

There is nothing more that can prevent interactivity from becoming the principle and essence of life itself: I am interactive therefore I am.

Pierre Moeglin, 'Les transe de l'interactivite'¹

'Interactive computer art' has become fashionable, undoubtedly as part of the current vogue for anything 'interactive'. Even the art world is finally showing signs of embracing it.

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One might argue that the proliferation of forms of computer-mediated interactivity in our everyday lives has

already given rise to a new subject position in relation to modes of audiovisual experience. It has been in the making in interactive science museums (such as La Villette in Paris), video game arcades, flight simulators and by PCs in homes and offices.

This new subject position is much more dynamic and 'responsive' than those allocated to the traditional spectator of cinema or television.² It emphasises the 'naturalness', immediacy and intimacy of the encounter between humans and technological objects. Instead of the familiar notion of human-computer *dialogue*, some observers have started to talk about the common *ground* between them. According to such views, an interactive system is not something distinct facing the user; rather, it is an environment that comprises both human agents and the synthetically created 'interface agents' as equal partners.³

Such a model implies an 'immersion through the computer screen', and thus a gradual dissolution of the human-computer interface. This might be expanded into a cultural statement, eventually announcing the collapse of the strictly polarised model of the 'two cultures'— the humanist and the technological—which has persisted throughout the Western tradition since the Industrial Revolution.⁴ In the 1960s of course, Marshall McLuhan was already a proponent for the idea of a *symbiotic* relationship between man and machine. The tactile metaphor was characteristic of this thinking — technology was understood not only as an extension of our 'external' sense organs, but of our nervous system as well.

In spite of McLuhan's brilliant intuitions, many questions about the quality of interaction are still open. Do interactive systems have a liberating or a constraining effect on us? Should 'immersiveness' be resisted as such? How much of the 'potential of interaction' is just hype — pseudo interactivity, perhaps serving someone else's ends? Should users be guided by 'maps' and 'guides', or left on their own? What possibilities for counter-readings and counter-uses do interactive systems offer? Does it matter that many of them are toy-versions of those developed by the military-industrial complex for surveillance and destruction?

It is possible to start answering some of these questions by looking at interactive art installations. I assume it is possible to see them as a continuing metacommentary on the state of interactivity, in the terms of which technological breakthroughs are probed and sometimes anticipated, in which new applications are found and ethico-philosophical issues arise. One might suppose that this field is paradoxically the least conditioned by the concerns of the military-industrial complex at the same time it is the most concerned about it.

Unfortunately, the field of interactivity is not homogeneous — in terms of production or exhibition. While some interactive installations are produced independently or are partly funded by public sources, other pieces claiming to be 'art' have unquestionably originated within the military-industrial complex. Their intention is, at least partially, to promote products and camouflage the less philanthropic aspects of the corporate profile.⁵

The Exchange of Addresses Considering the centrality of the relationship between the interactive system and a human agent, a useful starting point lies in the analysis of its *modes of address* — ie its method of establishing and maintaining a relationship with the user. In audiovisual theory the two main modes of address are 'indirect address' (which is the third person mode dominant in classical narrative cinema) and 'direct address' (the first person mode dominant in broadcast television). Most audiovisual texts are not 'pure'. Rather, they are combinations of different modes of address with a variety of sub-categories.⁶

In classical cinema the spectator is 'sutured' into the cinematic spectacle by constant changes in the point-of-view. This impersonal third person

mode dominates, with the characters living in a self-sufficient world and the spectator watching it from the outside. There are moments, however, when the characters seem to talk directly to you, but even in this is motivated from *within* the fictional world. The spectator is called to join in only through identification with the characters' points-of-view. The spectator is thus considered a voyeur, a libidinous outsider.

In broadcast television however, the spectator is constituted as an acknowledged subject of the program flow. A crucial role is played by the presenter or anchor-person who addresses the implied spectator directly. All other material on TV (including re-runs of classical films) is subordinated to this recurring mode of address. The presenter and other familiar screen personalities such as news-readers (who have been granted the privilege of addressing the spectator in the first-person mode) can thus be seen as assuring representatives of the world of television. The spectator is constituted as a 'partner' representing the domestic world. These worlds are connected by a variety of cues, such as home interiors in the studio and so on.

Interactive systems further complicate the situation by requiring the user's active and physical (not just mental) participation. Not only does the interactive piece address the user, but the user also addresses the piece. David Tafier has called this situation "a second person (I-you) exchange".⁷ Whereas the television spectator addresses the screen primarily by turning it on or off, or by channel-surfing with the remote control, a constant 'exchange of address' (a *change of direction* of address) may take place between the human and the computer. It is also possible to imagine a situation where the computer-generated world is submitted to the address of the user. Here the separation between direct and indirect address (from the user's point-of-view at least) makes little sense.

While one of the central functions of direct address on television is to keep the spectator watching a single program without changing channels, the direct address of interactive installations requires one to *make a choice*, to reconsider the situation. The recurrence of the direct address may serve a 'binding function' (even when *guiding* the user through the database) as on television. However, the interactive user cannot be carried away by the program flow; the user is kept in a state of constant alertness. Another question that arises here is to what extent this state can become automated, activating a reflex-like psychological challenge/response mechanism. Pessimists already see this happening with the excessive playing of video games.

Intimate Conversations As with television, the direct mode of address in interactive works can take many different forms. The most explicit form can be found in the use of a fictional screen personality as a mediator between the virtual world of the computer and the user. This solution recalls the television experience, particularly if a full-screen talking head is used. A good example of this can be found in Lynn Hershman's *Deep*

Contact (1990). Even its installation component simulates the domestic living-room atmosphere.

In *Deep Contact* we communicate repeatedly with a screen personality named Marion, dressed (or rather undressed) as a hostess from 'Call Girl' spots on TV. Marion appears at certain points in the Macintosh Hypercard-based program addressing and seducing the user. The user selects paths in a landscape representing different sexual fantasies by *touching* (via a touchscreen) parts of Marion's body. The female body (or rather its graphic representation) thus serves as a menu that contains the erotic experiences it promises.

The intimate tactility of the relationship is already created in the first image, where we see Marion knocking on the screen from the inside, begging somebody to touch her body. There is no other way to start the program. The insistence on the connection between direct address and screen-mediated tactility reminds one of Douglas Davis' 1970s television performances — except that here the user does have a way to respond. In their own ways both examples bring forth the enormous distance built into the colloquial direct address encountered during a normal TV-event. While television images may challenge, they never respond; they lack intimacy, and are one-way only.

The psychological tension between Marion's insistent address and the desire to touch the image is surprisingly high. *Deep Contact* demonstrates that physically touching a representation can still be a problematic thing in a culture where visual communication has traditionally been mediated, reduced to an optical-mental operation. While some religious traditions have restricted the visibility of certain sacred images (the shroud of Turin) and allowed tactility in other cases (kissing the statue of the Virgin Mary), 'thou shalt touch the image with your eyes only' has been the rule from classical academic painting to the cinema — and even to ready-mades and found-objects.

Constructed screen personalities have not only been used in the role of a guide. In Hershman's pioneering videodisc *Lorna* (1983) the artificial character was the centre of attention. While learning about Lorna and her problematic life the user was encouraged to help her, to become her psychoanalyst. Luc Courchesne's *Portrait One* (1991) belongs to a 'conversational' genre. It offers an intimate conversation with a remarkably life-like character named Marie, who stares at the user from the screen during the whole session.

Menus and Maps Direct address does not, however, have to be personified in anthropomorphic creatures. It can assume the form of a short casual instruction ('touch the screen', 'click on 'left' or 'right' to proceed', etc.) or that of a menu or a map. The menu is used, for example, in audiovisual 'poetry machines' to provide the user with the instructions and the tools for 'composing' with the database. A good example is provided by Bill

Seaman's *The Exquisite Mechanism of Shivers* (1992), which offers the user multiple ways of treating the audio-visual fragments of poetry stored on a videodisc.

The map can be included in the image program and called on the screen intermitantly, or it can be included as a separate, free-standing 'board', as in Jeffrey Shaw's *The Legible City* (1980-90) and Michael Naimark's *VBK - A Moviemap of Karlsruhe* (1991). In these 'virtual voyaging' or 'surrogate travelling' pieces, the map simulates the role of an ordinary city map, helping users orient themselves in the virtual city. Simultaneously, it points out the limits of the virtual world and thus maps the field of interaction.

The opposite of such clearly mapped works are the pieces that refuse to guide the potential user at all. Such works dispense with direct address, or at least suppress its anchoring function. Ken Feingold's *The Surprising Spiral* (1991) doesn't even announce itself as interactive. The spectator is supposed to find out by accident or by inferring from the general design of the installation. What's more, Feingold's piece leaves a doubt about the nature of the interaction — the user who operates the book-shaped touch screen will never be certain of the outcome of their touches. In fact, images and sounds 'randomly' appear in real-time or with a time lag; they may even be the previous user's choices.

Feingold's piece is a labyrinth which neither shows the way through the maze nor is willing to reveal it little by little. The user remains face to face with a mystery object. Some people have been frustrated with the impossibility of mastering the rules of the game even after a lot of trying; they attribute their problem to imperfect programming. In so doing they conform to one of the most common features of interactive systems: that there is a possibility of learning. There is, in fact, a pedagogical subtext inherent in most interactive artworks, whether it is underlined or not. They share this feature with functional, goal-orientated applications of interactivity.

Feingold's own point of view would probably be that *The Surprising Spiral* is a piece of art, and not a video game. An artwork is entitled to retain its ambiguity. A painter or a poet does not provide the keys to their work. Why should an interactive artist be expected to? At this level *The Surprising Spiral* could be read as a *meta-interactive* work. Its aim is to question certain *données* of interactivity, in much the same way as Feingold's videotape *Un chien délicieux* questioned the ideology of documentary truth. Feingold simply added a fictional voice-over 'translation' to authentic documentary footage, without marking the result as fictional.⁸

Cinema and Interactivity The use of direct address in interactive systems is central because of the constant need to involve the subject. Thus, when indirect address is used it must almost inevitably be subordinated to some form of direct address. This is certainly the case with 'interactive movies' such as the one by the Czechoslovakian filmmaker Raduz Cincéra being shown at the Futuroscope theme park in France. The audience can

decide — at certain moments — the way the story is to proceed by a majority vote, using push-buttons connected to an electronic voting system. Unfortunately the voting takes place only at certain crucial moments, which are over-determined by multiple forms of direct address: stopping the film, projecting graphic signs on the screen, turning on the lights and even allowing a live hostess appear on the stage to direct the voting! The film itself, *Le vieil arbre et les enfants*, proceeds from a traditional narrative position which does not acknowledge the presence of the audience.

This form of audience participation amounts to little more than an entertaining trick. It demonstrates how difficult it is to introduce intelligent interactivity into a multiperson situation. There is some truth in Michael Naimark's observation: "The Movie World Understood Realness But Not Interactivity [...] The Computer World Understands Interactivity But Not Realness."⁹ One of the most successful audience participation pieces I have experienced did not involve computers at all. At 'Les arts étonnants' at Toureoug, France in October 1991 artist Alain Fleicher made the audience reflect back towards the screen a movie that was projected towards them by means of individual handheld mirrors. The resulting picture on the screen was a constantly forming and deforming 'pixel-image'.

An interesting attempt to mediate between the movie world and the computer world can be found in the interactive cinema pieces by Grahame Weinbren. *The Erl King* (1988, with Roberta Friedman) and *Sonata* (1992) resemble other interactive computer installations, allowing one person to interact via a touchscreen while others form an audience who observe the interaction on monitors incorporated in the installation. The audiovisual material in these pieces (mostly camera-images stored on videodiscs) is heterogeneous in form, ranging from performance and 'emblematic' shots to didactic and narrative sequences. In *Sonata* there is even a complete narrative movie, shot by Weinbren and based on Tolstoy's 'Kreutzer Sonata', hidden in the database.

While interacting with these pieces the user is drawn into a rapid-fire exchange with constantly changing modes of address. None is given absolute authority over the others, even though there seems to be some hierarchical structuring. In *Sonata*, the image of wolves sitting on a tree, staring at the user (from Freud's case history of the Wolf Man) unexpectedly appears, and seems to provide some kind of interpretative frame. Weinbren himself has referred to the Freudian dream narrative as a subtext for his compositions. The viewer is meant to be carried in a subjective state, "keenly aware that there are, 'behind' or within each image, other images and image-sets that may not show on screen in the current performance of the piece".¹⁰

Even though there are graphic cues included in *The Erl King* to direct users, they are mostly carried by their choices in a relatively unanticipated way. The images in both direct and indirect modes function here in an undifferentiated manner as 'symptoms'. Both may equally attract touches

according to the users' wishes and lead to additional layers of images and sounds. In *Sonata* there are fewer cues on the screen and the interaction is much smoother (thanks to the digitalisation of the signal from the analog videodisc). Still, the 'cognitive map' behind the images and sounds seems easier to master than in *The Erl King*.¹¹

There are long segments in *Sonata* during which the hand of the user functions as a real-time film editor. While the 'Kreutzer Sonata' sequence is running, the user can reveal different views (camera-angles, framings) of the same scene by touching the upper side of the screen. Split-screen effects are activated by sliding ones hand laterally across the screen, revealing another story or scene that looks as if it were taking place simultaneously. Here the user's hand intrudes in a *self-sufficient world* (via an indirect mode of address) 'from the outside'.

This situation seems to have a parallel in that large group of video games, which are observed from an objective camera-position and are manipulated (using a joystick) by the player's 'invisible hand'. There is a difference, though: in a video game the player is represented by an agent who is controlled by the user, whereas in *Sonata* the user is more genuinely outside. Role playing has more of an effect on the discursive frame (the 'montage' of one layer or between layers) than on the outcome of the 'story' within it. Mythological associations to 'the hand of God' come easily to mind.

Puppeteers as Puppets In terms of mode of address, artificial reality systems provide a peculiar kind of human-computer interface. The user is confronted with their own presence in a computer-generated environment. Technically these systems are a hybrid of closed circuit video and computer technology. The role of video as an input-output loop may recall the closed circuit video installation, which was a favourite form of early video art during the 1960s and 1970s. Such installations allowed the spectator to see their own image in real-time in different configurations of monitors. This created a mirror-like situation which (among other things) investigated the viewing subject's identity in relation to real and virtual spaces.

In artificial reality installations the image of the user's body (scanned in by a video camera) is superimposed on the artificial reality (created on the computer) allowing the user to interact with real-time body movements of the 'puppet on the screen'. This is true of Myron Krueger's *Videoplace* system, which has had numerous incarnations (since 1974) and also applies to the Vivid Group's *Mandala* system (since 1986). In an artificial environment however, the presence of the human agent does not have to be visible — it can also be audible. Body movements can create a soundscape by triggering a variety of virtual sound effectors, as in David Rokeby's *Very Nervous System* (since 1986).

One peculiarity of these systems is their theoretically complex interplay between retaining and annihilating distance simultaneously. Keeping physical distance — remaining in the video camera's field of vision — is a

requirement for immersion in the virtual environment. This situation could be referred to as 'tele-tactility'. Externalisation of the body leads to its *internalisation*. The result is a kind of a *bilocation*, an experience whereby the body seems to be in two places simultaneously.

This readily evokes parallels with the literary tradition of the *Doppelgänger* or with the field of paranormal phenomena (in which the subject sees their own body as if from the outside, as in levitation). These parallels don't carry very far. A basic difference can be found in the fact that these fantasies have no 'remote control' relationship between the real and the virtual body. The virtual body is often seen as a threatening independent agent or as a passive, hologram-like image. The split is definitive.

In artificial reality systems there is an immediate, existential relationship between these two bodies. The virtual body is not our rebellious shadow — even though *Videoplace* may sometimes play with this idea. It is an extension of the physical body of the user. It is also our representative in the artificial world, but it is a peculiar one. Instead of the more customary situation wherein we select an agent to represent us in the computer world (the protagonist of a video game for instance) here we act as puppeteers directing ourselves as puppets.

Another difference between an artificial reality system and the fantasies mentioned above lies in the fact that levitating bodies and *Doppelgängers* are believed to materialise in the same space the physical body is located. Artificial reality, however, purports to transport the virtual body to a *parallel, alternative reality*, with its own 'natural laws'. It is, according to Krueger, a responsive environment. Ideally, such an environment is 'smart', provided with some artificial intelligence. It does not just respond to external stimuli, but acts on them in unpredictable ways. *Videoplace* may tease, or even 'mutilate' the virtual body on the screen. Artificial reality thus clearly combats the idea of AI as necessarily embodied in anthropomorphic creatures. It is 'spatialised intelligence', which may evoke the Haunted Houses of the early silent cinema.

Controlled Rush Into the Image In most artificial reality installations I have seen, immersiveness has been restricted by the fact that they don't form complete wrap-around surroundings, which would annihilate the sense of real space and involve the subject totally. The *Videoplace* and *Mandala* installations present a clear demarcation between the real and the artificial world. In practice this is provided by the visibility of the frame of the screen — as in painting, photography and cinema — and by the distance of the user from the screen. The refusal to build immersive artificial realities isn't a technical imperative. In Krueger's case it is an ethical stand against 'isolating people' and alienating them from "the other activities that take place in a work environment".¹²

Ideas such as immersion and immersiveness easily evoke negative connotations about losing hold of reality, of being pulled into the eye of the

storm, or of drowning in an interactive environment. An LSD trip, a theme-park ride or an intensive session on an arcade simulator game can all be characterised as immersive experiences. Members of the moral majority groups see television and the media in general as immersive and alienating, dragging their victims away from natural virtues and social life. Here immersion and penetration regain their full sexual connotations.

Some immersive technological spectacles do indeed aim at causing a vertigo by offering an out-of-the-ordinary experience that exceeds customary spatio-temporal limits. Extraordinary speed, supported by synchronised multi-sensory devices is certainly the central attraction of the Showscan 'dynamic cinema' ride. Equally important is the first person point-of-view. Unlike conventional narrative cinema however, there is no exchange of 'looks'. Everything is seen from a subjective camera position, identified with the point-of-view of the spectator. There isn't even a lateral panning camera movement, just the high-speed motion into the image along the depth axis.¹³

This kind of immersiveness — understood simply as a pre-programmed penetration into an image — is also encountered in computer-based installations that do not present a complete wrap-around environment. In terms of interactive systems however, we should speak about 'controlled immersion'. The possibility of the rush into the depth is there, but only as one of the options of the system. Even the player of a regular Formula One simulator game is given a certain margin to control the headlong rush into the image. Driving speed and direction can be varied to a certain extent. The driver can also 'pan' with the virtual camera identified with their own point-of-view coupled with the movements of the car.

There is a whole genre of interactive art installations based on this subject position, which I propose to call 'inverted direct address' — referring to the fact that the active, controlling gaze that addresses the system belongs to the user. This genre has been variously called 'virtual voyaging' or 'surrogate travelling', and is best represented by the oeuvres of Jeffrey Shaw and Michael Naimark. Naimark actually participated in the production of *Aspen Movie Map* which was produced at MIT in 1978-79 and is usually considered the first of the genre.

In virtual voyaging installations the user is given the sensation of travelling inside a virtual landscape while remaining physically motionless. The virtual landscape can be a city created in 3D computer graphics, as in Shaw's *The Legible City*, or it can be a computer-controlled videodisc with a camera-image reconstruction of an actual city, as in *Aspen Movie Map* or in Naimark's *VBK - A Movie map of Karlsruhe*. The interface can be anything from a joystick or a spaceball to an adapted surfing board (as in Peter Broadwell's and Rob Myers' *Plasm: Above the Drome*, 1991) or a bicycle (*The Legible City*).

By coupling first-person vision and virtual mobility these installations provide the virtual voyager with a *mobile panavision*. This has restrictions how-

ever. In *The Legible City* the 'virtual camera' (identified with the real-time vision-movements of the user) is limited to a street-level point-of-view. It can, however, be switched to an 'X-ray mode' and penetrate walls. In *VBK - A Movie map of Karlsruhe* the freedom of vision-movement is restricted to the tramline network of the city, captured through the windscreen of a tram. There also exists the possibility to speed up the motion of the 'virtual tram' into a real phantom ride.

'Unrestricted movement' through virtual space may be a technical goal and a cyberpunk dream, but it isn't necessarily an artistic aim. Restrictions can be artistic principles of composition and used to direct the subject's attention to other levels of signification. The strength of *The Legible City* lies in the transformation of the act of vision-movement into an act of reading/writing. The idea of realising the rows of houses as letters, words and sentences is rich with cultural implications.

Back to 'Reality' While there is not much interesting artistic work done in the field of totally immersive environments at present, this is certainly one of the upcoming frontiers. Total immersion is not only a logical conclusion of the discourses on the human-machine symbiosis, it is also in sync with trends in contemporary popular culture, neo-psychedelic house dancing and cyberpunk mythology. On the other hand, the attraction towards immersive experiences is a cultural *topos*, which is activated now and again in appropriate cultural circumstances. Early Romanticism for example, gave birth to Blake's visions, Coleridge's *Kubla Khan* ('received' under the influence of opium) and to the great wrap-around Panoramas of the turn of the century.

Artist-created immersive environments are at their most interesting when they reach a balance between critical distance (*vis à vis* the most excessive aspects of immersiveness) and sheer sensory delirium. There are obviously two paths to follow, which are related to different ideas about bodies in space. One kind of environment is experienced in the real, while the other kind is experienced in a virtual body. Usually (but not necessarily) this division coincides with another one separating 'multiperson' from 'single person' experiences.

The first option refers to projected environments, where interaction is made possible by sensors installed in the space or worn by visitors. The other refers to virtual reality installations and 'movies', designed to be experienced with head mounted displays (HMD). Unfortunately, the few existing examples of such work with artistic pretensions — Matt Mullican's *Five Into One* (1991), Monica Fleischmann's and Wolfgang Strauss' *Home of the Brain* (1992) and Nicole Stenger's *Angels* (1992) — are all somewhat disappointing.¹⁴

This is only partly due to the technical deficiencies (uncomfortable interface, slow or rough graphics) and the problems of exhibiting this kind of work. I have a feeling that 'being inside' adds relatively little to the achieve-

ments of installations like *The Legible City*; even as a sensory experience the novelty soon wears off. Doubts can also be expressed about the quality of interaction. Brenda Laurel has remarked: "If a representation of the surface of the moon lets you walk around and look at things, then it probably feels extremely interactive, whether your virtual excursion has any consequences or not."¹⁵

The consequences are extremely important, but they do not have to be concrete. They can be mental — intellectual and emotional — as well. Many interactive systems still underestimate our capacity to fill in the gaps with our imagination. I therefore see it as desirable for interactive art to look for an equilibrium between technological and mental interaction, as well as between pre-programmed interaction and original real-time creation. The interactive artist should not be content with the role an illusionist, of being a technological magician. They should deal with illusions that bring people back to 'reality', whatever that means.

Many thanks to Jacqueline Stoeckler and Jukka Sihyonen for critically reading this article at different stages of its development.

1 "Dès lors, plus rien n'empêche l'interaction d'apparaître ni plus ni moins comme le principe et l'essence même du vivant: je suis interactif, donc je suis". Pierre Moëglin, 'Les tranches de l'interactivité', in *Les transinteractifs*, Derrick de Kerckhove and Christian Sévrette (eds), Espace SNVB International, Paris, 1990, p. 106.

2 This doesn't imply, however, that the subject position constituted by the cinema or by broadcast television would be totally passive. Different feed-back modes — real and imaginary — are even encouraged. What's more, the spectator as a subject isn't absolutely tied to this position; rather, they have a wide variety of different ways to react, from 'preferred' readings to 'counter-readings'.

3 Brenda Laurel, *Computers as Theatre*, Addison-Wesley, Massachusetts, 1991.

4 Simon Penny, 'Machine Culture', in *SISEA Proceedings*, Wim van der Plas (ed), Groningen, 1991, p. 184-191.

5 William Bricken's statement, "The 3D sound stuff at NASA is art. Myron (Krueger's) work is art. The code is, the VEAS (Virtual Environment Authoring System) is art — that is, some coding style considerations are motivated by aesthetics", doesn't really help us out from this dilemma. Neither does Brenda Laurel's article 'Artistic Frontiers in Virtual Reality', from which this quotation is taken (*Siggraph '92 Visual Proceedings*, John Grimes and Gray Lorig (eds), ACM, New York, 1992, p. 60). The corporate people are far too eager to join the artists' ranks, with far too little credits.

6 See for example: Bill Nichols, *Ideology and the Image*, Indiana University Press, Bloomington, 1981, pp. 182-207; Margaret Morse, 'Talk, Talk, Talk — The Space of Discourse in Television', *Screen*, Vol. 26, nr. 2 (March-April 1985), pp. 315.

7 David Tafler, 'Beyond Narrative: Notes Toward a Theory of Interactive Cinema', *Millennium Film Journal*, nos. 20-21 (Fall/Winter 1988-89), pp. 122-123.

8 This raised a storm amongst the more traditionally-minded documentary film-people at the 37th Annual Robert Flaherty Seminar in the summer of 1991. See Laura U. Marks' review of the event in *Afterimage*, Vol. 19, No 4 (November 1991), p. 4.

9 Michael Naimark, 'Realness and Interactivity', *The Art of Human-Computer Interface Design*, Brenda Laurel (ed), Addison-Wesley, Massachusetts, 1990, pp. 456-457.

10 Graeme Weinbren, 'An Interactive Cinema: Time, Tense and Some Models', *New Observations*, No 71 (October-November 1989), p. 14.

11 My impressions of *Sonata* are based on a short session in the artist's studio in New York City, August 6, 1992. The impressions usually change during subsequent sessions.

12 Myron W. Krueger, 'Videoplacement and the Interface of the Future', in *The Art of Human-Computer Interface Design*, op.cit., p. 420; Myron W. Krueger, *Artificial Reality II*, Addison-Wesley, Massachusetts, 1991.

13 For an intelligent discussion of this, mostly in the context of computer graphics and computerized special effects on television, see Margaret Morse, 'Television Graphics and the Body: Words on the Move', paper for 'Television and the Body', Society for Cinema Studies, Montreal 1987 (unprinted manuscript).

14 I haven't had a chance, at the time of writing, to navigate through Stenger's *Angels*. My impressions are based on a demotape documentation about such a navigation in *ACM Siggraph Video Review*, Issue 83 (1992), and on an article by Louis M. Brill, 'Paradise Found in VR Movie', *Siggraph 92 Show Daily*, July 29, 1992.

15 Brenda Laurel, *Computers as Theatre*, op.cit., p. 21.