Explicit FEA Applications

LS-DYNA is used extensively by manufacturers to model high-transient, short-duration dynamic events that require high-quality explicit FEA capability. The application provides a comprehensive selection of material models, element formulations, contact algorithms, short-duration impact dynamics, and a postprocessor, LS-POST, that aids in the visual review of simulation results.

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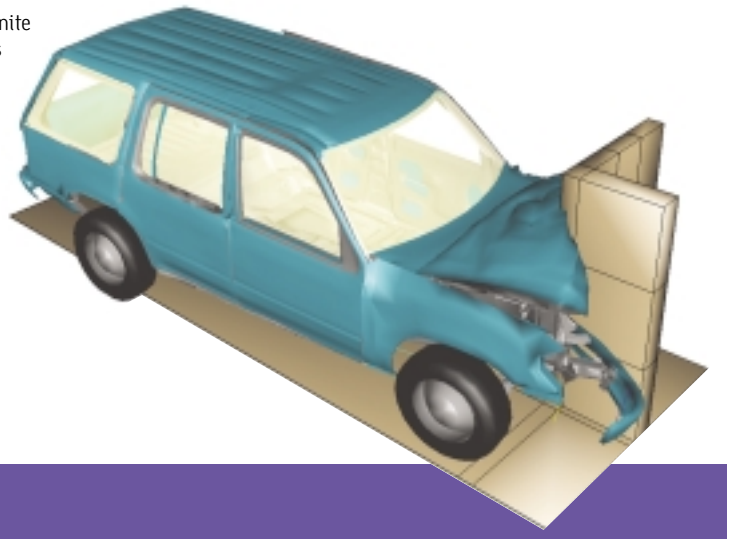

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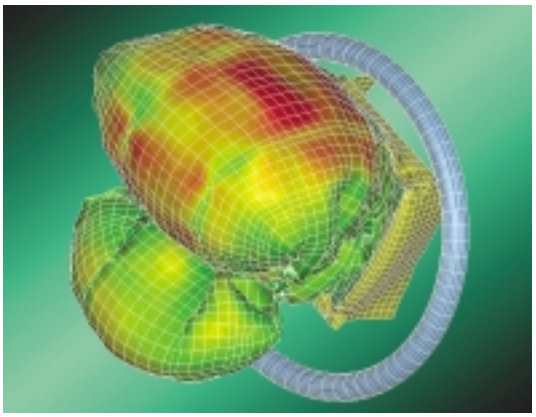
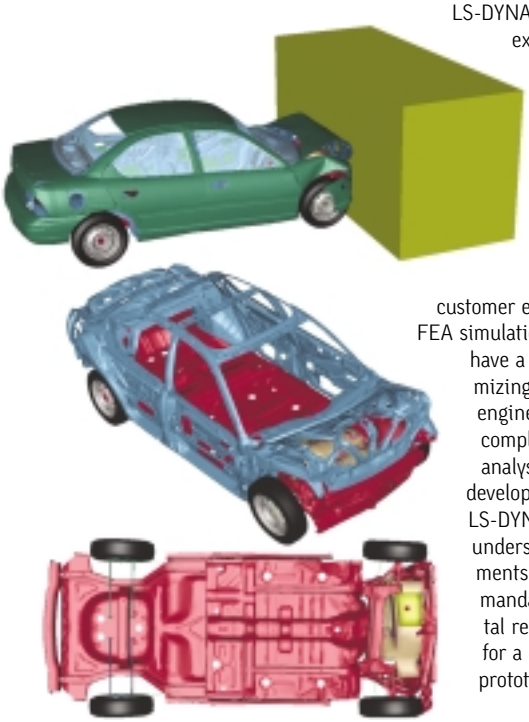
LS-DYNA simulations for the automotive industry include vehicle crash and rollover, airbag deployment, and occupant response. For the aerospace industry, LS-DYNA simulates bird impact on airframes and engines and turbine rotor burst containment, among other simulations. Additional complexities arise from simulations of this class since they often require predictions of surface contact, modeling of material penetration, and accurate failure assessment.



Implicit FEA Developments

Prior to the current version of LS-DYNA, v960, LSTC customers performed implicit FEA using LS-NIKE. Today, such implicit analysis capabilities are included in LS-DYNA. For example, the springback that occurs during metal-forming simulations can now take advantage of the LS-DYNA software's static stress analysis capability.

According to Hallquist, "As we increase implicit capabilities within LS-DYNA, we can eliminate the need for a separate implicit analysis [LS-NIKE] software. By including explicit and implicit capabilities in a single application, we hope to simplify both code development and analysis. Engineers would be able to use LS-DYNA to move seamlessly from explicit simulation mode to implicit static analysis."



Joint Customer Focus

As the scalability of MCAE simulation software has increased, so have manufacturing industry investments in MCAE technology and customer expectations of high-quality FEA simulation solutions. LSTC and SGI have a collaborative history of optimizing FEA software that enables engineers to perform increasingly complex explicit and implicit analysis earlier in the product development cycle. For example, LS-DYNA simulations can aid in understanding the design requirements of various government-mandated safety and environmental regulations, without the need for a complete set of physical prototypes.

As Hallquist notes, "Together, LSTC and SGI will continue to invest in efforts that advance the features, performance, and parallel scalability of LS-DYNA with the intention of enabling our manufacturing industry customers to transition toward a prototype-free product design and development environment."

As a result of this collaboration of joint technologies of HPC systems and FEA software, LS-DYNA, when executed on an SGI Origin 3000 series system, often exhibits linear scalability as high as 64 processors for various industrial-sized models. For DaimlerChrysler, it means a reduction from 204 hours on one processor to less than 3.5 hours on 64 processors for a frontal crash simulation with nearly 450,000 elements. The substantial savings in simulation turnaround time allows several more studies to be performed towards optimization of the vehicle's design for crashworthiness and safety.

Similarly, an aerospace customer who develops gas turbine engines for aircraft has utilized the parallel scalability of LS-DYNA on a 64-processor Origin 3000 series system to reduce from 156 hours to 2.5 hours the time it takes to develop a 500,000-element model for blade-out simulation.

SGI high-performance computing abilities and LS-DYNA have provided similar benefits for automotive customers such as General Motors, SAAB Automotive, and Mitsubishi Motor Company; for aerospace customers such as Rolls-Royce in the design of aircraft engines and General Electric CR&D in the design of aircraft engines and

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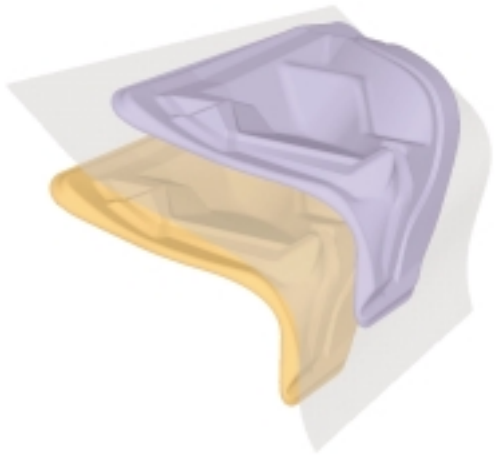
power-generation equipment; and for Procter & Gamble in the development of consumer products.

As emerging algorithm developments and improved hardware architectures continue to enhance MCAE methodology, advancements in MCAE software scalability will be ongoing. SGI and LSTC are working together to provide integrated solutions that optimize not only the next generation of LS-DYNA for SGI HPC systems, but also the support resources and quality assurance testing that is designed to resolve code inconsistencies as quickly as they arise. At present, LSTC developers subject LS-DYNA to more than 1,000 test problems—from simple test cases to full-sized industrial models—on Origin systems before the application is certified and made available to customers.

According to a large U.S. automotive manufacturer, "We received outstanding support from LSTC and SGI on the QA project of LS-DYNA v960 for the SGI Origin systems. SGI continues to lead in supporting the ISVs and customers ... LSTC and SGI have dedicated people who think the same way as their customers and who work well between their organizations and with their customers."



New developments between LSTC and SGI applications engineering include an enhanced I/O scheme that will significantly improve overall model turnaround in a mix of LS-DYNA jobs in an HPC production environment. Additionally, as model size and complexity continue to grow, the requirements for efficient postprocessing and visualization are critical. LSTC and SGI are working together on capability improvements to LS-POST. One goal for LS-POST, which presently supports OpenGL standards, is to enhance the software for use in an SGI Reality Center environment where it can provide large-scale visualization in a collaborative engineering environment.

Staying Competitive

To sustain a competitive edge, engineers within the manufacturing industry will rely increasingly on advancements in FEA applications to improve the structural integrity and performance of their products. To that end, SGI will continue to collaborate with leading application developers such as LSTC to provide the required application environment and solution quality and performance.

Together LSTC and SGI will continue to develop software and hardware performance improvements, enhanced features and capabilities, and greater parallel scalability to accelerate the overall solution process of FEA applications. To date, this alliance has improved FEA modeling practices in research and industry on a global basis. It will continue to provide advancements in a range of engineering applications.

SGI Technologies Help Create a

Cleaner, Leaner Power-Generation Industry

The power-generation industry is in a state of flux. In response to deregulation, increasingly stringent emissions-control standards, concerns about nuclear energy, and myriad other issues, the power-generation industry is constantly reshaping itself.

To minimize the impact of marketplace variables, more power companies that design and manufacture equipment for generation are using high-performance computing (HPC) and advanced visualization technology to help the industry achieve cleaner, more efficient, and more reliable power generation—and to do so profitably.

SGI plays a significant role in helping the power-generation industry achieve these goals by providing a range of HPC solutions that facilitate structural analyses and computational fluid dynamics (CFD) analyses. In addition, SGI advanced visualization systems enable companies to take virtual walk-throughs of complex power-generation facilities and assess their viability long before the first construction shovel ever breaks ground.

Advancing Turbine Designs

Of specific interest to the power-generation industry is the adoption of conventional aircraft-engine technologies to gas turbine engine design, resulting in increased thermal efficiencies. High thermal efficiency means more useful energy is produced from a given amount of fuel, which leads to lower fuel costs and reduced emissions of harmful carbon dioxide and nitrogen oxide pollutants.

In designing turbines for power generation, SGI technologies help companies develop higher-quality products that cost less to build and maintain, and reduce the time it takes to get them to market.

SGI high-performance severs and advanced visualization technology provide the means by which companies can perform full mechanical simulations to predict how turbines and their material will perform in real-world environments. This makes it possible for engineering teams to explore multiple design alternatives, select the best options, and then use virtual reality interfaces to identify and resolve design and manufacturing problems before ever creating a physical prototype. Even the factory layout, tooling, and manufacturing processes can be simulated, thus further preventing potential costly delays and inefficiencies.

SGI Technologies at Work

Advanced Turbine System (ATS) Program: The U.S. Department of Energy's Advanced Turbine System Program, which began in the early 1990s, called on various turbine manufacturers to design new, high-efficiency gas turbine engines. Program goals included a 60% or greater efficiency in a combined cycle mode (i.e., in combination with a steam turbine generator), nitrous oxide (NOx) emission levels of less than nine parts per million, and a 10% reduction in the cost of electricity.

Achieving the efficiency objective would require turbines to endure significantly higher turbine inlet temperatures. The higher temperatures would, in turn, require advancements in materials, cooling systems, and combustion techniques.

At the onset of the ATS program, combustion temperatures above 2300°F caused metals in the turbine blades and in other internal components to begin degrading. Conversely, higher temperatures were the key to higher efficiencies. The net result was a heat barrier that effectively limited the generating efficiency at which a turbine power plant could convert fuel into electricity.

To overcome these barriers, many of the ATS program participants relied on SGI Origin family systems, which utilize SGI® NUMA multiprocessor architecture, to provide the speed, high bandwidth, and parallel scalability (among other attributes) necessary to enhance the simulation capabilities of the MCAE applications used in the turbine design and development.

Among the ATS program's participants, and one of its major success stories, was SGI customer GE Power Systems. In early 2000, GE Power Systems efforts culminated in the unveiling of the H System™ gas turbine, the first gas turbine to break through the temperature barrier and push efficiencies to unprecedented levels.

Using advanced materials and new innovations in steam-cooling technology, the turbine is capable of operating at 2600°F. The H System gas turbine works in a combined cycle mode and is the first to surpass the 60% efficiency threshold. In an industry that typically measures improvements in tenths of a percent, H System is nearly 5% better than its best available predecessor.

Also, H System NOx emissions levels of nine parts per million—half the average of the turbines now in use—provide for significantly clearer turbine operation and make it highly suitable for use in environmentally constrained areas.

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Eye on Innovation

INDUSTRY

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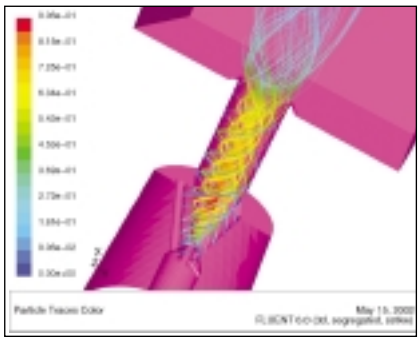
ALSTOM Power: ALSTOM Power, located in Finspang, Sweden, produces midsize power-generation turbines in the 15 MW to 50 MW range. Recently, ALSTOM Power added the high-performance computing power of the SGI® Origin® 3400 server to its turbine development program. SGI Origin 3400 provides an efficient applications environment for product design software and will be used to enhance CFD and mechanical integrity analyses. This will enable ALSTOM Power to significantly reduce development costs (specifically, technical outsourcing expenses) and time to market.

Lennart Bredenholt, IT purchasing manager at ALSTOM Power, points out that, "We have a significant need for high-performance computing at ALSTOM Power. Our recent investment in the new SGI Origin 3400 server will enable us to reduce consulting costs and shorten lead times for turbine development. Origin 3400 will also improve our ability to simulate turbine aerodynamics, cooling, and combustion, evaluate more effectively how the machine responds to different conditions, and determine which components would benefit from further improvement. Our ultimate goal is to produce higher-performance products with longer life spans."

Gas turbines are complex products incorporating complex processes. Customers demand high performance without sacrificing reliability. The Origin 3400 server helps ALSTOM Power's engineers analyze increasingly complex aerodynamics, acoustics, combustion, and structural problems and helps them do so with greater confidence. This reduces the need for expensive full-scale testing.

The main CFD applications used by ALSTOM Power are FLUENT®, from Fluent, Inc., and CFX-TASCflow from AEA Technology. According to Pontus Slottner, who is responsible for the research division's supercomputing, FLUENT is used for combustion and cooling and CFX-TASCflow is used for compressor and turbine aerodynamics calculations. Slottner said that the new Origin 3400 server also has helped the company's CFD experts significantly improve both workflow and product quality:

- Improved time utilization—Less time is spent on preprocessing, leading to larger models. As a result, computing time has replaced hours of engineering time.
- Increased analytical capacity—It is now possible to run four big or eight smaller parallel analyses. Previous limitations allowed only one big or four smaller parallel analyses.
- Faster analyses—Certain types of calculations can now be completed up to an average of 30 times faster.
- More test runs—The increased capacity allows more test runs before the final calculation and leads to generally improved solutions.



Example of simulation: burner in test plant.

- Higher-performance products—CFD analyses of numerous alternative designs during concept and early design phases ensure "best concept" selection and, ultimately, higher-performance products and shorter product development cycles.

Bechtel: One of the world's largest engineering construction firms, Bechtel has been at the center of energy development since the 1940s, having built more than 450 power stations with a total generating capacity exceeding 160,000 megawatts. Today Bechtel uses two Silicon Graphics Onyx2 systems and two Silicon Graphics Octane workstations to develop external virtual walk-throughs of power-generation facilities. The 3D digital models, based on Bechtel 3D CAD engineering models and created in MultiGen Creator™ software, represent various standard-sized power-generation facility configurations. Bechtel customers can view the models on a monitor or with head-mounted displays that allow the viewer to interact with the virtual model.

The virtual models can save customers time and money by helping to identify and resolve potential problems before they occur, improve decision making, and speed time to completion. The company also has plans to create virtual safety walk-throughs to help its customers monitor plant and worker safety during construction of the power-generation facility.

The virtual walk-throughs created on SGI systems have proven to be effective tools for Bechtel customers. They help keep the company on the leading edge, whether at industry trade shows or on customer projects.

Industry Outlook

Around the globe, countries and corporations are working to resolve the demand for energy through a mix of viable resources, including oil, natural gas, nuclear energy, and hydroelectric power, as well as renewable alternatives such as wind and solar power. In all areas, the move to improve power-generation efficiencies in order to maximize power output while minimizing cost expenditures is ongoing.

To help achieve these goals, SGI will continue to provide the power-generation industry with an ever expanding and highly scalable array of HPC solutions for efficient structural and CFD analyses in mixed-application environments and deliver advanced visualization technologies that provide the insight needed to create high-efficiency power-generation equipment.

Eye on Innovation

Visual Area Networks

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increasing end-user needs in multiple areas—memory, number of CPUs and graphics pipes, and I/O bandwidth. In addition, the need for travel or relocation to a site that offers high-end capabilities is eliminated, thus saving time and enhancing end-user productivity.

Visual Area Networking at Work

MSX International, a leading supplier of engineering services for automotive and other engineering-intensive industries, immediately recognized the advantages of Visual Area Networking for its operations and has been using OpenGL Vizserver in its MCAE group for over a year. "With OpenGL Vizserver, we can bring the compute and visualization power of our SGI Onyx 3000 series system directly to our engineers' desktops," said Iain Gibb, CAE manager at one of MSX International's U.K. sites. "Our engineers no longer require expensive desktop systems to do their work, and the quality of OpenGL Vizserver output, even on a laptop system, is sufficient to allow us to use visualization regularly in meetings and design reviews, thus improving productivity." MSX International will soon be using OpenGL Vizserver to improve collaboration between sites in the U.K. and, ultimately, to improve collaboration worldwide.

Accessing the Future

Visual Area Networking is delivering on SGI's commitment to providing future-driven solutions that solve real-world problems today and its promise to improve the way people work and organizations operate.

Instead of duplicating costly resources time and again, Visual Area Networking allows companies to use existing infrastructures to disburse information from a single, secure high-performance computing and visualization system to end-user workstations, desktop PCs, laptops, wireless tablets, and even PDAs—anywhere, anytime. This, in turn, provides the means by which organizations can resolve design, development, production, and manufacturing issues before they even have the potential to turn into multimillion-dollar problems.

Visual Area Networking, with its ability to provide universal access to complex images and large data sets, is leading the way in helping today's industries move beyond a position of information superiority to one of decision superiority—the ability to use advanced visualization to work collaboratively, act decisively, and move swiftly to market.

Northrop

[continued from page 4]

Other areas in which digital prototyping inroads are being made, albeit at a slower pace, are the testing of dynamic events. However, Newport News' engineers will continue using the results of physical prototype testing to prove the validity of the digital model.

VASCIC

The Virginia Advanced Shipbuilding and Carrier Innovation Center (VASCIC), also located in Newport News, Virginia, is a state-of-the-art R&D integration facility managed by Newport News. The institution, which opened in 2001, brings together manufacturing, defense, and academia and serves as a collaborative proving ground for advancing visualization and other technologies that support Navy initiatives—future naval capabilities, total ownership cost reduction, and technology transfer. Newport News hopes to implement the technology advancements made through VASCIC directly into its aircraft carrier design and construction.

Into the Future

In the years and projects ahead, large-scale shipbuilders such as Northrop Grumman Newport News will continue to increase their reliance on visualization technologies as expressed through digital prototyping, visual mock-ups, and SGI Reality Center facility presentations to their customers. Because moving tremendous amounts of data forward to current technology platforms takes innumerable staff-hours to accomplish, the first fully digitally designed aircraft carrier is still some years away. However, there appears to be no doubt among industry insiders that it will happen.

To ensure that shipbuilders and manufacturers realize their visualization technology benchmarks, SGI will continue to design and develop robust workstations and high-performance computing solutions with optimum speed and graphics capabilities that will further improve upon the capability, survivability, and combat effectiveness of the backbone of America's defense.

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