SGI® Reality Center™ Technology: Measurable ROI

SGI Reality Center facilities seamlessly integrate advanced visualization hardware and software technologies to create immersive environments that envelop participants in a state of virtual reality (VR). Within the manufacturing industry, VR impacts the areas of conceptual design, digital prototyping, engineering analysis, and production planning and training, and it serves as an increasingly effective business development tool for sales and marketing.

The ability to recognize a positive return on investment (ROI) for leading manufacturers has made SGI Reality Center facilities an indispensable tool in today's global marketplace. Using the power of collaborative visualization, they facilitate collaborative decision making and multidisciplinary communications that enable companies to identify and resolve manufacturing problems while in a virtual state. By making decisions based on digital models, companies can save developmental time and money while significantly reducing time to market. SGI Reality Center environments support the entire product development process, from conceptual modeling to engineering and design review, visualization of complex analysis data, factory floor simulation, training, and customer reviews.

Any industry that requires 3D information to be navigated or examined in finite detail will benefit from SGI Reality Center technology. Automotive companies (such as TWR, headquartered in Leafield, Oxfordshire, England) use it for the collaborative development of conceptual, functional, and ergonomic design and engineering for both the exteriors and interiors of automobiles, and to design a vehicle's manufacturing precess. Manufacturing industry service bureaus (such as QMI Solutions in Brisbane, Australia) use Reality Center to enable urban planners and civil engineers to review the environmental impact of proposed new developments in full. Finally, general manufacturers (such as Thomson multimedia in Indianapolis, Indiana) use SGI Reality Center facilities to style and enhance the design and functionality of state-of-the-art consumer electronics products and the retail environments in which they appear.

TWR, QMI Solutions, and Thomson multimedia are three very different companies focused on an equal or greater number of areas of expertise with a common advantage—real-time visualization technologies implemented through their SGI Reality Center facilities. SGI Reality Center technology has been instrumental in helping each of these companies realize a significant ROI on their initial investment.

Among the most quantifiable benefits brought about by SGI Reality Center facilities usage is the reduction in physical prototypes and the significant costs associated with their creation. The concurrent downsizing of product development cycles, which accelerates time to market, is equally quantifiable. Development cycle reductions have ranged from 30% for consumer goods to upwards of 70% for automobiles.

The competitive advantage of reduced time to market is the biggest and most lucrative advantage SGI Reality Center facilities bring to an industry's doorstep. Getting to market before your competitors increases market share and establishes leadership status, two powerful weapons for sales and marketing divisions within any organization.

An additional benefit for companies that employ SGI Reality Center technologies is good publicity—the type that public relations firms thrive on. For TWR, it meant additional press in industry trade publications, which portrayed the company's SGI Reality Center facility usage as a leading-edge move. Local, national, and international television media also intrigued by virtual reality technology, ran feature stories on TWR and the advantages of using an SGI Reality Center facility.

Finally, there is the somewhat less quantifiable aspect of virtual reality technology, known as collaboration. While the overall effects of it can be subjective in nature, it is clear to TWR, QMI Solutions, and Thomson multimedia that collaboration has made its mark on product design and development. Solving what appear to be minor complications in the early stages of development can mitigate costly production errors. On a global scale, SGI Reality Center facilities make it possible for companies to leverage the power of the Internet to facilitate collaborative ventures with customers and vendors around the world, in real time. This means that the human time commitment required to complete global projects can be shifted from travel to on-the-job productivity.

The application of virtual reality technology in product design, engineering, and manufacturing has revolutionized the work of many industries. What was once considered appropriate only for companies on the outer reaches of the cutting edge has now become generally accepted as a critical resource.

SGI is the industry pioneer in developing immersive environments and the only computer-systems company delivering robust and deployable collaborative visualization solutions. SGI® Onyx® family systems are the

only systems designed from the ground up to support immersive high-performance visualization. Moving forward, SGI will continue to innovate, developing next-generation technologies that will deliver the highest available performance. An excellent example is Visual Area Networking, SGI's vision for providing universal access to advanced visualization. It will provide any user on any client device located anywhere in the world with direct access to SGI Reality Center technology. Innovations such as this ensure that SGI customers will continue to recognize unsurpassed levels of return on their SGI Reality Center technology investments.

sgi®

Corporate Office
1600 Amphitheatre Pkwy.
Mountain View, CA 94043
(650) 960-1980
www.sgi.com

North America 1(800) 800-7441
Latin America (52) 5267-1387
Europe (44) 118.925.75.00
Japan (81) 3.5488.1811
Asia Pacific (65) 771.0290

SGI® Reality Center™ Technology: Measurable ROI

1.0 Overview

SGI Reality Center facilities seamlessly integrate advanced visualization hardware and software technologies to create immersive environments that envelop participants in a state of virtual reality (VR). Within the manufacturing industry, VR affects the areas of conceptual design, digital prototyping, engineering analysis, production planning and training, and facility walk-throughs, as they relate to product development. VR serves as an increasingly effective business development tool for sales and marketing.

The objective of this paper is to show the various ways in which the SGI Reality Center technology provides a positive return on investment (ROI) for manufacturers that utilize collaborative decision-making and multidisciplinary communication to identify and resolve manufacturing problems in a virtual state. We will show that by making decisions based on digital images, companies can optimize their designs without sacrificing product quality or integrity, minimize the number of physical prototypes required, and speed product development cycles, thus saving developmental time and money while significantly reducing time to market.

2.0 Introduction

SGI Reality Center environments and their ability to facilitate the power of collaborative visualization are indispensable tools among leaders in today's global manufacturing industry, enabling those leaders to reengineer their product development practices and bring new, better-quality products to market faster, at a lower cost, with more options for consumers. SGI Reality Center environments support the entire product development process, from conceptual modeling to engineering and design review, visualization of complex analysis data, factory floor simulation, training, and review for customers.

3.0 Collaborative Visualization

People do their best work when they work together. Within the confines of an SGI Reality Center facility, collaborative visualization serves as the common language for multidisciplinary teams, quickly turning individual differences into team strengths rather than liabilities.

Collaborative visualization enables everyone on the team, regardless of background or training, to interact with and experience the products they are creating, not just view them. Engineers and designers can interact with 1:1 scale (and larger) 3D digital prototypes, achieve consensus, and implement design changes in a fraction of the time it takes to build physical prototypes, saving costly production missteps and reducing time to

market. Digital prototyping also enables them to visualize and interact with models and processes without the attendant danger, impracticality, or significantly greater expense that would be encountered in the environment if it where physical.

3.1 The Power of Collaborative Visualization

· Enable collaborative decision making
· Expedite insights into complex problems
· Significantly reduce production and labor costs
· Streamline project analysis, design, engineering, and testing
· Eliminate the impracticality, danger, or expense encountered in physical environments
· Demonstrate products, processes, and plans with unparalleled realism
· Improve skill acquisition and concept retention
· Enable intuitive exploration and precise analysis of relationships between variables
· Allow interactive analysis of high-resolution, time-varying data sets of unlimited scale

4.0 Who Benefits

SGI Reality Center technology adds tremendous value to industries where it's vital to visualize spatial relationships and analyze, design, engineer, and understand such relationships. Any project in which 3D information must be navigated or closely examined will benefit from SGI Reality Center technologies.

The automotive industry uses SGI Reality Center facilities for collaborative development of conceptual, functional, and ergonomic design (both exterior and interior). Urban planners use SGI Reality Center facilities to review the environmental impact of proposed new developments in detail. They can even use time-lapse visualization to project their developments forward in time to determine how it will look both architecturally and aesthetically as the area matures. And multimedia companies use SGI Reality Center facilities to style and enhance the design and functionality of state-of-the-art consumer electronics products and the retail environments in which they appear.

To that end, this paper will focus primarily on three companies and the ROI derived from their use of SGI Reality Center technology:
· TWR, headquartered in Leafield, England, is a global company that for more than 25 years has provided the automotive industry with fully integrated services in vehicle design, engineering, and manufacturing.
· QMI Solutions, formerly known as Queensland Manufacturing Institute, in Brisbane, Australia, was established in 1993 to assist local and interstate manufacturing organizations in becoming more

competitive globally through the adoption and use of new technologies.

- Thomson multimedia, a company with roots that date back to 1880, has a presence in more than 30 countries, and its Consumer Products Division ranks as the world's fourth largest supplier of consumer electronics, with brands that include Thomson, RCA, and Technicolor.

For all industries that benefit from the use of VR applications, SGI Reality Center facilities deliver the highest quality performance and realism possible in a wide range of display configurations.

5.0 Assessing the Need

The calculation of ROI for any expenditure can differ significantly from case to case. ROI can be seen as purely financial (profit from sales or a reduction in production costs), or it can be realized in units of time (human and mechanical) or a combination of time and money, which is often the case. Therefore, it is important for a company to look at all areas in which the addition of an SGI Reality Center facility can impact ROI—design, engineering, manufacturing, and sales and marketing.

5.1 TWR

In the case of TWR, the company was looking for a solution that would help it move beyond the limitations of desktop CAD technologies when designing and engineering for its OEM clients.

In 1998, a team of engineers led by Ross Kirkham, TWR's then-IT manager and present-day group IT director, embarked on an internal program to determine the feasibility of adding an SGI Reality Center facility to the company's suite of design and engineering tools. At the same time, Kirkham wanted to determine which companies were actually capable of delivering productive virtual reality technology to TWR.

One of the first orders of business was to establish a set of goals TWR would achieve by installing an SGI Reality Center facility at its Leafield, England, facility. Areas in which TWR hoped to benefit were in its ability to exploit the latest technologies, reduce engineering time, encourage innovation through faster analysis and feedback, increase end-product quality, and, ultimately, build incremental business with auto manufacturers.

Kirkham also determined that one of the key benefits of TWR having an SGI Reality Center facility would be the convenience of finally having all of the company's design, engineering, and manufacturing data together in a single environment. This would ensure greater local collaboration and faster problem identification

and resolution, and accelerate decisions moving forward. Exactly how rapidly all these changes would take place was still unknown, but simply knowing that together these advantages would significantly reduce time to market—the key selling point for OEMs—made the argument for installing an SGI Reality Center facility extremely compelling.

Choosing a company to help develop, build, and assist in the operation of the Reality Center at Leafield was slightly less involved, as there were only two real players at the time who could provide the advanced visualization technologies TWR required. After a brief review, TWR chose SGI because of its leadership position in the digital prototyping marketplace and its ability to provide a higher level of hardware and software integration. TWR's previous successes with projects involving SGI® workstations also proved influential.

The final step before installing an SGI Reality Center facility was for Ross to convince TWR CEO Tom Walkinshaw, the TW in TWR, that it was a sound business investment. A trip to the SGI Reality Center installation in Theale, England, provided some additional inspiration. A visionary in his own right, Walkinshaw was quick to see how SGI Reality Center technology would serve well the needs of TWR and its clients. The decision to move ahead with the SGI Reality Center facility at TWR began soon thereafter.

5.2 QMI Solutions

QMI functions as a service bureau for industries within the state of Queensland, in northeast Australia. Its purpose is to assist local and interstate manufacturing organizations in becoming more competitive globally through the use of advanced technologies. By investing in new technologies, such as an SGI Reality Center facility, QMI is able to benefit a broader audience of industries and companies.

Instrumental to securing an SGI Reality Center installation for QMI was visionary and then-CEO Scott Loose. In 1999, Loose, together with SGI, set about putting together a feasibility study to prove the viability of adding real-time visualization capabilities to QMI's capabilities roster. To secure funding for the project, QMI turned to Queensland's Department of State Development, which is responsible for infrastructure facilitation, urban, regional, and rural development, and investment attraction for the state.

A business case was made that an SGI Reality Center facility would be a technology diffusion project that would benefit not only private-sector industries within Queensland but also throughout Australia. Additionally, government agencies such as city planners and public

works would benefit. QMI would leverage its existing technologies and market presence to promote real-time visualization as a next-level business tool that would help secure new customers. By broadening its customer base, QMI would help Australian industries and government agencies to become less reliant on overseas skills and services and become more competitive globally.

In short, the increased competitive capabilities of Queensland's industrial infrastructure would be the ROI by which QMI's SGI Reality Center facility would be judged.

"If visualization technology could be applied to all of the $45.1 billion (Australian) worth of Queensland projects current and in the pipeline stage, savings of some $2.2 billion (Australian) could be possible. International trends show that visualization can deliver an average of five percent cost saving in the life of projects" said Loose.

To help promote its efforts to secure funding for an SGI Reality Center facility, QMI teamed with SGI to create an SGI Reality Center Technology Road Show that traveled to every capital city in Australia. Local industries and government agencies were invited to attend and learn more about areas in which SGI Reality Center technology could benefit local industries, including digital prototyping, product design reviews, urban planning, building and plant design, construction, simulation, collaborative design and engineering, maintenance analysis, training and education, and marketing.

In 2001, Queensland's Department of State Development gave the nod to approve funding for QMI's SGI Reality Center facility, which would operate under the name Reality Works. The program was to be spread over a four-year period. This would ensure QMI's ability to build the SGI Reality Center facility, make it fully operational, and become self-sufficient.

5.3 Thomson multimedia
Thomson multimedia provides industrial design for the entire realm of RCA consumer electronics products—from broadcast satellites systems, broadband products, and cable modems to HDTVs, projection TVs, DVD players, VCRs, and beyond. The work is handled by the company's Industrial Design Group, which has design centers in Indianapolis, Indiana, and Paris, France.

The Industrial Design Group routinely handles more than 100 RCA product design projects annually, with many requiring multiple rounds of prototype construction. In the overall production process of a consumer electronics product, prototyping is one of the most costly and time-consuming phases.

In 1998, Thomson multimedia's global design development manager, Mike Squillace, was looking for a visualization solution in which he could leverage the company's digital assets, 3D images, to reduce outside development costs—specifically, physical prototypes.

"Visualization technologies give Thomson a competitive edge against other consumer electronic companies because we use it to leverage our digital assets across the entire product development process, starting with initial design concepts, design approval, packaging, promotional literature, and rapid prototyping," said Squillace. "The same files are sent to engineering to develop the core of the product, and to the tool vendor, who cuts the steel from which production parts are created for the product that eventually ends up on a retail shelf. The digital images used in the initial stages of product design are also used to show how the product will look in home and retail environments, even how the product and packaging will appear on store shelves. At Thomson, shelf presence and packaging are paramount, because in consumer electronics, packaging sells the product."

With the cost of appearance-only prototypes ranging from $15,000 for a telephone to $25,000 for a large television set, the desire to trim costs was sizeable. Also, the need for fewer prototypes would shorten development cycles and improve time to market, thereby extending the period for which new product profit margins are at their highest for retailers. The cumulative effect of all this would provide Thomson multimedia with more time to address an increased number of new business opportunities than would otherwise have been possible.

The visualization solution chosen for the job was an SGI Reality Center facility. As Squillace tells it, "SGI was selected as our hardware provider, in part, because of their reputation as a leader in visualization. SGI was also the first hardware platform that the Industrial Design Group purchased when we made the initial decision to use CAD to create our products. SGI people were passionate about what they did, just like us. They helped us brainstorm how to take a technology that we saw the oil and gas industry and automotive industry using successfully, and apply it to consumer electronics."

6.0 Developing a Solution
In each instance, SGI Sales and SGI Professional Services worked with the team leaders at TWR, QMI, and Thomson multimedia to establish the criteria for Reality Center acceptance and how it would best serve the company or organization moving forward. Capability presentations at existing SGI Reality Center facilities were held for team leaders within each organization as

well as their respective executive committee members and/or government representatives, who ultimately would grant approval for the facility to be built.

SGI Reality Center technology demonstrations of work done with the Jaguar XK8 automobile and the Rolls Royce Trent 800 Aero Engine were instrumental in convincing TWR. To assist QMI in its quest to secure an SGI Reality Center facility, SGI created a Reality Center Technology Road Show to demonstrate a variety of product design, development, and manufacturing capabilities to government bodies and organizations throughout Australia. Additionally, QMI conducted a needs assessment that included interviews with potential industry stakeholders and a pilot project. Thomson multimedia traveled to an SGI Reality Center facility in nearby Detroit to learn how the advanced visualization techniques that are used to benefit the automotive industry could be applied to the design and development of consumer electronics products.

In developing the SGI Reality Center facility for TWR and QMI, SGI selected Trimension Systems, a company known for its creation of leading-edge virtual environments. Trimension worked closely with SGI to select the projectors and projection screens that would best optimize SGI hardware solutions. SGI Professional Services provided the overall project management, systems integration, initial training, and ongoing technical support.

To assist with the Thomson multimedia SGI Reality Center facility, SGI selected Mechdyne Corporation, a provider of one-to-one, large-scale, and multiscreen virtual reality and visualization systems. As with Trimension, Mechdyne worked closely with SGI to supply projector and projection technology for the Thomson multimedia SGI Reality Center facility. Again, SGI Professional Services managed the overall integration of the computer and projection hardware and provided training and ongoing technical support.

7.0 Component Selection

While software requirements may differ somewhat by industry and by individual company, in each case described here, the SGI® Onyx® family of computers was used to maximize software performance in each company's immersive environment.

SGI Onyx family high-performance visualization computers are based on SGI® NUMAflex™ architecture and are the only systems designed from the ground up to support immersive visualization and to simultaneously process 3D graphics, imaging, and video data in real time. The SGI Onyx family of high-performance visualization computers also features full-scene anti-aliasing (FSAA), which, through a multisampling of geometries, transforms the otherwise jagged edges of large-scale nonlinear digital images into smooth, flowing lines.

SGI Onyx family systems provide a rich feature set, including clip-mapping, texture paging, volume rendering, anti-aliased full-frame HDTV display, and stereo projection to provide lifelike 3D images—the types of features required for ultrarealistic, high-performance immersion in an interactive system. SGI Onyx family systems can equip an SGI Reality Center facility with multiple visual display channels and superb media tools such as digital audio, video reference input, optional real-time graphics-to-video reference input, and optional digital video for routing multiple video and audio streams.

7.1 TWR Hardware and Software
For TWR the choice was simple. Only the SGI® Onyx® 3400 system with InfiniteReality3™ graphics, equipped with three graphics pipes and three projectors, could provide the graphics power required to conduct full-size design review studies of an entire car, complete with texture and lighting. The high-performance power of the Onyx family system would also allow TWR to use the system to perform compute-intensive analyses such as crash-test simulation and computational fluid dynamics (CFD) whenever the system was not being used for visualization.

TWR is always evaluating new applications and continually upgrading existing apps to expand the capabilities of the SGI Reality Center facility, as is required for increased productivity.

Specifics regarding TWR's current SGI Reality Center facility configuration and a sampling of software applications now in use can be found in the Appendix of this paper.

7.2 QMI Solutions Hardware and Software
SGI is a long-standing provider of virtual reality technology to Australia, having played a leading role in working with early adopters to establish visualization technology's presence on the continent. To date, SGI has been instrumental in developing nine Reality Center facilities throughout Australia. Due to QMI's previous close ties to SGI® SiliconWorks™ manufacturing industry solutions (originally set up to demonstrate how SGI advanced computing technology could be used to advance manufacturing practices) and the company's extensive use of SGI workstations for CAD/CAM/CAE projects, the decision to turn to SGI for its new immersive visualization installation was easy. Independent outside consultants who reviewed the QMI proposal before presenting it to the Queensland Department of

5

State Development (which ultimately gave the go-ahead) agreed that the SGI Reality Center facility was the best technology to help QMI extend the advantages of real-time visualization to Queensland's industrial infrastructure.

Unlike TWR, with its focus squarely on automotive OEMs, QMI's portfolio of real-time visualization applications covers a broader range of industries. According to QMI Reality Works Manager Nelson Frolund, "With Reality Works still in its first year of operation, our software applications are limited to the specific requirements of our current customers. However, given our extensive marketing efforts to secure new customers, that should change rapidly over time, as new customers come on board with new and different software application needs. By adding additional real-time visualization applications as needed, we can keep start-up costs down and ensure that application acquisitions reflect the needs of our customers."

Specifics regarding QMI's current SGI Reality Center facility configuration and a sampling of software applications now in use can be found in the Appendix of this paper.

7.3 Thomson multimedia Hardware and Software

Selecting SGI hardware for use in its SGI Reality Center facility proved to be a transition for Thomson multimedia's Mike Squillace. The company's Industrial Design Group had already been using SGI workstations to create its 3D digital assets for more than five years. Given SGI's reputation as a leader in visualization technology, the decision to use the Silicon Graphics® Onyx2® high-performance visualization computing system was clear. The company also uses desktop workstations for developing projects displayed in the Reality Center facility.

In the area of software, Thomson multimedia relies on a mixture of applications based on IRIX® OS and Macintosh®. Silicon Graphics® Octane2™ systems are tasked with creating CAD and other types of 3D drawings, animation renderings, and QuickTime® VR productions. In some cases, the completed pieces are imported into Macromedia® Director® and run on Macintosh® G4 computers.

Specifics regarding Thomson multimedia's current SGI Reality Center facility configuration and a sampling of software applications now in use can be found in the Appendix of this paper.

8.0 Building the Reality Center Facility

SGI Professional Services played a significant role in building and installing the SGI Reality Center sites at TWR, QMI, and Thomson multimedia. Because of the time needed to gain approval for SGI Reality Center facility contracts, building and installation resources were planned for and made available well in advance. Once the approval to build was granted, the actual building of the facility began soon thereafter. All three SGI Reality Center facilities were completed and up and running, on average, within five to six months.

At TWR, SGI was responsible for the installation of the Onyx 3400 system and the overall systems integration. Display provider Trimension Systems was selected to install all display and control equipment. Overseeing the project for TWR's Ross Kirkham.

At QMI, SGI again brought Trimension on board to help build the SGI Reality Center facility, there under the direction of Nelson Frolund, manager of the new facility.

For construction of the SGI Reality Center facility at Thomson multimedia, SGI Professional Services teamed with Kaleidoscope, an SGI software-integration collaborator, and display provider Mechdyne Corporation. Here, too, SGI directed the installation of Onyx hardware and overall systems integration while Mechdyne handled the installation of screens, projectors, and control equipment. Ted Woerner, director of design visualization, helped supervise the installation for Thomson multimedia.

For each organization, the completion of the SGI Reality Center facility build-out and the availability of the facility for actual use occurred simultaneously, with a need for only minor adjustments that were resolved within the first few months of operation.

9.0 Training and Support

SGI Professional Services provides a wide range of training options during SGI Reality Center installation, start-up, and any ongoing proficiency training required when hardware and/or software additions, upgrades, and enhancements are made to the facility. Additionally, display providers used in the installation provide on-site familiarization for any of their control equipment.

Ultimately, the level of training required to fully optimize the time- and cost-saving advantages of visualization technologies will vary, depending on the needs of the organization and the incoming skill sets of those intending to utilize them. In most instances, engineers who were adept at using graphics and modeling applications at the CAD level were trained to use real-time visualization in a Reality Center environment.

All three organizations achieved a desired level of hardware and software user proficiency within the first several months, on average, the vast majority of it coming from hands-on use. Formal training sessions, generally conducted in a collaborative environment, were determined by the specific hardware and software requirements specific to each organization. Among the applications for which SGI Professional Services provided formal training were SGI® OpenGL Performer™, SGI® OpenGL Vizserver™, and various modeling applications, including REALAX®, MultiGen, and Vega™.

9.1 TWR

At TWR, formal training sessions were conducted over a two-week period for six to eight senior-level TWR engineers and those who were to make up the SGI Reality Center facility staff. All other training was hands-on, and took place in the engineers' normal work environment. Because many of the TWR engineers had used SGI workstations since 1997, and were already familiar with IRIX OS-based software applications, transitioning to new applications on the same platform required little additional training.

TWR has since appointed an SGI Reality Center facility manager to provide full-time technical support and assist with further hardware or application training. SGI again played a formal role in providing training for the new manager.

Most significant among the collaborative benefits afforded by the SGI Reality Center environment is a greater cognitive awareness of how the knowledge set of one discipline can further that of the other. And the more efficiently multidisciplinary teams work together, the more effective their efforts become.

SGI Professional Services continues to work with TWR's SGI Reality Center facility manager and engineering staff to upgrade and enhance system hardware and software capabilities every six months. Doing so will ensure that TWR and its OEM customers will maintain a competitive edge in the design and engineering of next-generation automotive products.

9.2 QMI Solutions

QMI found that engineers experienced in CAD-level graphics and modeling made a slightly faster transition than those who came from a strictly modeling background. Still, the transition to working in a virtual reality environment happened rather quickly. For QMI, the rapid transition of skill sets was an important selling point when the institute was seeking funding from Queensland's Department of State Development. Because those who were to run the SGI Reality Center facility would not have to go through significant

retraining, it meant that more time and money could be put toward marketing the facility to potential new customers.

To optimize the SGI Reality Center capabilities, QMI brought on SGI virtual reality project consultant Andy Dennison. Dennison puts in three days a week at the facility, working with five QMI staff members as well as the full-time graphics person and one-day-a-week technical support person supplied by SGI to ensure all hardware systems remain viable during the first 18 months of operation. In his consultatory capacity, Dennison uses his previous experience in running an SGI Reality Center facility in the U.K. to provide support for developers who are transitioning workstation CAD and modeling skills to real-time visualization. At the same time, Dennison offers advice on various development projects and works directly with QMI's SGI Reality Center facility manager, Nelson Frolund, to develop project proposals for and make formal presentations to potential QMI customers.

9.3 Thomson multimedia

Thomson multimedia experienced a slightly faster transition with its SGI Reality Center facility, as its design engineers continued to use many of the same software applications used on desktop workstations. According to the director of design visualization for Thomson multimedia, Ted Woerner, "Photo-realism is inherently important in the design of our consumer electronics products, as we are constantly making critical aesthetic judgments about the product. Because they are often much smaller in size than other manufactured goods such as automobiles or industrial equipment, our 1:1 visualization needs are comparatively smaller."

"Our work-in-progress designs, which can range from a handheld remote control device to a large projection TV, need to reflect a high degree of detail in a 1:1 scale product design review. Because the number of real-time visualization applications able to provide the degree of photo-realism we require is so limited, we've found it easier to use our current applications."

Subsequent to the installation of the SGI Reality Center facility, SGI collaborator Kaleidoscope, one of the original software integrators on the project, was asked to help Thomson multimedia develop an interactive SGI Reality Center facility promotion. The promotion was to highlight the SGI Reality Center facility's capabilities, as well as the advantages of mixing live-action digital video with photo-realistic virtual prototypes to promote virtual retail simulation and plan-o-gram layout. The audience would be Thomson multimedia customers such as Best Buy, Circuit City, and other large-volume clients.

Working in conjunction with Thomson multimedia's design organization, Kaleidoscope created the opening animation sequence. The production, which took six weeks to complete, included photo-realism—an instrumental tool in the RCA product design process—animation, and 3D manipulation.

Thomson multimedia's promotional effort paid off. The production proved to be very effective in convincing Thomson multimedia customers that the SGI Reality Center facility would set the company apart from its competitors.

Today, Kaleidoscope continues to provide Thomson multimedia with industrial design, animation, and ongoing digital design support.

10.0 Using SGI Reality Center Technology

The application of virtual reality technology in product design, engineering, and manufacturing has revolutionized the work of many industries. What was once considered appropriate only for companies on the outer reaches of the cutting edge has now become generally accepted.

Inside the SGI Reality Center facility, long-standing engineering disciplines-CAD, CAM, CAE, and modeling—integrate seamlessly to create a whole that is greater than the sum of its parts. Components that were once developed in a vacuum and relied on actual physical assembly to determine final size calculations now fit together perfectly in both a virtual and physical state.

Real-time visualization has done much to affect time to market for manufacturers. Design and mechanical engineers collaborate with manufacturing to do their part in creating virtual prototypes that display a greater level of accuracy and precision than a host of their physical forerunners. In the end, virtual reality enables manufacturers to feel more confident about the aesthetics, functionality, manufacturability, and overall safety of the final product.

The reduction of expenditures, the time savings, the innovations that result from collaboration, and, ultimately, the reduction in time to market are the driving factors that encouraged TWR, QMI, and Thomson multimedia to invest in SGI Reality Center facilities. These companies now benefit from the same superior real-time visualization technologies found in each of the more than 550 SGI Reality Center facilities around the globe.

10.1 TWR

TWR's origins are in automotive racing, and while that heritage remains strong, it accounts for only 12% of the company's business. Today, the bulk of TWR's work comes from the design, engineering, and manufacture of automobiles and engines for OEMs worldwide and from design and performance enhancements to their current vehicles and engines.

Prior to installing the SGI Reality Center facility, TWR was already using SGI workstations to significantly reduce design times. For example, using SGI equipment, the company was able to create the Nissan R390—a completely new road car created and then developed as a race car for Le Mans, all within nine months. It was the success of projects such as this that inspired TWR to once again turn to SGI to help it create still greater successes on an even larger scale.

The SGI Reality Center facility at TWR's Leafield location came online in May 1999. The opening of the facility brought with it the distinction of being the U.K.'s first curved screen, full-size immersive virtual reality environment. The facility seats 15 to 20 comfortably. However, working sessions, which range in attendance from six to eight people, are the day-to-day norm.

The SGI Reality Center facility is a popular place. Something is taking place there 24 hours a day, seven days a week. Weekdays see a steady stream of working sessions, including styling exercises, design and engineering reviews, and sales and marketing presentations to existing and potential TWR customers. TWR also makes SGI Reality Center facility time available to its IT partners who wish to demonstrate their capabilities to potential customers. Scheduling for the Reality Center facility is done through a central booking system, using Microsoft® Outlook® Diary, an off-the-shelf application found in Microsoft® Office.

The SGI Reality Center facility is also used to support TWR in joint presentations to OEM customers around the globe using the power of the Internet and PTC® DIVISION™ dVISE®, a software application that turns CAD data into functioning, interactive virtual products for real-time on-screen testing across multiple machines in both local- and wide-area networks.

Prior to each design review, the data that is to be reviewed is copied and sent to participating locations. During the review, orientation and positional data relating to areas within the design are exchanged between the sites. Review participants see each other as avatars (virtual human representations) that are able to move around the virtual model independently, or synchronize at one point in the scene, thereby

allowing all participants to view exactly the same thing, at the same time.

TWR currently uses this technology to conduct design reviews between the U.K. and Detroit, Michigan and between the U.K. and Melbourne, Australia, as well as three-way collaborations involving all three countries.

After hours and on weekends the SGI Reality Center takes on an even more computational function, performing CFD analyses to assess the external aerodynamics and to run crash-test simulations to evaluate vehicle safety.

CFD analyses performed in SGI Reality Center facilities allow any number of vehicle design iterations to be tested simply by making computational changes in the design or engineering specifications. This, in turn, helps minimize the number of physical prototypes manufactured for actual wind-tunnel testing. Consequently, the physical prototypes that are created bear the most desirable attributes of the simulated designs.

Crash test simulation, in particular, is of high interest to OEMs as physical crash testing is a significant cost factor in overall vehicle development. Because physical crash test models must be fully developed and assembled prototypes, costs can run upwards of $1 million per prototype per crash test. Being able to perform the same simulations using virtual reality can cut the number of necessary physical crash test models nearly in half, a tremendous savings in both cost and development time.

10.2 QMI Solutions

The SGI Reality Center facility at QMI, with its theater-style seating, boasts room for 25, and its spherical screen ensures all attendees a fully immersive experience. And like most SGI Reality Center installations, QMI's generally plays host to smaller collaborative sessions of eight participants or less.

A wide range of companies and government agencies in Queensland are expected to take advantage of the facility, and in excess of 12 projects will be completed in the first nine months of operation. The facility manager, Nelson Frolund, says that QMI is actively promoting the facility to potential customers for use in the areas of digital prototyping, urban planning, building and plant design, construction, simulation, collaborative design and engineering, product and maintenance analysis, training and education, and marketing.

Frolund goes on to outline what the SGI Reality Center facility at QMI can do for Brisbane, Queensland, and

all of Australia's industries, "The Reality Works center can achieve significant savings for our customers by facilitating collaboration and removing time and cost barriers associated with creating physical prototypes. The facility will enable them to make better decisions by providing a much more accurate accounting of product design and functionality early on in the development process. This, of course, will aid in reducing time to market and enhance their ability to deliver projects on budget."

Of the potential clients the Reality Works center seeks to attract, high on the list is urban planners. With Brisbane and the surrounding state of Queensland being among Australia's most prolific in terms of new urban and industrial growth, the SGI Reality Center facility's ability to provide real-time visualization could prove significant in helping local, state, and regional planners create a well-balanced, low-impact urban development roadmap to the future. Not surprisingly, the facility's initial projects have included the first phase of development of a dedicated busway in north Brisbane, a large-scale shopping mall, and a housing development. Preliminary feedback from these projects is showing benefit to clients, both from the improving internal design review capability and from better communication with the end client.

"In every instance moving forward," Frolund said, "our goal is to get potential customers into the Reality Works center, sit them down in front of the screen, and help them understand the value of real-time visualization. If even a fraction of the companies coming in to experience the SGI Reality Center facility's capabilities come to fruition—and we've had up to 150 visitors come through in a single week—Reality Works and QMI will be well on our way to accomplishing our mission."

The existing client base of engineering customers is also still being served—QMI has been able to allocate Onyx family system resources for multiprocessor computational fluid dynamics simulations during off-peak times, when compute horsepower for graphics is rarely needed.

Of the prospective Reality Works center customers Frolund can point to in the early stages of QMI's efforts to market the service, a resounding 90% are currently not QMI customers, and the success rate of getting those prospective customers in to see the facility is well over 70%.

10.3 Thomson multimedia

The Thomson multimedia SGI Reality Center facility, installed in 1999, has proven beneficial not only in the visual development and design of the RCA brand, but

also in how that brand will ultimately be displayed in a retail environment—from multimedia boutiques to high-volume chain superstores.

On average, more than 150 projects find their way into and back out of the Thomson multimedia Industrial Design Group annually. Some last for only a matter of weeks, while other, more large-scale projects may take up to six months to complete. Each makes its way through the SGI Reality Center environment.

The SGI Reality Center facility itself accommodates an audience of 12 in front of its 18-foot by 8-foot flat-panel projection wall. Thomson multimedia is the first company in its market to deploy a large-scale visualization solution to the world of consumer electronics. The facility is currently used for design reviews, product display visualization, and customer focus groups.

In the first year of the facility's operation, nearly all outside prototyping expenses were eliminated. Ted Woerner, director of design visualization at Thomson multimedia, said, "These cost savings alone paid for the center's first-year operating expenses. Our model shop still builds a significant number of new product models every year, but prior to having the SGI Reality Center facility, we also had substantial outside mockup expenses. These have largely been eliminated. In addition, we also have found that we are now typically building only one prototype for each new product. This is because the realism of our virtual prototypes in the SGI Reality Center facility are high enough that we can make accurate aesthetic judgments and evaluate iterative design changes prior to construction of the physical model." As the facility enters its third year of operation, no outside prototyping is expected to take place.

10.4 Going Digital

The decision to move from physical prototypes to a fully digital approval process for final product design was an easy one for Mike Squillace, global design development manager at Thomson multimedia. However, he was concerned that it might take a while for others to get comfortable making important product and design decisions using only a digital image. Squillace had a plan to test the waters.

The Industrial Design Group was working on an entirely new design for a large-screen RCA projection TV. As the project progressed, a series of CAD designs was developed for the product and reviewed following the company's usual protocol. Then the project reached the product acceptance meeting, at which all involved project managers are asked to sign off on the final design of the product before it moves into full-scale development. Squillace asked the acceptance committee to give its approval based solely on the 3D digital images that would be presented. He explained that cost and time expenditures could be reduced considerably if the approval process accepted digital prototyping as the norm.

Upon review, the committee was convinced enough to give the design its stamp of approval. However, just to be sure, the designers had completed a full-size prototype of the product and had it waiting in a nearby room. Once the committee had approved the project, members were escorted to the room, shown the prototype, and asked if it accurately reflected what they saw in the digital prototype. Except for a slight color differentiation (an easy fix), the answer was a resounding "Yes." Since that meeting, the Industrial Design Group hasn't built another physical prototype before a product acceptance meeting.

Overall, the impact on RCA product development has been a nearly 30% shortening of the development cycle. That number is compounded by faster product development and reduced time to market. Getting a product to market even one week sooner means not only additional profits, but also higher per-unit profit margins, until competition drives them down.

Woerner reaffirmed the time- and cost-saving advantages of the SGI Reality Center facility. "The decision to rely strictly on digital prototypes was an easy one to make. The SGI Reality Center facility provided the hardware and software application tools we need to create full-size digital mock-ups in detail. From a design perspective, the result has been a significant drop in the cost of bringing a product to market. By eliminating the need for first round physical prototypes, the entire product design and development process is now a much shorter timeframe. Our ability to get products approved in a digital state and into production at a much accelerated pace can actually impact initial sales once the products land in a retail environment."

Woerner went on to say, "While the SGI Reality Center facility provides the perfect forum in which to effectively communicate digital designs, our use of the center has expanded. We're now finding that the SGI Reality Center facility is an excellent tool for creating multimedia presentations that we can use to help promote upcoming RCA products and technologies to the trade, retailers, and even consumers."

Additionally, Thomson multimedia sales and marketing has found that these types of presentations can be instrumental in securing advance buy-in from large-volume RCA retailers and chain superstores.

11.0 Collaboration

Collaborative work sessions have been around for as long as there has been the need to work together to arrive at a common solution. Throughout time, these collective meetings of the minds have brought together an outpouring of thoughts and ideas. Each vision had merit, but not all fit what was construed to be the master plan. Finding common ground on which to base a sound decision was often elusive.

SGI Reality Center technology, through the power of real-time visualization, enables multidisciplinary teams of designers, engineers, and manufacturers to reach a common ground quickly and efficiently and to instill customer confidence by ensuring the look and performance of the final product before the manufacturing begins. This collaborative effort, inspired by SGI Reality Center technology, can significantly reduce product development costs and help trim weeks, months, even years off time-to-market timeframes.

11.1 TWR

At TWR, real-time visualization technology has proven to be a highly effective tool in creating a collaborative environment in which multidisciplinary teams can design, engineer, and manufacture automobiles that set the industry standards for superior quality.

Ross Kirkham, IT director, says, "Collaborative real-time visualization promotes innovative thinking by serving as a catalyst between TWR engineers, the software they use to create their design, and the hardware that delivers it to the team. It keeps them focused on taking advantage of everything the SGI Reality Center facility has to offer and using it to keep TWR a leading-edge company."

Overall, because multidisciplinary teams are able to use the SGI Reality Center installation to collaboratively visualize and analyze large CAD data, TWR has been able to gain product insights faster, thereby enhancing the company's ability to ensure the fit and functionality of vehicle components before the first prototype is built.

For example, by using real-time visualization of high-fidelity, 1:1 scale (and larger) 3D vehicle renderings in its SGI Reality Center facility, TWR was able to eliminate the need for six full-size clay vehicle prototypes in the creation of the Renault Sport Clio V6 for client Renault. The SGI Reality Center installation made it possible for participating teams from TWR and Renault to interact with every part of a vehicle's design and achieve consensus early in the process.

Typically, automotive manufacturers will require that 10 to 15 prototypes be built to assess the integrity of the design before moving forward with a project. The reduction in prototypes translated to a savings of £250,000 ($375,000) per prototype to Renault and helped to reduce what would normally be a three- to four-year product development process to just 17 months.

It is also important to note that the same collaborative advantages that TWR experiences at its SGI Reality Center facility in Leafield translate seamlessly to design and engineering reviews on an international scale. Currently, the TWR facility links to SGI Reality Center facilities in Detroit and Melbourne, Australia, for remote collaborative review sessions.

11.2 QMI Solutions

QMI's SGI Reality Center facility manager Nelson Frolund puts it simply, "It's still too early to form any quantitative opinion as to the overall impact of the collaborative advantages provided by the center. What we do know at this point is that fully immersive real-time visualization has already enabled the communication of complex ideas and concepts in a language that everyone can understand—visualization. To what degree it impacts how people of various disciplines work together is what we expect to learn in greater detail after getting a few more projects under our belt."

Still, the idea of being able to put multidisciplinary teams in front of the same data set in front of a full-sized virtual reality environment is a strong selling point, and one that seems to be playing well to the potential SGI Reality Center installation customers—even in the manufacturing sector, which is typically regarded as one of the more conservative industries.

One of the projects recently completed at the SGI Reality Center facility is the first phase of development of Queensland Transport's Inner Northern Busway in Brisbane. The busway, a dedicated road that is to be used exclusively by buses and emergency vehicles, is a sister project to the recently completed multimillion-dollar South East Busway, the largest public transport project ever undertaken by Queensland's state government. The project involved getting buy-in from local urban planners, government funding agencies, politicians, and the businesses and residents of Brisbane whom it would impact directly. By allowing all parties to immerse themselves in the same full-size urban settings and see exactly where the busway would be built and how it would impact future phases of the project, Brisbane urban planners were able to significantly reduce the approval time that a project of this magnitude usually commands.

To facilitate future collaborations on a regional, national, and international scale, QMI is currently reviewing the addition of SGI OpenGL Vizserver to its list of offerings. SGI OpenGL Vizserver would enable QMI to distribute collaborative visualization sessions to remote customer systems running a mix of desktop operating systems.

11.3 Thomson multimedia

Thomson multimedia's SGI Reality Center facility has more than achieved its original goal of significantly reducing outside physical prototype expenditures—it has eliminated them altogether. All RCA consumer electronics products are now designed, approved, and developed in a fully digital, virtual state. The results of working in such an environment include accelerated product development cycles, faster time to market, and prototype cost savings.

Working in a fully digital environment also has enhanced the collaborative efforts of Thomson multimedia designers, engineers, developers, and sales and marketing reps. This increased interdependency is most apparent as projects transition from one phase to the next, culminating in product acceptance meetings. The meetings serve as Thomson multimedia milestones for final product sign-off before actual production begins.

Several unforeseen collaborative efforts also have taken root in the SGI Reality Center facility since its installation. Among them is the creation of multimedia presentations used to promote RCA consumer electronics products, both within Thomson multimedia's Industrial Design Group and to existing and potential customers.

"The 2001 Consumer Electronics Show (CES) is a perfect example," said Ted Woerner. "Thomson was introducing RCA's new advanced LCOS (Liquid Crystal On Silicon) technology. We used the SGI Reality Center facility to create a three-minute computer-generated video using 3D CAD images provided by our engineers. The purpose of the video was to demonstrate, educate, and entertain as it explained the new technology. The presentation was burned onto 1,000 DVDs and 2,000 CDs, sent to Thomson multimedia sales reps and product dealers, and handed out at CES. The promotion was a big success."

The success of SGI Reality Center multimedia presentations has not gone unnoticed. Thomson multimedia's sales and marketing team immediately saw the potential to use the SGI Reality Center facility to assist them in creating sales presentations to large-volume and superstore customers. At that point, the facility began developing what has come to be known internally as

retail visualization—entire digital retail settings in which RCA consumer electronics products would appear.

The retail visualizations are a combination of digital photography, digital video, and animation that feature virtual (not yet manufactured) products, complete with detailed graphic representations of virtual (not yet printed) packaging. Every attention to detail is afforded to each customer presentation, from shelf height, display configuration, and light placement to where and how the product should be positioned in the actual store for maximum sales impact.

For sales and marketing, this new collaborative venture with the SGI Reality Center facility has helped to provide sales insights and merchandising opportunities that can be of direct benefit to Thomson multimedia customers. In return, retail visualization has helped to accelerate customer buy-in, lock down retail shelf space, and bolster RCA consumer electronics sales for Thomson multimedia.

12.0 The Real ROI

Return on investment cannot be judged solely by financial profit. Time is a critical factor, as are the resources required to generate ROI. Time to market is a powerful stimulus. While these are the tangible ROI benefits companies desire, there is also that intangible benefit that in no way can be discounted—the human impact on ROI. Experience tells us that we can have all the desired processes in the right place at the right time, but without the humans to drive them forward, they garner no return.

TWR, QMI, and Thomson multimedia are three very different companies focused on an equal or greater number of areas of expertise. Still, they have a common advantage. Real-time visualization technologies implemented through their SGI Reality Center facilities have been instrumental in helping each of these companies realize a significant ROI on their initial investment.

Among the most quantifiable benefits brought about by SGI Reality Center facility usage is the reduction in physical prototypes and the significant costs associated with their creation, which,as we have seen, can range from $15,000 for a simple telephone to $375,000 for a 1:1 scale motor vehicle. Companies such as Thomson multimedia that rely solely on 3D digital images to approve final product designs have eliminated the need for outside physical prototypes altogether. TWR's ability to eliminate six 1:1 scale physical prototypes in just one project—creating the Renault Sport Clio V6 for Renault Automotive—saved the company $2.25 million.

The concurrent downsizing of product development cycles, which, ultimately, accelerates time to market, is equally quantifiable. Development cycle reductions have ranged from 30% for consumer goods to upwards of 70% for big-ticket items such as automobiles. The Renault Sport Clio V6 was created in just 17 months, compared to the industry-standard timeframe of three to five years.

But by far the biggest benefit for the companies that use SGI Reality Center technologies has been the cumulative effect of drastically reduced physical prototyping and significantly shorter development cycles—improved time to market.

This, and this alone, is the biggest and most lucrative advantage SGI Reality Center facilities bring to corporate doorsteps. And while time to market does provide some hard numbers that financial types can get their arms around, more importantly it brings to the fore one of the most coveted of all business positions—competitive advantage.

Getting to market before your competitors increases market share and establishes leadership status, two powerful weapons for sales and marketing divisions within any organization. It also means you will be unchallenged by sales from similar competing products, and that means unchallenged profitability. Not being undercut has the added financial bonus of being able to earn the highest possible profit margins in a product's lifecycle, before competition drives prices down.

SGI Reality Center facilities provide sales and marketing teams with the ability to sell more effectively. In fact, the sales and marketing departments within TWR, QMI, and Thomson multimedia all see their SGI Reality Center facilities as essential tools for winning new contracts.

Thomson multimedia's retail visualization efforts are an excellent working example of how 3D images and virtual reality can impact sales and brand image. By creating an entire virtual retail environment, complete with virtual products, and depicting it in the actual store in which the products will occupy shelf space, Thomson multimedia is providing its customers with selling insights they may never have taken the time to discover on their own.

In the end, both parties benefit. Thomson multimedia gets earlier buy-in, advance commitments for future shelf/floor space, better product placement within the store, more prominent product displays, and a first-in-line competitive advantage over competing products. Thomson multimedia customers get turnkey displays, advance buy-in pricing that can translate to profit margin increases, more accurate sales projections, and merchandising insights that can further affect their bottom lines.

An additional benefit for companies that employ an SGI Reality Center facility is good publicity—the type on which public relations firms thrive. For TWR, it meant additional press in industry trade publications and wider coverage on local, national, and international television. This also is exactly what has happened to QMI.

Finally, there is the somewhat less quantifiable aspect of virtual reality technology known as collaboration. While the overall effects of it can be subjective in nature, it is clear to TWR, QMI, and Thomson multimedia that collaboration has made its mark on product design and development. Solving what appear to be minor complications in the early stages of development can mitigate costly production errors. QMI estimates that Queensland industries that take advantage of SGI Reality Center technology offerings could save as much as $10 million (U.S. $5.3 million) in cost overruns annually.

The ability of virtual reality to help collaborative teams eliminate design, development, and production problems in the early stages of a product can also lead to higher-quality, better-engineered products. In an increasingly crowded global marketplace, with products clamoring for attention, incremental gains such as these can, and often do, become competitive advantages.

On a global scale, SGI Reality Center technology makes it possible for companies to leverage the power of the Internet to facilitate collaborative ventures with customers and vendors around the world, in real time. Time and distance no longer matter. Travel expenditures can be slashed, and the human time commitment required to complete global projects can be shifted from travel to on-the-job productivity.

Ted Woerner, director of design visualization at Thomson multimedia, sums up ROI potential with an invaluable comment: "I strongly feel that you cannot underestimate the effect that [SGI] Reality Center technology has on our customers, not just in the way we design our products, but in the way we present our products. It lets them know that they are dealing with a company on the cutting edge. What it says to them is, 'If [Thomson multimedia] puts this much thought and effort and professionalism into presenting new products [to us], think about what that says about how they handle the rest of their business.' For our customers, it establishes a level of confidence in our company that our competitors simply are not able to match."

13.0 Appendix

The following are SGI Reality Center facility hardware configurations and software applications (partial listing) currently in use by TWR, QMI, and Thomson multimedia, respectively.

13.1 TWR System Configuration

- SGI Onyx 3400 system with 12x RI4000™ 500 MHz processors, 6GB RAM, 5x 36GB disk storage
- 3x InfiniteReality3 graphics pipes (2 with 2x RM, 1 with 4x RM), 2x DG5-2 (2-channel display generator), 1x DG5-8 (8-channel display generator)
- 1x DIVO graphics-to-video option for Onyx family systems
- 3x SEOS Prodas CRT projectors with edge blending— optimized for multichannel curved screen immersive applications; supports stereo mode (active stereo)
- Trimension R2 Researcher Screen (12-ft radius, solid/spherical), 170°x46° field of view
- Surround sound—VR participants experience real-time events as multiple-channel sound effects are manipulated within the immersive space; sounds can be synchronized to a 3D computer and the video image being displayed
- StereoGraphic® CrystalEyes®—a lightweight, wireless eyewear system that delivers high-definition stereographic 3D images in conjunction with compatible software and standard workstation displays
- 80GB DLT backup system—provides backup and archiving of all the data and software on the system

13.2 TWR Software Applications

- OpenGL Performer—a powerful and comprehensive programming interface for developers creating real-time visual simulation and other performance-oriented 3D graphics applications
- Dassault Systemes CATIA® V4—one of the main engineering CAD tools, it allows design review meetings to be conducted using the native data without the need for translation
- Dassault Systemes 4D Navigator—another engineering CAD tool that can run using native data without translation
- PTC® ICEM® Surf™—in the creation and development of Class A surfaces, it enables stylists and engineers to use virtual modeling to work out design treatments dynamically on screen and immediately see the aesthetic, as well as the engineering, implications of their ideas
- EDS® Vis Mockup—a real-time digital prototyping solution that provides interactive visualization (walkthroughs) and analysis of products (created in Unigraphics or Ideas) to find and resolve manufacturing issues early in the development process
- PTC® ICEM® DDN—a 3D CAD/CAM solution covering all applications, from 2D design and drafting to

complex surface and solid modeling, in an open systems architecture
- EDS® Unigraphics—a scalable, integrated, CAD/CAM/CAE solution used in product development
- EDS® I-deas®—a scalable, integrated, CAD/CAM/ CAE solution that supports the digital master model approach by leveraging the Internet to fully communicate information to everyone involved in the product development process
- Alias|Wavefront™ StudioTools™—provides a comprehensive suite of 3D industrial design software for automotive design
- PTC DIVISION dVISE—turns CAD renderings into functioning, interactive virtual products for real-time on-screen testing across multiple machines in both local and wide-area networks
- PTC® DIVISION™ dvMockUp—enables visual analysis, simulation, and real-time design collaboration of 3D CAD models across multiple machines in both local- and wide-area networks
- SGI® ClearCoat™ 360—allows automotive stylists to interactively evaluate design models in real scenes, including real-time calculations of lighting and reflections
- Opticore Opus Realizer™—real-time software used in parallel with different types of CAD systems in the design process and utilized for presentations of various design concepts
- CEI EnSight—enables interactive visualization and animation of results data from finite element modeling applications, including CFD analysis and structural deformation

13.3 QMI System Configuration

- SGI® Onyx® 3200 system with 4x RI2000A™ 400 MHz processors
- 2GB RAM, 5x 73GB disk storage
- 1x InfiniteReality3 graphics pipe x 3 channels
- 1x DG5-8 (8-channel display generator)
- 3x Barco® 909 CRT projectors—SEOS optimized for multichannel curved-screen immersive applications; supports stereo mode (active stereo)
- Trimension R2 Researcher Screen (12-ft radius, solid/spherical), 160°x40° field of view
- Surround sound—VR participants experience real-time events as multiple-channel sound effects are manipulated within the immersive space; sounds can be synchronized to a 3D computer and the video image being displayed
- StereoGraphic CrystalEyes—A lightweight, wireless eyewear system that delivers high-definition stereographic 3D images in conjunction with compatible software and standard workstation displays
- 80GB DLT backup system—provides backup and archiving of all the data and software on the system

QMI also uses Onyx2, Silicon Graphics® Octane®, and Octane2 high-performance computers for developing projects displayed in the SGI Reality Center facility and uses an SGI® Origin® 200 server as the workgroup, software license, and data backup server.

13.4 QMI Software Applications
- OpenGL Performer—a powerful and comprehensive programming interface for developers creating real-time visual simulation and other performance-oriented 3D graphics applications
- MultiGen Creator™ Pro and MultiGen Creator™—comprehensive software toolsets for creating highly optimized, high-fidelity real-time 3D content for use in visual simulation, urban simulation, and other applications
- MultiGen-Paradigm® Vega—real-time development and run-time environment for visual simulation
- PTC DIVISION dvMockUp—enables visual analysis, simulation, and real-time design collaboration of 3D mechanical CAD models
- REALAX, including RXrealtime™—a real-time rendering tool layered on OpenGL® with multiprocessor support, and RXscene™—a polygon and spline-based modeler that also functions as an extensive scene editor for generating and editing complex virtual worlds
- FLUENT® and GAMBIT®—computational fluid dynamic analysis with pre- and post-processing of fluid flow simulations
- EDS I-deas—a scalable, integrated, CAD/CAM/CAE solution used in product development
- PTC® Pro/ENGINEER®—a scalable, integrated, CAD/CAM/CAE solution used in product development

13.5 Thomson multimedia System Configuration
- Onyx2 system with 4x R12000™ 300 MHz processors
- 2GB RAM, 54GB disk storage
- 1x InfiniteReality3 graphics pipe x 2 channels
- 1x DG5-2 (2-channel display generator)
- 1x DIVO graphics-to-video option for Onyx family systems

- 2x Macintosh G4 450 MHz processors
- 2x Barco® 1209S CRT and 1x Barco Reality 6300 LCD projectors—ultrahigh resolution viewing and ultra-wide display compatibility, with built-in IRIS® automatic alignment system
- Mechdyne™ MD Wall™ (18-ft x 8-ft rigid screen with rear projection)
- Surround sound—VR participants experience real-time events as multiple-channel sound effects are manipulated within the immersive space; sounds can be synchronized to a 3D computer and the video image being displayed
- StereoGraphic CrystalEyes—a lightweight, wireless eyewear system that delivers high-definition stereo-graphic 3D images in conjunction with compatible software and standard workstation displays

13.6 Thomson multimedia Software Applications
- OpenGL Performer—a powerful and comprehensive programming interface for developers creating real-time visual simulation and other performance-oriented 3D graphics applications
- Alias|Wavefront StudioTools—a powerful toolset for creating free-form conceptual models and accurate machinable surfaces on Onyx2 systems
- Alias|Wavefront™ Maya®—a leading animation package for the games, cinema, and SFX industries
- EDS I-deas—a scalable, integrated, CAD/CAM/CAE solution that supports the digital master model approach by leveraging the Internet to fully communicate information to everyone involved in the product development process
- Apple® QuickTime VR—a photo-realistic cross-platform virtual reality technology that moves the photographic images from the flat, 2D world into an immersive environment, complete with 3D imagery and interactive components
- Macromedia® Director® Shockwave® Studio—used to create extensible multimedia content (including 3D) that is deployable across the Web and fixed media.