The Market for Visual Simulation/Virtual Reality Systems

Third Edition

A Study Conducted by CyberEdge Information Services, Inc.
Principal Research by Ben Delaney

Study conducted 1999, 2000
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Executive Summary

THE MARKET FOR VISUAL SIMULATION-VIRTUAL REALITY SYSTEMS, THIRD EDITION

EXECUTIVE SUMMARY

A study conducted by
CYBEREDGE INFORMATION SERVICES, INC.

PRINCIPAL RESEARCH BY BEN DELANEY

Study conducted 1999-2000

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CyberEdge
INFORMATION SERVICES ®
The VizSim and Virtual Reality Solutions Group
New York — San Francisco

INTRODUCTION TO THE THIRD EDITION

KEY FINDINGS

- **Third annual report in an on-going study**
- **Substantially greater response provides more and better data**
- **Detailed analysis of over 100,000 data points**
- **Provides actionable knowledge for investors, vendors and end users**

Welcome to the Third Edition of *The Market for Visual Simulation / Virtual Reality Systems.* This report adds to the growing body of understanding of the Visual Simulation (VizSim) marketplace. It includes findings on the Financial aspects of the business, a Demographic look at the participants, and an exploration of the Technology. Finally, it contains the Recommendations of its author on how to use the information it contains to prosper in this marketplace.

This study, and the reports generated from it, are based on detailed surveys conducted among thousands of people involved with VizSim technology and systems. Over the past three years, over 10,000 people have been offered the opportunity to participate in this on-going study. This year, nearly 500 people returned questionnaires, and we had an 82% increase in usable response compared to the previous year. People from every part of the industry responded, from top management at multi-billion dollar corporations and government agencies, to the sole owners of still-tiny back-room operations. We got information from military, commercial and academic laboratories, and from the entertainment industry. We have data from six continents, including Africa and Central and South America for the first time. Despite the valuable diversity, our respondents had one thing in common. They contributed a bit of their substantial knowledge of the industry to a composite picture of great depth and breadth.

That gratifying response has provided over 100,000 data points. We present what we believe is the most immediately useful and salient slice of that data in this report. We will continue to examine the data with other reports and bulletins in mind, as well as special reports for our clients. Readers are invited to contact us with particular questions that may be answered by looking at this data in another way. We are able to cross-tabulate on any question, or investigate any sub-group of the sample population. Please inquire for details of the process.

WHO WILL FIND THIS STUDY VALUABLE?

We believe that this report will benefit investors, vendors, and end users. Investors will find information regarding the strength of the industry, key players, market shares, user satisfaction with vendors, and much more that will contribute to their due diligence during negotiations and deal making. Manufacturers and software publishers, as well as systems integrators and consultants will all benefit from knowing what applications lead the market in various regions, where money is being spent (and made), what users think of various products, and most importantly, what users think of their companies. End users will find

the discussion of the applications and the technologies valuable, and will find much value in the ratings of companies and products.

All readers will benefit from the overview of the marketplace provided in this report. We also believe that the Opportunity Index™ section will provide valuable insights that all three groups of readers will find especially eye opening and useful. The Opportunity Index™, which we introduced last year in the Second Edition of this report, provides fast and valuable insight into the most important aspects of VizSim systems and their components. The Opportunity Index™ will provide investors with information that most companies would rather keep quiet. Vendors will see ways to rapidly and easily gain market share. End users will learn what is really important to look for when making purchase decisions.

We thank all of the people who have contributed their time and knowledge to make this ongoing study possible. Without them, there would be no industry, no study, and no report. Most importantly, we thank the pioneers of VizSim for building the outstanding computers, image generators, display and I/O systems, and the software that make virtual worlds not just amazing, but substantial contributors to our health, wealth, and knowledge. Thank you every one.

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KEY FINDINGS

- **Market value: > $24 billion in 2000**
- **Growth rate: > 50%**
- **Average system cost: $140,000**
- **Number of systems sold annually: >9,000 in 2000**
- **People actively using VizSim: >5,500 worldwide**
- **End users of VizSim: > 2,700**
- **Top 3 business apps: Virtual prototypes, design evaluation, architecture**
- **Greatest increase in applications delivered since last year: Business services and entertainment**
- **Percent of VizSim systems using the internet for content delivery: 21%**

- **Fastest growing component sector: CAVE/Dome/Theater, 92%**
- **Most common 3D input system: Generic mouse**
- **Grade VizSim systems receive from respondents: C**
- **Lowest rated component of VizSim systems: The entire system**
- **Top rated companies: Hardware; Intel, Software; Shout Interactive, Service; Hewlett Packard**
- **Number of respondents: 226**
- **Margin of error: ±5.95% at 95% confidence**

THE STUDY

This is the third edition of the annual report of CyberEdge Information Services' ongoing study of the Visual Simulation/Virtual Reality (VizSim/VR) marketplace. By asking the same questions each year, we are building a store of data that provides novel insights into the people, technology, and business of interactive simulation. This year we have nearly doubled the size of our sample, which increases both the breadth and the depth of the collected data. We have more ways to look at the data, and with well over 100,000 data points, we have much more data to examine. We have created a big picture of the industry, but with the capability to burrow into the data and find the small facts that can make a difference in understanding and action.

More than 450 people returned our questionnaires, and 226 provided useful answers to the 47 questions we asked. We received responses from six continents. Our sample includes people from government, academia, many types of business and industry, and small entrepreneurs. The members of the sample population are largely involved in senior management, though many provide information from lower levels of corporate and academic enterprises.

In addition to having more data to work with, we have also attempted to anticipate questions similar to those asked last year by providing additional financial information in this edition. We have added breakdowns by company revenue in many areas.

As with any survey of this sort, we find some anomalies in the data. Many of these are caused by rounding errors, respondents answering some questions but not others, and

other vagaries of the sampling used. However, we have adjusted where possible and believe these data present a coherent and useful portrait of the financial health of the industry.

Thanks to our larger survey sample, we feel that the figures presented in this Third Edition are more reliable than ever. This information is presented with a margin of error of 5.95% at 95% confidence. In other words, the reader can be 95% sure that our figures are accurate to plus or minus 5.95%. This also means that differences of less than 6% are statistically equal in this year's study data.

The data for this year's report was collected by email. We sent a letter announcing the survey, and asking people to participate. About a week later, we sent the survey to over 8,000 people. Ultimately, 452 returned surveys, and exactly one-half of those, 226 responses, were involved in the VizSim industry.

This report is organized in four main sections. Section One deals with financial information. Section Two covers demographic findings. The third section presents findings on technology and rates user satisfaction. Finally, Section Four provides recommendations as well as the Opportunity Index™ for each component and complete systems.

THE VIZSIM/VR INDUSTRY

Though no longer in the spotlight of media hype, or perhaps because of that, the VizSim business is growing at a substantial and sustainable rate. For the purposes of this study we look at all VizSim systems, which we define for the purposes of this report as "the use of 3D, real-time, interactive computer graphics to create a user-response environment. Any application of such a system is included in our study design." (from the instructions to survey participants.)

This definition includes 3D chat rooms on the Internet and multi-million dollar oil exploration systems, as well as anything in between or beyond that scope. Because of this very broad definition of the field, we are able to obtain a very complete sense of the industry.

We find that Business Services and Entertainment are the two fastest growing application sectors, while military activity seems to be slowing relative to the rest of the industry. This is actually good news, because while military spending has not decreased, private sector expenditures are up sharply.

With the growth of the industry, we find people selling and using VizSim on every continent but Antarctica. They are using systems to help conceive, design, build, test, sell, and train users about products and processes of many kinds. From 3D chat rooms, which we estimate have around 40,000 users worldwide (from data obtained elsewhere), to medical training, to automotive design and crash testing to testing virtual prototypes of future weapons systems, VizSim is making a bottom-line contribution that has caused companies to add it to their technology mix.

We find that there are around 5,500 people involved with VizSim worldwide, and about half of them are strictly end users. This is a big change in the ratio, and implies that one of the common insider complaints, that VizSim companies just sell to each other, is no longer valid. We find a total industry value of around US$ 24 billion with annual growth of around

50%. VizSim is a big, vibrant, healthy business, at last. Average system cost is around $140,000.

VizSim people are largely in North America, where 59% of the population will be found, with another 28% in Europe. They are reading at least 206 different publications, though just 7 titles were cited more than 10 times.

This study does not survey technology in terms of innovation or capabilities, but we do look at what users think about the systems and components they use, and the companies they get them from. We find a lot left to be desired in systems and components. Like last year, our respondents only give systems and most components a "C" grade. In fact, head-mounted displays, one of the signature components of VizSim systems, suffered an 10.6% drop in overall satisfaction rating. The biggest rating gain is VizSim systems in general, up 5.1%, but still only achieving a 2.95 rating, out of a possible 5.

In order to help the readers of this report focus on areas of opportunity, we have developed the Opportunity Index™, which we introduced last year. This tool looks at the lowest rated features of the eight components we asked about, as well as VizSim systems in general. We present this information so that one can see where the greatest engineering and marketing leverage may be obtained in each focus area. The Opportunity Index™ indicates that the key leverage points for all components and systems are these:

- Reliability
- Documentation
- Warranty support
- Useful feature sets

In rating of vendors, we asked our respondents to provide grades for Hardware, Software, and Service. The top three companies in each category are:

	Hardware		Software		Service	
Rank	Company	Rating	Company	Rating	Company	Rating
1	Intel	3.86	Shout Interactive	4.00	Hewlett Packard	3.92
2	StereoGraphics	3.84	Alias|Wavefront	3.73	CGSD	3.90
3	SONY	3.83	SoftImage	3.65	Fakespace/Pyramid	3.89

Table 1: Top rated companies; Hardware, Software, Service.

FINANCIAL SUMMARY

In essence, the financial situation in the VizSim business is good. Companies are growing through absorption and sales. New products are generally better than old ones, and less costly. The number of end users is increasing rapidly, and those users are seeing solid returns on their investments. All in all, the climate is good for continued growth.

The value of the VizSim industry is currently pegged at about $24.7 billion for year 2000, climbing to over $37 billion in 2001. The rate of growth is still over 50% per annum. As is to be expected, larger companies are starting to predominate in the industry as smaller companies are acquired, merge, or close.

VizSim Industry Revenue Trend 1998-2001

(Revenue in $000, vertical axis from 0 to 40,000,000; horizontal axis years 1998, 1999, 2000, 2001)

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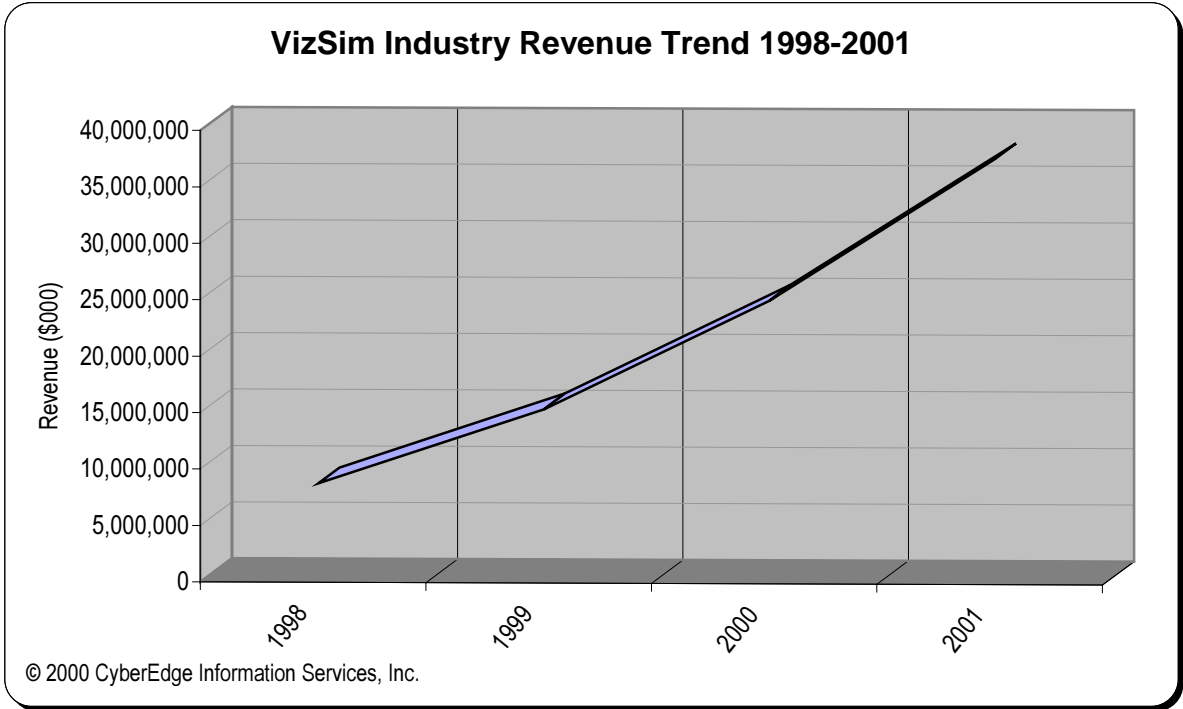
Chart 1: Industry revenue trend, 1998-2001.

It is not the very largest companies that dominate the sales of VizSim systems, but rather the mid-sized operations, with annual revenue in the $1-99 million range. These companies sell more systems than others do. However, the most valuable systems are being sold by the largest companies, those with $100 million or more in annual revenue. The following two charts illustrate these facts.

Systems Sold, 1999 and 2000, by Company Size

(Vertical axis 0 to 6,000; Company Sales Value categories: < $500K, $500K-.9M, $1M-9.9M, $10-99.9M, $100-499M, > $500M; series: Total systems, 1999 and Total systems, 2000)

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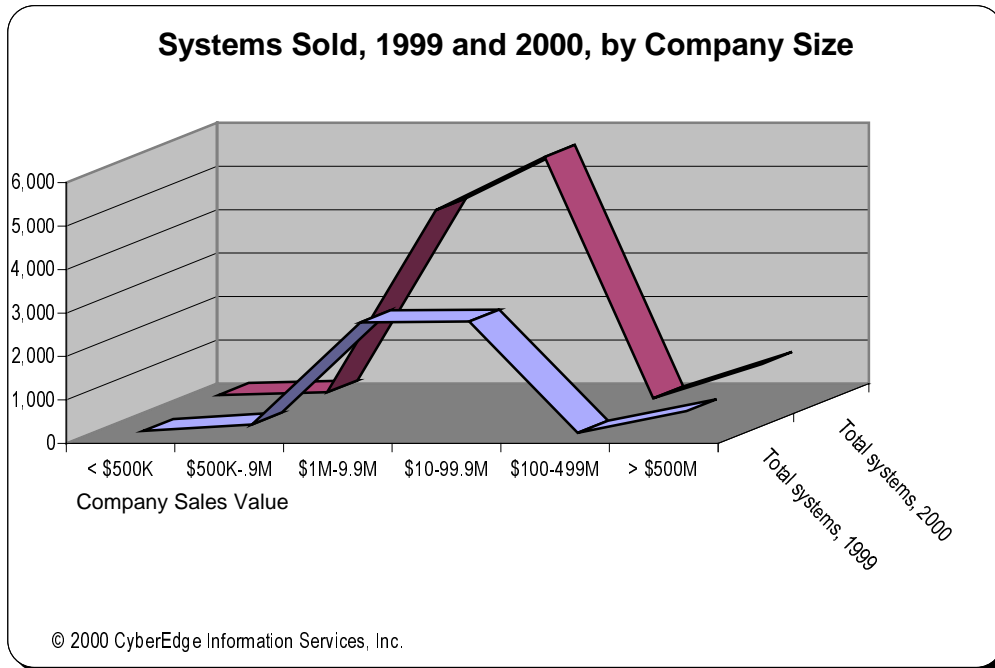
Chart 2: Systems sold, by company size, 1999, 2000.

Prices of VizSim Systems by Company Sales Volume
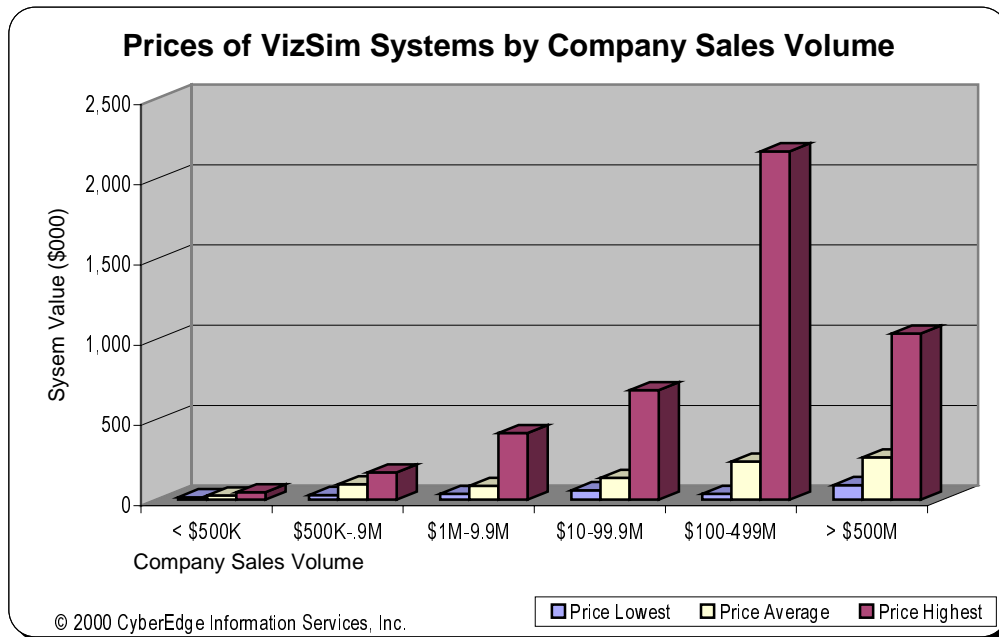
Chart 3: Price of individual systems, by company size.

Unit sales and the value of those units vary greatly by region, but are increasing everywhere. Asia is making a strong comeback after their recent economic problems. North America still leads in units and value, and will continue to do so for the foreseeable future.

Value of Vizsim Systems Sold, by Location 1999, 2000

	Africa	AS/O/AU	Europe	C, S Amer	N Amer
Value 2K	4,897	473,477	3,956,236	13,284	12,009,265
Value 99	2,449	263,978	2,076,822	6,073	4,696,973

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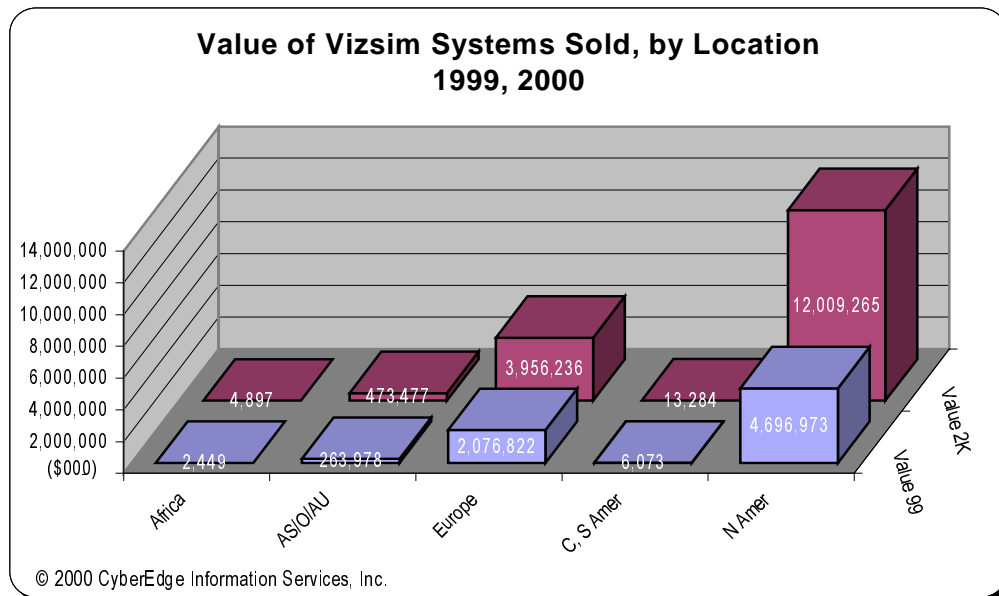
Chart 4: Value of systems sold, by region.

Average system price in 1999 was about $140,000, though there is a large variation between business sectors and geographic regions. Here is a geographic breakdown of the low, average, and highest prices paid for VizSim systems.

Question 5-7: What was the lowest, highest & average price of complete VizSim/VR systems you sold or bought in 1999?

	In what geographic area					
	Africa	AS/O/AU	Europe	SAmer	NAmer	Average
Lowest Price US$ (thousands)	5	6.9	66.63	1.5	34.3	22.86
Responses (Least)	1	10	38	2	50	
Highest Price US$ (thousands)	200	302.91	664.29	44	533.81	349.00
Responses (Highest)	1	11	38	2	52	
Average Price US$ (thousands)	10	74.36	117.66	15.5	90.66	61.63
Responses (Average)	1	11	35	2	50	

Table 2: System prices by location.

DEMOGRAPHIC SUMMARY

Among our key demographics findings is that the number of people who identify themselves as strictly end users is large – more than 2,700 worldwide. This figure, nearly half of the total universe, shows that VizSim is finally moving out of the laboratories and into office, factories, hospitals and schools, where it contributes not curiosity value, but a solid return on investment.

We identified 5,534 people as being active in the VizSim industry. This number is lower than last year, but we believe that the difference is statistical, not actual, and that the much larger sample in this year's study makes our latest figures more accurate. Those people include systems integrators, component manufacturers, software publishers, and end users. Here is how the total population breaks down geographically. Note that multiple answers were allowed to this question, so the total varies from our stated total population.

Question 1: Is your company primarily a seller or user of visual simulation (VizSim) or virtual reality (VR) systems, components, or software? (Entire Universe)

	Total	Africa	AS/O/UA	Europe	C/SAmer	NAmer
System Integrator	1,298	24	147	514	24	588
Component Mfg.	661	24	24	171	-	441
Software Pub.	2,057	24	196	784	24	1,028
End User	2,693	-	269	759	73	1,592
Total	6,709	73	637	2,228	122	3,648

Table 3: Population of universe by respondent type.

This chart shows how these groups compare proportionally.

Q1: Respondent Type, 2000

Seller of Complete Systems 19%

Manufacturer of Components 10%

End User 40%

Software Pub/ developer 31%

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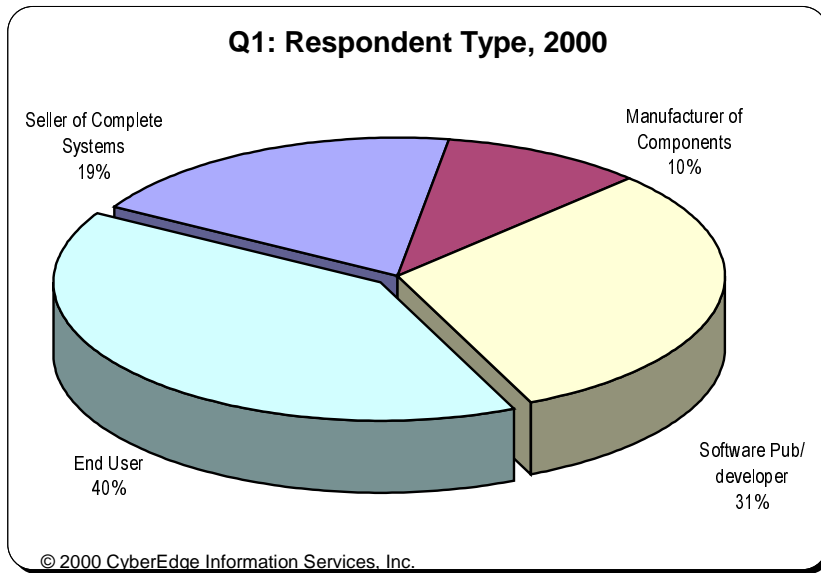
Chart 5: Respondent type ratio.

Our respondents are still mostly in North America, though there are significant numbers of people working in the industry on every continent. Here is a geographical breakdown of involved people.

Q4: Geographic Distribution of VizSim Businesses

North America 59%

Central/South America 2%

Europe 28%

Asia/Australia/ Oceana 11%

Africa 0%

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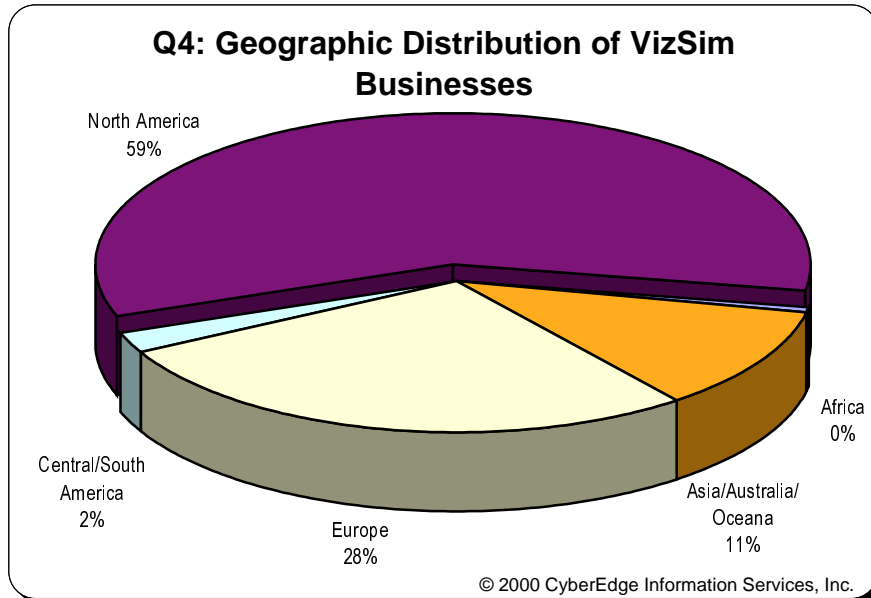
Chart 6: Geographic distribution of respondents.

As the industry matures, the average time our respondents have been in it increases, too. The average time in the business is 5.6 years. This chart shows how the experience of the population is proportioned.

Q2: For How Many Years Have You Been Using or Selling VizSim Systems?

3 to 5 years
31%

5 to 10 years
33%

1 to 2 years
16%

Less than 1 year
7%

More than 10 years
13%

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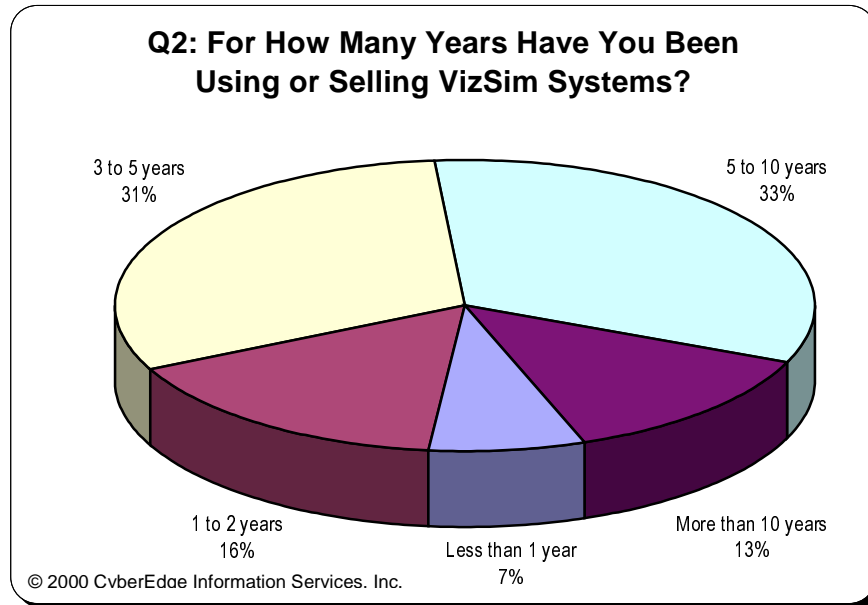
Chart 7: Longevity of Respondents.

We have identified 57 business sectors in which VizSim is used. Our respondents are busy people, characterized by the fact that on average, they serve 7.33 sectors each, up slightly from 1999 at 7.27. When looking at the percentage of people involved, we see that military activities are taking much less of the talent available, which instead is moving into consumer product marketing and other business and manufacturing activities. This is a good sign, for it shows that the technology is showing increased return on investment, critical for uptake in the private sector.

The applications with the most people working in them are shown in this chart, which present the 15 most-cited applications.

Question 14: Please indicate the business sectors for which your company has accepted or delivered VizSim/VR systems in 1999.

	Total 2K	% Tot 2K	Total 99	% Tot 99	% Change	Sector	Rank 2000	Rank 1999
VizSim/VR	78	4.7%	41	4.6%	2.1%	R	1	3
Virtual prototype	66	4.0%	54	6.0%	-5.0%	M	2	1
Postgraduate education (College)	60	3.6%	40	4.4%	-22.25	T	3	4
Design evaluation	59	3.6%	31	3.4%	5.6%	M	4	8
Architecture	58	3.5%	34	3.8%	-8.6%	B	5	6
Museum/Exhibition (non commercial)	54	3.3%				B	6	N/A
Medical training	54	3.3%	30	3.3%	0.0%	T	7	10
Software development	51	3.1%	31	3.4%	-9.7%	C	8	9
Collaborative work	50	3.0%	28	3.1%	-3.3%	M	9	13
Undergraduate education (College)	50	3.0%	32	3.6%	-20.0%	T	10	7
Trade show exhibit	48	2.9%	30	3.3%	-13.8%	B	11	12
Military ops training	46	2.8%	45	5.0%	-79.0%	T	12	2
Consumer products marketing	44	2.7%	19	2.1%	22.2%	B	13	22
Military	44	2.7%	38	4.2%	-55.6%	R	14	5
Game/LBE development	43	2.6%	25	2.8%	-7.7%	E	15	15

Table 4: Top 15 applications of VizSim ranked, 1999 and 2000.

Sector codes: R = Research, M = Manufacturing, T = Education/Training, B = Business Services, E = Entertainment.

The following chart compares the metacategories of business sectors for 1999 and 2000 involvement. We see that Business Services and Entertainment have increased activity, while Computers/Communication and Education and Training have gone down.
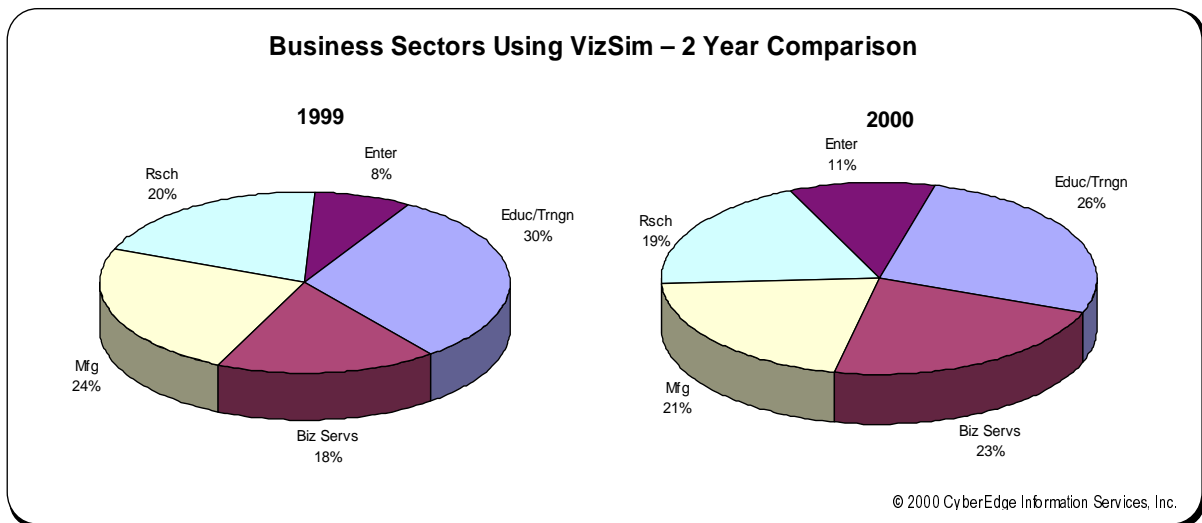
Chart 8: Business category ratios, 1999 and 2000.

Different regions show different emphasis on business sectors. This chart show a breakdown of business sectors cited by location.
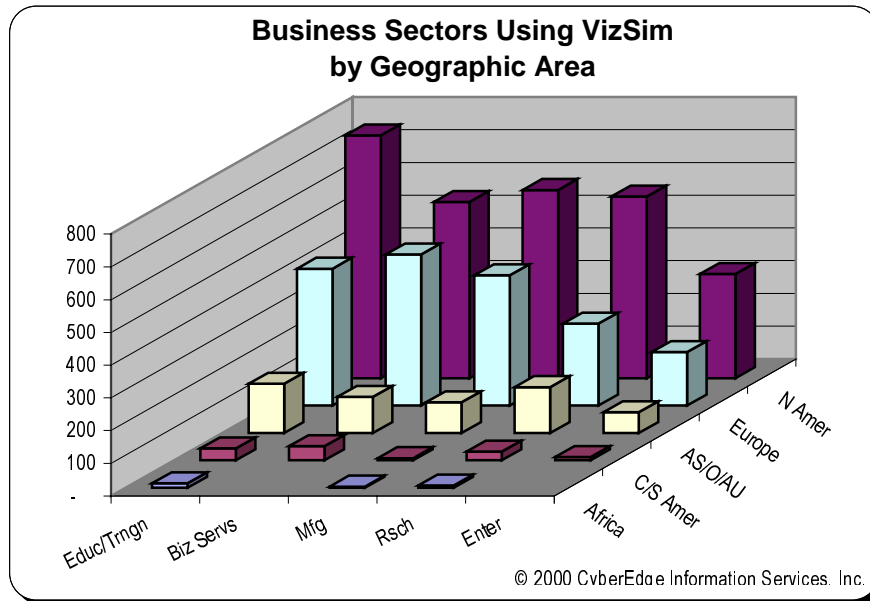
Chart 9: Business sectors cited by location.

What people read provides insights to what they are doing, where their interests lie, and how to best get marketing and other messages to them. Our respondents read a lot, citing more than 200 publications (206 in all) that they read regularly (3 of 4 issues) in relation to their work. Reading patterns vary by region, type of respondent, and business sectors served. Reading patterns have not changed much in the course of this study, though the ratios change from year to year. The next chart illustrates the percentage of respondents reading the top five publications, compared to last year.
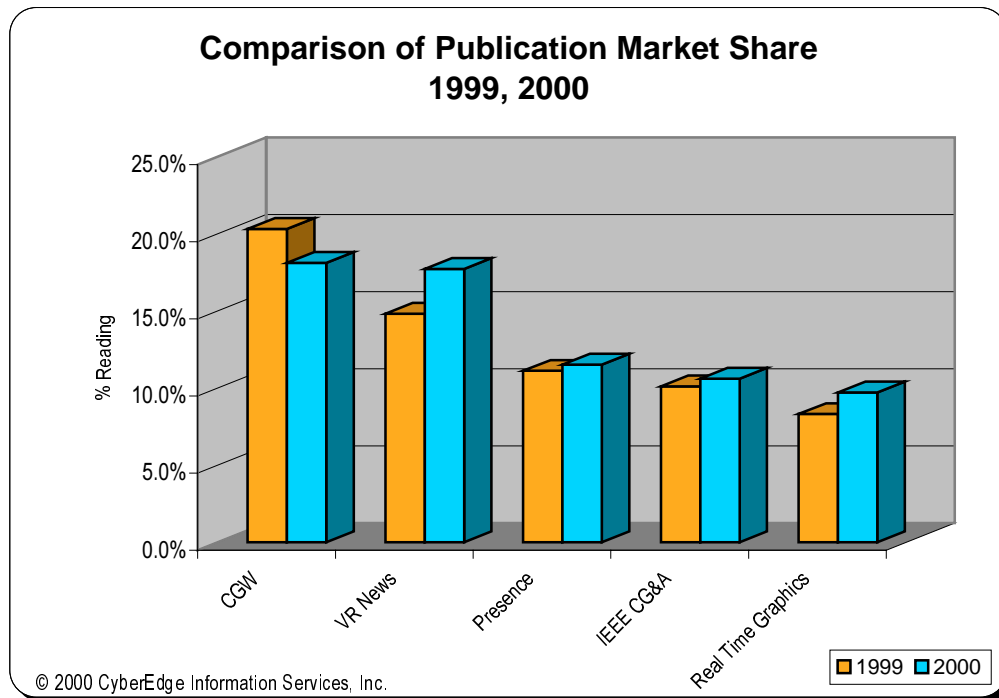
Chart 10: Comparison of Publication Market Share, 1999, 2000.

TECHNOLOGY SUMMARY

There is a very large variety of components used in VizSim systems around the world, appropriate to the applications for which the systems are used. While this precludes there being a truly "average" system, we do provide an overview of the most common components that are used, which make up a "typical" configuration.

Component	Most popular brand
3D Input Device	Generic Mouse
Image Generator	SGI
Display System	Desktop monitor, monoscopic
Head-Mounted Display	Virtual Research
Haptic Feedback Device	SensAble
Large-Screen Display	Generic Desk
Modeling software	3D Studio Max
Operating system	Windows NT
Runtime software	WorldToolKit
Tracking system	Polhemus
Cost	139,860 (US $)

Table 5: Configuration of "typical" VizSim system.

An interesting trend is found when looking at display systems used. Though the ordinary desktop monitor is still the most commonly used display, CAVE-and-Dome-like systems are increasingly being used. The use of these large display systems will increase over 90% in 2000. Here is a breakdown of display systems used in VizSim.

	1998	1999	% Change	2000	% Change
Desktop monitor, monoscopic	2,630	6,063	56.6%	12,292	78.6%
Head-mounted display	1,315	1,437	8.5%	2,529	48.0%
Large screen, such as a wall, desk, or theater	292	581	49.7%	2,284	87.2%
Desktop monitor, stereoscopic	657	867	24.1%	1,977	66.8%
CAVE or Dome	146	552	73.5%	1,976	92.6%
	5,040	9,499	46.9%	21,058	76.1%

Table 6: Trend in display system usage in VizSim, 1998-2000.

In the area of operating systems (OS's) used in VizSim, MS Windows is maintaining a majority of installations. IRIX is the most common UNIX variety, and Windows NT the most common version of that system.

Q17: On what OS(s) do the VizSim systems you buy or sell run?

- UNIX 43%
- Windows 51%
- Macintosh 4%
- Other 2%

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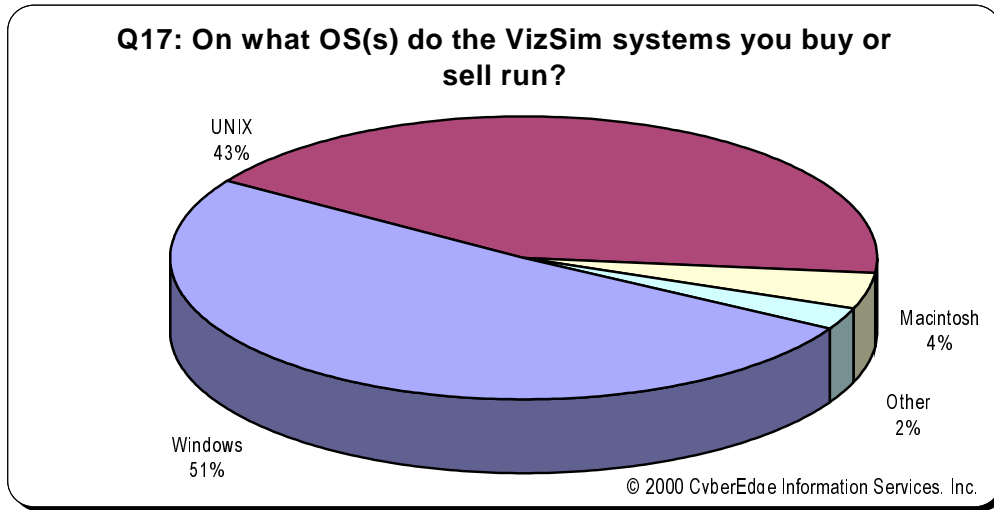
Chart 11: OS Market share.

The Internet has become a fairly popular delivery system for VizSim content, but primarily for lower-cost systems. This chart shows which delivery systems are used in configurations at different price points.

Delivery System Employed in VizSim Systems of Various Prices

Legend: CD-ROM/HD, Internet/Public network, Hybrid, LAN/WAN, Public Presentation, Other

X-axis: < $10K, $10-24.9K, $25-49.9K, $50-99.9K, $100-249.9K, $250-499.9K, $500K +

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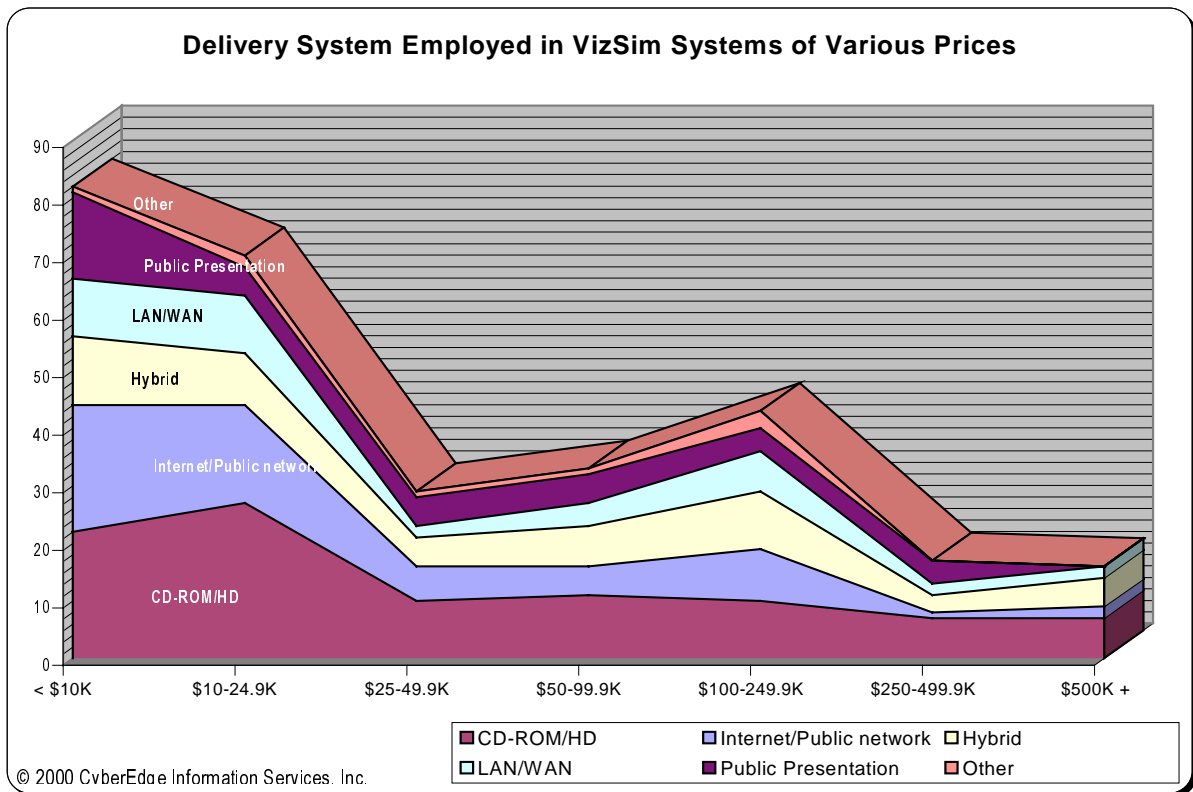
Chart 12: Delivery methods employed in VizSim systems of various prices.

Perhaps the biggest issue we address in our look at technology is the satisfaction of users of systems and components. As we continue to look at this, we find that while overall satisfaction has inched up a bit over 5% since last year, all components and complete systems still garner only a "C" grade. This is not good enough, and we hope that the information provided here will help vendors improve their products.

We look at these items in our satisfaction ratings:

- Hardware by company
- Software by company
- Service by company
- VizSim systems in general
- 3D input devices
- Haptic feedback systems

- Head-mounted displays
- Image generators
- Large-screen displays
- Modeling software
- Runtime software
- Tracking systems

This chart summarizes the satisfaction ratings for Hardware, Software, Service, VizSim systems in general, and the eight components we look at individually.

	Rating	Index	98 Rating	% Chg	98 Index % Chg
3D Input Devices	3.82	114.7	3.7	3.2	3.1%
Runtime Software	3.56	106.9	3.6	-1.1	-1.1%
Modeling Software	3.47	104.2	3.3	5.1	4.9%
Hardware (Overall)	3.46	103.9	3.5	-1.2	-1.2%
Large-Screen Displays	3.39	101.8	3.4	-0.3	-0.3%
Image Generators	3.35	100.6	3.4	-1.5	-1.5%
Tracking systems	3.25	97.6	3.3	-0.7	-1.5%
Haptic Feedback Systems	3.23	97.0	3.3	-1.7	-2.2%
Service (Overall)	3.21	96.4	3.2	0.0	0.3%
Head-Mounted Displays	3.13	94.0	3.5	-10.6	-11.8%
Software (Overall)	3.13	94.0	3.2	-4.3	-2.2%
VizSim Systems	2.95	88.6	2.8	5.6	5.1%
Average	3.33	100.0	3.35	-0.6	-0.6%

Table 7: Components and systems satisfaction ratings, with previous year figures.

We see that like last year, complete VizSim systems are ranked lower than any of their components, though the rating did improve by more than 5%. The whole is less than the sum of its parts, it appears. Only two other items showed improved ratings this year; 3D input devices, and Modeling Software (Service showed a statistically insignificant improvement of .01 points). Of the 12 items rated, 8 showed lower ratings, two were up significantly, and two were essentially unchanged. The overall rating is down about half a point.

We provides suggestions for dealing with these issues in the *Recommendations* Section.

RECOMMENDATIONS SUMMARY

Our recommendations for investors, Vendors and end-users are all similar: focus on the growth areas, and use the Opportunity Index™ information to ensure that you understand where problems may arise in systems and components.

We have identified a number of application areas where the use of VizSim is growing. These include:

- Architecture
- Collaborative work
- Consumer Product Marketing
- Design Evaluation
- Entertainment
- Medical Training
- Military Operations Training
- Museums and Exhibitions
- Trade Show exhibits
- Virtual prototyping

All of the application areas listed above are using VizSim to advance their business goals. This shows the increasing maturity of the industry, and also implies that systems must be as good as other business equipment. They are not now that good, and vendors who find ways to increase reliability, reduce complexity and cost, and deliver usable systems "out of the box" will certainly be successful.

We believe that the VizSim industry presents a good climate for investment. Annual growth exceed 50%, and the industry is currently valued at more than $20 billion worldwide. We suggest that investors practice due diligence, and be aware of the industries that are using VizSim to greatest advantage, such as energy exploration, medical training, and virtual prototyping.

A quick perusal of the Opportunity Index™ section shows that reliability is the single biggest issue, and opportunity, in the industry. In most of the component ratings, "Seldom breaks or malfunctions" got very low ratings. Prices are widely perceived as too high, and this also presents an opportunity. The vendors who increase reliability and robustness while reducing cost will be able to promote those facts to a willing audience.

IN CONCLUSION

We are eager to continue this study next year, and hope to see improvements in many areas. We are certain that the growth in the industry will continue, and that the return on investment for VizSim users will improve as system costs go down and reliability goes up.

VizSim has grown up. It is no longer a laboratory curiosity, or TV freak show. It is a useful and available technology, adding value in almost every application. The data here indicates a healthy industry with vast potential. We will return annually to tell you how that potential is being realized.

The objectives of this study are straightforward. They are:

1. Identify significant markets and trends in VizSim/VR sales.

2. Provide reliable estimates of the size (in dollars and units) and growth of the market.

3. Provide as much understanding of market conditions and needs as possible.

4. Identify significant opportunities or barriers to success in this market.

We used generally recognized techniques for obtaining the information needed to answer these questions.

PRIMARY RESEARCH

This study continues research started in 1997, and we view it as one continuing piece of work, the product of which is an annual report on the VizSim/VR marketplace. This is the third such report. It is based on primary research conducted by CyberEdge Information Services, Inc. in late 1999.

For this study, we contacted more than 8,000 individuals identified as having experience and interest in Visual Simulation and Virtual Reality. These people were chosen from lists of publication subscribers, VizSim/virtual reality conference attendees, visitors to our web site, inquiries received in our office, and a variety of other sources. The majority came from our company database. Each member of the survey group was sent an email message advising them that they were going to receive a questionnaire, and offering them the opportunity to opt out. A week later, we emailed questionnaires to each of them.

This is not a true random selection, because such a selection would have little bearing on the information sought, due to the relatively small number of companies buying and selling VizSim products and services in the general population. From the consistency of answers, and their correspondence with the most credible secondary data, we believe that our sample is representative and reliable.

Each respondent was asked to answer 47 questions regarding the size and direction of the VizSim/VR marketplace, and the components of systems they sold, bought, or used. Their answers were tabulated and used to provide both actual numbers and extrapolations. Please see *Appendix B (*page **Error! Bookmark not defined.**) for a sample of the survey instrument.

We received 452 usable surveys, of which 226 stated that they were not involved in the VizSim/VR marketplace per our definition. The information contained in this report is based on the remaining 226 questionnaires. We received responses from six continents, providing a truly worldwide picture of the marketplace.

From the raw data, we used standard statistical methods to arrive at estimates for data not available directly. Several crosschecks provide verification of the consistency of the data and resulting estimates. This survey has a margin of error of ±5.9% at a 95% confidence level. That means that we are 95% sure that our information is accurate to within ±5.9%.

Many of the questions invited our respondents to provide multiple answers. For that reason, some tables, such as that for *Publications*, and *Components Included in Systems*, show more responses then the number of people answering the survey. In some cases, we have normalized these answers to provide a statistical equivalent of one answer per person. In other cases, we show the raw data. In either case, we often then project to the entire universe. We explain which methods are used in notes to the tables.

STUDY STATISTICS

This survey was conducted entirely by email. We compiled a list of 8,030 people who we had reason to believe were involved with VizSim in some manner. The following chart provides details of the response to our mailing.

Survey Statistics

			% change from 1999	
Questionnaires emailed	8,030	100.0%	134.6%	
Undeliverable/bounced	2,974	37.0%	422.4%	
Deliverable	5,056	63.0%	96.1%	
Opted Out	528	10.4%	369.2%	
Usable Sample	4,528	89.6%	88.5%	
Completed Questionnaires	453	10.0%	255.9%	
Completed Questionnaires	452	100.0%	255.4%	(one duplicate removed)
Not Involved	226	50.0%	426.4%	
Involved	226	50.0%	182.3%	
Completed Questionnaires	452	8.2%	255.4%	
Involved	226	4.1%	182.3%	
Estimated Universe	5,534	100.0%	61.1%	

Table 8: Survey statistics.

CyberEdge Information Services, Inc. (CEIS) is one of the world's leading providers of VizSim/VR research and marketing services, training, news, and information. In the past three years, CEIS has completed ten research projects exploring the business and technology of visual simulation, tracking systems, and related areas. Our on-line publication, *CyberEdge Electric!* has been visited by more than 80,000 business, research, and technical people from more than 70 countries.

From 1991 until 1997, CEIS published *CyberEdge Journal,* the most trusted VR publication in the world. Its 35 issues covered all the significant products, people and activities in the virtual reality community, and were read in nearly 50 countries. In April 1997, CEIS, in cooperation with Aligned Management Associates, produced *Virtual Reality Universe '97,* the acclaimed business and technology conference attended by over 1,000 people.

The CEIS Solutions Group was established in 1996 in response to a number of requests for consulting assistance. It is under the leadership of CEIS President and Founder, Ben Delaney, an internationally respected authority on VizSim, the impact of technology on society, and related fields. It provides marketing, market research, training, VizSim development projects, and consultation.

The Solutions Group is comprised of a highly skilled group of international experts in Marketing, Research, Training and Education, VRML, VR, JAVA, the Internet, Systems Architecture, and the marketing, financing, and impact of those technologies. They contribute to various projects as requirements warrant.

The Solutions Group's provides consulting services to a growing number of Fortune 500 and other companies around the world. These clients are involved in VizSim, cultural preservation, consulting, training, conference production, and publishing. A few of CEIS's clients are:

- Ascension Technology Corporation
- Aligned Management
- CAE Electronic
- Computer Graphics Systems Development Corp. (CGSD)
- EDS Europe
- IEEE Publishing
- InterSense Corporation
- InWorld VR
- Jon Peddie Associates
- LTI
- KMPG
- Occupational Health Network
- Retinal Displays Inc
- SGI
- Siemens
- Systems Engineering Research Institute
- UB Networks
- Virtual Technologies, Inc

Mr. Delaney's comments on technology have been quoted in the *International Herald Tribune, The Wall Street Journal, Popular Science, Business Week*, and many other publications. He has been seen on the PBS science series, *Newton's Apple*, and on the Discovery Channel's *Next Step*. He has addressed academic and corporate audiences in more than a dozen countries, discussing the importance and impact of VR and interactive media technology. He is also a regular contributor to *IEEE Computer Graphics and Applications*, and *Real Time Graphics*, covering virtual reality applications, software and hardware, book releases, and critical commentaries on the industry.

Prior to entering the VR industry, Mr. Delaney's experience included many years of marketing, market research, and computer systems design and implementation. He has served as Direct Marketing Manager for *PC WORLD* magazine, President of ProMarketing, and Director of Marketing for Dahlgren Control Systems.

For more information on the CEIS Solutions Group and Mr. Delaney please visit our award-winning web site, *CyberEdge Electric!* – http://www.cyberedge.com.