Sciences of the Interface, ZKM 2001

The Art of Interface Technology (2001)

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S. 272-281

1 Introduction

This paper is about the art of interface technology, projecting the future of the image technology. I focus on the physics of the image. From the physics of computation, as we have learned it from the work of Fredkin and Feynman, I sketch a forecast of the future of the image.

2 Observation of Observation

Firstly, I will describe some of my own work, dating from about thirty years ago, to formulate the problem. The first video that I show has been produced for the Austrian Television. It was broadcasted in 1970. It is called "The Endless Sandwich" [1]. It contains already the model of multi-universes, or as Otto Rössler formulated: The boy in the bubble. Here we have many boys in bubbles, a little bit like a Russian doll. You also see a cascade of observers.

Twenty years later, Niklas Luhmann started the discussion on "the observer of first or second or third order etc" [2]. In my own work I already investigated the idea what happens if one observer observes another observer. Imagine that this was broadcasted in real television, which means that you will find a real person at the end of the chain of mutual observers.

An error happens in the first Universe. The person has to get up to correct the error, and while he does so, it jumps to the next Universe. In the end, each Austrian TV viewer had to get up to readjust his own TV. So this is one of the first models of Multi-universes and how the information exchange and transformation works. You can see very clearly that the TV is treated as a kind of interface.

Another work I did in 1973 was called "The Observation of Observation – Uncertainty" [3]. It was a closed-circuit video installation. Somebody was watching himself, but due to the installation of cameras and monitors, he could only see himself from the back, not, as he was expecting, from the front. Watching oneself in such a way destroys one's identity. Like in quantum physics observation is an act that influences the information we get. Already in the beginning of the seventies I saw a correspondence between quantum theory and media theory, respectively image theory. The correspondence centred around the function of the observer, as well as in quantum mechanics as in interactive video-based and computer-based installations.

3 Theory comes before Experience

I would like to call back to your minds that Heinrich Hertz did his famous experiments in 1886 and 1889 in Karlsruhe. As you know, in his laboratory he generated for the first time electric waves and showed that these electric waves are identical to optical waves. Thereby he proved first of all the existence of electric waves and secondly that Maxwell's equation from 1873 had

Figure 1: *Screenshot of the Video "The endless Sandwich".*

been right. This for me is the beginning of a new era, because it shows that theory comes before experience. Before, physics and philosophy relied on the primacy of experience, on which the theories were modelled. In the case of Hertz' derivations, for the first time, theory was much ahead of experience. Experience was exchanged by what we call experiments.

Everybody accepts that you need a lot of theory in the natural sciences. The new era, the new world is theory dependent. However, an interesting point is: the only field in which people usually do not accept the dependency on theory is art. They want to understand art immediately. If an artist argues that you need explanations, that you cannot look on art without theory, as is the case, with abstract paintings, he usually is attacked, because such an artwork is regarded as too dependent on theory.

There is a book in America called "The painted word" [4], and the author, Tom Wolfe, is blaming modern art, e.g., the abstract expressionism of New York, exactly because of this. He says that this art is only valuable because of the many written commentaries added to these artwork. My suspicion is that people that refuse art that depends on theory want to exclude art from the modern world. What we do in art nowadays is like in science to formulate theories and then we make experiments to prove them. Only art of this kind is art as a part of modern times.

In the nineties I focused in my work and philosophy of the image on the virtual image in computer based interactive installations. I discovered three steps defining the new virtual or algorithmic image. First the virtuality of the information storage. The next step is the

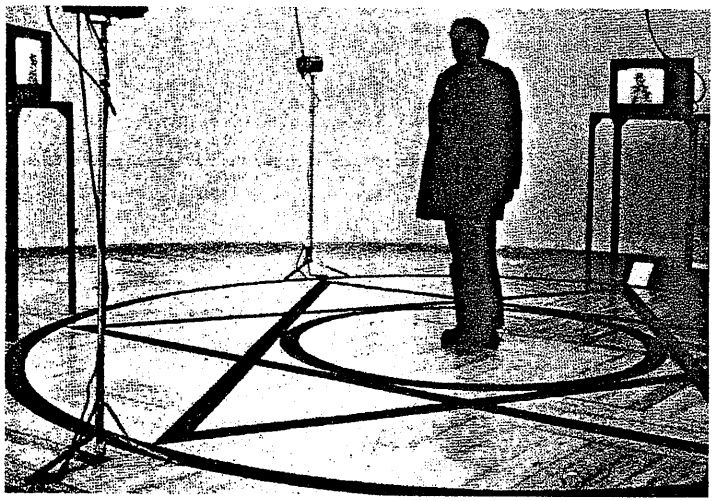

Figure 2: *"The Observation of Observation – Uncertainty", a closed-circuit video installation.*

variability of the image contents. Finally, when an image is just a set of variables which can vary at any moment, this image becomes a system which has a lifelike behaviour. We then speak about the viability of the image behavior. What do we have to expect for the next decade?

4 Distinction Constitutes the Interface

To approach to the idea of an interface consider two states, state A and state B, respectively, and that the interaction between these states is not restricted to one direction, but takes place in two directions. In a sense, this bidirectional interaction is reversible, if you accept for a moment this expression. Between these two states, a transformation of information takes place correlating cause and effect. If you have a cause here, you have an effect there. Normally this happened in a local horizon. The interaction in a computer based installation is locally bound. In net-based installations the interaction is not longer locally bound. The interaction is reversible and approaches the simulation of what in quantum physics is called "entanglement". A cause in one point of the universe has an effect on one point beyond the local horizon.

What I would like to do now is to outline the steps that we have to make according to this definition. It is a kind of differentiation which leads to the idea of an interface. For example, Ivan E. Sutherland wrote in 1963 his famous Ph.D. thesis He defines a tablet as an interface to the machine. "Sketchpad: A Man-machine Graphical Communications System" [5]. A change in the tablet (state A) results in a change on the computer screen (state B). But the question is now: Is the machine the interface, as suggested by Sutherland's title, or is the alphabet already

an interface and the machine just a physical implementation of a formalism?

What we have to do here is in fact to create a difference. George Spencer Brown wrote a book in 1969 called "Laws of Form" [6], and his first sentence was: "What you have to do whenever you create a system, whenever you look at the world, you have to draw a distinction". Draw a distinction between you and the world, between your body and your soul. Whenever you make an observation, you draw a distinction. This is his basic theory.

The point is now that whenever you draw a distinction, like here in Sutherland, you can also, in a further step, erase a distinction. You will then find a new distinction. In fact, when you erase an old distinction, you are going on to construct a new one. The idea behind the distinction is equal to the idea of an interface. We define interfaces, then we erase them to construct new ones. In fact, I could call Sutherlands interface not a man-machine interface, but also a machine-machine interface, because both tablet and screen are machines. However, then I could say: here is my hand as an interface. Sutherland may say we have a hand, an interface and a machine, which is already a cascade of interfaces. People have normally the tendency to say that the hand is not an interface. But if you draw a distinction between your consciousness and your body, you realise that your hand is also an interface.

Adopting the title of the famous article by Warren McCulloch "What the Frog's Eye Tells the Frog's Brain" [7] the frog's eye actually can be seen as an interface to the frog's brain, because the frog's brain tells the frog's eye what to do. Thus, I, or speaking with rational psychology, my brain can tell my hand what to do and then my hand acts as an interface to this tablet which activates the machine.

So what follows from this: we construct a distinction, and a distinction is in fact a regulator on a relative scale. You have a set of variables and a scale of differences and then you take a regulator and draw the distinction – in this case between my hand and this tablet. I could just as well say that I draw the distinction between this tablet and the screen, or between the alphabet and my consciousness. In my opinion, the alphabet already is the first interface.

5 Interface Between Real and Virtual World

In 1991 I did one of the first interactive computer assisted installations [8]. I used buttons on the floor that activated letters when being stepped on. The installation was endowed with specific functions which allowed to write big or small letters etc. In addition, a memory function had been used that kept each phase of the motion memorized.

The point is now that you can also switch between different worlds. I made four different worlds available. The buttons are an alphabet for different worlds. There is a world of architecture, a world of objects, a world of letters and a world of gas clouds. The objects can be rotated, changed in color, texture, size etc. There is only one code, one interface, one set of buttons, but you can enter at the same time four different worlds. This is the idea of the Pluriversum or the Multiversum. You have access to four different virtual worlds. One could even think of thousands of different virtual worlds if we had the computers to make the calculations. Probabely we need quantum computers that enable us to make reversible communication between this massively parallel virtual worlds possible.

Here many people can walk around on an interface modelled after our alphabet and thereby create different vitual worlds. In the fourth world we find, as already mentioned, gas clouds. They are the first artificial creatures, because they have a lifespan of approximately 10 seconds, they are looking around to find others of the same color to copulate and create offspring, and if they find somebody with a different color they try to eat him to prolong their own lifespan. They were relatively autonomous, so here we have one of the first works with autonomous

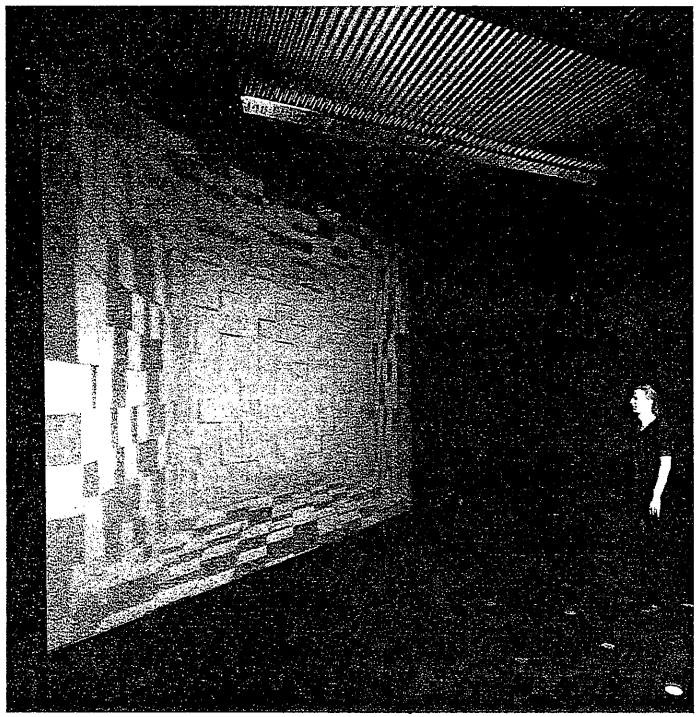

Figure 3: *Interactive computer-assisted installation.*

intelligent agents. It is a simple model of Darwinian evolution.

Now it becomes clearer what I mean if I say that an image has a lifelike behavior. It is important to realise that the interface is a regulator on a scale of distinctions. We can make different definitions. So we have in fact a hierarchy of interfaces.

The classical world just accepts an interface between two points of the real world. If we think again of those states A and B, then we accept naturally that these states are two states of the real world. In art, the idea of the hierarchy of interfaces enables us to have representational states in the real world or in the symbolic world like language or images. For example, a telephone is an interface in the classical world. It is an interface between two space-time points in the real world, e.g., from Karlsruhe to Sydney. There is an exchange of information in both ways. However, in the non-classical world we have different possibilities. Of course, there is also the possibility to connect two points in the real world, but as I have shown in my work, it is also possible to create an interface between the real and the so-called virtual world. It is yet another distinction as when using the interface of language, as we have seen before.

6 Bidirectional Interfaces

Whithin the range of computer assisted installations, we find an expanded set of interfaces, such as bicycles or plants, for example. All this installations deal with an exchange of information, however, they are still locally bound and not "reversible". When you are riding on the bicycle [1] [9], the image has still the same local horizon and the image has no effect back to you. Or, when you touch the plants [2] [9], it triggers the growth of plants in the simulation, but again, this has no effect back to the the real plants.

What we have to look for in the coming decades are transformations that are bidirectional. From the virtual world, something has to go back to the real world. We have also to overcome what I would like to call the locally bound situation of a computer installation or a video installation. To give a concrete example, assume a net-based installation by which one has the possibility to send a ping-signal to a server in Vancouver that activates it without the knowledge of the owner and that in turn sends back another ping-signal to your server here in Karlsruhe causing it to create images. Such a net-based installation offers for the first time the possibility of a non-local activity. This is, of course, just a simulation, and thus not fully comparable with non-locality in quantum physics. Rather, we here jump out of one local horizon into an image.

If I speak about an image, I do it in a non-classical way, as explained before. The image can be regarded as an information space. The possibilities we have now are activities in a remote information space and that this activities have an effect in the real local world, thus it is "reversible", so to say. Ralph Hollis' "Flotor" [10], as an other example, is an interface beyond the telephone, because it connects virtual and real worlds. With the "Flotor" one can activate and move around virtual objects. When the object falls down in the virtual world, it makes a sound, but you do not feel it. You could lift a weight of several thousand pound but do not feel it. Precisely this is what we are looking for at the moment – interfaces that are bidirectional or reversible between multiple virtual worlds or virtual worlds and the real world.

The next step therefore is to create interfaces between virtual worlds. If you have one image here and another image remotely, there is at the moment no possibility to exchange information between these two virtual worlds. Concerning the realization of interfaces between virtual worlds I rely in the skillfullness of the engineers to solve these problems. But the main problem in fact is, as I mentioned, if you regard the interface as a regulator on a scale of distinctions, to find an interface that regulates the information exchange between two virtual worlds. These different virtual worlds are called multi-user environments, or more precisely, multi-user virtual environments.

To explain this, let me give you an example. Assume two persons playing an online game. They sit each in front of their own computer screens, but in the game they enter the same virtual castle and meet. Now both person 1 and person 2 are facing a little monster, but in reality, there are two players, two real persons behind those monsters. These net games cannot be played without real persons, which is the main difference to standard computer or video games. You play remotely with other persons who are resided at different places. Each of those many users has a subjective point of view. If person 1 walks down a staircase and sees a monster coming up, which is person 2, then person 2, while walking up the staircase, sees a monster coming down which is person 1. What is this situation about? Are they entering a common visual space or even a common screen? No, this meeting is not a portal to a common

[1] of Jeffrey Shaws "Legible City" (1988–91)
[2] of Christa Sommerer's and Laurent Mignonneau's "The Interactive Plant Growing (1992)"

screen, but each screen is a window to a virtual environment that is not ubiquitous, but that in fact is multi-local. It is different from the cinema. The cinema is locally bound, which means that many persons are all in the same space.

7 Multi-local Structures of Communication

What we are entering now with the net is a multi-local structure of communication. This multi-local structure of communication gives us access to virtual environments. Looking back in the history of cinema from about 1820 to 1896, you can see that it took seventy years to develop the basics of cinema. Cinema was invented in the 19th century, but it was only in the 20th century that it has been developed for mass reception. In the beginning, due to technical restrictions, only a single person watched one film at one place at one time.

The beginning of virtual reality can be credited to Hugo Gernsbach, the editor of a famous science-fiction magazine. He was the first who developed an idea of virtual environments. He mentioned the idea of building VR machines. I myself tried to construct such a machine in 1966 [11]. It was a very primitive model, more or less an illusion. It is a helmet with a TV inside and some devices to regulate what you want to see. One year later, my friend Walter Pichler developed a media suit, combining radio and TV [12].

Out of these ideas, as you know, were born the famous head-mounted displays. These are not yet designed for multi-user capability, and in fact, here we are in the same situation as the cinema was in the 19th century – one person looks at one image at one time in one place. That is a single experience. The cinema was revolutionized in 1896 by the invention of the projector. Now many persons could look at one film in one place at one time. The single experience was turned to a collective experience. TV later on had a complete different structure, collective, but distributed or multi-local. Now many persons at different places could watch one film at one time.

Now, with video, many persons at different places can watch different films at different times. Here we have for the first time the idea of parallel communication. People sitting and watching TV can not communicate. The TV is not interactive. In virtual reality, as I said before, we started, as in cinema, having one person at one place seeing one image at one time. In contrast, with the mobile phone, we repeat for the first time the distributive collective structure of television. Many people at any time in any place can communicate. We have here for the first time an interactive multi-local communication structure.

Naturally, the same happens with the Net [13]. What the projector was for the cinema, the net is for the idea of multi-user virtual environments. Now anybody at any time can see anything anywhere. The crucial point is in fact that the net is a multi-local communication channel.

We are now capable to distribute interactive activity from the locally bound to the non-locally bound simulation of different virtual worlds. The net for the first time shows the possibility of interacting between real and virtual worlds and, additionally, on a "reversible" scale. What is not possible at the moment is interaction between two virtual worlds. How can we continue this research?

8 Multi-User Online Environments

Recently, I talked to Fredkin, who has already been working on these ideas for a long time. He told me what topics he is working on at the moment. Imagine a cinema situation with four different viewers looking at four different films on the same screen. It is still locally bound, but

four users are looking at the same time into different worlds. What you need to achieve this are special projection lenses (Fresnell-lenses), an eye-tracking-system to know exactly where the person is looking at, an LCD-display and a projector that moves and rotates in a way that the beam is focused directly to the eye.

Finkelstein already in 1983 has written an article about computer interactivity simulating quantum complementarity [14]. Otto Rössler and myself announced at the documenta X 1998, that electronic media, as a part of physics, show parallelisms to quantum mechanics on different levels. For example, closed-circuit installations are just realistic implementations of the observer problem. When we go onward to the models used by Everett and DeWitt, we are already close to the ideas of Fredkin and others.

What we are searching for is to look into one window, however, not only seeing one, but several virtual worlds. These parallel virtual worlds are non-local, they are distributed through the net. There is a work by David Deutsch [15] who established the idea of quantum parallelism, which is the basis for parallel quantum computation and therefore the basis for the possibility of parallel virtual worlds. Today we have just multi-user online games, but the idea would be to develop multi-user online environments that people can enter.

The objective will be to make it possible to enter different parallel virtual worlds and communicate between them. The effect of this would be philosophically interesting. When you are able to make an interface between virtual worlds that are the same as between real ones, these virtual worlds become an ontological equivalent of real worlds.

When Fredkin, Landauer and Toffoli organized in 1981 at the MIT a conference called the physics of computation [16], there was a famous lecture by Richard Feynman "Simulating physics with computers" [17]. He refers to ideas he got from Fredkin 1975 and says: "Nature is not classical, and if you want to make a simulation of nature, you better make it quantum mechanical". This is also valid for the future of the non-classical image. For many people the ideas of quantum mechanics and quantum computing sound crazy, but I think they are the basis for the future of the physics of the image – multi-user virtual environments.

9 Neurocinema

One last idea: The interface of the new cinema will not be the eye. Since J. E. Marey and Peter Mark Roget who discovered the "laziness of the retina" (persistence of vision), the role of the 19th century physiology has been turned over to neurophysiology. What was done in physics, from Ernst Mach to Farraday, is done by quantum physics today. The idea of neurocinema was already developed in the 19th century. Poisot, a forgotten inventor, had the idea of producing electricity with the brain and feeding it to a lamp. From this, naturally, it was not far to the idea of a kind of cinema which does not need the eye any more. There is a book by Mass and Bishop entitled "Pulsed neural networks ", [18] which shows precisely that the pulse-based firing of neuro-spikes is how we see. We do not see spatially, but by means of a temporal code. Now we have to construct nano-machines that help to control the activation of one spike. If we would be able to simulate the activities of the spikes, we were able to create images without the eye. At the moment, the eye delivers some 15% of the information that we need to see something. I always say that the eye is nothing else than the doorkeeper at an hotel. A doorkeeper only sees what the director tells him to see. The most important information comes from the brain, why not simulate the firing of spikes and forget about the rest?

This step forward to neurocinema is already shown to us by a film called "Strange Days" [19], directed by Kathryn Bigelow and the scenario written by James Cameron. Cameron did his homework very well when he wrote the scenario. In this film from 1995, you see people with

a strange net on the head. With this device you go around to film something when somebody falls down a building, another one rapes a woman. The point is that you get an experienced view of what happens. You can then buy these digital films and with your own net on your head, you can see with the eyes of somebody else. The cinema of the 21st century will make it possible to see the world with different eyes. Imagine that your wive is on holidays and you just switch some channels in your neuromachines to be able to see what she sees. One can imagine such a device like the windscreen of a car, where the images are superimposed over your own perception.

Of course, you can also regulate these images to see only the ones of your wife or you can switch them off altogether. In the film, the net was called a "squid". The film critics thought of course that this was just a fancy name for a funny machine, but in fact James Cameron had done his homework. "Squid" is the abbreviation of superconducting quantum interference device and is used in magnetoencephalography (MEG) for neuro-imaging. It is, though in fiction, one of the first realizations of quantum computing. It is the idea of neurochips that could be the basis of the future cinema stimulating the brain, not stimulating the eyes. The classical world of images was a trompe l'oeuil-technology, the new world of images is a trompe le cerveau-technology.

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