

# Interactivity, Public Art and Architecture

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*“There seems to be a parallel between the emergence of the archeological art and some changes taking place in the cultural and intellectual ambience. The general framework seems to be the gradual displacement of the 1980's "postmodernist" discourse in favour of an approach which once again seeks foothold in "real" space and time.”*

Errki Huhtamo<sup>1</sup>

### Introduction

I was struck by how many of the conference presentations, not simply in this session, mention the word “architecture” or “city”. As Errki Huhtamo points out in the above quote, this seems to be an expression of a general desire for an art that is in part tangible, physical and social in nature and intent. When he talks of archeological art he appears to mean an art referencing and recycling earlier technological histories. An art that attempts to gain critical purchase through a tension between its electronic space and its physical and mechanical one.

Thus while I intend to concentrate on examples of haptic or physically responsive interactive art in public spaces and installed architectural contexts -that is ”real” space and time, I recognise here a fascinating problem of definitions . For “Public” space in the late 20th century also means the infinitely expanding region of cyberspace. I tend to agree with Paul Virilio’s term for this bifurcation of our realities as the “accident” or advent of virtual technologies. The question of virtual worlds and architectures of the net will be later addressed, since the same syntax and grammar of experience applies to both aspects of digital art in the “public” domain.

What Virilio also makes clear is that the new technologies are progressively diminishing and even finally eliminating a fundamental condition of human perception -spatial distance<sup>2</sup>, the distance between subject and the object. In this reading “distance” is a positive quality of vital importance to the development of meaningful art .

## **Philosophies**

The tracking of recent philosophical debate explains the renewed interest in strongly physical presence and digital interaction. Following from Benjamin, for Baudrillard the ‘aura’ of authenticity is lost forever in a world of media simulation, defined as a creation of the “Hyper-real” which has no material origin or reality . In media culture the ground of truth is lost and all that remains is a universe of self-referring “simulcra of simulations” which render decidability impossible. To Baudrillard this is the last throw of corporate capitalism , where instead of the territory preceding the map, the map of media simulation engenders the territory of consumer culture.

Other French philosophers have identified the anarchistic potential of the same process of simulation. Gilles Deleuze, inverts Baudrillard’s definition of simulacra as perverse deceptions and false images. To Deleuze the simulacrum circumvents authority by including the spectator and the spectator’s viewpoint as the sustaining necessity of the illusion. The simulacrum should not be thought of as a degraded copy, but as a positive force with the power to subvert the world of representation, by transcending the idea of original and copy and so denying the privileging of particular viewpoints. As I hope to show, this is precisely reflected by emerging trends in new genre public art that uses digital technology for “subversion” as an artistic strategy. Krzysztof Wodiczko’s urban projections are a perfect example of this approach.

For Paul Virilio an evolutionary ‘accident’ has occurred and the universe is henceforth split into two competing , but equal realities : the virtual resulting from an accident of the ‘real’ , asserting that a ‘substitution’, rather than a “simulation”, has occurred.<sup>3</sup> This implies that we can choose to live and breathe in cyberspace: while some artists such as Stelarc have literally tried to wire themselves in physically, the artists in this discourse are living with and examining the contradictions embodied in this “substitution” of realities.

In the 1990s the question for artists has become not the authenticity of the image and its relationship to a set “reality”, but who controls the generation of simulations or substitutions and their contexts of their presentation. New practice in public art is intent on exploring these issues of control creatively. The gap between non-digital practice and technological art is finally closing after many years in which form supplanted content.

## **Origins**

Consistent themes and uses for electronic art in public contexts were established early in the century and threads of similar practice may be traced through from Dada, Futurism and Constructivism and the Bauhaus to the present day. After all Tatlin was playing with motorised architecture in his monument to the Third international in 1920. The distant relationship between artist and architect has also created problems in the integration of public art , let alone digital art into public spaces. It is no accident that some of the more successful examples of actual or potential public art works using new technology have been produced by architecturally trained artists, most notably Shaw, Moller and Diller & Scofidio. Because of the paucity of such examples, I won't apologise for addressing the potential found in several gallery works which could equally well serve in a public context.

In researching the origins of interactive work of this nature I was profoundly embarrassed to discover a common tendency ( including my own) to repeat the experiments achieved nearly 70 years ago. Worse still much of the technology evident today in public installation works is largely unchanged since the mid-60s! So much of what we think of as innovative was explored in some way during that period. EAT - Experiments in Art and Technology was founded in 1966 . B y 1969 it boasted a worldwide membership of 3000 artists and 3000 engineers.

Rauschenberg and the group staged a series of large-scale public events and installations called 9 evenings. The most notable was “Open Score” at the NY Armory in 1966. A Tennis match with rackets containing tiny fm transmitters ensured that each time a ball was hit a light would extinguish to an amplified sound: eventually the match ended in total darkness.500 volunteers then entered the court and went through a number of

behaviours in darkness while their cctv infra red images were the only thing the audience could see on huge projection screens—a form of “darkness visible”.

In “Soundings”, a collaboration with Bell labs, Rauschenberg installed sound sensors to control a lighting rig. Audience talk controlled the light falling on the huge multiple mirrored plexiglass panels silkscreened with images of wooden chairs so the chairs appeared to move randomly. While breaking ground in the development of public installations, the inconclusive nature of these experimental pieces was only partly due to immature technology, their rather vague grasping after metaphor and meaning suggests that Rauschenberg simply ran out of steam after solving the technical problems.

EATs seduction by technology was to culminate in the Expo 70 Pavilion in Osaka. Sponsored by Pepsi it was an attempt to create a “living responsive environment”, a non-hierarchical theatre space. It was a reprogrammable space with a giant “mirror room” full of interactive sound areas, a giant fog sculpture and motorised exterior sculptural elements or “floats” by Robert Breer. Innovative work was done with individual wireless hand sets and programmed laser displays. Visitors were responsible for their own experiences. The world of Fluxus and the Happening governed what was little more artistically than “son et lumiere”<sup>4</sup>.

## **Contrasts**

If we compare this kinetic architecture with public art such as the Monument against Fascism by Jochen and Esther Gerz, we can see how far notions of appropriate content have moved in two decades. Installed in Hamburg in 1986 in the form of a Lead column 30 feet tall, the public were invited to incise it in response to a text pledging personal political responsibility. It soon became a graffiti board, sinking into the ground on hydraulic ram as the texts filled it. It refused to be the normal kind of authoritative symbol, but instead acted as repository for all the pain and contradiction of Germany past and present. The column is now fully hidden. While employing little in the way of new technology, it remains a seminal work of public interaction. All the more powerful as a metaphor for the buried tensions around racism and the Holocaust still prevalent in today’s Germany.

Another early monumentally large public installation exhibiting the same techno-enthusiasms as Pavilion was Michael Hayden's Arc en Ciel 1978, consisting of many-hooped fluorescent tubes arching above the platforms of the Yorkdale subway station in Toronto . The piece measured 570 feet in length and was responsive to infra-red radiation. The arrival or departure of a train caused the piece to ripple with sweeps of multicoloured light following the passage of the warm subway train. 20000 effects were programmed on a cycle of 40 hours. The sensors could even respond to the movements of individuals on the platforms. The contrast with Diller and Scofidio's 1995 intimate text work at Lexington subway could also not be greater.

One of the most successful works of computer art of the late sixties and early seventies in terms of a fully realised interactive installation was produced by Edward Ichnatowicz. The giant public piece which performed a seminal role in the realisation of what was artistically possible with computing and robotics was the Senster.<sup>5</sup> It was an active metaphor playing on an audience's techno-fear and its simultaneous ability to control the products of nightmare remotely. Installed at the Phillips' industrial exhibition Evoluon at Eindhoven in 1971, it represented an extremely ambitious technical and artistic feat. About fifteen feet long and 8 feet high, the Senster consisted of six independent electro-hydraulic servo systems based on the articulation of a lobster's claw , allowing six degrees of freedom. The Senster had a "head" with four sensitive microphones which enabled the direction of the sound to be computed and also a close range radar device which detected movement. The whole was controlled in real-time by a digital computer which sent feedback from the movement and sounds of visitors to the Evoluon , so that the servos could reposition the head anywhere within 1,000 cubic feet within a couple of seconds.

Using a predictor, the programme put the machine through a complex series of accelerations and decelerations for the maximum efficiency of motion. The net result was convincingly lifelike in its movements and would shy away from loud noises. Unlike the automata of earlier ages the Senster didn't try to conceal its inner workings, never the less the public's response was to treat it as if it were a wild animal. The Senster, which works on so many levels of meaning and has never been surpassed in a robotic piece.

At the same time these early and grandiloquent projects were being thrust into the public eye Myron Kreuger was patiently mapping the territory by developing a language of interaction. Since 1974 his efforts have been focussed on the development of 'Videoplace' .An attempt to create a wire-free projection environment capable of responding to each participant differently with over 12 interactive routines. The most famous of these was the 'critter'-a small circular figure which avoids contact with a projected image of the participant. Kreuger's outstanding achievement lay in the foresight he showed in examining possible types of interaction, many of which inform both telematic and installation practice today. Interacting recently at an exhibition in Duisberg with a reconfigured version of this piece, I was struck by the play space, capable of reducing adults to their 5 year old selves. <sup>6</sup>

## **Contemporary work**

This sense of play , curiosity and inventiveness is reminiscent too of the fairground attraction and in many ways his approach mirrored that of Toshio Iwai whose entire oeuvre including his public art is based on play . In "Another Time, Another Space"created in Antwerp central station in 1993. Toshio Iwai made an electronic hall of mirrors using a tree structure of video screens. The installation featured 15 video cameras, 30 computers, 30 video monitors, and a videodisk recorder. The comings and goings of people through the station were filmed by the cameras, and manipulated in real-time by the computer to deform shape, time reference, and showing a different time-space environment in each movement. Video processing software reflected back crowds like fields of wheat where algorithms interpreted successive layers of crowd as wave- like motions. Sober-suited business men leapt and cavorted in front of these magic mirrors.

“I used the "Another Time, Another Space" system to create an experimental event as part of an NHK television program. People passing in front of Shinjuku Station were photographed by a video camera and the images were altered and projected onto the giant Alta Vision screen across the street. It caused a much larger commotion than we expected. The moment the image appeared on the screen, hundreds of people started gathering in front of the station and waving their hands and moving their bodies as they watched their images on the screen. In that moment the big screen that everyone had been taking for granted suddenly became a giant interactive event.”<sup>7</sup>

## Haptic Interfaces

This brings me to the principle subject of this paper, the nature of physical interaction in public art. Intimacy or crowd collaboration are both legitimate modes for the experience of public art. While Jeffrey Shaw is not an example of a public artist he is a wonderful source of examples of appropriate physical interfacing to works which could easily be placed in public contexts. Perhaps because of his background in architecture Shaw has always included strong physical elements for interaction in all his works. He defined the relationship between responsive architecture its development at ISEA 1994:

“Responsive soft architecture in the 60's  
Kinetic luminous sculpture in the 70's  
Virtual architecture in the 80's  
Televirtual architecture in the 90's”

His famous piece *The Legible City* <sup>8</sup> 1989 , combines a highly physical interface with virtual reality. The City is a computer controlled and projected virtual urban landscape made up of solid three-dimensional letters that form words and sentences instead of buildings along the sides of the streets. The architecture of text replaces exactly the positions of buildings in a plan of the real cities (New York and Amsterdam). This spatial transformation of narrative is literal in every sense.

Bicycling through this city of words is a journey of reading , choosing a direction is a choice of text and meaning. The image of the city is projected on a large video screen in front of the bicycle which is fixed like an exercise-bike.

His “Revolution” 1990 was an interactive videodisk installation which allowed the user to turn the mill of history, tracing 200 years of turbulent history from 1789 to 1989, The considerable physical effort required to turn the installation is enough on its own to give “gravitas” to the content, demonstrating a perfect synchronisation of metaphor and interface.<sup>9</sup>

While Shaw’s works required a single user, another experimental interface which prefigures multi-participatory public works was created at the Banff Centre in Canada by Perry Hoberman . *Bar Code Hotel* <sup>10</sup> is an interactive environment for multiple participants . An entire room is

covered with printed bar code symbols, an installation was created in which every surface can become a responsive object, making up an immersive interface that can be used simultaneously by a number of people to control and respond to a projected real-time computer-generated three-dimensional world.

Each “guest”, who checks into the Bar Code Hotel is given a bar code wand, Because each wand can be distinguished by the system as a separate input device, each guest could have their own consistent identity and personality in the computer-generated world. And since the interface was the room itself, guests could interact not only with the computer-generated world, but with each other as well. The objects in Bar Code Hotel were based on a variety of familiar and inanimate things from everyday experience: eyeglasses, hats, suitcases, paperclips, boots, and so on. Thus the co-dependence of our two universes was established through the simplest piece of supermarket technology.

The largest scale experiment in public interaction in virtual spaces was the BBC’s “Mirror” <sup>11</sup> project which used the net and vrmf to create various user spaces with representation by simple geometric avatars. The physical interfacing was trivial by comparison with Davies’s work and suggests a very wide gap between participatory VR in the gallery and in larger public contexts.

In 1995, through the direct physical control of breathing, Char Davies’s “Osmose” <sup>12</sup> allowed the participant to explore a poetic virtual universe. The user sinks like a diver into a virtual and seemingly organic landscape as their breathing slows. Because of the unusual interface many participants found it parallel to near death experiences, particularly as the virtual world throws you out at the end of your timeslot, by shrinking to a bubble in infinite space.

Sommerer and Minnoneau have consistently worked with artificial life environments, often controlled through highly physical interfacing. From their interactive Plant Growing 1993 where virtual plants grew by the electrostatic reaction of plants to human touch, through to the water-covered interface of A-Volve in 1994. A survival of the fittest virtual aquarium where creatures created by the audience struggle to swim, eat and die. Audience attention through touch prolongs the life of the



creatures. The advent of a biological interface between real and virtual space had arrived.

### **Telematics and the collapse of distance .**

While Virilio implies a certain unease with the collapse of “distance”, the physical telescoping of experiential distance is greeted with wonder and utopian enthusiasm by many artists. The confounding of immediate presence and art is a questionable mental manouvere, if the context and content do little more than embarass or confound the public. Galloway and Rabinowitz<sup>13</sup> created Hole in Space in 1980 using a direct video livelink installed between LA and NY streets allowing direct dialogue between public in the two locations. It is debateable whether this was early teleconferencing or art.

In a lighter frame, Paul Sermon’s experiments with telepresence such as Telematic Dreaming 1992- an interactive bed where through an aligned projection of a similar bed two people displaced by distance could indulge in interactive foreplay with each other’s video ghost. The variety of human behaviours is endlessly fascinating to audiences, but the art remains close to a 60s Happening.

My “Memory Wall” proposal uses physical telemetry depending on a two way array of wired hydraulic rods, like a vastly expanded executive toy. Bas relief projections would be transmitted between two public venues, as the audiences literally embed themselves in the wall.

### **Architecture**

If we look next at the possible fusion of physical architecture and public art works, we see another discrepancy. Materials technology in the 1990s is begining to deliver the means for artist-architect collaborations which might finally realise some of the 1960s dreams of adaptive or “liquid” architecture . Dreams of groups like Cedric Price’s Archigram and later visionaries like John Fraser<sup>14</sup> . The development of electro-heliological fluids which transform from liquid to solid state at the passing of a current, piezo-electrical ceramic which can change colour to order, SMA-shape memory alloys which act like muscles and liquid crystal glass, paint and inks that respond to tiny electrical or temperature changes allow a building or artwork to behave in a biological manner. New research in

nanotechnology combined with artificial life programming implies self repairing and “living” systems grown around human needs.

Even at the basic level of combining existing architectural materials with digital artwork, very little has been achieved, although the techniques are already in place. My researches into large scale digital murals in ceramic are only one example<sup>15</sup>. The work of Art of Change in London’s East end is also worthy of note.<sup>16</sup> Public art tends still to rely on the same electromechanical mechanisms developed 30 years ago by EAT. The use of digital signage and billboards for public art in the late 80s early 90s is well documented and often proved a powerful tool in the hands of an artist as accomplished as Jenny Holtzer<sup>17</sup>. However more permanent integration of such work in public contexts remains elusive. An exception to this curious reluctance to engage with new materials is Christian Moller.<sup>18</sup>

His pioneering work points the way, with buildings such as the ZeilGalerie in Frankfurt (1992) which changes colour at night according to wind direction and speed, while a sine wave of light ripples its length governed by ambient noise from the street. People gather at night to clap and create sounds that alter the wave. How seriously one should take such interaction as art is another question.

Moller’s more thoughtful gallery piece Electronic Mirror confounds our narcissism with a distance sensor and electroresponsive LC glass, clouding-over our image on close approach so we are literally swallowed by the glass like digital prisoners-shadowing the original myth.

In Space Balance (Ars Electronica 1992) a virtual interior architecture mirrors the hydraulic tipping of the viewing platform. The participants can roll virtual balls which click as they collide by the movement of their bodyweight on the platform. A similar device was used in “The Virtual cage” in Frankfurt in 1993. The viewer dances on the platform in relation to a virtual swarm that interacts with the viewer’s movements. This use of a tilting floor is currently being developed by Grahame Weinbren as a way of allowing audience participation in his interactive films and by Mirosław Rogoła in his 1994 ZKM installation Lover’s Leap.

## **New initiatives**

In Bristol a number of new initiatives are changing the climate on artist-architect collaboration. The Multi-million pound Harborside development

promises to incorporate the latest technologies in artist -architect collaborations. This unique scheme offers unprecedented opportunities because of the large public spaces and the nature of the building development. A state-of-the-art hands-on science centre with a vast changing LC wall , an imaginative centre for the performing arts and an electronic zoo, where live habitats are telematically projected in real time, frame and contextualise the public spaces. My current collaboration with the Inscape architecture group is around an interactive architecture and public art proposal- the Orbit Project. This is an attempt to map the millennial configuration of the solar system onto a city landscape. A genuine art-science collaboration, each planetary site would generate its own artist's commission.

At the centre of the scheme is a giant orrery, housed in a glass dome. Its major features would be an interactive physical solar system model, with scaled rotating planets controlled by computer in response to visitor's touch-screen commands. This will be housed in a glass dome etched with markings showing constellations and incorporating interactive electro-chromic or flat plasma glass displays, providing information about the solar system in response to visitor interrogation. Around the dome will be an interactive spatial music installations based on sound elements from the main planets recorded by radio telescope and activated by visitor presence and movement through Ultrasound detectors linked to midi sequencers. The surrounding podium and pavement will, through an artist's commission, celebrate historical and mythological understandings of the Sun

The 9 scaled planets will be housed in a sealed transparent glass cylinder towards the base of each 8 metre obelisk, constructed in similar modular form, but of varied high quality materials reflecting the geography of each planet. At each site, an artist's commission including strong community involvement, also interpreting associated mythology, would utilise and landscape the podium and pavement base. Interactive technologies would be part of the commissioning brief for each site. A pilot full scale model obelisk has already been temporarily shown in Bristol.

### **New Digital Landscapes and Subversions**

In contrast to this rather formal and monumental project , There have been a number of attempts to create interactive architectural spaces by British

artists. For example Simon Biggs with his installation “Heaven” , commissioned by the European Media Art Festival 1993 for a projection onto the ceiling of the Dominikanerkirch, Osnabruck, Germany, 18 metres above the viewers heads. Cathedral uses remote visual sensing techniques to track the viewer. Each viewer was allocated an angel (or demon, depending on location) which followed the position of the viewer on the floor analogously on the ceiling. The viewers actions control not only the behaviour of the angels/demons but also a large range of other images, which are dynamically composed on the ceiling used audience movement to alter virtual architectural features such as angels and gargoyles projected onto the roof space. In the 1993 River Crossings public art project , Susan Collin’s Tunnel , similarly mapped responsive soundscapes and video projections into a pedestrian tunnel under the Thames.

In Britain the Imag@nation<sup>19</sup> initiative, as mentioned earlier, is opening up opportunities for new media public works in the SW . The artist-led scheme is a million pound initiative involving twelve major digital commissions two conferences, workshops and a host of smaller events. The artists involved reflect a diversity of practice, but all are in some way related to a tradition of site-specific and community based practice where the monumental and corporate is often subverted. This is reflected in the installations of several of the artist initiators who see themselves as working with new genre Public Art<sup>20</sup> .

My residency commission at Bristol’s Watershed, “Screening the Virus<sup>21</sup> , was a part of World Aids Day arts initiative . It was a multimedia public art piece based on experiences and issues raised by sufferers, carers and friends of those with HIV or AIDS. A work in progress, it attempts a similar openness to public feedback as Gerz’s monument. As a web space it will self-curate submitted images and words by an automatic comparison with a list of keywords. The site is planned as a set of four domains, or landscapes, based on the mediaeval humours of earth, water, air and fire. Each landscape stands for a different aspect of the experience of HIV/AIDS and contains a generic human figure. The figures form part of the selection interface. Callers’ contributions in image and text - personal responses to different aspects of AIDS - determine the relative ‘health’ of the figures, depending on the number and type of hits. The more positive the attention given by callers the healthier the bodies will appear (reflected through colour changes), thus acting as a ‘barometer’ of the climate and nature of the attention the site receives. Any homophobic or abusive

contributions will be included as part of the context of this electronic AIDS quilt. The site will also be projected as a three dimensional installation responding to audience through pressure pads and video detectors.

Annie Lovejoy is another lead artist in the Imag@nation initiative. Her work also addresses difficult public issues-her digitally produced sugar packets were distributed throughout Bristol's recent Festival of the Sea, warning that much of the maritime wealth of the city came from earlier its involvement in the slave trade and its main products sugar and tobacco. Her digital land-art works are sensitive reminders of the power of language. Her giant computer originated "Watermark" from 1996 at Newton-le-Street in Northumberland is a vast pun, visible for many miles. Sited by a canal, it comments on the scars of the first industrial revolution. The digitally designed grass in her 1995 Shave<sup>22</sup> residency piece "Pause" was cut out and watered for a week and then returned to its more arid site suggesting the relativities of nature through its videoplayer text.

One of my current collaborations is with Tony Eastman in a proposal for an interactive light causeway to St Michael's Mount in West Cornwall activated by tidal pressure with sound installations at either end, based on the legend of the giant who is believed to have built castle rock. The Project would leave a physical legacy in the form of a giant carved footprint surrounded by the inscribed writing of local children. The project is precisely the kind of mixed media event that is now emerging in public art practice with the idea driving the technology rather than the reverse.

A similar set of ideas informed my recent work "Here be unicorns" -a playful installation which was part of the Open City Public art project in Bristol. The computer designed and cut steel unicorn templates referenced the gold unicorns mounted on top of the city hall. They were moved across a grassy area leaving their pale green shadows where the sunlight was blocked. As they were moved, images were to be progressively etched on their surface, based on dreams posted by the public in a special "dreambox". They suggested the loss of an earlier legendary past where nature was an undivided whole. Mapping the public's dreams on the unicorns was an attempt to recall a part of that magic. My own dreams were shattered when one was stolen. The immediate response was to stage a scene of crime scenario using digital posters, where the public were invited to assist in its recovery. The other unicorn has found a home in a

local school , covered in children's dreams.

Simon Poulter is another digital artist involved in Imag@nation who was originally graphic designer and his public artwork deals with the power of the corporate through digital posters, websites and multimedia pieces. He attempts to underline the contradictions behind the smooth facade of advertising. Through his “countermarketing” company UK Ltd<sup>23</sup> he has variously attempted to sell Stonehenge and “discovered” a 15th century scratch card . He ran a PR and marketing campaign in the manner of British Airways or British Gas. Pathfinder prospectuses were issued along with press releases to MP's, business people, the media and the public. This resulted in calls from national newspapers, Bank Managers and business people. The press releases declared UK Ltd's interest in complete deregulation, including its ambitious plan to privatise Stonehenge and turn it into a theme park. UK Ltd opened a number of 'share shops' around the country, offering further information on its share portfolio. At each share shop, the CEO of UK Ltd has attended a launch and talked ”keenly” to the general public about share ownership.

It sometimes seems there are as many types of public digital art as there are artists. As we have seen successful practice must place content and meaning above technology. It must achieve “distance” in its true sense of all elements in clear relationship. But if it fails to engage with the full potential of those technologies, it fails to find the new form and meaning for which all art ultimately strives. The old voices may be saying the same things, but , as always, only the new voices can be heard by the tired ears of the “Public “. To quote Regina Cornwell:

“These explorations are crucial to how the world can be re-drawn and viewed in an art whose power is in its open-endedness and polyphony. And for the participant the installation too is hard work. To be meaningfully experienced demands time and serious attention.”

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1 Humato-Telepolis - das Magazin der Netzkultur ([www.ix.de/tp](http://www.ix.de/tp)).

2 Virilio, "Big Optics," Jonathan Crary, *TECHNIQUES OF THE OBSERVER: ON VISION AND MODERNITY IN THE NINETEENTH CENTURY* (Cambridge: The MIT Press, 1990),

3 Interview in "ctheory" 1995

4 Pavilion-Experiments in Art and Technology, B.Kluver Dutton, NY, 1972

5 Science and Technology in Art today Jonathan Benthall ps80-83 Thames and Hudson London 1972

6 InterAct :Schlüsselwerke Interaktiver Kunst Wilhelm Lehmbruck Museum Duisberg 1997

78 Personal e-mail description

8 Ten 8 V2 No2 Digital Dialogues ps 46-47 Autumn 1991

9 InterAct :Schlüsselwerke Interaktiver Kunst

10 Banff Centre for the Performing Arts 1992

11 BBC Television The Net 1995

12 Shown at the Museum of Modern Art , Montreal , September 1995 and Serious Games in London 1997

13 InterAct :Schlüsselwerke Interaktiver Kunst catalogue ps22/23

14 See Architecture Association website  
<http://www.gold.net/ellipsis/evolutionary/evolutionary.html>

15 Research carried out at the Cardiff Institute Department of Ceramics 1991-2

16 Peter Dunn and Loraine Leeson have collaborated in Londons Docklands as political artists mounting poster campaigns against corporate developers in the area for nearly

two decades. Art of Change is an agency for public art and digital media.

17 See Jenny Holzer by Diane Waldman Guggenheim Museum 1997

18 Interaktive Architektur Christian Moller Galerie fur Arkitektur und Raum Berlin 1994

19 Funded by the Arts Council of England via an Arts for Everyone award .This project will run across the English South West region from 1997 to 1999

20 See Mapping the Terrain: New Genre Public Art, Suzanne Lacy ,Bay Press Seattle 1995

21 The Screening the Virus residency was funded by Artec, Cambridge Darkroom and SW Arts as part of World Aids Day events. The pilot web site accessible via ArtAids <http://www.illuminate.co.uk/artaids/pages/credits/index.html>

22 An annual international residential workshop for artists staged at Shave Farm Somerset

23 Website for UK Ltd is at <http://www.livjm.ac.uk/~agitprop/>