# **Defining Virtual Reality: Dimensions Determining Telepresence**

*ABSTRACT*

Virtual reality (VR) is typically defined in terms of technological hardware. This paper attempts to cast a new, variable-based definition of virtual reality that can be used to classify virtual reality in relation to other media. The defintion of virtual reality is based on concepts of “presence” and “telepresence,” which refer to the sense of being in an environment, generated by natural or mediated means, respectively. Two technological dimensions that contribute to telepresence, vividness and interactivity, are discussed. A variety of media are classified according to these dimensions. Suggestions are made for the application of the new definition of virtual reality within the field of communication research. Defining Virtual Reality: Dimensions Determining Telepresence Virtual reality (VR) has typically been portrayed as a medium, like telephone or television. This new medium is typically defined in terms of a particular collection of technological hardware, including computers, head-mounted displays, headphones, and motion-sensing gloves. The focus of virtual reality is thus technological, rather than experiential; the locus of virtual reality is a collection of machines.1 Such a concept is useful to producers of VR-related hardware. However, for communication researchers, policy makers, software developers, or media consumers, a devicedriven definition of virtual reality is unacceptable: It fails to provide any insight into the processes or effects of using these systems, fails to provide a conceptual framework from which to make regulatory decisions, fails to provide an aesthetic from which to create media products, and fails to provide a method for consumers to rely on their experiences with other media in understanding the nature of virtual reality. Theoretically, these inadequacies are manifest in three ways. First, a technology-based view suggests that the most salient feature in recognizing a “VR system” is the presence or absence of the requisite hardware.2 In other words, a given system is arbitrarily classified as “VR” or “not-VR,” depending on whether it includes a minimal corpus of particular machines. Second, such a definition provides no clear conceptual unit of analysis for virtual reality. If VR consists of a hardware system, where do we look to identify a single “virtual reality”? Examining the technological apparatus alone does not seem adequate for this purpose. A third and related problem is the lack of theoretical dimensions across which virtual reality can vary. All systems meeting the basic hardware requirements “are VR,” and all others are “not-VR.” However, once this initial classification has been made, such a dichotomous definition offers no suggestion of how systems classified as “not-VR” may resemble those that “are VR,” nor how different virtual reality systems can be compared. In the absence of a clear theoretical unit or any relevant dimensions for study, it is difficult to perform social science research that addresses the similarities and differences among various virtual reality systems, or that examines VR in relation to other media. Probably the most effective solution to the problems with the current usage of “virtual reality” would be to abandon the term entirely (at least for research purposes), in favor of a more theoretically grounded term. However, the term has stuck in academic as well as popular usage. It is therefore expedient to form a theoretically useful concept out of virtual reality. This paper is an effort to fill this need, addressing the aforementioned faults by defining virtual reality as a particular type of experience, rather than as a collection of hardware. Defining virtual reality in this way will provide

(a) a concrete unit of analysis for VR, (b) a set of dimensions over which VR can vary, and, perhaps most importantly, (c) a means for examining VR in relation to other types of mediated experience.

DEFINING VIRTUAL REALITY

Most popular definitions of virtual reality make reference to a particular technological system. This system usually includes a computer capable of real-time animation, controlled by a set of wired gloves and a position tracker, and using a head-mounted stereoscopic display for visual output.3 The following are three examples of such definitions: Virtual Reality is electronic simulations of environments experienced via head mounted eye goggles and wired clothing enabling the end user to interact in realistic three-dimensional situations. (Coates, 1992) • • • Virtual Reality is an alternate world filled with computer-generated images that respond to human movements. These simulated environments are usually visited with the aid of an expensive data suit which features stereophonic video goggles and fiber-optic data gloves. (Greenbaum, 1992) • • • The terms virtual worlds, virtual cockpits, and virtual workstations were used to describe specific projects…. In 1989, Jaron Lanier, CEO of VPL, coined the term virtual reality to bring all of the virtual projects under a single rubric. The term therefore typically refers to three-dimensional realities implemented with stereo viewing goggles and reality gloves. (Krueger, 1991, p. xiii) Though these three definitions vary somewhat, all include the notions of both electronically simulated environments and of “goggles ‘n’ gloves” systems as the means to access these environments. The application of these definitions (and any other definition that is similarly based on a particular hardware instantiation) is thereby limited to these technologies; their units of analysis and potential for variance are left unspecified. However, it is possible to define virtual reality without reference to particular hardware. Presence and Telepresence The key to defining virtual reality in terms of human experience rather than technological hardware is the concept of presence. Presence can be thought of as the experience of one’s physical environment; it refers not to one’s surroundings as they exist in the physical world, but to the perception of those surroundings as mediated by both automatic and controlled mental processes (Gibson, 1979):

• Presence is defined as the sense of being in an environment.4 Many perceptual factors contribute to generating this sense, including input from some or all sensory channels, as well as more mindful attentional, perceptual, and other mental processes that assimilate incoming sensory data with current concerns and past experiences (Gibson, 1966). Presence is closely related to the phenomenon of distal attribution or externalization, which refer to the referencing of our perceptions to an external space beyond the limits of the sensory organs themselves (Loomis, 1992). In unmediated perception, presence is taken for granted—what could one experience other than one’s immediate physical surroundings? However, when perception is mediated by a communication technology, one is forced to perceive two separate environments simultaneously: the physical environment in which one is actually present, and the environment presented via the medium.5 The term “telepresence” can be used to describe the precedence of the latter experience in favor of the former; that is, telepresence is the extent to which one feels present in the mediated environment, rather than in the immediate physical environment.

• Telepresence is defined as the experience of presence in an environment by means of a communication medium. In other words, “presence” refers to the natural perception of an environment, and “telepresence” refers to the mediated perception of an environment. This environment can be either a temporally or spatially distant “real” environment (for instance, a distant space viewed through a video camera), or an animated but non-existent virtual world synthesized by a computer (for instance, the animated “world” created in a video game). Reeves (1991), in a discussion of responses to television, describes this experience as a sense of “being there.” He claims that a combination of automatic perceptual processes, mindful direction of attention, and conscious processes such as narratization all contribute toward our perceiving mediated experiences as if they were real.6 Others have also constructed taxonomies for examining

mediated experience. Shapiro and McDonald (this issue) differentiate between reconstructed reality, which is created in individuals based on accumulated data from mediated presentations or memories of events, and constructed reality, which focuses on how individuals accept mediated presentations of events as real. Heeter (1992) describes three distinct types of presence that contribute to the experience of “being there:” subjective personal presence, social presence, and personal presence. Robinett (1992) draws a similar distinction between real (unmediated) and synthetic (mediated) experience in the context of discussing presence. The use of “telepresence” to refer to any medium-induced sense of presence is similar to some, but not all, previous uses of the term. The term was coined by Marvin Minsky (1980) in reference to teleoperation systems for remote manipulation of physical objects. Sheridan & Furness (1992) have continued this tradition by adopting the name Presence (rather than Telepresence) for a new journal dedicated to the study of both teleoperator and virtual environment systems. In the first issue of the journal, an entire section is devoted to the concept of telepresence. Sheridan (1992) uses the term “presence” to refer to the generic perception of being in an artificial or remote environment, reserving “telepresence” only for cases involving teleoperation. However, in the same section of the journal, Held & Durlach (1992) use “telepresence” to refer to the experience common to both teleoperation and the experience of virtual environments. The broader term is used here in order to highlight the similarities between teleoperation and virtual environments. By employing the concept telepresence, we can now define “virtual reality” without reference to any particular hardware system: • A “virtual reality” is defined as a real or simulated environment in which a perceiver experiences telepresence.7 Admittedly, this definition does not mesh precisely with typical uses of the term. Indeed, given the broad definitions of the concepts involved, this definition of virtual reality includes virtually all mediated experience. In so doing, it suggests an alternative view of mediated communication in general. Traditionally, the process of communication is described in terms of the transmission of information, as a process linking sender and receiver.8 Media are therefore important only as a conduit, as a means of connecting sender and receiver, and are only interesting to the extent that they contribute to or otherwise interfere with transmission of message from sender to receiver. In contrast, the telepresence view focuses attention on the relationship between an individual who is both a sender and a receiver, and on the mediated environment with which he or she interacts. Information is not transmitted from sender to receiver; rather, mediated environments are created and then experienced (see Sheridan, 1992). Machines mentioned in previous definitions of virtual reality (computers, position sensors, headmounted displays, etc.) are all relatively recent developments. However, the definition of VR as telepresence can be applied to past, present, and future media technologies. Consider, for example, the telephone. Most users take for granted the possibility of talking to someone who is not physically present as if they were standing in the same room. How can one explain the seemingly bizarre ability to speak to someone who is not present by means of talking into a piece of plastic? Of course, as mentioned above, this process can be conceived in terms of senders, receivers, and messages. However, such an explanation fails to account for the odd experience of speaking to someone who is not actually there. Where does such a conversation take place? The most plausible conceptual model is that both parties, by means of the telephone, are electronically present in the same virtual reality created by the telephone system. A few additional examples illustrate this difference with respect to a number of different media: • Reading a letter from a distant friend or colleague can evoke a sense of presence in the environment in which the letter was written, or can make the distant party seem locally present. This feeling can occur even when one is unfamiliar with the remote physical surroundings. • When people telephone an airline using a toll-free number to make reservations for a flight, they often ask the operator where he or she “really is.” They do this because they are uncomfortable interacting in a virtual reality that has no other contextual clues, and I therefore wish to create a background into which to place the operator’s character.10 • Users of multiple online systems (such as bulletin boards, conferenceing systems, etc.) report that each system provides a distinct “sense of place.” • Listening to live recordings of music (recordings made during a performance) gives the listener a sense of presence in the room (e.g. concert hall) in which the recording was made. However, recordings made in a studio can also evoke such feelings, even though there was no single “performance” at which a listener could have been present. • Nuclear power plant operators observe the inside of the reactor by means of a remotely mounted moveable camera and handle radioactive chemicals by means of remotely controlled mechanical “hands.” • Video game players describe the experience of moving an animated car on the screen as “driving.” Each of these situations evokes, in some sense, a feeling of telepresence. A similar sense can be experienced via virtually any technology used in mediated communication. Newspapers, letters, and magazines place the reader in a space in which the writer is telling a story; television places the viewer in a virtual space in which both viewer and on-screen objects are present; and video games create virtual spaces in which the game-player is an actor. Thus, the definition of virtual reality in terms of telepresence provides a conceptual framework in which such newly developed technologies can be examined in relation to other media technologies. Furthermore, defining virtual reality in terms of telepresence alleviates the three difficulties enumerated above. First, VR refers to an experience rather than to a machine. The definition thereby shifts the locus of VR from a particular hardware package to the perceptions of an individual. Second, this definition specifies the unit of analysis of VR — the individual — since VR consists of an individual experience of presence. Thus, dependent measures of VR must all be measures of individual experience, providing an obvious means of applying knowledge about perceptual processes and individual differences in determining the nature of VR. Finally, since this definition is not technology-based, it permits variation across technologies along a number of dimensions. The remainder of this paper will be dedicated to explicating virtual reality in relation to two such dimensions—vividness and interactivity.

## Variables Predicting Virtual Reality

First-person experiences of the real world represent a standard to which all mediated experiences are compared, either mindfully or otherwise; face-to-face interaction with other humans is used as a model for all interactive communication (Durlak, 1987). The human perceptual system has been tuned through the process of evolution for the perception of real-world environments. The experience of virtual realities can be enhanced by appealing to these same perceptual mechanisms (see Reeves, 1991). However, since VR is defined in terms of an individual experience of a particular kind, it is difficult to arrive at operational measures of telepresence (see Held & Durlach, 1992). Since telepresence is necessarily experienced by means of a medium of some kind, properties of the medium will also affect the perception of virtual reality. Factors influencing whether a particular mediated situation will induce a sense of telepresence include the following: the combination of sensory stimuli employed in the environment, the ways in which participants are able to interact with the environment, and the characteristics of the individual experiencing the environment. Thus, telepresence is a function of both technology and perceiver.

*Variation Across Technologies*

Sheridan (1992) identifies five variables that contribute to inducing a sense of telepresence. Three of them are technological: the extent of sensory information, control of sensors relative to environment, and the ability to modify the physical environment (see Biocca, 1992, Figure 3, for a graphical depiction). The other two are task-, or context-based: task difficulty, and degree of automation. Zeltzner (1992) provides a similar matrix of variables that describe the capabilities of graphic simulation systems, which he terms autonomy (human control), interaction (real-time control), and presence (bandwidth of sensation). Naimark (1992) employs a six-category taxonomy for visually representing and reproducing experience. Robinett (1992) presents a more technically-driven ninecategory taxonomy to describe environments presented by head-mounted displays: causality, model source, time, space, superposition, display, sensor, action measure, and actuator. Two major dimensions across which communication technologies vary are discussed here as determinants of telepresence. The first, vividness, refers to the ability of a technology to produce a sensorially rich mediated environment.11 The second, interactivity, refers to the degree to which users of a medium can influence the form or content of the mediated environment. Media artist Michael Naimark (1990) refers to these same properties as realness and interactivity. Others, including Laurel (1991) and Rheingold (1991), make similar distinctions. See Figure 2 for a graphical depiction of these two dimensions and for some of the variables that contribute to each. When considering these dimensions, one should remember that virtual realities resides in an individual’s consciousness; therefore, the relative contribution of each of these dimensions to creating a sense of environmental presence will vary across individuals. Similarly, differences in the content of the mediated environment — that is, in the kinds of entities represented and in the interactions among them — will also affect the perception of presence. However, the variables vividness and interactivity refer only to the representational powers of the technology, rather than to the individual; that is, these variables determine properties of the stimulus that will have similar but not identical ramifications across a range of perceivers. The remainder of this section considers these two dimensions in some detail.

*Vividness*

One variable property of media technologies that influences their ability to induce a sense of presence is vividness: • Vividness means the representational richness of a mediated environment as defined by its formal features, that is, the way in which an environment presents information to the senses. Vividness is stimulus driven, depending entirely upon technical characteristics of a medium. Rafaeli (1985) refers to this property as “transparency” (p.9). A highly vivid medium can be considered “hot” in the McLuhanesque sense, as it “extends one [or many] sense[s] in ‘high definition.’” (1964, p. 36). Many factors contribute to vividness. Two generalized but important variables will be discussed here: sensory breadth, which refers to the number of sensory dimensions simultaneously presented, and sensory depth, which refers to the resolution within each of these perceptual channels.

Breadth is a function of the ability of a communication medium to present information across the senses. J. J. Gibson (1966) defines five distinct perceptual systems: the basic orienting system (which is responsible for maintaining body equilibrium), the auditory system, the haptic (touch) system, the taste–smell system, and the visual system. Inputs to several of these systems from a single source can be considered informationally equivalent (Gibson, 1966). However, the redundancy resulting from simultaneous activation of a number of perceptual systems reduces the number of alternative situations that could induce such a combination of perceptions and therefore strengthens the perception of a particular environment.

This concept is best illustrated by an example. Imagine standing on a street corner in a rainstorm. Which sense is responsible for generating a sense of presence in that environment? The haptic system is activated by raindrops hitting the body, but a similar sensation could result from being sprayed by a nearby sprinkler. Similarly, the smell of a soggy dog standing nearby could result from other situations. But when these perceptions occur simultaneously — the image of raindrops falling on the streets and the buildings, the sound of the raindrops hitting the ground and the cars driving across wet pavement, and the taste of wet diesel exhaust from passing buses — a sense of being on a street corner in the rain is clearly generated. The vividness of the street corner scene is not generated by any single sensory input alone but by the simultaneous juxtaposition of all sensory input. Often, redundant information is presented simultaneously: One hears an explosion, sees the flash, and smells the smoke simultaneously. This redundancy serves to further enhance vividness.

Traditional media such as print, telephone, television, and film are relatively low in breadth, relying primarily on the visual and auditory channels. However, some artists have attempted to expand these boundaries. Films such as Earthquake (Robson, 1974) and The Tingler (Castle, 1959) included vibrating devices attached to theater seats in order to add haptic sensation; the film Polyester (Waters, 1981) was originally presented in “Odorama” — on entering the theater, theatergoers were presented with a “scratch-and-sniff” card and were instructed to smell certain scents at appropriate points during the film. One notable early example of an attempt to provide great sensory breadth in a mediated presentation is the Sensorama device, developed by Mort Heilig (see Krueger, 1991, and Rheingold, 1991 for more detailed descriptions). This arcade-game style simulator utilizes four of the five senses to simulate a motorcycle ride: Users see the Manhattan streets go by, hear the roar of the motorcycle and the sounds of the street, smell the exhaust of other cars and pizza cooking in roadside restaurants, and feel the vibration of the handlebars. Similarly, many theme park attractions, particularly those at Walt Disney World and Disneyland, use a high degree of breadth in order to simulate a sense of presence. The addition of changes in orientation, haptic sensations, smells, and tastes, in combination with auditory and visual sensation, are particularly effective in this regard. For example, the Star Tours and Body Wars simulators combine a motion platform with multichannel sound and film to simulate space travel and a tour through the human body, respectively. Other attractions use similar means to enhance the sense of presence induced by scenes employing animated three-dimensional figures: In the Pirates of the Caribbean attraction, the smell of gunpowder is used to enhance the illusion of being in the midst of a battle; the Universe of Energy in the EPCOT Center employs heat lamps and humidifiers to simulate the experience of being among the dinosaurs; and the Spaceship Earth utilizes chemical smoke to enhance the perceived realism of sending smoke signals with a simulated campfire. Newer media technologies have made similar efforts to augment the breadth of mediated experience (see Biocca, 1992). For instance, sound has become increasingly important in computer interface design, and new tactile-feedback controllers have been developed for use in computer-based interactive systems. Given the great attention such technologies have achieved in recent years, it seems safe to assume that substantial advances will be made in this direction in the near future. The vividness of a particular mediated representation also depends upon the depth of the sensory information available in each perceptual channel. This concept can be described in terms of “quality”: an image with greater depth is generally perceived as being of higher quality than one of lesser depth; the same is true for auditory representation. Informationally, depth depends directly upon the amount of data encoded and the data bandwidth of the transmission channel. In real-world perception, depth is taken for granted, as our sensory mechanisms almost always operate at full bandwidth. However, the same is not true of mediated perception. In designing media systems, we must always make sacrifices in bandwidth; no currently available auditory or visual recording systems match the capabilities of the human auditory and visual system. For instance, in the case of the auditory system, our ability to recognize the particular sounds, such as those of different musical instruments or different voices, results from the simultaneous perception of a complex combination of amplitude and frequency cues, as well as differences in arrival time and intensity between the signals from the two ears (see Wenzel, 1992). In order to represent a sound precisely by means of a medium, all of these characteristics must be precisely recreated. However, depending on the intended purpose of a medium, this is not always necessary: The telephone system has been optimized for the transmission of comprehensible speech in the minimum possible bandwidth and therefore utilizes only the minimum level of sound quality required for comprehensibly transmitting speech signals. Because speech perception is a direct symbolic process (Gibson, 1966), a lower-bandwidth representation is sufficient for conveying content. In contrast, compact discs (CDs) have been optimized for distribution of recorded music and thereby must be capable of representing a far wider auditory bandwidth. They therefore encode a substantially greater quantity of data and can provide much greater depth. But neither of these systems is capable of encoding the full range of ambient and spatial information that is essential in presenting a realistic auditory representation of a space; however, both “surround-sound” systems that use loudspeakers to create an illusion of space (Dressler, 1988; Mead, 1987), and immersive, headphone-based auditory displays that present acoustic environments keyed to the motion of the wearer (Wenzel, 1992; Durlach, et. al., 1992) promise to extend the ability of media systems to recreate the spatial detail that is so important in inducing a sense of presence (see Blauert, 1983). A similar tradeoff is evident in the case of television transmission. Most commercial films are shot using 35 mm film, which has a high visual resolution in terms of both number of picture elements (pixels) per unit area and the range of different colors that can be represented by any given pixel. Film therefore exemplifies great sensory depth. In contrast, television is technologically limited to only 525 lines of resolution (for the NTSC video standard used in America) regardless of screen size, and can capture a much narrower range of colors with each pixel. Television is therefore considerably lower in depth than film. The desire to bring greater sensory depth to the television image is the motivating force behind the Advanced Television (ATV) systems currently under study.however, these advantages come at great cost in terms of bandwidth requirements.12 Various nonimmersive “three-dimensional” visual systems, including the ViewMaster, “three-dimensional” films, and holograms, attempt to accurately portray a sense of depth across part of the visual field, while immersive visual displays such as stereoscopic head-mounted displays create a sense of presence by presenting a visual environment that moves with the viewer. The relative contributions of breadth and depth to vividness are not constant. For example, a silent film has considerably greater image detail than does a video presentation with sound; it is therefore greater in depth but lesser in breadth. Similarly, a compact disc recording of an opera has much wider frequency bandwidth and greater dynamic range in the auditory domain than does a standard videotape of the same performance, but the videotape includes image. The simultaneous engagement of multiple perceptual systems is an extremely effective means of engendering a sense of presence, even if some stimuli are quite low in depth (as is the case in the aforementioned Disney attractions). It is likely that breadth and depth are multiplicatively related in generating a sense of presence, with each dimension serving to enhance the other; the exact nature of this interaction clearly warrants further study. New technologies promise to expand both the sensory breadth and depth of mediated experience (see Biocca, 1992, for a review). As media technologies become more and more vivid, it is possible that we will someday have systems capable of passing a “perceptual Turing test.” The ramifications of media systems whose representations are perceptually indistinguishable from their real-world counterparts is both exciting and terrifying—exciting because of the possibilities afforded by such systems to experience distant and nonexistent worlds, yet terrifying because of the blurring of distinction between representation and reality. Interactivity Communication media can also be classified in terms of interactivity: • Interactivity is defined as the extent to which users can participate in modifying the form and content of a mediated environment in real time. Interactivity in this sense is distinct from engagement or involvement as these terms are frequently used by communication researchers (see Rafaeli, 1986, 1988); for the purposes of this paper, interactivity (like vividness) is a stimulus-driven variable, and is determined by the technological structure of the medium.

Dimensions and Media

Media systems that are both highly vivid and highly interactive are not yet widely available. Indeed, video games are the closest most people have come to such systems. So too, media systems that allow individuals to interact with each other in natural ways within virtual environments are not yet common, nor are systems that can represent the seemingly infinite range of sensory raw materials present in the real world. However, systems that rate high on both dimensions are quite common in science fiction: The Holodeck on Star Trek: The Next Generation provides real-time interactive multisensory simulations, as does the nursery in Bradbury’s short story The Veldt (1951). Cyberspace, an electronic realm conceived by science fiction author William Gibson (1984), provides a somewhat different vision of an interactive multisensory environment. Cyberspace encompasses both real and synthesized realities as a unified matrix of data and is experienced by jacking in one’s nervous system directly to the mediated world by means of special hardware. Thus, unlike traditional mediated experience, cyberspace bypasses the sense organs completely, presenting its stimuli directly to the perceptual systems in the brain, thereby presumably maximizing both sensory breadth and depth. Gibson delineates the experience of cyberspace from another, non-interactive medium called simstim, which is also experienced via direct neural interface but permits only passive experience (much like television). Figure 3 classifies a wide range of media technologies, both real and fictional, in terms of vividness and interactivity.15 In considering this chart, it is interesting to note both the areas that are covered by technologies that are currently present, and the areas that remain blank, for which the appropriate technologies have not yet been developed. Since the dimensions discussed here depend on a wide variety of independent variables, the exact relationship between these properties and the experience of telepresence (a dependent variable) is a matter for empirical study (though many hypotheses can be generated). It seems that vividness and interactivity are both positively related to telepresence; that is, the more vivid and the more interactive a particular environment is, the greater the sense of presence evoked by that environment. However, these predictions may not always hold and may be dependent on other mitigating factors. For example, as McLuhan (1964) predicted, an extremely “hot” medium (one that designed to maximize vividness) may actually decrease the ability of subjects to mindfully interact with it in real time. This may be a result of limitations on cognitive processing power available in the perceiver; rapid-fire, high-bandwidth, multisensory stimulation might engage such a great portion of the brain’s cognitive capacity that none is left for more mindful processes (see Lang, 1992; Reeves, Detenber, & Steuer, 1993). Communication Research and Virtual Reality Many studies regarding media content and individual factors contributing to mediated perception have been performed in the field of communication. However, few studies have explicitly addressed interactivity, vividness or similar variables. Quite a bit of research on interactivity has been done in the field of human-computer interaction, but, as noted by Rafaeli (1985, 1988), interactivity research has been sorely neglected by communication researchers. Similarly, most of the research on vividness has been technology oriented, in order to determine whether the cost of implementing a particular technological improvement is warranted by users’ increased “liking” (see McFarlane, 1991, and Neuman, et al., 1987, for examples of such studies; see Reeves, Detenber, & Steuer, 1993, for one counterexample). Thus, the precise ramifications of these variables and others like them are largely unknown. Progressively more advanced media technologies will enhance the sense of telepresence in a wide variety of virtual realities. Rapid advances in both multimedia computer technologies and in high-speed data networks hasten the development of a truly global village, in which our ability to interact with friends, family, and others who share interests smiliar to our own will no longer be limited by physical proximity. Such “virtual communities” represent one of the most exciting aspects of these developing new media, as they offer individuals a method for participation in, rather than mere observation of, the mediated worlds that surround them. The Internet, commercial online services, and BBS’s have already begun to offer the interactive capabilities required for such communities to form on a large scale.16 The development of increasingly vivid media is likely to further expand these possibilities, though the exact nature of the effects of these changes on the characteristics of interpersonal interactions in these virtual realities remains an open (and fascinating) empirical question. New media may greatly expand the ability to experience telepresence in virtual realities; however, these new developments are also certain to enhance the possibilities for using the media to manipulate and control beliefs and opinions. Furthermore, as an increasing proportion of most individuals’ experiences come via mediated rather than direct sources, the potentially detrimental effects of such manipulation increase exponentially. Regardless of the particular medium used, be it telephone, electronic mail, online chat system, computer-video conferencing, or immersive virtual reality, all mediated interactions fall within the domain of communication research. Indeed, communication researchers are uniquely suited to address the perceptual, technological, and social issues surrounding new media technologies before they become problematic by building upon the lessons learned through the study of earlier media. Rather than relying on engineers in laboratories to design the media systems of the future and then waiting for media behemoths to implement and distribute these new media, communication researchers have a responsibility to respond proactively by using what they have learned about people and media to study the concepts related to these developments, to make predictions about their possible effects, and to become involved in the design and implementation of new media systems before they are institutionalized. Rather than waiting for media industries to develop new offerings to be studied post hoc, researchers should be prepared to address general variables and to look across media while their work can still have significant impact on design and development of new media. It is hoped that the definitions and dimensions described here will facilitate the study of virtual realities in this way.