DOCUMENT RESUME

ED 350 766 EC 301 573

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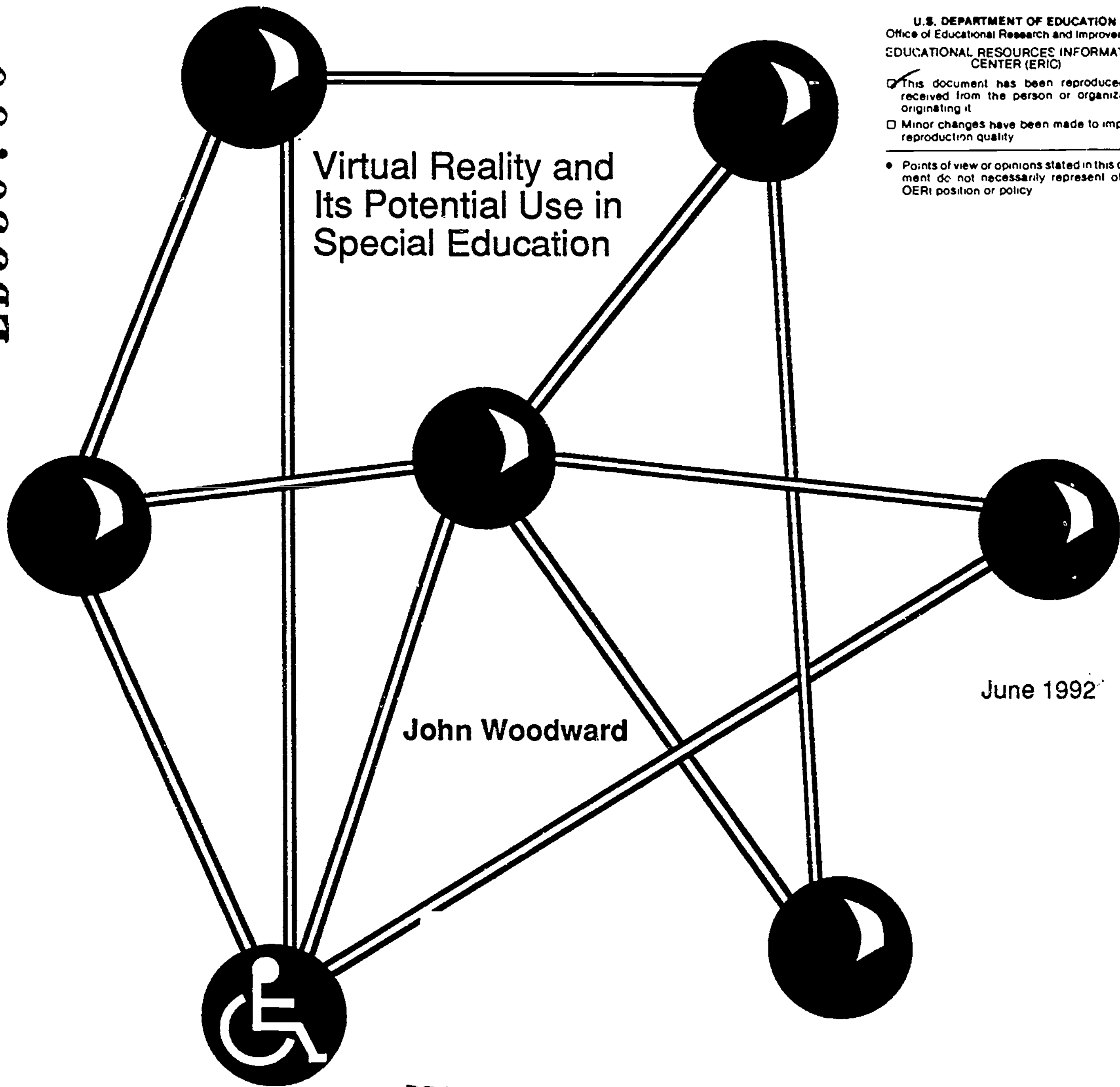
TITLE	Virtual Reality and Its Potential Use in Special Education. Identifying Emerging Issues and Trends in Technology for Special Education.
INSTITUTION	COSMOS Corp., Washington, DC.
SPONS AGENCY	Special Education Programs (ED/OSERS), Washington, DC.
PUB DATE	Jun 92
CONTRACT	HS90008001
NOTE	15p.; For related documents, see EC 301 540, EC 301 567-574.
PUB TYPE	Viewpoints (Opinion/Position Papers, Essays, etc.) (120) -- Information Analyses (070)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Accessibility (for Disabled); Computer Assisted Instruction; *Disabilities; Educational Media; *Educational Technology; Elementary Secondary Education; Instructional Effectiveness; *Interactive Video; *Research and Development; Research Needs; *Special Education; *Technological Advancement; Technology Transfer; Theory Practice Relationship; Trend Analysis
IDENTIFIERS	*Virtual Reality

ABSTRACT

As part of a 3-year study to identify emerging issues and trends in technology for special education, this paper addresses the possible contributions of virtual reality technology to educational services for students with disabilities. An example of the use of virtual reality in medical imaging introduces the paper and leads to a brief review of the history of interactive computing and the development of virtual reality as a special discipline out of stereoscopy and computer science. The toy industry is expected to downsize existing systems for the home market and exploit the commercial potential of virtual reality. Possible applications for instruction of persons with disabilities are discussed in light of both the intuitive appeal of the technology and mixed findings on the effectiveness of simulations as educational interventions and the lack of special education students as subjects in such research. The importance of ensuring equitable access to advanced technologies for students with disabilities is stressed. (Contains 18 references.) (DB)

Identifying Emerging Issues and Trends in Technology for Special Education



Virtual Reality and Its Potential Use in Special Education

June 1992

John Woodward

Prepared by COSMOS Corporation for:
U.S. Department of Education
Office of Special Education Programs
under Contract No. HS90008001

PREFACE

COSMOS Corporation is conducting a study of the issues and trends affecting the role technology will have in the 21st century for individuals with disabilities. This three-year study is funded by the U.S. Department of Education, Office of Special Education Programs (OSEP), under Contract No. HS90008001.

COSMOS Corporation was founded in 1980, and is located in Washington, D.C. Since its inception, the firm has conducted a wide range of applied social science projects for public and private organizations and foundations. COSMOS's specialties include: conduct of case studies; identification and validation of exemplary practices; evaluation of education, job training, and human services programs; provision of technical assistance to state and community agencies; and strategic planning for public agencies and public firms.

Project participants include expert panels, project fellows, an advisory board, a consortia of practitioners, and project staff. These experts in the fields of technology and special education have come together to examine the issues and trends in these two fields, and how they impact the use of technology for special education in the 21st century. Three expert panels have started examining these issues: one with a focus on technology outside the field of education, one on special education instruction, and one on evolving service delivery systems in special education. Over the three year period their research will be synthesized and become the basis for predictions about the future.

This document is one of the papers commissioned in the first year. The purpose of the paper is to present information on one or more issues as part of the expert panel discussions. It is being shared with people inside and outside of the project to stimulate discussion on the impact of technology in the early 21st century. Readers are welcome to comment on these findings and contact COSMOS Corporation for further information.

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"A HUMAN BEING SEES 155 DEGREES VERTICALLY AND 185 DEGREES HORIZONTALLY: A MOVIE SCREEN FILLS ONLY A SMALL PORTION OF THE NORMAL HUMAN FIELD OF VIEW."

Rheingold, 1991

Virtual reality seems like the stuff of science fiction. For the novitiate, it is eerie, disorienting, and somewhat unbelievable. Yet prototypic systems for commercial use are now well under way in many countries around the world. American researchers already are creating visual simulations or "cyberspaces" where architects and commercial real estate developers, for example, can stroll through buildings before they are even constructed. Others are "docking molecules" in an artificial reality that replicates the measures chemists use to describe molecular behavior--bonding, the attraction and repulsion of neighboring atoms, and the electromagnetic forces. Japanese scientists, often backed by the largest electronic companies in the country, are in the initial phases of developing communication systems for the next century, ones that would include a teleconferencing environment where individuals could have a virtual presence in meetings even though they could be physically anywhere in the world. And naturally, video game developers all over the planet are devising ways to apply virtual reality technology to games that enable players to see, touch, and shoot lifelike objects in their living rooms.

While some of these activities may seem utterly fantastic (or trivial), Rheingold's (1991) description of the coordinated effort at the University of North Carolina to build medical imaging tools is a compelling look at virtual reality's potential to save human life.

> When I passed through the computer graphics laboratory again, after the HMD [head mount display] demos, I saw a fleeting image on a screen on the other side of the room that looked like something from a slasher movie, like somebody had peeled the flesh off a quadrant of a human skull. I moved closer for a look. Marc Levoy was demonstrating the medical imaging technique known as "volumetric rendering." A closer examination of

> the color image on the display screen revealed the different layers of soft and hard tissues in the skull, portrayed in different degrees of transparency. Levoy tapped a command on the keyboard, and layers of cartilage or bony casings appeared or disappeared, grew opaque or transparent. The focus of effort here was not displaying full 3-D, but in solving the "visualization" problem inherent in trying to look through one kind of material at another kind of material: what colors, shadow textures, levels of transparency work best at rendering anatomical structures visible? (p. 31).

With 3D medical imaging, virtual reality does more than stimulate the imagination. It renders an a much more detailed picture of the body, showing doctors where they might make incisions or insert probes. By accentuating our vision, virtual reality augments what some believe are uniquely human abilities--to recognize patterns and make evaluations. Frederick Brooks (in Rheingold, 1991), for example, sees technologies like virtual reality as the next step beyond artificial intelligence. Rather than replacing or simulating intelligence, virtual reality amplifies it.

Virtual reality has evolved from two key areas of research and development: early attempts to extend the look and feel of movies, which reached its most popular expression in Cinerama, and significant developments over the last two decades in computer interfaces. Advanced efforts at special effects in movies were hampered by a lack of investment capital and the weak effects of the early technologies (e.g., 3D glasses for sci-fi films). Stereo cameras working in conjunction with head mounted devices which rendered a greater sense of interaction also had a brief research life in the late 1950's (Fisher and Tazelaar, 1990).

Developments in the computer arena have been much more profound, particularly when one considers how much of an impact the virtual reality perspective has had to date. When various prototypic interface components (e.g., mice, windows, desktop metaphors) were finally combined at Xerox PARC in the early 1970's into one working system, the notion of exploring or feeling our way around a computer achieved a certain level of reality. Within ten years of the Altair--computer for the masses advertised in popular science magazines which used switches for input devices and a row of lights for output--the Macintosh was a commercial product. Although we now take this kind of computer system for granted, the Macintosh interface allowed a wide range of users to navigate through a complex system somewhat intuitively. Taking today's graphic user interface to its logical next step, Rheingold (1991) observes, "The creation of the tools for interacting with computer graphics was also the beginning of the journey toward three-dimensional graphics and reality engines. If the ten-year rule of thumb holds true, personal computer enthusiasts by the millions a decade from now will be interacting directly with virtual worlds through their desktop reality engines" (p. 87).

Over the last decade and a half, virtual reality as a special discipline has emerged from stereoscopy and computer science. Current systems augment vision through various head mounting devices and goggles. Our auditory systems can be coupled to these devices, creating an increased sense of perspective. Finally, our tactile systems are extended through data gloves and body suits. New interfaces are likely to appear in the future which will further decrease the distance between the user and the simulated reality "out there." Eye tracking devices and "media rooms" (which are responsive to the humans who use them) are but a few of the alternative virtual reality interfaces.

The Commercial Potential of Virtual Reality

The projected potential for virtual reality systems within this decade has been estimated to be approximately $500 million. To a large extent, this will be driven by the toy industry, which will down-size existing systems for the home market. "The sheer size, financial clout, and economics of scale that the toy industry brings to the VR [virtual reality] game are a wild card in the future evolution of the VR industry. If the glove improves in accuracy and drops in price, if toy versions of full-body input suits become available in conjunction with toy 3D glasses, then the huge potential revenues could drive further research and development" (Rheingold, 1991, p. 164). Thus, the economies of scale brought about by this industry could lead to powerful, cost effective 3D chips for the virtual reality home or school systems of the future.

Even the prices of today's low-end virtual reality systems are approaching the affordable range for educational research and development. Using Intel's newest i860 chip on special video boards, an Amiga 500 computer, and an inexpensive data glove or trackball could bring the cost of a system down below $20,000. If one extrapolates from the pricing patterns of past technologies (e.g., CDs, personal computers, videodiscs), home systems could cost $500 or less by the end of the decade.

Further costs associated with applications outside of the engineering and scientific world will decline due to the growing libraries of images, scenes, and environments. Reworking this information into new formats will probably be less expensive than the costs incurred in designing instructional programs which accompany virtual reality systems. In other words, it is one thing to present a richly textured world for immersion and exploration, it is entirely another matter for educators to properly structure this kind of a setting for profitable learning. The issue of instructional design for virtual reality systems will be discussed further in the next section.

<u>Applications for the Handicapped</u>

The use of virtual reality systems for special education would seem to be limitless given the persistent need to augment or increase learning activities for handicapped individuals. The technology is seductive as a platform for idyllic visions what life could be like for handicapped persons in the future. However, the extent to which virtual reality can improve learning, for example, will depend on a number of factors; particularly the degree to which such systems are grounded in empirically supported methods of instruction. It is therefore essential to view current arguments for the virtual reality in light of past attempts in education to make learning more interactive and intuitive. Research into computer rich learning environments (and pre-computer era simulation games) is instructive on this point.

For example, sophisticated computer programs such as simulations, microworlds, and LOGO have long purported to be stimulating alternatives to routine instructional activities (Clements, 1990; Feurzeig, Horwitz, and Nickerson, 1981; Roberts, 1984). Simulations, for example, provide complex environments for problem solving. Ostensibly they demand a kind of higher order thinking that is non-algorithmic (i.e., paths or alternate means of working problems are not fully specified in advance), and multiple solutions are often acceptable. Simulations are one way for students to integrate knowledge through active learning, a concept that is often attributed to Dewey's (1928) theory of education. By allowing the application of declarative knowledge in an expanded number of contexts, simulations mitigate the tendency for facts and concepts to become stipulated or "inert" (Bransford, Sherwood, Vye, and Rieser, 1986). The benefits of this kind of higher order thinking for intellectual development are a consistent theme of the microcomputer revolution (Budoff, Thormann, and Gras, 1984; Ellis and Sabornie, 1986; Margalit, Weisel, and Shulman, 1987; Papert, 1980; Woodward, and Carnine, 1988).

Unfortunately, the research on simulations as educational interventions has been mixed, with relatively few studies conducted with special education students (Woodward, Carnine, and Gersten, 1988). Non-computer based simulations frequently have been no more effective than traditional methods. Furthermore, many students do not see the "big picture" in such experiences and instead, learn only a small part of what is simulated (e.g., a student learns a great deal about peasant life during the French Revolution by assuming the role of a peasant, but learns very little about the French Revolution itself).

The instructional hazards of simulations are just as likely to be true for virtual reality environments or microworlds (e.g., a science "lab" on magnets, an historical microworld of the Great Depression).

Early simulation researchers (e.g. Fletcher, 1971; Bell, 1975; Orbach, 1977) recognized that unless simulations (or the surrounding instructional conditions) do a better job of directing the learner toward explicit, measurable outcomes--it is likely that the value of simulations as educational techniques will remain modest. Many students, particularly those in the mildly handicapped category, will probably not attend to the critical features of simulations when they are left to infer appropriate game strategies and hence, they will fail to understand the underlying model upon which the game or environment is based.

This is potentially true of highly appealing virtual reality systems. One of the early developers of these systems, Frederick Brooks, has expressed such concerns--"although the educational value of simulation is very high, because it is 'learning by doing,' many phenomena require firsthand experience in order to know the difference between theory and practice. He [Brooks] is also concerned that as VR [virtual reality] systems grow more realistic, their potential for being dangerously misleading also increases. No model can ever be as complex as the phenomena it models, ..." (Rheingold, 1991, p. 44).

Other computer scientists express comparable reservations about the reputed benefits of "sensing behind" two dimensional representations of objects. James Foley (1987), writing in a special issue of Scientific American on advancements in computing, questions how much reality we need to understand something.

> Instinctively it would seem that a system inviting user interaction and presenting information in accessible formats would be much faster, more instructive and easier to learn than conventional interfaces. This kind of hunch is difficult to quantify. Would a materials engineer understand a stress analysis better if he could apply the stress with his own hand? Will molecular interactions become more obvious if their forces can literally be felt? And how "real" do artificial realities need to be to accomplish their purpose? (p. 135).

These caveats are not meant to undercut virtual reality's potential value for education. If anything, they remind us of Hanley's (1984) concern that special educators look beyond their infatuation with the technology per se to rigorous evaluations of technology's effectiveness as a learning tool. It may be, for example, that virtual reality is best suited to only a limited set of knowledge representations (e.g., 3D graphs of data, representations of mechanical objects) and shows only marginally improved effects when used in microworlds. However, as with computer simulations, programming languages, and microworlds, these issues are best answered through experimental research rather than conjecture. Clearly, this is an important role for federal funding.

Perhaps the most intuitively appealing applications of virtual reality is with the severely retarded or physically impaired. Uses of data or body gloves have the potential to be extraordinary devices for biofeedback training and instruction. These virtual reality systems not only could enhance an individual's understanding of how something operates or is assembled (e.g., common tasks in sheltered workshops), but learning how to operate something as well. For those afflicted with cerebral palsy, body gloves could be coupled with elaborate training and feedback systems to refine body movement and control. Virtual reality systems may also play an important role in refining images for the visually impaired.

Concluding Remarks

The striking rate of advancement in virtual reality research and development make it likely that broadly available systems will appear within the next five to ten years. As previously stated, low cost systems are already available for the special education researcher (although the technical expertise for assembling, operating, or integrating them may not be). The lingering question is much less one of quality or cost of the technology, but if and when it will appear in what we now conceptualize as public education.

Rheingold's (1991) book, Virtual Reality, generally presents a comprehensive picture of R and D efforts and future applications of the technology. Noticeably absent, however, is any mention of its use in conventional education. As with other technologies today, will the best systems for mass distribution appear only in middle class homes for the purposes of entertainment and as educational tools in a few wealthy suburban schools? Will the only use of data gloves, for example, be in specialized rehabilitation settings? The equitable access to advanced technologies, in addition to the incentive structures which will modify these tools for a unique population, are the central issues that special educators need to investigate as they create scenarios for technology use over the next 20 years.

REFERENCES

Bell, D., "Simulation games: Three Research Paradigms," *Simulations and Games*, 1975, 6:271-287.

Bransford, J., Sherwood, R., Vye, N., and Rieser, J., "Teaching Thinking and Problem Solving," *American Psychologist*, 1986, 41:(10) 1078-1089.

Budoff, M., Thormann, J., and Gras, A., "Microcomputers in Special Education: An Introduction to Instructional Applications," (Revised Edition), Brookline Books, Inc., Cambridge, Massachusetts, 1985.

Clements, D.H., "Metacomponential Development in a Logo Programming Environment," *Journal of Educational Psychology*, 1990, 82:(1)141-149.

Dewey, J., "Democracy and Education," MacMillan, New York, 1928.

Ellis, E., and Sabornie, E., "Effective Instruction With Microcomputers: Promises, Practices, and Preliminary Findings," *Focus on Exceptional Children*, 1986, 19:(4)1-16.

Feurzeig, W., Horwitz, P., and Nickerson, R., "Microcomputers in Education, (Report No. 4798)," Bolt, Beranek, and Newman, Cambridge, Massachusetts, 1981.

Fisher, S.S., and Tazelaar, J.M., "Living in a Virtual World," *Byte*, July, 1990.

Fletcher, J., "The Effectiveness of Simulation Games as Learning Environments," *Simulation and Games*, 1971, 2:425-554.

Foley, J.D., "Interfaces for Advanced Computing," *Scientific American*, 1987, 257:(4)126-135.

Hanley, T., "CAI in Special Education: Research Directions, Peabody Journal of Education," 1984, 62:(1)22-39.

Margalit, M., Weisel, A., and Shulman, S., "The Facilitation of Information Processing in Learning Disabled Children Using Computer Games," *Educational Psychology*, 1987, 7:(1)47-54.

Orbach, E., "Some Theoretical Considerations in the Evaluation of Instructional Simulation Games," *Simulation and Games*, 1977, 8: 341-360.

Papert, S., "Mindstorms," Basic Books, New York, 1980.

Rheingold, H., "Virtual Reality," Summit Books, New York, 1991.

Roberts, F., "An Overview of Intelligent CAI Systems," *Peabody Journal of Education*, 1984, 62:(1)40-52.

Woodward, J., and Carnine, D., "Antecedent Knowledge and Intelligent Computer Assisted Instruction," *Journal of Learning Disabilities*, 1988, 21(3):131-39.

Woodward, J., Carnine, D., and Gersten, R., "Teaching Problem Solving Through Computer Simulations," *American Educational Research Journal*, 1988, 25:(1)72-86.

PAPERS AVAILABLE FROM COSMOS

The papers commissioned by the project are available upon request include:

"Technology and Interactive Multimedia" by Ray Ashton;

"VLSI Technology: Impact and Promise" by Magdy Bayoumi;

"Conceptual Framework: Special Education Technology" by Richard Howell;

"Demographic Characteristics of the United States Population: Current Data and Future Trends" by Beth Mineo;

"School Reform and Its Implications for Technology Use in the Future" by John Woodward;

"Textbooks, Technology, and the Public School Curricula" by John Woodward;

"Workforce 2000 and the Mildly Handicapped" by John Woodward;

"Virtual Reality and Its Potential Use in Special Education" by John Woodward; and

"Annotated Bibliography: Training, Education Policy, Systems Change, and Instruction" by Lewis Polsgrove.

Copies of these reports are available upon request.