Joanna Alexander
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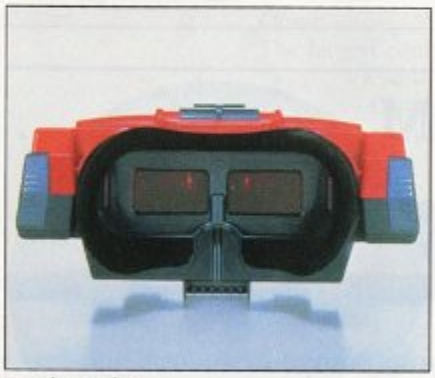
Nintendo's New Baby Boy

Consumer VR was born in Las Vegas this winter, and it's a boy. Nintendo's Virtual Boy was formally unveiled at the Winter International Consumer Electronics Show in January, 1995. The new 32-bit game system will be released this summer simultaneously in the U.S. and Japan at a suggested retail price of $200. We were at CES and took a look at this first virtual reality system developed and produced for the mass market.

The Virtual Boy hardware has two components: the HMD and double-handed controller. The HMD bolts to a metal stand (Virtual Boy is designed to be played seated at a table) and you press your face into its foam rubber eye cups to play. The stereoscopic display is a licensed version of Reflection Technology's Scanned Linear Array display and provides a field of view of approximately 60! that is monochrome (red). The spatial resolution is approximately 380 x 220 pixels of 4-bit grayscale and is amazingly sharp. The single-color displays seem to make the image very easy to converge. Nintendo has added interpupillary distance and exit pupil adjustment controls making this one of the sharpest views we've seen in an HMD at any price point.



Nintendo's Virtual Boy.

Nintendo recently acquired a minority interest in the privately held Reflection Technology. "We are very excited to be working with the worldwide leader in the home video game industry," commented Al Becker, President of Reflection. "Our brain-trust at Reflection has been working on this technology for a number of years and this exclusive worldwide licensing arrangement with Nintendo will place our technology into the hands of millions of consumers."

Nintendo was demonstrating the first three games that will be initially available for Virtual Boy at CES—a boxing game, a 3D-pinball game, and a racing title. Only the racing game was real-time polygonal, the other two were sprite-based. Without headtracking (Virtual Boy does not have a position sensor), the effect was kind of like a monochrome ViewMaster—the stereo separation of foreground and background objects was very good. But will it be good enough for the increasingly sophisticated game consumer? Nintendo thinks so. It is backing the U.S. launch with more than $20 million in marketing support and projects that Virtual Boy sales in the U.S. will be two million hardware units and four million software units by March 1996.

"It has always been Nintendo's strategy to introduce new hardware systems only when technological breakthroughs allow us to offer innovative entertainment at a price that appeals to a worldwide audience," says Nintendo Co., Ltd., President, Hiroshi Yamauchi. "Virtual Boy delivers this and more. It will transport players to a 'virtual utopia' with sights and sounds unlike anything they've ever experienced—all at the price of a current home video game system."

VIRTUAL BOY TECHNICAL SPECIFICATIONS

CPU: 32-bit RISC processor @ 20MHz
Display: dual mirror, scanned linear LED arrays
Software: ROM cartridge
Power Supply: battery operated, 6 AA batteries
Audio: stereo sound with self-contained dual speakers
Controller: double-grip controller with 2 plus-key buttons
Measurements: 8.5"H x 10"W x 4.3"D
Weight: 760 grams

With Virtual Boy and the soon to be released Ultra 64 game system, Nintendo has aggressively positioned itself as the technology leader in video games—something that it desperately needed to do in the wake of Sega's market dominance. Which reminds us of something John Sculley said while he was chairman of Apple. When asked what computer company he feared most in the future, Sculley replied, "Nintendo."

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ENTERTAINMENT SPECIAL

WELCOME TO THE NEXT LEVEL

VR GOES MASS MARKET IN 1995

BY JOANNA ALEXANDER, JEFF CLOSE, JANET GALORE, AND MARK LONG

You only need to understand one thing to appreciate just how phenomenal the next generation of video gaming will be: it takes a two-processor Silicon Graphics Reality Engine just to emulate the real-time performance of twenty Ultra 64s—Nintendo's soon-to-be-released game system.

A Reality Engine costs in the range of $250,000. The Ultra 64 will retail for $250. That's a three order-of-magnitude reduction in price performance. If these graphics systems were cars, and you bought a 1993 model Reality Engine for $180,000 and it went 100 miles per hour, your 1995 Ultra 64 would cost $180 and go 1,000 miles an hour.

The potential for consumer Virtual Reality (VR) is exciting for both consumers and developers. This first of a two-part series provides an indepth look at the next generation of gaming—and discusses the mass-market VR technologies and applications.

The VR Games and Application Challenges

If you break down the components of a VR game system, what do you find? A hardware platform, a head-mounted display (or an analogously immersive display device), an interaction device (such as the Powerglove or a joystick), system software, possibly networking, and an application.

With the exception of the application category, the path toward improvement is pretty clear. The hardware should run faster. The display should be brighter, sharper, and have higher resolution. When coupled with an HMD, it should also be lighter weight and contain faster and more accurate head tracking. The system software should support the blazingly fast hardware without making a fuss or creating bottlenecks. Networking should support real-time multiplayer environments.

The path toward improvement is in allowing an infinite number of players to network with real-time results (including speech) over, say, a telephone line. The interaction device should provide force feedback and support 3D navigation, object interaction, flawless speech generation and recognition. Extra time building muscles on weight machines should not be a prerequisite for extended use.

Now for applications. Applications should be more . . . fun, useful, compelling. Great—a clear directive if ever there was one.

The Players

The big news in consumer VR is, of course, the next generation of dedicated game machines. All of the new systems are capable of extraordinary real-time polygonal performance.

CHIP SIMONS

And at least three—Sega, Atari, and Nintendo—have shown HMDs that will be available this fall.

Sega Commits to a Design

Sega was the first to show an HMD at the 1994 Consumer Electronics show. Since then the product has gone through two redesigns and has been quietly withdrawn from Sega's current product list until the bugs have been worked out. The original design, however, put a stake in the ground for Sega's competitors. The HMD was to retail for $199. An amazing price point given that the device was stereoscopic and included head-tracking.

The real reason the HMD's release has been delayed may be that the 16-bit Sega Genesis was simply not up to the task. That will not be the case with the Sega Saturn, Sega's 32-bit replacement for the Genesis.

The Saturn is powered by two Hitachi SH2 32-bit RISC chips running at 27MHz. These two CPUs along with a Hitachi SHi 24-bit DSP, make the Saturn capable of 900,000 Gouraud shaded polygons a second—which is more than enough scene complexity for a compelling VR game.

Sources close to Sega say that the Sega VR HMD has been re-engineered for Saturn and that a handful of internally developed titles are in the works. You only need to look at Sega's current coin-op titles (also based on the Saturn architecture), such as Virtual Fighter2 and Daytona USA, to see what's in store for Sega VR. Indeed, Sega is hot to promote the idea that what you play in the arcade today, you will be playing at home tomorrow.

Another interesting feature of the Saturn project is the Sega Channel—Sega's interactive television, play-by-cable system. The Sega Channel is currently being tested in twelve cities in the United States and Japan, and at press time was due for national opening. The Sega Channel is a joint venture between Sega, Time Warner, and TCI, the cable company. It is widely believed that the Channel's game-on-demand, multiplayer networking could revolutionize gaming.

The big news in Consumer VR is the next generation of dedicated game machines.

Atari's Second Chance

Atari's 64-bit Jaguar system was released over a year ago, but Atari is attempting to recapture some of the spotlight with its recent HMD announcement and by releasing a new crop of HMD-compatible games. The British Virtuality Ltd., recently entered into an exclusive agreement to provide Atari with a consumer version of its successful arcade HMD.

Atari, seemingly back from the dead after its VCS debacle, has a competitive machine in its Jaguar. Two custom-built 64-bit RISC processors working in parallel with a high speed Blitter GFX ASIC give Jaguar impressive Gouraud shaded polygonal performance. IBM is assembling the Jaguar for Atari in its North Carolina computer manufacturing plant and both companies say that the installed base of Jaguars has grown to over 200,000 units.

Competing in 1995, however, will require that Atari achieve critical mass with its software developers. Most developers have adopted a wait-and-see attitude with the Jaguar, and only thirty titles are available—only half of those being polygonally based and so suited for VR. Atari claims that their software problem is being remedied, but its larger problem may be that it doesn't have the financial muscle to compete with giants like Sega and Nintendo.

Whatever the outcome, it is certain that the Atari/Virtuality VR offering will be one of the best. Virtuality knows more than anyone else about making consumer VR products robust and inexpensive. And Atari's 64-bit multiprocessor architecture has sufficient bandwidth to handle the real-time demands of VR games.

The Egghead Shred, a VR character created and copyrighted by Paradigm Simulation, Inc.

Nintendo's Dream Team

Scheduled for a September debut in both the United States and Japan, Nintendo's 64-bit console will probably be the last to enter the market this year. But the firm is determined that it will arrive with enough impact to wipe out any lead that Sega and Atari might build. Most industry insiders point to Nintendo's late entry into the 16-bit market as the reason it lost so much ground to Sega in 1993. But Nintendo has moved more aggressively than its competitors to sign world-class partners to ensure that its release will dominate—

CyberMaxx HMD was the first to market.

technically at least—the field. Consider their line-up:

•*Silicon Graphics, Inc.* Silicon Graphics (SGI) is the world leader in 3D computing and the creator of the computer graphics technologies behind movies like *Jurassic Park* and *Forest Gump*. Using the RISC microprocessor technology licensed from MIPS Technologies Inc., a subsidiary of SGI, Nintendo's Ultra 64 will be the first application of what SGI is calling Reality Immersion Technology.

•*Rambus Inc.* The Ultra 64 motherboard will be the first game console to use the Rambus DRAM ASIC. The Rambus DRAM architecture relies on a custom interface built into the DRAM and a controller that uses a synchronous, block-oriented protocol to access data at the stunning rate of 500MHz—most PCs access at speeds between 30 and 66MHz.

•*Alias Research, Paradigm Simulation,* and *MultiGen, Inc.* These three companies are the leaders in the high-end 3D modeling and database software market. Alias is developing a customized version of its modeling software for game artists and designers to create characters and environments.

Paradigm and MultiGen have been the standard for several years in software that optimizes 3D databases for fast, real-time performance in defense-simulation applications. Their database hierarchy, level-of-detail switching, model articulation, and texture-editing tools are the foundation of simulation software for everything from M1 Abrams tanks to the B2 bomber.

All eyes are on Nintendo to see if it really can pull this ambitious project off on time. And with Ultra 64's scheduled September launch, this "Dream Team" is working overtime integrating and testing this breakthrough system. As Tom Jermoluk, president and chief operating officer at SGI explains, "The engineering team is in fast-forward-mode.

We're moving to silicon in January—that's tech talk for saying the hardware designs are complete and we're ready for mass production. Nintendo Ultra 64 is the first application of Reality Immersion Technology, a new generation of video entertainment that enables players to step inside real-time, 3D worlds. Software companies like Alias and MultiGen will make it possible for publishers to create games with imagery, graphics, and environments and character movements more realistic than ever thought possible on a home entertainment system. Meanwhile Rambus technology will increase processing speed to an industry-leading 500MHz."

The Project Reality team is being led at SGI by George Zachery, a veteran of the VR industry. Zachery was the business director at VPL before joining Silicon Graphics and has gone on to lead SGI's charge into the consumer entertainment market.

The heart of the Ultra 64 will be a specially modified R4200 MIPS RISC CPU running at 100MHz. The real-time performance will exceed 100,000 anti-aliased, trilinear texture-mapped polygons per second at 24-bit color depth. The display output will accommodate up to HDTV (high definition television) resolutions (megapixel)—making it more than capable of driving VR applications.

Nintendo has already released an HMD (see Virtual Boy in this issue's game column) and although it is not compatible with the Ultra 64, at least two Nintendo-licensed hardware peripheral manufacturers are rumored to have HMDs in the works for Ultra 64. Nintendo seemed to have all the momentum of a freight train going into 1995, and it appears that the only thing that may derail its success is its decision to continue to use cartridges as its media format, while the rest of the industry has elected to use compact discs.

Peter Main, Nintendo of America's sales and marketing director, says, "Sticking to cartridges reduces the price point by at least $150. Nintendo certainly has not turned its back on CDs and Ultra 64 has been designed to allow for a CD add-on." CD or not, Nintendo and SGI appear to be poised better than their competition for a future that will launch VR entertainment on a mass-market scale.

Head Mounted Displays

Four major vendors of HMDs have been making their pitches grab the public's enthusiasm and interest. Forte has their VFX1 helmet, Virtual I/O presented two versions of their i-glasses, VictorMaxx demoed their much-publi-

Forte's VFX1 helmet.

cized CyberMaxx, and Virtual Entertainment Systems has a Seventh Sense display system. In addition, Nintendo has shown their Virtual Boy, but we'll take a separate look at that. First, let's compare the first four:

Forte's VFX1

Forte's VFX1 display has a field of view (FOV) of approximately 53 degrees by 35 degrees horizontally by vertically. The display resolution is 166.4-pixel liquid crystal display (LCD). The on-board head-tracker has a range of +/-45 degrees roll, +/-70 degrees pitch, and 360 degrees around. The Forte team has been very helpful to many developers in integrating the tracking software. The current prototype weighs approximately 1 pound. It has a suggested retail price (SRP) of $900.

The VFX1 headphones have a frequency response of 20Hz to 20KHz and have good sound quality. The VFX1 display is driven by the feature connector of the host video graphics array (VGA) card. While this guarantees compatibility with most display adapters, it also leaves them tied to the VESA standard for display resolution and vendor support. This may prohibit using it with certain specialty video display cards such as the Matrox line. The full-coverage helmet design was comfortable but seemed somewhat large and bulky to most consumers who had tried more than one model.

Virtual I/O's i-glasses!

Virtual I/O has demonstrated versions of their i-glasses! with both 138K and 180K pixels resolution. It has a horizontal FOV of 30 degrees. The headphones have a response of 20Hz to 20KHz and Virtual I/O is working on integrating a microphone with the HMD.

The current prototype has a tracking range of +/-45 degrees roll, +/-70 pitch, and 360 degrees. The head-tracker we reviewed has a minimum tracking rate of 60Hz, and in a second mode can track at up to 250Hz. The display unit is driven externally off of the display card port, and hence needs no additional boards. It does require a VGA to NTSC converter (which they sell) for use with PCs. The tracker connects through the serial port and we had relatively little difficulty integrating it with our software.

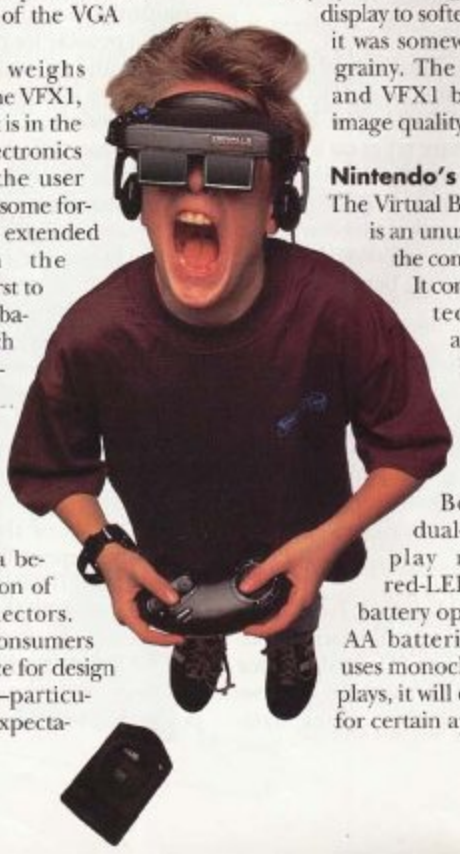
The physical or ergonomic design of Virtual I/O's product is outstanding, and, in fact, has already won an award for industrial design. The glasses have the controls in sensible locations, have easily adjustable headphones, and are very light (8 ounces). They are actually pleasant to wear! The SRP is $600 without the tracker, $800 with it.

Virtuality makes consumer VR products robust and inexpensive.

Victor Maxx's CyberMaxx

The CyberMaxx has a 180K pixel display with an FOV of 60 degrees by 53 degrees. It weighs 14 ounces, slightly less than the VFX1. Its head-tracker has a +/-45-degree roll and pitch tracking ability and 360 degree rotation, and is connected to the serial port. The display is driven off of the VGA card output.

Although it weighs slightly less than the VFX1, most of the weight is in the visor-mounted electronics box and hence the user could experience some forward neck pull in extended use. Although the CyberMaxx was first to market, it will probably not hold much share until it undergoes a redesign. The current configuration is front end heavy, ergonomically unfriendly, and comes with a bewildering collection of cables and connectors. The majority of consumers have zero tolerance for design flaws like these—particularly when their expectations for VR are already overblown. The CyberMaxx has an SRP of $800.



Virtual Entertainment System's Seventh Sense

The Seventh Sense unit has a single high-res LCD display. The head-tracker offers +/-50-degree roll, +/-50 degree-pitch, 360 degrees around, and operates at 30Hz. The display unit is driven off a proprietary 256-color video card that comes with the HMD. The audio is full stereo and the unit comes equipped with a built-in microphone.

The ergonomic design of the Seventh Sense is a plus. It is fairly light and comfortable to wear—among the better of the HMDs we've reviewed. It will have an SRP of around $400.

Summary

It is difficult to compare the image quality of these HMDs on a factual or objective basis (so keep in mind that disclaimer). The higher resolution Virtual I/O i-glasses had excellent optics and image quality, sufficient to run Microsoft Windows with and still read the Windows screen fonts. The VictorMaxx HMD did not yet have the depixillated display, which slightly fuzzies the display to soften it. As a result, it was somewhat harsh and grainy. The Seventh Sense and VFX1 both had good image quality.

Nintendo's Virtual Boy

The Virtual Boy by Nintendo is an unusual offering on the consumer VR front. It contains the display technology they acquired from Reflection Technology, Inc., of Waltham, Massachusetts. The Virtual Boy uses tilted dual-mirrors to display monochrome red-LED displays. It is battery operated with six AA batteries. Because it uses monochrome LED displays, it will only be suitable for certain applications, but

keep in mind that it is Nintendo who is behind it. If 1 percent of Nintendo's installed base buys it, there will be 300,000 Virtual Boys out there. It will have an SRP of around $200, making it accessible to many people.

The product's name provides an interesting comment on Nintendo's culture. They still chose to call this the Virtual Boy and not the Virtual Kid or something else.

The 3D immersive game design is still at a formative stage. Only a few game designers have made the transitions successfully. Others will certainly follow. At this nascent stage of the medium's exposure, however, only a handful of game builders have been able to design applications that exploit VR rather than simply port existing applications onto it.

What do these game developers have that the others don't? Maybe it's a great imagination or 3D graphics experience. Perhaps they possess an unerring sense of what makes games fun, a large budget, a rap sheet. Whatever it is, it really makes their games stand out as exceptions among the plethora of titles in 1995.

3D immersive game design is still at a formative stage.

The challenge these game makers met and mastered is simple to state, but complex to implement: create an application that thoroughly utilizes the impressive new hardware platforms; make it fun and compelling; make users experience something that they never have before. A tall order—some designers have hit two, or even two-and-a-half out of three.

What's Next

The next issue of *VR World* will feature the second part of "VR Goes Mass Market." We'll look at some actual games that indicate the emergence of a consumer VR games market. We'll discuss 3D sound—which is critical for providing a believable VR experience. We'll also highlight interactive systems that are not currently integrated VR systems, but are ripe for such a development.

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