

# 1

## The Vision of Virtual Reality

Frank Biocca

Taeyong Kim

*University of North Carolina at Chapel Hill*

Mark R. Levy

*University of Maryland*

When anything new comes along, everyone, like a child discovering the world, thinks that they've invented it, but you scratch a little and you find a caveman scratching on a wall is creating virtual reality in a sense. What is new here is that more sophisticated instruments give you the power to do it more easily. Virtual reality is dreams.

— Morton Heilig<sup>1</sup>

The year is 1941. Engineers and industrialists are introducing a new medium to the country. Few can predict the significant influence of this new "gadget" with the odd name, tele-vision—vision at a distance. It is not just a novelty in a research lab or an amusement at a World's Fair. Although a technological reality, it is not yet a psychological and cultural reality. In the early 1940's there are less than 5,000 sets in the United States. But soon, the light from the TV screen will flicker in every home and mind in the country.

Change the channel. The year is 1988.<sup>2</sup> Engineers and industrialists are

---

<sup>1</sup>Quoted in Hamit (1993, p. 57).

<sup>2</sup>Unlike television, dating the "public introduction" of virtual reality is more than a bit difficult. The full-scale introduction of television required legislation allocating parts of the electromagnetic spectrum to broadcasters. Historians date public introduction of TV as the emergence of the first permanent broadcasts using those frequencies. VR, on the other hand, is a heterogeneous cluster of simulator technologies that has been slowly diffusing for decades. There is, strictly speaking, no starting point, and, as this chapter suggests, VR is part of the grand evolution of media technology toward the reproduction of the "essential copy" and the achievement of "physical transcendence." We use the year 1988 because it marks a milestone

introducing another new medium to the country. Like television, virtual reality (VR) is not just a novelty in a research lab or an amusement at a World's Fair. More than 50 years after the introduction of television, VR technology presents us with devices such as the head-mounted display, a television set that wraps itself around our heads both literally and metaphorically.

This book is an attempt to explore the vision of communication in the age of virtual reality. VR dangles in front of our eyes a vision of the media's future, changes in the ways we communicate, and the way we think about communication. The medium that tantalizes us so has gone by a number of names: computer simulation, artificial reality, virtual environments, augmented reality, cyberspace, and so on. More terms are likely to be invented as the technology's future unfolds. But the enigmatic term *virtual reality* has dominated the discourse. It has defined the technology's future by giving it a goal—the creation of virtual reality. Virtual reality is not a technology; it is a destination. In this book we look toward this destination and collectively ask ourselves a deceptively simple, but profoundly nuanced question: What is communication in the age of virtual reality?

Virtual reality? It is a quirky phrase, but it seems inspired. Attributed to the quodlibetic mind of Jaron Lanier, the phrase united the many voices of its rivals—virtual environments, virtual worlds, virtual space, artificial reality—into a single chant seeming to emanate from a distant future. Not everyone likes it. The scientific community at places like MIT, University of North Carolina, and at military research centers were uncomfortable from the start with this upstart, pop culture term. On the net and in scientific journals like *Presence*, researchers insisted that their work would be better described by terms like *virtual environments* or *simulation*.

But Lanier's VR cyberslogan and its uncertain vision was spread at warp speed by a technophilic press. For TV, magazine, and newspaper journalists virtual reality was a "sexy" term for computer experiences. Many of the smitten reporters were children of the 1960s (e.g., Rheingold, 1991). To these and other observers the more pedantic term, *simulation*, suggested something more akin to silicon implants than a slogan for info-revolution. In article after article the vision of VR was dangled in front of a public entranced by the curious pleasures of interactive technology. In a field that was dominated by military applications, the childlike, dreadlocked Lanier sounded more like a poet or new age prophet than a "computer geek." In a typical early interview in 1989, the pied piper of VR played his song:

Virtual reality will use your body's movements to control whatever body you choose to have in Virtual Reality, which might be human or be something

---

in the general public's awareness of the technology and the beginning of a significant rise in public discourse about the vision of virtual reality (see Figs. 1.1 & 1.2).

different. You might very well be a mountain range or a galaxy or a pebble on the floor. Or a piano . . . I've considered being a piano. . . . You could become a comet in the sky one moment and then gradually unfold into a spider that's bigger than the planet that looks down at all your friends from high above. (Kelly, 1989, p. 34).

This was a very different vision of the computer, something more in tune with science fiction or fantasy play. Some researchers in areas like scientific visualization and flight simulation were uncomfortable with what this vision promised. "We can't really do that," some objected. "Hype!" others protested. But word of the vision of virtual reality ricocheted around the interiors of the public imagination and resonated with some primal desire for a dream machine. Lanier and his supporters in the press provided an outlet for that ancient desire.

The meteoric trajectory of the phrase *virtual reality* is a metaphor for the rise of virtual reality technology as a whole. The first phase of the diffusion of a technology is the knowledge phase (see Valente & Biardini, this volume). Figures 1.1 and 1.2<sup>3</sup> plot the different trajectories of the phrase *virtual reality* and a competing term for the same technology, *simulation*, in newspapers and magazines in the early 1990s. As the graphs reveal, usage of the term *simulation* declined and phrases like *virtual environment* barely registered a blip on the public radar screen. Usage of the phrase *virtual reality* rose rapidly, especially in newspapers where it surpassed usage of the more general term *simulation*.

Along with the term *cyberspace*, the phrase *virtual reality* has come to

<sup>3</sup>Method: The diffusion of the terms *virtual reality* and *simulation* was measured by counting the number of articles that mentioned the term *virtual reality* and/or *simulation* once or more in their titles or in the body of the texts.

The terms were searched in a large sample of articles in 96 newspapers and 173 magazines published in the United States in the period from January 1, 1988 to December 31, 1993. These publications were searched on NEXIS, a popular on-line data service providing full-text articles in newspapers, magazines, journals, and other mass publications.

Only publications that were part of the database for the whole period of 1988–1993 were used. Among the newspapers and magazines available in NEXIS, 96 papers (approximately 58% of the available newspapers) and 173 magazines (55% of the available magazines) turned out to have been present throughout the research period.

The two terms, *virtual reality* and *simulation*, were searched throughout the titles and main texts of the articles of the selected publications in the database. Because the term *simulation* may have been used for other meanings (e.g., children's simulations of adults), only the articles that contain the words "simulation" and "computer" were counted.

First, the number of newspaper articles containing the term *virtual reality* and/or *simulation* were counted for every 6-month period starting January 1, 1988. The same search was again conducted in magazines. Second, the number of newspaper articles that mentioned the term *simulation* with *computer* were counted and the magazine articles were also examined in the same manner. Finally, to measure the overlap between the two searches, the number of newspaper and magazine articles containing both terms, *virtual reality* and *simulation* (with *computer*), were counted.

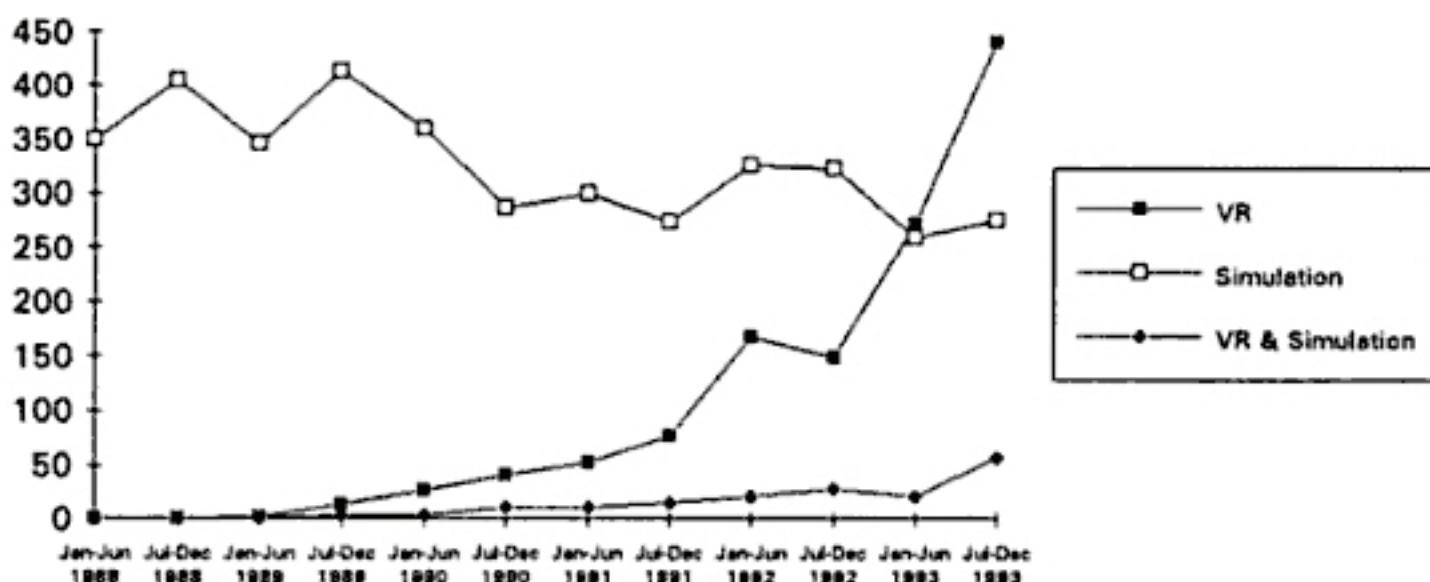


FIG. 1.1. Graph shows the frequency that the terms *virtual reality* and *simulation* were used in 96 daily newspapers from Jan. 1988 to Dec. 1993 (see footnote 3).

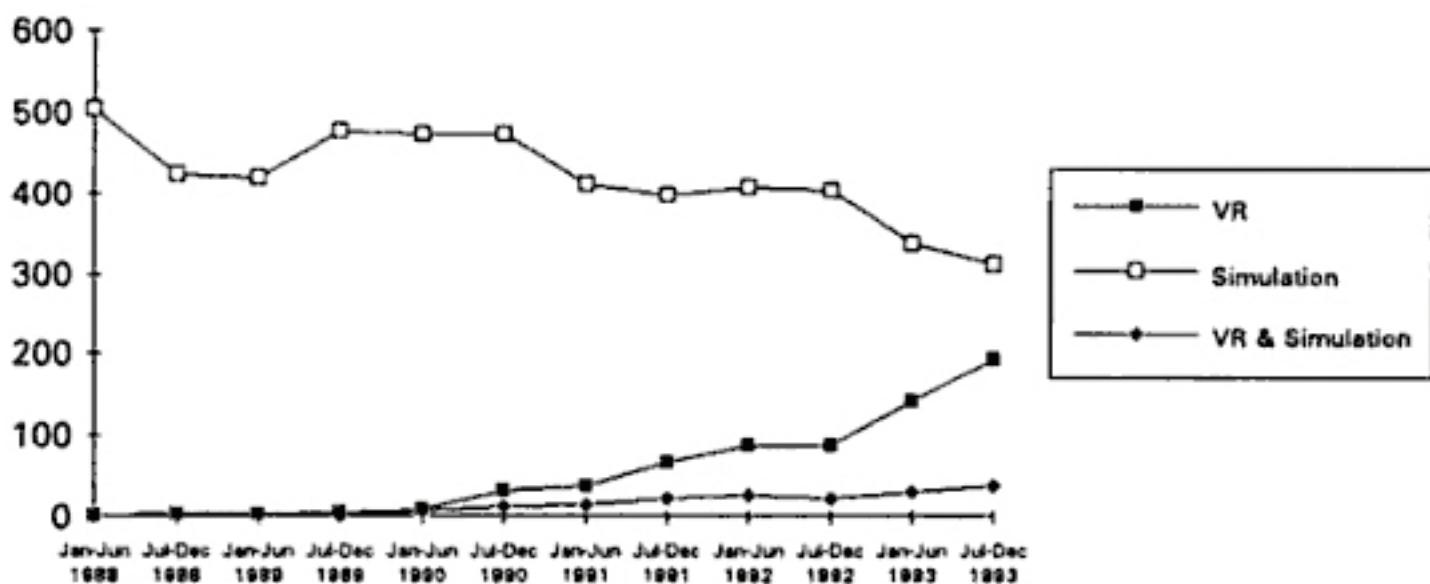


FIG. 1.2. Graph shows the frequency that the terms *virtual reality* and *simulation* were used in 176 news and business magazines from Jan. 1988 to Dec. 1993 (see footnote 1).

symbolize both our enthusiasm and ambivalence about social and cultural transformation through technology. For some, virtual reality is the first step in a grand adventure into the landscape of the imagination. Virtual reality promises a kind of transcendence of the limits of physical reality. Others are more cynical or uncomfortable about the whole idea of virtual reality. They feel the phrase is an oxymoron; it promises the impossible. Like an Escher drawing of impossible staircases, it offers a vivid vision of something that can never be. But reality has never been the concern for some virtual reality enthusiasts; they want a computer-generated world where an Escher staircase can be experienced rather than imagined. As respected VR computer scientist Fred Brooks put it, the technology allows one to experience "worlds that never were and can never be" (Brooks, 1988). If the reader finds that Brooks' words seem vaguely familiar, perhaps you hear the echo of a very ancient promise of *all* media technologies.

## THE 2,000-YEAR SEARCH FOR THE ULTIMATE DISPLAY

Is virtual reality technology the first step toward the ultimate display or the ultimate communication medium? Some of the pioneers of virtual reality have heralded it as the “ultimate form of the interaction between humans and machines” (Krueger, 1991, p. vii) and “the first medium that does not narrow the human spirit” (Jaron Lanier, quoted in Rheingold, 1991, p. 156). Although some of this rhetoric is clearly overblown, VR embodies a number of conceptual breaks with existing media as it tries to reach out to some vision of the ultimate medium.

A powerful and unusual vision of the ultimate medium surely gripped the work of one of the most revered pioneers in computer graphics and VR, Ivan Sutherland (1965): “A display connected to a digital computer gives us a chance to gain familiarity with concepts not realizable in the physical world. It is a looking glass into a mathematical wonderland. . . . There is no reason why the objects displayed by a computer have to follow the ordinary rules of physical reality. . . . The ultimate display would, of course, be a room within which the computer can control the existence of matter” (pp. 506, 508).

At first, the idea of the “ultimate display” seems rather startling. Many see Sutherland’s paper as particularly inspired and novel; it is often quoted. Sutherland was clearly a visionary, but his dream is an ancient one. The dream of the “ultimate display” accompanies the creation of almost every iconic communication medium ever invented. There are two aspects to this dream, and VR shares these with older iconic media like painting, photography, film, and television. The drive powering the creation of many of these media has included (a) the search for the *essential copy* (Bryson, 1983), and (b) the ancient desire for *physical transcendence*, escape from the confines of the physical world. Seeking the *essential copy* is to search for a means to fool the senses—a display that provides a perfect illusory deception. Seeking *physical transcendence* is nothing less than the desire to free the mind from the “prison” of the body.

Almost 2,000 years before Sutherland’s musings about the ultimate display, we can see the stirrings of the search for the essential copy in a story recounted by the Roman naturalist, Pliny. It is an anecdote from ancient Greece, but imagine it, if you will, as a modern competition between two VR programmers to see who can produce the best perceptual illusion:

The contemporaries and rival of Zeuxis were Timanthes, Androcydes, Eupompus, and Parrhasius. This last, it is recorded, entered into a competition with Zeuxis. Zeuxis produced a picture of grapes so dexterously represented that birds began to fly down to eat from the painted vine. Whereupon Parrhasius designed so lifelike a picture of a curtain that Zeuxis,

proud of the verdict of the birds, requested that the curtain should now be drawn back and the picture displayed. When he realized his mistake, with a modesty that did him honour, he yielded up the palm, saying what whereas he had managed to deceive only birds, Parrhasius had deceived an artist. (Pliny, 1938, pp. 64-65)

In later years, painters expressed the desire for the essential copy as a desire for a canvas that would become a magic window or mirror on the virtual world created with brush strokes. This vision of the ultimate "windowed" display finds expression in the world of the painter, architect, and theorist of linear perspective Leone Battista Alberti (1462/1966). He espoused the technology of perspective to produce a painting so perfect that it would dissolve into a window—an ultimate display of the virtual scene.

The search for the ultimate display sometimes involved a celebration of the ability to use the senses for communication. Today, communication through sensory-intensive means like "visualization" is sometimes opposed to communication through more abstract means such as words or numbers (Mitchell, 1986). In the past, this desire for displays that "spoke" to the senses sometimes expressed itself as a critique of other forms of representation like words, narratives, and texts. For example, the painter Francastel was so moved by the power of the perspective realism of Masscio's Renaissance masterpiece, *Tribute Money*, that he declared; "Henceforth man will be defined not by the rules of narrative, but by an immediate physical apprehension. The goal of representation will be appearance, and no longer meaning" (Francastel, quoted in Bryson, 1983, p. 3). In this prediction of the future, it is interesting that the sensory realism of the essential copy is seen as opposed to the text and narrative—the icon would eventually overcome the linguistic sign.<sup>4</sup>

By 1760, prior to the arrival of photography, de la Roche was predicting the emergence of a medium that would lead users to question reality:

You know the rays of light that reflect off bodies are like an image that paints these bodies on polished surfaces, the retina of the eye, and for example, on water, and on mirrors. The elemental spirits have sought to fix these passing images. They have composed a material . . . so that a painting is created in the blink of an eye . . . and . . . trace on canvases images that are imposing to the eye and make one doubt one's reason, so much so that what we call reality may be nothing more than phantoms that press upon our vision,

<sup>4</sup>But even today where visual culture seems in ascendance there are still many who argue for the superiority of text and narrative over the image: "My suspicion is that, in general, words are much more powerful than images, and that images have relatively little effect unless they are verbalized by the addition of narrative fantasy" (Mitchell, 1986, p. 89).

hearing, touch, and all our senses at once. (Authors' translation of quote in Fournier, 1859, pp. 18, 20; see Biocca, 1987)

With the arrival of photography, the dream of the essential copy became even more intense. Far more stunning and prescient than Sutherland's vision is that of Oliver Wendell Holmes Sr. In 1857 Oliver Wendell Holmes, father of the famous jurist, saw a glimpse of the future of VR when he lifted a stereoscope to his eyes for the first time. After the initial strain, as the lenses forced his eyes to fuse the different images only inches away, Holmes saw a vision. Holmes prophesied the creation of a giant universal database that would house essential copies of all things, something on the scale of Ted Nelson's hypermedia Xanadu. Holmes, of course, saw the essential copy through the eyes of the 19th century. Globe-trotting adventurer-scientists would stock a curio cabinet of essential samples of reality, a collection so large that it would be housed in an immense stereographic library or museum. Essential copies of all things would be gathered from around the world and kept for 3-D examination in the vast, cyberspatial museum of forms (see Biocca, 1987). After peering through his stereoscope, Holmes took up his pen and wrote the following in the prophetic voice that seems to accompany much writing at the birth of a new medium:

Form is henceforth divorced from matter. In fact, matter as visible object is of no great use any longer, except as the mold on which form is shaped. . . . Matter will always be fixed and dear; form is cheap and transportable. . . . The consequence of [photography] will soon be such an enormous collection of forms that they will have to be classified and arranged in vast libraries. . . . The time will come when a man who wishes to see any object, natural or artificial, will go to the . . . stereographic library and call for its skin or form. . . .

We do now distinctly propose the creation of a comprehensive and systematic stereographic library, where all men can find the special forms they particularly desire to see as artists, or as scholars, or as mechanics, or in any other capacity. . . . This is a mere hint of what is coming before long. (Holmes, 1859, pp. 251-253)

Holmes' library of 3-D forms is slowly being constructed polygon-by-polygon in a worldwide, broad-band network of computers. Holmes' magnifying glass has been melted down and reshaped into a fiber optic cable.

With the arrival of radio and television, it became clear to the searchers for the ultimate display that the essential copy needed to take in more senses, and that this was possible! The baton was passed to other visionaries like the Italian Futurists. Dizzy with the technopower of radio and early

television in the 1930s, they looked forward and trumpeted the inevitable arrival of virtual reality: "We now possess a television of fifty thousand points for every large image on a large screen. As we await the invention of teletouch telesmell and teletaste we Futurists are perfecting radio broadcasting . . ." (Marinetti & Masata, 1922/1992, p. 265). To this vision of telepresence, the Futurists added, "In its second National Congress Futurism decided that the following have been overcome. . . . Overcome the machine 'with an identification of man with the very machine destined to free him from muscular labor and immensify his spirit . . .' " (Marinetti & Masata, 1922/1992, p. 265).

In this second quote we see an early 20th-century example of the second goal driving the search for the ultimate medium, the desire for physical transcendence, a desire that permeates most visions of future technologies, be they concrete models or science fiction.

The search for the essential copy and the desire for physical transcendence find expression at the birth of the computer revolution as well. Just at the end of World War II, Vannevar Bush wrote an influential article that claimed that "there are signs of a change as new and powerful instrumentalities come into use" (Bush, 1945, p. 101). The vision in this article would later influence key engineers at the Advanced Research Projects Agency (ARPA), the Stanford Research Institute (SRI) XEROX Park, and many others (see Englebart, 1962, 1988). Echoing Holmes' fascination with stereoscopic photography he argued that, "Certainly progress in photography is not going to stop" and that "improvements in stereoscopic technique are just around the corner" (Bush, 1945, pp. 102–103).

But the adumbration of the arrival of VR lies not just in Bush's musings about 3-D images but also in his desire to have a machine that would assist in the "manipulation of ideas." This was his famous proposal for a machine he called *Memex*, a hypermedia computer. Unlike Holmes' naturalistic library of forms, Bush's Memex was to be a personal library of thought, but one that would eventually expand into a cyberspatial associative network of various forms of information: text, images, audio clips, and so forth.

With Memex, the notion of the essential copy takes an important step—the essential copy becomes an *all-encompassing virtual environment* of information. It is an environment in which the mind lives and works. In his seminal article the desire for physical transcendence also displays an important VR theme. The desire for physical transcendence is cast as not just some general desire to overcome the limitations imposed upon humans by the physical environment, but to *overcome the limitations of the senses, to augment the senses through electrical means*. Bush (1945) wrote:

All our steps in creating or absorbing material . . . proceed through one of the senses. . . . Is it not possible that some day the path may be established more

directly? . . . In the outside world, all forms of intelligence, whether of sound or sight, have been reduced to the form of varying currents in an electric circuit in order that they may be transmitted. Inside the human frame exactly the same sort of process occurs. Must we always transform to mechanical movement in order to proceed from one electrical phenomenon to another? (pp. 107-108).

Here we see the expression for a communication medium on par with a VR interface connected to highly networked cyberspace. Bush presented us with a modern form of the vision of the ultimate display.

This modern vision of the ultimate display coalesces into sensory experience in the work of Morton Heilig (1955/1992). Heilig's work on his vision of the ultimate display has been recently rediscovered and embraced by the virtual reality community (e.g., Heilig, 1955/1992; Rheingold, 1991). Studying filmmaking in Rome on the GI Bill and a Fulbright, the young Heilig was intrigued by U.S. press reports about Cinerama and 3-D films in the early 1950s. His experience of Cinerama in a Broadway theater was, according to Heilig, "a really pivotal experience in my life" (Hamit, 1993, p. 54). That experience awakened Heilig, and he inherited the ancient vision of a destination called virtual reality. We can see all the elements of the ancient vision in an article he published in a Spanish/English publication called *Espacios* in 1955. In Heilig's article we hear the modern echo of the age-old call for a technology that will create essential copies of sensory reality:

Man's nervous system—sensory nerves, brain, and motor nerves—is the seat of his consciousness. . . . In time all of the above elements will be recorded, mixed, and projected electronically—a reel of the cinema of the future being a roll of magnetic tape with a separate track for each sense material. With these problems solved it is easy to imagine the cinema of the future. Open your eyes, listen, smell, and feel—sense the world in all its magnificent colors, depth, sounds, odors, and textures—this is the cinema of the future! . . . For without the active participation of the spectator there can be no transfer of consciousness, nor art. Thus art is never "too" realistic. (Heilig, 1955/1992, pp. 281-282, 285)

The way Heilig's vision is articulated would seem familiar to the modern communication researcher. He writes of the inadequacy of language; of "more direct forms of communication—painting, sculpture. . . ."; and of media as "extensions" of the senses (see Fig. 1.3). Heilig would later be embraced by VR engineers because he successfully embodied his vision of an "experience theater" in a multisensory entertainment simulator called Sensorama, patented in 1962 (Rheingold, 1991). Heilig's arcade ride was only a small realization of a much grander plan for a mass medium that would beam multisensory experiences to a nation eager to "feel physically

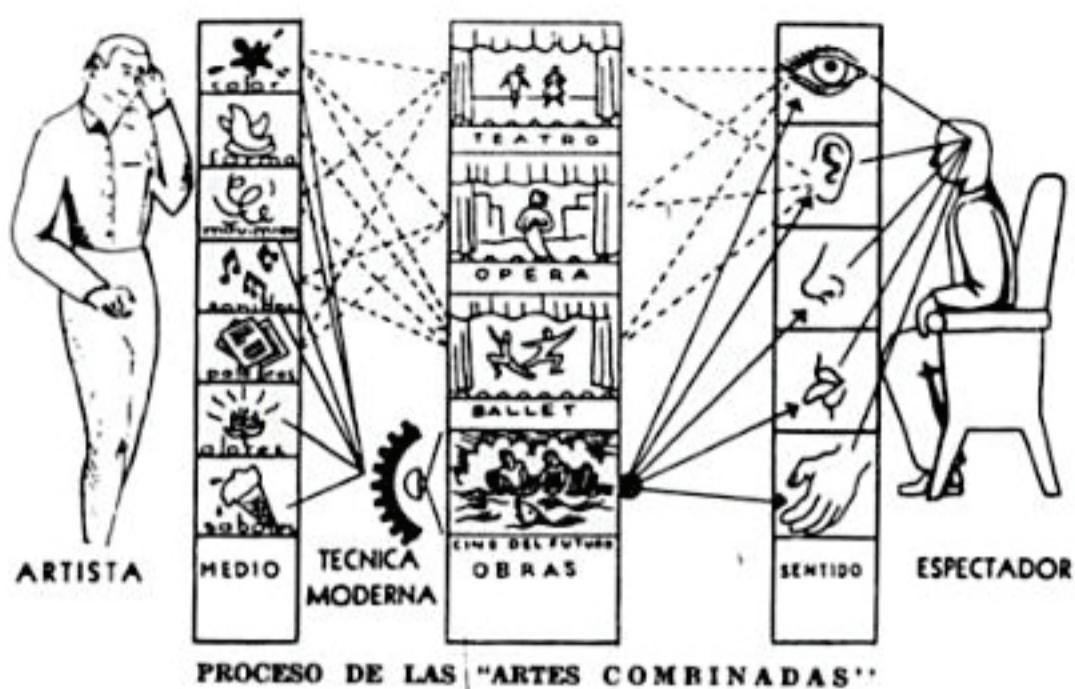


FIG. 1.3. Graphic model of mediated, multisensory communication between an artist and a spectator. From Heilig (1955/1993). Reprinted by permission of MIT Press.

and mentally transported into a new world" (Heilig, 1955/1992, p. 284) (see Fig. 1.4).

Today, as it has for over 2,000 years, the vision of ultimate display continues to race ahead of VR technology. Ivan Sutherland and all his progenitors are the latest prophets in a long chain of VR prophecy. The vision that is expressed in this prophetic search for the ultimate display is more than just "hype"; it is desire. As with the Futurist manifestos, we often read and hear a technohubris fed by an age-old desire for physical

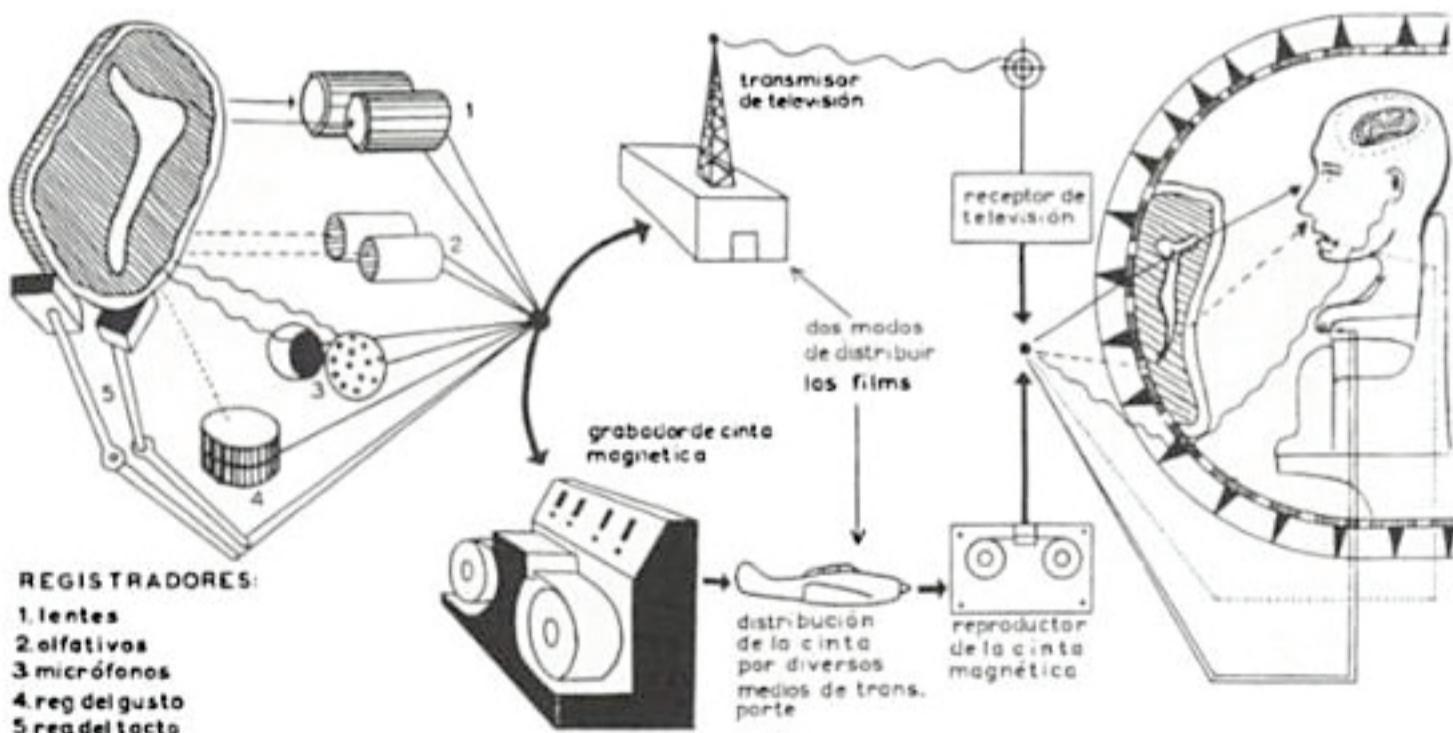


FIG. 1.4. Heilig's (1955) vision of a multisensory mass medium of the future. On the left electronic sensors probe some real-world object. The sensation of that object is transmitted via broadcast or magnetic tape to a spectator who experiences it in a multisensory experience theater. From Heilig (1955/1993). Reprinted by permission of MIT Press.

transcendence. This desire is one of the most powerful forces driving the history of communication. Looking back at the history of communication technologies, Daniel Czitrom observed, "The dream of transcendence through machines is an ancient one, and the urge to annihilate space and time found particularly intense expression through new communication media. . . . The accelerated evolution of media hardware and software has been fueled by the persistence of utopian urges in the population at large" (1982, pp. 187, 194).

### IS IMMERSIVE VIRTUAL REALITY THE ULTIMATE MEDIUM?

We see that the vision behind the creation of VR is consonant with the vision behind the creation of many of our communication media. But this leaves open an important question: Does this mean that VR represents the early stages of the arrival of the ultimate medium? Or, as in the past, are we just projecting this longstanding desire for the essential copy and for physical transcendence—for a dream machine—onto yet another promising but inadequate technology? It is too early to tell, but this book asks the question (see Steuer, this volume).

The promise of VR has yet to be proven—it's still mostly a vision. At the time of this writing, most virtual reality technology still has the look and feel of a prototype, a jumble of wires, LCDs and artful technical compromises (Brooks, 1988), just a portal looking out on a more mature technology to come. These improvised introductory systems remind us of the very early television set, a low-resolution array of black and white lines barely sketching a snow-spotted image. Just as with the early television sets, the image of a new, radically different communication technology is visible.

It is fitting that VR appears at the end of the millennium. One suspects that the ultimate display wears a messianic crown of thorns; it is a techno-Godot, long awaited but yet to arrive. It may even be an expression of our desire to assume a Godlike control of reality. The ultimate display will never arrive. It is a moving target. Like addicts for sensory stimulation, we will always crave more convincing and exhilarating "essential copies," more overwhelming sensations, more physical transcendence.

### REFERENCES

- Biocca, F. (1987). Sampling in the museum of forms: Photography and visual thinking in the rise of modern statistics. In M. McLaughlin (Ed.), *Communication yearbook 10* (pp. 684-708). Hillsdale, NJ: Lawrence Erlbaum Associates.

- Brooks, F. (1988). *Grasping reality through illusion: Interactive graphics serving science* (Tech. Rep. No. TR88-007). Chapel Hill: University of North Carolina at Chapel Hill, Dept. of Computer Science.
- Bryson, N. (1983). *Vision and painting: The logic of the gaze*. New Haven: Yale University Press.
- Bush, V. (1945, July). As we may think. *The Atlantic Monthly*, pp. 101-108.
- Czitrom, D. (1982). *Media and the American mind: From Morse to McLuhan*. Chapel Hill: University of North Carolina Press.
- Englebart, D. (1962, October). *Augmenting human intellect: A conceptual framework* (Summary report, contract AF 49(638)-1024). Stanford: Stanford Research Institute.
- Englebart, D. (1988). The augmented knowledge workshop. In A. Goldberg (Ed.), *A history of personal workstations* (pp. 187-232). New York: ACM Press.
- Fournier, E. (1859). *Le vieux-neuf, histoire ancienne des inventions et découvertes modernes* [The old-new, history of ancient inventions and modern discoveries] (Vol. 1). Paris: Dentu.
- Hamit, F. (1993). *Virtual reality and the exploration of cyberspace*. Carmel, IN: SAMS Publishing.
- Heilig, M. (1992). El cine de futuro: The cinema of the future. *Presence*, 1 (3), 279-294. (Original work published 1955)
- Holmes, O. W. (1859). The stereoscope and the stereograph. *Atlantic Monthly*, 3(25), 249-262.
- Krueger, M. (1991). *Artificial reality*. Reading, MA: Addison-Wesley.
- Marnietti, F.T., & Masata, P. (1992). La radia. In D. Kahn & G. Whitehead (Eds.), *Wireless imagination: Sound, radio, and the avant-garde* (pp. 265-268). Cambridge, MA: MIT Press.
- Mitchell, W. J. T., (1986). *Iconology: Image, text, ideology*. Chicago: University of Chicago Press.
- Pliny (1938). *Natural history*. Cambridge, MA: Harvard University Press.
- Rheingold, H. (1991). *Virtual reality*. New York: Summit.
- Sutherland, I. (1965). The ultimate display. *Proceedings of the International Federation of Information Processing Congress*, 2, 506-508.