dependent: more autonomous in relation to the images coming before and after, and more dependent upon the observer. Or the other way around: more autonomous in relation to the observer and more dependent upon images coming before and after. The solution was a digital database of images coupled with an interface for endlessly retrieving new images, recombining and transforming them so the same image never appears twice and you never know what the next image will be. Unlike Gabriel learned how to program a computer, and Beuys was the first result. In this constellation there is nothing why the breathing-related movements of the belly would shift rectangles and polygons on a screen. Still, the connection between belly and image cannot be denied. Both are one system, connected via the belt and the computer. Mutual autonomy and dependency: again, the definition of interactivity. Because the image wanted to go on and on, Ulrike Gabriel hooked it up with something that never stops: our breathing.

Terrain_O1 is a later installation by Gabriel, from 1994. You sit on a chair with a band around your head. Sensors in this band monitor your brain waves and show these on a small monitor beside you. In front of you, under an array of strong lights, is a large round metal plate with thirty free roaming mechanical "pill bugs," about the size of your hand. They are made of something like tin foil, have solar panels built into their backs and are fitted with wheels. As soon as the lights are switched on and throw a pattern of light dots on the metal plate, the robot animals start to move. They go towards the light and avoid contact with each other. As a group, they demonstrate some interesting behavior: gathering, separation, pairing, panic, backward retreat (fear of being touched). Researchers of animal behavior would have a field day with them.

The array of light and the lights give off depends on how many brain waves you produce on the monitor. The quieter your alpha and beta waves are, the more light is produced. Initially, when you are just setting down and adjusting to the system you have just become part of the robots do nothing. When you close your eyes and manage to relax your brain, the lights start to glow and the robots demonstrate their movement tricks. But as soon as you look to see what is going on, your brain waves peak again and the lights go out and there is nothing of any interest to see anymore. You control the system as much as it controls you. Only if you succeed in watching the robots without thinking or feeling anything can you see what the robot insects are doing, instigated by you. You must watch completely level-headed. If you can pull that off, try looking in all objectivity at real animals, your fellow men. Gathering, pairing, fear of being touched, panic —

interview

Peter Weibel

Peter Weibel, born 1936, is director of the ZKM (Zentrum für Kunst und Medientechnologie) in Karlsruhe, Germany.

PETER WEIBEL (1944) is director of the ZKM (Zentrum für Kunst und Medientechnologie) in Karlsruhe, Germany.

Peter Weibel, 1966. (c) ZKM

You have been part of the movement that created the electronic arts as we know it today, as an artist, a theorist and an organiser of festivals and events. You have witnessed the rise of electronic art from its tentative beginnings until the present day, in which electronic art is an accepted art form amongst others. Is that at the beginning, what do you consider to be the roots of electronic art, media art?

I'd like to mention a neglected art movement from the 1940s, the avant-garde film, in which people started to think about the expansion of cinema techniques as an expansion of the function of the image. Usually this art movement is seen in connection with the art movement of the 1960s and 1970s, with visual artists like Marcel Duchamp and Man Ray, from an art historical point of view this may be correct, but the artists from the 1940s, me included, did try to establish an art of the moving image. I asked myself why not use my film as the basis for an image, and why not separate ourselves from painting, and from the tradition of the image as it was coded as representing something. Even abstract art was still under the Damascus' sword of representations. It didn't represent the outside world, but an inner world, as the artist claimed. Me, on the other hand, was interested in the ludic aspect. When Holli Vroman made the movie Zorns Lernpfad, in which he replaced images with letters in a mathematical model, he was questioning our image perceptions. More important than any objective or subjective representation for us were the inherent material qualities of the cinema. This startling point not only to structural and materialist cinema, but also to expanded cinema. Our goal was to expand and extend the cinematographic code in a critique of representation. In a critique of the relation between image and reality.

The models we had for this critique came from three different philosophical discourses: semiotics, mathematical logic, and cybernetics. Semiotically the image in cinema can be described as "iconic" — directly derived from reality, as in mainstream cinema. If you go one step further the cinematographic image can be said to be of a symbolic nature — not only is there an external relation to reality, but also an internal relation to other parts of the film, within the organised structure of cinema. This second, synthetic approach allows the use of a different model than the iconic one, namely a matheamatical or musical model to structure cinematographic material, as in early Peter Greenaway movies. The third approach is the pragmatic one how is the behavior of the spectator encoded in relation to the images? In my own work I attacked this pragmatic dimension of the cinema: what does a certain mean, or an avoidance? Why do people have to pay, go in, sit down? Why project on a screen, why not have 20 projectors, 20 screens? I used a mathematical model, I called film a calculus, or an algorithm I would say the equations which the audience perceive. The audience perceives the film as a code, and as a generator plus a temporal succession: first you have a camera, then you do a film with a camera, then you do the film, then you project the film, et cetera. First I said why not do it vice versa? Why not put somebody in front of a screen with a light on it and just the sound of a camera running? I changed the calculus of the system. I saw the audience as a projection of the image.

And then I discovered a new medium that recorded and projected at one and the same time video. Video had the simultaneity in my head that was looking for in cinema. As early as 1969 I started working with it. I made a work in which people came into a space where they only saw a camera. At the same time I showed other visitors in another room. By themselves the structure of the space and the people coming in. The pragmatic aspect of placing a gallery become the semantic and syntactic product that people came to see in that gallery. That was very strange then: visitors always came to see an art object. But in this installation
a small screen on the text machine side, with sound.

The interactivity in this complicated installation is this: the text writer enters words, the VR navigator chooses from among them, the text machine with the database constructs sentences out of the words chosen, and the image generator translates these sentences into virtual sculptures which the navigator can float towards and around (until they become so large that they explode, as rumour has it). Both participants in this installation provide the content of their interactive devices, even if this is mediated by the image generator and the database of text fragments. Both the words from the writing participant and the images from the navigating participant are unstable. All the combinations of words into sentences and into three-dimensional shapes are unique. There is no underlying system, only esthetics.

Why do all this? Why make things so complex? In this installation words and images are the media for a form of communication which, although it uses linguistic and visual signs, does not use linguistic or visual meanings. Every possible meaning is being neutralized by the preprogrammed arbitrariness of the text machine and the image generator. It is the audience outside the constellation that projects meaning onto the words and sees representations in the images—the communicating participants are focused on something else altogether. This is what makes "Memory Space" game the exchange between the two players has no need for the weight of interpretation — very unlike everyday life. To the audience, however, something else applies. Once you have found out how the words and images in the installation are generated, try applying that objective view to the sentences and images you read and see on a daily basis. Their meaning is just as preprogrammed and arbitrary. You don't need to interpret them; you can do without their meaning. They function outside of their meaning, following different rules. But they most certainly have an effect, both on each other and on you. Here is a third definition of interactivity: communication without the detour of meaning.

The eye of the beholder

"Erst die Theorie entscheidet darüber, was man beobachten kann. "It is theory which decides what can be observed," as Albert Einstein remarked to the youthful Werner Heisenberg, the latter, and "only theory, the knowledge of the laws of nature, enables us to draw conclusions about the processes behind them, based on our sensory perception." In other words, the perceived world does not exist outside of the way in which we organize our perception by means of abstract concepts. We will never be able to see the world as it exists independently of our insights. When nature gives an intelligible answer to a question posed by science in the form of an experiment, this may lead to a change in the theory and to the forming of new concepts. After this, the world will look different.

Classical physical science, as established by Isaac Newton in his Philosophiae naturalis principia mathematica (1687), describes the world in an ideal state, as seen by an abstract observer. What it does not describe is the world as it exists in reality. Space and time, distance and duration, mass and speed to Newton were quantities that existed independently of our sensory impressions, and he had discovered their underlying principles. Newton pointed out the order in a chaotic world, and it was a stable, timeless, uncontrollable order. It wasn't until 1905 that Einstein showed how, for us, there were no absolute quantities and all our observations were relative. To a stationary observer, time passes differently than to a moving observer. Even space is not a homogeneous, endless continuum but is curved around a "mass point". This relativism of Einstein's, the introduction into knowledge of active observation, subsequently led to Heisenberg's idea of the uncertainty principle. In the subatomic range an observation influences the path of an observed particle, because in order to see a particle path, a light photon has to hit the particle, which in turn changes its path. It is impossible to know simultaneously where a subatomic particle is and how fast it is moving. One can only know its approximate position and movement. Knowledge of sub-

The writer as exhibitor: the art object has vanished. There was no artwork in the form of an object, no image in the form of an object like a painting. There was only the spectator himself as the image, seeing and being seen. The acts of seeing and observing became the image. The processes of vision became exposed. The mechanisms of exhibitions became exposed.

Expanded cinema was the beginning of a turning away from object-based art towards a process-based art, a moving away from material art towards immaterial art. But nobody from the art circle had a theory about it, nobody could understand it. As long as the society itself was in a revolutionary moment, with the student revolts and all, this didn't matter. We had an audience who could make an audience from our work. When at the beginning of the 1970s this revolutionary situation declined and everything became normal again, we lost our audience. There was a reaction to conventional art forms. This forced us to create our own circuits and to continue our work.

So media art came from expanded cinema and not from video art.

It came from avant-garde cinema. The most successful video artists today, like Douglas Gordon, Peter White, and Aljosha Strajlic, are working on the conceptual elements of expanded cinema, from time delay to multiple screens to multiple narrations, etc. Video can repeat these experiments of expanded cinema more easily, more cheaply, faster, technically better. A continuous projection in a time delay requires a complicated machine for cinema. With video you just press the button. The film avant-garde worked at the border of its medium, at the aesthetic, synthetic and pragmatic border.

And video artists work in the middle of their possibilities, not at the borders of their medium.

Exactly. The only place where video has reached a border of sorts is in video installations. To go beyond avant-garde cinema video artists started to make installations that worked in real time. Then they realized that this was still too iconoclastic. People in the 1980s were hungry for images — there was a return to painting, at least. So video artists started to make environments stuffed with materials that were richer than the immaterial video images. The Installation Bill Viola made with trees lying around, or Fabrizio Pioli working with marble plates. I myself have always refused to show anything else but video images and video cameras, although it demanded more of the viewer. From June Palk turned a light installation into a particle installation with bodies or human-like robots. If he had made them as just sculptures, everybody would have said they were silly. This brings me to the real problem with video art. Media like cinema, video and, later, computer are about dislocation, while classical art is about location. Theater takes place in time and place on a stage; a sculpture is bounded in space, as is architecture. But from the telegraph in the 1840s onwards it became possible to separate message from messenger. Before that, one needed a physical carrier, a person or an animal or a machine, to send a message. With new media we no longer need such physical carriers of the message. The new aesthetics is about dislocation; the message goes from one locus to another. Video is of course ideal for this. You can send messages from one room to another; even within a room make a distance between camera and image. Media are also about acceleration, and even work against the body. Television now has more power than before. It's not a horse, but a new form of the human body. Television enables you to see further than your eyes, a telephone to hear further than your ears. Technical media are not only an extension of the body, they can reach beyond it. It is therefore a tragic paradox to make media look like humans or humanoids. One has to think that these media are made to go beyond the borders of the human body, and then you make a clumsy humanlike thing with these media: it's like making a car that looks like a horse. In politics it's not what is most successful, it's what is most aesthetically beautiful. And what is even worse, it brought psychology back into it. The avant-garde cinema movement was not
tomic particles is not absolute but vague, a matter of calculating probabilities.

The irony of atomic research in the twentieth century is that initially scientists wanted to know how atoms could be stable that, even after going through all sorts of chemical combinations, they always emerged again in the same form. The answer was Niels Bohr's "atomic model," in which a stable number of protons and neutrons were held together by nuclear forces. Around this nucleus float the same number of electrons as there are protons in the nucleus. But these electrons are unstable; they can collect and radiate energy and do so in discrete quantities (quanta). Matter can be converted into energy and vice versa (E=mc²). Light is a stream of particles or a wave movement, depending on how you look at it. Soon the atom nucleus itself proved to be not stable but fissionable: atomic energy, nuclear weapons. What started out as interest in the stability of matter led at the end to the realization that all building blocks of the universe are unstable.

Heisenberg: "Nature has been fashioned in such a way that it can be understood. That is to say: our brain has been fashioned in such a way that it can understand nature." In the classic mechanical worldview the following thought experiment was permissible: If you could observe the position and velocity of every building block of the universe, then according to Newton's laws of motion you could know not only the present but also the complete past and future of these elements. Position and velocity (the trajectory of a body) provide enough information to describe the entire life of the body, both forward and backward in time. What this thought experiment reveals is that in the mechanical world view the universe contains hardly any information at all, even though the "mechanics" believed they now had at their disposal all the information there was to have.

Information, in the eyes of early cyberneticists - Claude Shannon, Norbert Wiener, Heinz von Foerster - was the degree of organization in a system. Entropy, in this sense, was the degree of disorganization within that same system. The amount of entropy is the negative of the amount of information. Every closed system tends towards a state of full entropy, according to the second principle of thermodynamics ("spontaneous reactions always evolve toward a state of maximum disorder"). Therefore, entropy is the most probable state of any system.
addresses you, nothing from that person's body penetrates into your body. The only thing that is being disturbed is the equilibrium of your ears and auditory nerves, and your body reacts to this by neutralizing this disturbance. This is what we perceive as hearing. Living systems are "autopoietic"; they are closed systems that continually generate themselves just by continuously correcting the disturbances in their state of equilibrium caused by breathing, eating, sensory impressions and internal shifts. If it no longer succeeds in doing this the unstable system resorts to a stable condition: death.

The world can be understood, but what is understanding? It is different when you describe something in words and symbols than when you intervene. It is different when you write than when you read. By deriving the role of the observer Newtonian mechanics has in fact only studied nature's "intentions" - the laws of nature in their pure form - but not what nature perceptibly does. In the 20th century the roles have been reversed, and not only in the natural sciences. "Not the intention of the author but the effect his words have is essential" - this was the starting point on which Marshall McLuhan based his media theory. "The listener, not the speaker, determines the meaning of what is said" - this was the insight on which Heinz von Foerster based his cybernetics of cybernetics. Perception and that which is perceived are equally unstable.

Chaos

It is the unstable world that entices unlike Gabriel to play. The world everywhere is different, depending on the position and velocity. The world of the unstable media - "media" seen as anything that can contain or transfer information, "information" seen as the relationship between triviality and improbability. The fact that I can write this and you can read it is, in the light of astronomical, geological, and biological evolution, highly improbable, and in that sense highly informative. Our wonder over this fact and our awe of it form the religious dimension of unstable art. Life is no doubt an island in a sea of chaos. But not all chaos is entropy, end point. Sometimes it can be a beginning, as was discovered at the end of the 20th century. Chaos is the way towards information.

Until far into the 1980s, the apocalyptic mood was a defining property of 20th century consciousness. Misconceptions, heat death or cold death, hail of bombs, melt-down in nuclear power plants, acid rain, poisoning of the environment, AIDS; everything seemed to point in the direction of total entropy. Then, shortly before the turn of the century, the eyes of science suddenly turned energetically toward another phenomenon until then had to be repressed in order to keep stable the mechanical, thermodynamic and quantum-mechanical worldview, even if the fears and desires expressed in the process had continually occurred in popular culture and politics. It was now discovered that within turbulent, fluctuating, principally uncontrollable processes and "far-from-equilibrium" states, there was an amazing order-at-work, as long as you applied a simple mathematical formula to them.

It started in meteorology, that nightmare of everyone who believes in the predictable capability of natural science. Edward Lorenz demonstrated that the weather is so dependent upon minor variations in any of its many determining factors that long-term predictions are in principle impossible, even with the best computers. But the fact that the weather is unstable does not imply that it cannot be described. Within this chaos there is a stable structure of information, which Edward Lorenz - to the astonishment of the scientific community - managed to lay down in a handful of nonlinear formulas. After this, other principally unsolvable problems were identified in other fields as well. Benoît Mandelbrot demonstrated that the length of an irregular entity - the perimeter of an island, a tree, a cauliflower, a cloud - can never be absolutely determined, since it depends on the distance between the measurer and the object to be measured. From a satellite the perimeter of England has a certain length, from the ground it is much larger, and on a molecular scale it is almost infinite: the coastline is fractal. Mitchell Feigenbaum

revelation on the material level - what I would call the "disposition". Unlike in other art forms, in media art there are still revelations to come on this material level, on the level of deconstructing the disposition.

At the same time it can be said that the technical media have claimed representation. Photography, film and later television and video are capable of far more precise and cheaper representations than brushes and paint, for example. The function of representation has gone from the art image to other technical images. The use of photography, film and later electronic media in representative ways succeeded more triumphantly in 20th century science. Therefore we are facing another problem now: What to do with all those new technical images of which only one percent is considered to be art? What to do with all the images created by astronomers, Hollywood filmmakers, mathematicians, journalists, medical scientists... Up to 20 years ago Newton was a kind of cultural art form. The doctor got the information by listening to the sounds he got from the body of the patient. A doctor diagnosed a patient by way of ultrasounds, a stethoscope, et cetera. But today's advanced computer systems can make pictures of practically every bone and layer of the body. Medicine has become a visual art. And if we were forced to make a judgment about which kind of pictures is most needed today, the images of medical art or the images of medical culture, I'd have to say neither science pictures.

The true revolution of the media was not the representation of the spectator and listener, but also the obliteration of the artist as the one and only creator of images. The first stage started with the invention of photography in 1839 and was observed as what kind of technical images can be art? That battle was won today by many people who work with photography and video and computer are seen as visual artists and accepted as such by galleries and museums. The next stage is about the question: what is the direction of art in the dialectics with all the other classes of experts who can make images? We have to rethink the relationship between technical images and art.

The source content of successful media art today is mainstream cinema, coupled with the technique of the avant-garde cinema of the 1960s. We invented techniques like time dilation, but we created our own images. Douglas Gordon makes Psycho and extends it to 24 hours. I think that's a wrong relation to mass media. The relation should not be to popular mainstream cinema, but to the real competitors: images created by scientists. It is important to find out what the difference is between our work and theirs. Or maybe make an alliance. We should overcome Hollywood cinema, invent new strategies of interactive cinema, with virtual worlds, at camera. We should think again in the spirit of the avant-garde cinema, what methods for the encounter between spectator and image.

One of the problems with interactivity you mentioned is that people just want to push the buttons. That seems to be the normal reaction: how can I do something with this installation? This means that the image isn't really important anymore. The artistic material is the interaction, not the images. Which suggests to me that we're leaving the idea of the image as the central locus of art behind when we get lost in the interface.

I agree that in interactivity pressing buttons has become more important than the image. The image in its function of representation has lost its appeal. What has become important in interactive installations is that one's actions affect the image. Even in some works here at the ZKM like the Film actually represents something. I'd say that the image's importance is being replaced by representation by processing. Since the process is as important as the result, the image must have something of this processing. Groups like Knowledge Research succeed in doing so. They offer no nice images: no trees, no buildings, no plants. They show interactivity itself. They understand that the image should deal with processing, not with representation. Art has to leave the ruins of representation and move into practice of processing. In the words of Manuel Castells, when you show processing, instead of the flow of power you have the power of flow. Even in society the process of information is now the driving force. We no longer have a society of flesh and bone, but a society of information, in which information, data are being shuffled around the globe on an enormous scale. If you make an anatomy of society, you should give windows into this processing of data that governs the world. That is exciting. That is the true media art of today.
summed up this insight in his precept that from a certain distance objects and processes lose their meaning. This is to say that the degree of understanding of the world depends on the distance between the observer and the observed. If something makes no sense to you at all, then stand a little closer or further away.

This same total relativity and destabilizing of observation and the observed that was such a destructive experience to twentieth-century humans enabled chaos theory to come to the realization that the certainty, durability, stability and timelessness for which the classic natural sciences (and arts) had aimed were not the most interesting states in the world. A non-trivial, dynamic order can be found anywhere where nature organizes itself and becomes more complex as time goes by, against all the laws of probability. "Irreversibility is a source of order at all levels. Irreversibility is the mechanism that allows order to come out of chaos" (Ilya Prigogine). For centuries we have mirrored ourselves in stable images – in drawings, paintings, graphics, sculpture, photography, film, video. Even music, the most unstable of all media, could be encoded in scores, on gramophone records, tapes and compact discs. Even ballet. But at the end of the 20th century we see unstable media, unstable art, where the repressed ephemeral nature of the world is festively celebrated in all its once-only-ness. Celebrated as complexity through simplicity – made possible by that same computer that through sheer calculating capacity uncovered the regular irregularities in the weather, but also in riffs, animal populations, the price of cotton, serrated coastlines, boiling water, clouds, heartbeats, and in the images you can conjure up via software by breathing, by not thinking, by forgetting all known meanings.