INTERACTIVE DIGITAL ART
Visual Motifs and their Meaning

Penesta Dika

This book relies on my dissertation thesis of 2008 that I wrote under the supervision of Prof. Dr. Christa Sommerer & Prof. Dr. Oliver Grau at the Institute of Interface Cultures - University of Art and Industrial Design in Linz, Department for Media Studies.

Table of Contents

List of Figures

to my daughter Egnatia and my nephew Ares

Abstract

An artwork's motifs define and constitute its content; they shape its theme and overall impression. This book focuses on the visual motifs that appear in interactive digital art. 'Interactive digital art' includes work equipped with digital sensors, internet-based pieces, pieces based on artificial intelligence (including genetic art), or pieces using telematics, voronoi diagrams or fractal rules. It also includes biological art and device art, and computer-graphics and animations in general, presented as video-installations, virtual-reality or augmented-reality installations. Interactive digital artworks are characterized by making the observers not only passive viewers, but also active co-authors of the work. Interacting with such artworks allows visitors to be part of a sophisticated process, to participate in changing and re/creating this process, or in exploring it using tools like joystick, mouse, or head-mounted display, or via specially created platforms. In some artworks, visitors can participate via non-material interfaces. Different research methods such as visual perception based on psychology, and established art historic comparative methods are put together to analyse these artworks. This book locates the interactive digital artworks in an art historic context, illustrating the character and development of pre-existing visual motifs from the palettes of Old Masters to contemporary interactive digital art.

1. State of the Art: Books and Online Sources

Interactive digital art, which is part of new media art, developed out of art forms that dominated the 60s, for example installation, happening, fluxus, and conceptual art. Some media art critics mentioned this fact in their writings. For example, Christiane Paul advances her opinion like in the following: "*Digital art did not develop in art-historical vacuum either, but has strong connections to previous art movements, among them Dada, Fluxus, and conceptual art. The importance of these movements for digital art resides in their emphasis on formal instructions and in their focus, event, and audience participation, as opposed to unified material objects.*"[1] Digital art is also inspired by art forms such as Futurism, Constructivism, Dadaism and Surrealism, which dominated the first half of the 20th century. Additionally, Kinetic Art, Land Art and Environmental Art played an important role in the genesis of interactive digital art. Interactive digital art was also influenced by photography, video art[2] and film.[3] As a result the literature about interactive digital artworks gives different points of view. This is the issue that research studies can complement, yet also oppose each other. According to Ryszard W. Kluszczynski "*...as a result of this complex genesis, the history of interactive art does not lie in linear order but follows several individual paths, usually parallel and entangled in some areas. […] Consequently, we have a number of histories of interactive art, complementary and sometimes conflicting.*"[4] He assumes that

[1] Christiane Paul. Digital Art, Thames & Hudson, London, 2003, p. 11.

[2] See Axel Wirths: *"Die Reihe [Ausstellungsreihe] stellt den Versuch dar, die mittlerweile als klassische Videokunst zu bezeichnenden Installationsarbeiten von Künstlern wie Nan Hoover, Klaus von Bruch oder Marcel Odenbach mit neuesten Entwicklungen der Medienkunst in einen gemeinsamen Kontext zu bringen. Hierzu zählen vor allem die Arbeiten von Sommerer & Mignonneau, Jeffrey Shaw oder Bill Seaman. Keine neue künstlerische Entwicklung und mediale Aussageform ist losgelöst von vorherigen zu sehen, vielmehr bauen sie aufeinander auf, haben mannigfaltige Bezugspunkte, ergänzen und erweitern das Alte, ohne es abzulösen. Die Videokunst, und auf ihr aufbauend die gesamte Medienkunst, ist in sich facettenreich und einer extrem virulenten Entwicklung unterworfen, die den darstellenden institutionellen Strukturen in großen Sprüngen voraneilt.*", in: J. Wenzel, and A. Wirths, Der elektronische Raum. 15 Positionen zur Medienkunst. Bonn, 1998, p. 9.

[3] See Bruce Wands: *"Many curators and critics see digital art as an evolutionary development of the mechanical and electrical processes of photography, film and video. This approach forms part of a larger historical perspective, in which photography itself evolved from drawing and painting. Although initially there was considerable resistance to the concept of photography as fine art, it is now widely recognized as such and occupies a place in the collections of major museums worldwide. Film is a logical evolutionary step from photography: the physical nature of the medium is identical, although differently formatted in order to move through the camera quickly and to capture motion. Video, too, can be thought of as usurping film technology."* in: Bruce Wands. Art of the Digital Age, Thames & Hudson, New York, 2006, p. 11ff.

[4] R. W. Kluszczynski, *"Viewer as Performer or Rhizomatic Archipelago of Interactive Art"*, pp. 65-82, in: Sean Cubitt and Paul Thomas (Ed.), Relive, Media Art Histories, MIT Press, Cambridge, 2013, p. 65.

interactive art is shaped mostly in five fields of artistic activities such as kinetic art, the art of action, installation art, the art of electronic media, and conceptual art.
In the following is discussed the existent literature which includes interactive digital artworks. The aim for this literature review was to find out what kind of research is present in the existent literature on the visual aspect of interactive artworks.

In her book "Pioniere Interaktiver Kunst", published in 1997, art historian Söke Dinkla illustrates the connection between interactive media art and vanguard art at the beginning of the 20th century. The art styles which included the participation of the observer – such as Futurism and Dadaism – are highlighted as important for the commencement of interactive media art. Referring to this, Dinkla refers to conclusions made by Regina Cornwell (1992)[5], Itsuo Sakane (1989)[6] and Roy Ascott (1966)[7]. She considers happenings, cyborg art, reactive environments, closed-circuit-installations, and different experiments in art and technology as possible influential factors for the establishment of interactive media art. Dinkla categorizes work examples of interactive media art in interactive environments and interactive installations. This is a global categorization according to diversity of this kind of art. The visual aspect of the works are described, but not as the central or main issue.

The literature and art historian, Annette Hünnekens, takes the categorization of interactive media artworks further than Dinkla. In her book "Der bewegte Betrachter. Theorien der interaktiven Medienkunst", published in 1997, Hünnekens' chapter "from the image to the system" which is based on the notion of interactivity, considers the "inside image", "video-image" and "synthesized image", the "artificial intelligence creature", the "artificial intelligent system", the "data-net" and "data flow". She convincingly categorizes interactive media artworks in these chapters. The first chapter, for instance, (orig. Inneres Bild: Gedankenwelt) she built upon the predication of Kerckhove: "*Mit unseren Händen, Ohren, Augen und anderen Kanälen für Handlung und Empfindung richten wir >Schittstellen< zur Welt ein: Dies sind die Beziehungen, denen Künstler seit den Anfängen der Kunst größte Beachtung geschenkt haben*"[8]. Hünnekens also considers theories of Itsuo Sakane and of Le Moignes in arguing this chapter. For the second chapter (orig. Videobild: Closed-Circuit und Database) she explains that: "*Bei den entsprechend der Video-Überwachungstechnik eingesetzten Closed-Circuit-Installationen werden die Besucher meist ungewollt oder unbewußt mit ihrem eigenen Bild auf dem Monitor konfrontiert, wobei sie gleichzeitig von anderen Besuchern beobachtet werden können."*[9] The possibilities for manipulation were *"unmittelbar mit dem Verhalten verbunden und entsprechend begrenzt: Es geht weniger darum, den Betrachtern die Möglichkeit zur Teilnahme einzuräumen, als ihnen ihre Situation zu verdeutlichen, sich in einem sie bestimmenden technologisch determinierten System zu*

[5] R. Cornwell, Interactive Art. Touching the "Body in the Mind", in: Discourse, Nr. 14.2, 1992, pp. 203-221.

[6] I. Sakane, *"Introduction to Interactive Art"*, in: Wonderland of Science Art – Invitation to Interactive Art, Kanagawa International Art and Science Exhibition 1989, pp. 3-8 and pp. 38-42.

[7] R. Ascott, *"Behaviourist Art and the Cybernetic Vision"*, Part 1, in: Cybernetica. Review of the International Association for Cybernetics, Vol. 9, Nr. 4, 1966, pp. 247-264.

[8] Derrick de Kerckhove: *„Common Sense"*, pp. 31 – 40, in: BINAERA: 14 Interaktionen. Kunst und Technologie. Kunsthalle Wien, 1993, p. 35.

[9] Annette Hünnekens. Der bewegte Betrachter. Theorien der interaktiven Medienkunst, Wienand Verlag, Köln, 1997, p. 22ff.

befinden."[10] The research, art-work and opinions of different artists and researchers are interpreted, detailing different terms and notions, backgrounds and origins to explain the forms of this kind of art. Although the second part of the book is less scientific than the first, it can still be recommended as a good source of research on interactive media art, especially interactive digital art. Yet here also the visual aspect of the art-works, particularly the visual motifs, is not an extensive or key focus.

In 1997, the former director of the Media Museum in Karlsruhe, Hans-Peter Schwarz, edited the catalogue "Media-Art-History" for the Museum "Centre for Art and Media" (ZKM-Museum). In addition to describing the media artworks of the ZKM-Museum, Schwarz wrote a preface about museums that show media artworks. This preface contains an analysis of works that are made with game-aims as well as works that are made for the net. The author also deals with the technology of media and with its historical evolution. The space in which media artworks are developed is discussed in its own chapter. Media artworks are treated in context with known forms of theatre, cinema or photography; Schwarz tries to show a developmental line into which media art would fit in the future. In this well-structured preface, one would expect a chapter about the context of artistic aims (including the visual aspects) and specifications of the works which are permanently exhibited in the ZKM-Museum, but this is absent.

In the book "Art@Science", published in 1998, researchers and artists Christa Sommerer and Laurent Mignonneau do well to illustrate that the borderline between scientific and artistic works is almost imperceptible in interactive media art. Collaborations between artists and scientists, in particular "artists as researchers", accomplish this. Furthermore, "Art@Science" discusses media artworks in the chapters "telecommunications", "scientific visualization", and "artificial life". The book also deals with chaos and complex systems – theories, public spaces for presenting and preserving new media art, education of art and science as well as the historical and cultural context of art and science. Due to the fact that the works that are used as examples in this book are mostly interactive digital artworks, "Art@Science" should be used primarily for research on interactive digital art, or for understanding the origin and creation of such artworks.

The book "Visual Digital Culture" by culture critic and theorist Andrew Darley, published in 2000, describes media artworks by focusing on digital entertainment such as film, video and games. It does not include research into interactive digital artworks that influenced the creation of the visual digital culture. However, the book does contain a chapter about the aesthetics of digital works.

Peter Gendolla, Norbert M. Schmitz, Irmela Schneider, and Peter M. Spangenberg edited the book "Formen Interaktiver Medienkunst" in 2001. On the one hand, the articles in this book include a historical overview of interactive media art, on the other hand, there are chapters on the theory of interactivity and the theory as practice or vice versa. Furthermore, this book deals with the current position of this kind of art. The various articles create a conglomerate of different points of view of interactive media art. Through these different points of view, the nature of interactive media art and its variety is illustrated. It needs to be said that although different aspects of interactive media art are mentioned, the different forms of interactive media art are not clearly explained. Visual characteristics, particularly visual motifs in such

[10] Hünnekens (1997), p. 22ff.

artworks are not discussed enough. Visual relationships between such artworks are not treated as an important characteristic.

In 2001, Lev Manovich, theorist of new media art, conducted a specific analysis of media artworks: he did research on new media mostly in reference to the media of film and the history of film. His book "The Language of New Media" posits a relationship between the history of cinema and the history of new media. In addition, it argues that there is relation between avant-garde film and new media. Due to the focus on describing the language of new media, few examples of interactive digital art are discussed. For instance, Manovich's conclusion on the visual aspect of a work of Jeffrey Shaw that: "*Although Legible City was a landmark work in that it presented a symbolic rather than illusionistic space, its visual appearance in many ways reflected the default real-time graphics capability of SCI workstations on which it was running: flat-shaded shapes attenuated by a fog.*"[11] It is a kind of description which considers the visual aspect of an interactive artwork. But, the theories in this book are primarily dedicated to media artworks of film. Therefore, Manovich's analysis can barely be used for interpreting interactive digital artworks, but it is a very good source for information about technological devices used in relation to the virtual reality.

Christiane Paul, curator in the field of new media art, wrote a book on digital art in 2003. Besides giving an overview, her publication "Digital Art" deals for example with processed photography and digital sculpture; Paul's book is not specifically on interactive artworks. The author considers "installation", "film, video and animation", "internet art and software art" and "virtual reality and musical environment" as forms of digital art.[12] Furthermore, Paul categorized digital artworks thematically and she created categories like "Artificial Life", "Artificial Intelligence and intelligent agents", "Telepresence, telematic and telerobotics", or "Body and Identity". It may be said that this book is a diverse book about digital art with compressed information and can be used as a handbook on digital art.

In the same year (2003), in the book "Virtual Art: From Illusion to Immersion", art historian Oliver Grau chose a specific point of view on media artworks: he depicted them in relation to historic examples (historic art of illusion and immersion like those in old frescos). The author connects old art forms with new media artworks. Notions such as natural interfaces, spaces of knowledge, telepresence and evolution are discussed in his book. The all-encompassing depiction of each artwork must be praised for its precision. This book includes visual aspects (including visual motifs) of interactive artworks as one of the main parameters for researching them. Relationships between artworks are created on the basis of their visual aspects.

Theatre and video artist, as well as critic, Michael Rush wrote about another topic: his book "New Media in Art", published in 2005, shows the use of new media and its appropriate technology for new media artworks. Rush considers earlier art forms, such as the fluxus movement and artworks by Marcel Duchamp or John Cage, as important. He also relates new media art and performance, video or video-installation. Digitalization is for him an important factor in creating contemporary art: digitally altered photography, digital cinema, computer art, interactive art (including installation and cinema), and virtual reality are art-forms that emerge from digital possibilities. This book represents a good source for media art in general but is not specific for researching on visual aspects of interactive digital artworks.

[11] Lev Manovich. The Language of New Media, MIT Press, Cambridge, 2001, p. 261.

[12] Paul (2003), p. 70.

In 2006, the director of New York's "Digital Salon" Bruce Wands wrote his book "Art of the digital Age". He divided the dimension of digital art into the following chapters: "digital imaging", "digital sculpture", "digital installation and virtual reality", "performance, music and sound art", "digital animation and video", "software, database and game art" and "net art". The book also contains an overview and there is a chapter about the future of digital age. The different categories are simply summarized and well-illustrated.

The conference "MediaArtHistory" is established on 2005 in order to consider media art, including interactive digital art.[13] The books that were edited as results of this series of conferences can be seen as a key source for researching interactive digital art. Firstly, the book "MediaArtHistories" of 2008, edited by Oliver Grau, includes the main topics for researching media artworks from different perspectives. The digital artworks are argued convincingly as part of art history by the authors within this book. Major chapters such as "Origins: Evolution Versus Revolution", "Machine-Media-Exhibition", "Pop Meets Science" and "Image Science" discuss among other things the origin of digital art, the technology (including preservation), the science behind those artworks and the meaning of those artworks.

Oliver Grau (with Thomas Veigl) edited another book on digital art "Imagery in the 21st Century" on 2011 which discusses images from different points of views (arts, humanities and natural science). The researchers treat the "Image Phenomena of the 21st Century", pointing out those within current research used screens, bio art, video art, visualization, and others. Also "Critical Terms of the 21st Century" are discussed by inclusion of, for instance, analysis of interfaces, or of the emotional aspect of interfaces. A major chapter on the new tools for image analyses includes a discussion on computer graphics as research method, and the challenges of media art to contemporary society. Furthermore, historical research has been done so that the state of the art can be better understood.

Also "Relive. Media Art Histories" edited by Sean Cubitt and Paul Thomas on 2013 is linked to the conference series of "MediaArtHistories". It includes methods for research, media archaeology and the history and philosophy of media, illustrated by examples from eastern Europe, Australia, and New Zealand. It also deals with the contradictory scales of evolution, life cycles, and bodily rhythms in bio art; and the history of the future - how the future has been imagined, planned for, and established as a vector throughout the history of new media arts.

One part of interactive digital art that relies on the rules of Darwinian evolution for its creation, has been treated more extensively on the year 2014 in the book "Meta-Life: Biotechnologies, Synthetic Biology, Life and the Arts", edited by Roger Malina and Annick Bureaud. This book can be used as a good source for researching artworks based on bio-art or artificial intelligence, including their visual motifs. Its chapters: Between Bio, Silico and Synthetic: Of Life and Arts; Artificial Life and the Arts; Bioart; Bio-Fiction, Design, Architecture; and DIY Biology-Biohacking includes research of theoreticians and historians and also of artists themselves. Social, political and ethical issues as well as the nature of the kind of art which includes even the creation of living objects are displayed well and researched deeply into their art of presentation and creation. But those artworks are only a part of the interactive digital art.

[13] http://www.mediaarthistory.org

Catalogues of festivals, collections and exhibitions of interactive digital art are important sources on interactive digital artworks. Centers like "Ars Electronica" in Linz (Austria), "Center for Art and Media" (ZKM) in Karlsruhe (Germany) and NTT InterCommunication Center (ICC) in Tokyo are important sources for new media artworks (online and offline) including interactive digital artworks. Also online databanks such as ADA, https://www.digitalartarchive.at/nc/home.html (formerly the "Database of Virtual Art"; www.virtualart.at), "netzspannung.org" (media arts & electronic culture), or the material of the conferences about Histories of Media Art, Science and Technology (http://www.mediaarthistory.org/) are important online sources for new media art.

Generally speaking, there are books, catalogues and online databases about digital artworks and they study different categories of this kind of art. There are examples in the literature that also deal with interactive digital artworks. The problem of the visual aspect in this kind of art is not sufficiently discussed in primary literature. So far an analysis of visual aspects – especially the visual motifs that appear in these artworks – is missing. This issue, its background, its aim, its characteristics and the method of conducting this kind of research is described in the following chapters of this book.

2. Introduction to Interactive Digital Art

2.1. Digital art and new media art

Digital art is a kind of art that is based on digital technology. According to Bruce Wands "A *more complete understanding of digital art will emerge as we examine its relationship to technology and contemporary art, the way in which these artworks are created, and the inner make-up of the digital artists."*[14] Digital art includes any kind of art produced with the support of digital technology such as software art, computer art, new media art, interactive media art, animation art, virtual reality, web art, and music visualizations. According to the art historian Christiane Paul "*The terminology for technological art forms has always been extremely fluid and what is now known as digital art has undergone several name changes since it first emerged: once referred to as 'computer art' (since the 1970s) and then 'multimedia art' digital art now takes its place under the umbrella term 'new media art', which at the end of the twentieth century was used mostly for film and video, as well as sound art and other hybrid forms. The qualifier of choice here – 'new' – points to the fleeting nature of the terminology. But the claim of novelty also begs the question, what exactly is supposed to be considered 'new' about the digital medium?"*[15] In this issue, Paul added that: *"Some of the concepts explored in digital art date back almost a century and many others have been previously addressed in various 'traditional' arts. What is in fact new is that digital technology has now reached such a stage of development that is offers entirely new possibilities for the creation and experience of art."*[16] Interactive media art is nowadays more and more a digital art, but there are earlier interactive media artworks, which are kind of analogue artworks, or are created with a combination of analogue and digital techniques. This book will use the term "interactive digital art", since the artworks that will be used as primary examples are artworks equipped with sensors and digital techniques.

2.2. Forms and origins of interactive digital art

According to the art historian Christiane Paul "*It is problematic to claim that all digital artworks can be neatly categorized according to different forms: most of the time, these works combine various elements (such as a physical installation with a sound and Internet component) and defy a purely formal classification. Nevertheless, it is important to be aware of the formal aspects upon which the art is based.* […] *Among the forms that a digital artwork can take are installation; film, video and animation; Internet art and software art; and virtual reality and musical environments*."[17] Concerning the forms that digital art has Bruce Wands distinguishes two main kinds, traditional and new: "*Traditional forms of digital art include prints, photography, sculpture, installations, video, film, animation, music and*

[14] Wands (2006), p. 11.

[15] Paul (2003), p. 7.

[16] Paul (2003), p. 7.

[17] Paul (2003), p. 70.

performance. New forms that are unique to the digital realm include virtual reality, software art and net art."[18]

Interactive artworks are characterized by the fact that they offer possibilities for the observer to act in some form within the work. Art Historian A. Hünnekens took into consideration the beginning of the 20th century for the emergence of the diverse interactive forms. She argued this opinion considering Sakane's emphasis on the influence of the industrial revolution, in which context "*sich die Befreiung der tradtionellen Künste vollzog und eine neue Welle auch der Selbstbehauptung des Menschen ausgelöst habe. Die Vielzahl neuer Wahrnehmungsmöglichkeiten, die aus der technischen Innovation erwuchsen, brachten einen enormen kreativen Schub mit sich. In dieser technologischen Situation entstanden die ersten kinetischen, Licht und Bewegung als Medien nutzenden Arbeiten, die erst unter Einbeziehung der Bewegung des Betrachters vollendet wurden.*"[19]

Categories of interactive digital art are divided in different ways. Taking into consideration the way the artwork is being developed, we can distinguish, for example, interactive artworks which are web-based artworks or internet artworks, installations, or artworks based on music-visualizations, then the so called virtual realities, software art and computer art (including computer graphic and animation), new media art (including film, video art and photography).

Concerning the medium of the internet for developing artworks Paul wrote: "*Internet art has existed since the inception of the early World Wide Web, with several 'movements' developing at the same time. Internet art now has become a broad umbrella for numerous forms of artistic articulation that often overlap. There are hypertext projects that experiment with the possibilities of non-linear narrative; there are netactivism projects that use the network and its possibilities of instant distribution and copying of information as a staging platform for interventions, be they support of specific groups or a method of questioning corporate and commercial interests; there are performance and time-based projects that take place as actions within a specific timeframe during which they can be experienced by Web visitors worldwide."*[20] Paul counts here also "*Webcams and CUseeMee – desktop videoconferencing software that allows person-to-person video chats using desktop cameras and an internet connection* [which] - *have been used for artistic explorations of remote 'presence' and communication.*"[21] Interactive digital art as a web-based art offers often an online platform for accessing in a real installation space. But there are also projects, which are mainly based on a internet activity.

The Notion Installation art includes "*alle Phänomene auf den Raum bezogener künstlerischer Arbeiten, die auf sehr explizite Weise den Betrachterraum miteinbeziehen, das heißt im Gegensatz zur traditionellen Plastik die Grenzen zwischen Werk und Betrachterumfeld auflösen. Um 1967 nahm das vorher meist für Haustechnik verwendete Wort im Kunstkontext Gestalt an: Der amerikanische Künstler Dan Flavin bezeichnete seine lichtstrahlenden Neonarbeiten als Installationen...* "[22] Concerning the added digitality to such art forms, we would have the result of a new art form. This would fit into the definition of C. Paul: "*Digital art installations are in and of themselves a broad field and come in myriad forms. Some are reminiscent of the large-scale video installations that include multiple projections, or of video works that incorporate the viewer in the imagery through live captures. Many are aimed at*

[18] Wands (2006), p. 11.

[19] Hünnekens (1997), p. 176.

[20] Paul (2003), p. 112.

[21] Paul (2003), p. 112.

[22] Hubertus Butin (Ed.). DuMonts Begriffslexikon zur zeitgenössischen Kunst, DuMont, Köln, 2006, p. 122ff.

creating 'environments' that can entail varying degrees of immersion, ranging from pieces that strive to envelop the audience in a projected environment to those that immerse them in a virtual world."[23]

Concerning the notion of "software art", Paul considers it rightly as a "*blurry terminology*"[24]. She explains that "*Software is generally defined as formal instructions that can be executed by a computer. However, every form of digital art employs code and algorithms at some level.* […] *...the term 'software art' is usually applied to projects that have been written from scratch by artists and run locally on a computer – with or without incorporating live data from a network – or that can be downloaded from the Internet to be installed on a local machine."*[25] As computer art, in contrast to software art, every artwork which is created, or just processed with the technology of computer can be understood. Interactive software or interactive computer artworks are characterized by the fact that their code allows a live changing of different values. Due to this, the results of these kinds of works vary. There are for example software or computer artworks which visualize in a symbolic way live values got by an activity of a user. Due to this the borderline between interactive software art and interactive computer art are also "blurred", so that the notion of interactive computer art should include also the notion of interactive software art. But, speaking about interactive computer art the audience would automatically think of interactive computer graphics and not of interactive software based art, which can even exclude graphic results.

Also new media artworks are developed into interactive digital artworks. Video artwork, photography and film in combination with new digital techniques are transformed into interactive digital artworks. As results we have interactive video-, or image-installations, interactive films, and even artworks, which are categorized as virtual realities.

[23] Paul (2003), p. 71.

[24] Paul (2003), p. 124.

[25] Paul (2003), p. 124.

2.3. Origin, meaning and forms of interaction

Interactive digital artworks are characterized by their making the observers not only passive viewers, but also active co-authors of the work. Michael Rush, referring to interactive art, the line of installation and cinema, advanced this opinion, pointing out that the end result is the "*truly participatory*": "*Beyond the 'clicking' and 'surfing' activities of the Web, which are, indeed, forms of interaction with computer technology, several contemporary artists have created works, often on a large scale, that are truly participatory. The entry of 'interactivity' onto the art scene has caused critics (as well as lexicographers) to revise what they call people who enjoy such art: museumgoers or viewers have become participants, players and users. Duchamp's dictum that viewers complete the work of art has taken on a new, more active meaning. There is no art in this arena without the public.*"[26] Their technology, based mostly on the digital, is equipped with various sensors to let the observer/user act differently compared to the traditionally interactive artworks. The new technologies used for the interfaces, which are based on the specifications of microprocessors, allow new aesthetic results emerge. Due to this, the visual aspects of the works have also changed.
The interaction was in traditionally artworks known as a kind of participative/responsive kind of interaction, which was based on the invitation of the artist for the audience to take part for completing the work. Frank Popper's opinion is that "*A preliminary distinction can be made between the terms 'participation' and 'interaction'. In the artistic context, 'participation' meant in the 1960s, and still means today, an involvement on both the contemplative (intellectual) and the behavioral level. It differed from traditional attitudes towards the spectator by this double invitation and by its political and social implications. Besides being invited to participate through the devices specific to the plastic arts, the spectator was often encouraged to take part in events resembling a ritual ceremony or tribal feast.*"[27] Further, Popper concludes that *"...the term 'participation', in the context of contemporary art, refers to a relationship between a spectator and an already existing open-ended art work, whereas the term 'interaction' implies a two-way interplay between an individual and an artificial intelligence system.*"[28] His opinion would be a good explanation source for the term of interactivity within interactive digital art, if he would include besides "artificial intelligence systems" also programmed works which aren't based on AI rules.
The visitors interact with interactive digital artworks navigating, exploring or being creative. They use tools like joystick, mouse, or head-mounted sensors. The navigation can be realized in virtual or in real spaces. The results show often a multisensory interaction, which creates the illusion that the user is inside a reality. According to Oliver Grau: "*The majority of virtual realities that are experienced almost wholly visually seal off the observer hermetically from external visual impressions, appeal to him or her with plastic objects, expand perspective of real space into illusion space, observe scale and color correspondence, and, like the panorama, use indirect light effects to make the image appear as the source of the real. The intention is to install an artificial world that renders the image space a totality or at least fills the observer's entire field of vision.*"[29]

[26] Michael Rush. New Media in Art, Thames & Hudson, London, 2005, p. 222.

[27] Popper (1993), p. 8.

[28] Popper (1993), p. 8.

[29] Oliver Grau. Virtual Art: From Illusion to Immersion. MIT Press, Cambridge, 2003, p. 13.

Rudolf Frieling considering the term of "Interactivity", based on the definition of Dinkla (1997): »*gattungsspezifische Bezeichnung für computergestützte Arbeiten, in denen ein Wechselspiel zwischen digitalem Computersystem und Anwender stattfindet*«, added on *"In Erweiterung dieser sehr engen Definition kann man die analogen Vorläufer der Medienkunst miteinbeziehen: Von John Cages musikalischen Konzepten des Einsatzes einer Reihe von Tonbandgeräten in den fünfziger Jahren über Nam June Paiks wegweisende Fluxus-Ausstellung Exposition of Music – Electronic Television 1963 in Wuppertal mit interaktiven TV-Apparaturen bis zu den Experimenten im Rahmen der Intermedia-Bewegung und des Expanded Cinema in den späten sechziger Jahren (zum Beispiel Peter Weibels Action Lecture von 1967 und Valie EXPORTs Tapp- und Tastkino von 1968) – immer sind es Kommunikationsprojekte und explizit »offene Kunstwerke«, die gerade durch den Einsatz von Maschinen, Apparaten und medialen Konzepten die Möglichkeit des Eingreifens der BesucherInnen einkalkulieren durch die Gestaltung einer technischen beziehungsweise medialen/sozialen Konfiguration, heute gemeinhin als »Interface« bekannt*."[30]
Dieter Daniels explains the term "interactivity" based upon the question of whether interactivity is an Ideology or a Technology.[31] His conclusion is that "*Ob wir mit Maschinen statt Menschen oder mit Menschen mittels Maschinen kommunizieren oder ob wir mit Menschen über Maschinen oder mit Maschinen über Menschen sprechen, wird durch die Verflechtung von menschlicher Gesellschaft und technologischer Parallelwelt immer schwerer zu unterscheiden. Das heißt auch, daß die Grenze zwischen Ideologie und Technologie unscharf wird, ja daß Technologie ein zentrales Element der Ideologie der 90er Jahre bildet."*[32] Daniels described the "*open or closed systems*" comparing them with John Cage's "Bottom-up" Structure and Bill Gates' software as "Top-down" Structure.[33] He pointed out that the contemporary meaning of "Interactivity" has changed *"... die Bedeutung von >Interaktivität< heute* [ist] *wesentlich an die elektronische Medien gebunden. Die Technik des Interface und die Regeln der Software geben den Rahmen einer solchen technologisch definierten Interaktion vor, die sowohl zwischen Mensch und Mensch mittels der Maschine als auch nur zwischen Mensch und Maschine stattfinden kann.*"[34] In contrast to this, Heidi Schelhowe's opinion is that the concept of the "*Interaktivität verfolgt zunächst den Weg, das zweckgerichtete Tun, die Erledigung einer Aufgabe durch den Menschen, in den Vordergrund zu stellen und einen direkten Umgang mit den repräsentierten Objekten zu simulieren. Die dem entsprechende Sichtweise des Computers ist die des Werkzeugs.*"[35] But during the interactivity between the human and the computer, the "*problems*" have to be dissolved by both: human and computer, and not just by human. The implemented software and even intelligent software (based on AI rules) are responsible for the part the computer plays during the interactivity. From this point of view the computer is not just a tool, it is often the object of communication and for communication. Its activity and role depends on the software that is being used, respectively depending on its programming in the concept of interactive works.

---

[30] Rudolf Frieling, *„Interaktivität"*, pp. 134-138, in: Butin (2006), p. 134.

[31] Dieter Daniels. Vom Ready-Made zum Cyberspace, Kunst/Medien Interferenzen. Cantz, Ostfildern, 2003, at: http://www.hgb-leipzig.de/daniels/vom-readymade-zum-cyberspace/, 24.03.2007, 13:40.

[32] Daniels (2003).

[33] See Daniels (2003).

[34] Daniels (2003).

[35] Heidi Schelhowe, Das Medium aus der Maschine, Zur Metamorphose des Computers, Campus Verlag, Frankfurt, New York, 1997, p. 162.

Elena Esposito explains the term of interactivity as follows: "*Unter Interaktivität verstehe ich jene Eigenschaften elektronischer Medien, die die Überwindung der Einseitigkeit der Fernkommunikation ermöglichen*."[36] But, within interactive digital art, interactivity can be present not just in the form of "*Fernkommunikation*". The interaction can be present also in its simplest form – using GUIs as a non-distance-communication. The visitor/user can be in front of the work and be interactive with it. What Esposito explains here can be considered only within the context of telematic artworks, excluding other forms of interactive art such as those based on GUIs. According to her "*Mit der Ausnahme des Telephons bieten die Formen der Fernkommunikation bisher weder dem Leser oder Zuschauer die Möglichkeit, auf den Gang der Kommunikation einzuwirken, noch dem Mitteilenden die Möglichkeit, sich, während die Kommunikation stattfindet, an den Reaktionen des Partners zu orientieren. In der Fernkommunikation ist die Antwort (ein Brief, ein Telephonanruf oder anderes), wenn es eine gibt, eine weitere Kommunikation und kein Bestandteil der laufenden Kommunikation. Das ist der Preis, den man bezahlen muß, um mit einer tendentiell unbegrenzten Zahl von Adressaten kommunizieren zu können, die sich an anderen und unbekannten Orten befinden und zu unvorhersehbaren Zeiten auf die Kommunikation zugreifen. Die telematische Interaktivität dagegen ermöglicht es, sofort zu reagieren – dies allerdings in Zuge einer Kommunikation, die fern und anonym abläuft.*"[37] It is clear that Esposito's definition of interactivity is limited to telematic works. She explains further, considering the communication itself that "*Die Interaktion unter Anwesenden ist die einzige Form nicht einseitiger Kommunikation, die wir bisher kennen. Sie findet unter Personen statt, die anwesend sind und dieselbe Gegewart teilen. Sie teilen denselben Wahrnehmungsraum und nehmen reflexiv wahr, dass sie wahrgenommen werden*."[38] She distinguishes the writing as two different forms of Communication: "*Schon mit der Schrift werden also zwei prinzipiell verschiedene Kommunikationsformen verfügbar, die nicht aufeinander reduziert werden können: die Fernkommunikation unter möglicherweise unbekannten Partnern und die Interaktion unter Anwesenden, die denselben Raum teilen und zeitlich synchronisiert sind."*[39] This point of view is present also within interactive digital art. But this explanation doesn't include the communication between a person and a programmed work itself. According to Esposito: "*Die Differenz zwischen verschiedenen Kommunikationsformen scheint weniger mit dem Medium als vielmehr mit der Funktion der Kommunikation zu tun zu haben, die von der betreffenden Kommunikation erfüllt wird. Die Evolution der Telematik und die Notwendigkeit, das Angebot an kommunikativen Leistungen neu zu gestalten, zwingen dazu, diese Funktionen schärfer als bisher zu unterscheiden.*"[40] Esposito concludes by explaining a kind of communication which is present in the form of selection-choice and the relevance-criteria of other people: "*die Last der Selektion zu delegieren und sich unterhalten zu lassen*"[41]. This point of view has been researched more closely by Robert Pfaller.

Robert Pfaller evaluates the philosophy of the term "Interactivity" in context with the artworks which are based upon it, as a kind of "not a real philosophy". He describes this as follows: "*…eine falsche Theorie der eigenen Praxis führt zur Deformation dieser Praxis.*

---

[36] Esposito, Elena. *„Interaktion, Interaktivität und die Personalisierung der Massenmedien"*, pp. 225 – 260, in: Soziale Systeme, Zeitschrift für soziologische Theorie, Jg. 1, no. 2, Verlag Leske + Budrich, Opladen, 1995, p. 226.

[37] Esposito, p. 226, in: Soziale Systeme (1995).

[38] Esposito, p. 228, in: Soziale Systeme (1995).

[39] Esposito, p. 229, in: Soziale Systeme (1995).

[40] Esposito, p. 255, in: Soziale Systeme (1995).

[41] Esposito, p. 257, in: Soziale Systeme (1995).

Selbst eine angesichts gelungener Kunstwerke gewonnene Fehleinschätzung […] *wird unweigerlich zu mißlingenden neuen Werken führen.*"[42] In this context he added that "*Die zahlreichen langweiligen interaktiven Installationen, die auf die ersten gelungenen Beispiele gefolgt sind, scheinen das zu bestätigen.*"[43] Pfaller used the term "Interpassivität" as a contrast to the term "Interactivity" for describing the works which, according to him, don't really rely on this term. As examples he mentioned sitcoms as programs which laugh about themselves (Dosengelächter), or the "*Klageweiber*", who "*trauern beim Ableben einer uns nahestehenden Person an unserer Stelle. Wir, selbst unbewegt, trauern durch sie*."[44] Further examples for his term are: a beer ordered in a bar, which will be drunk by a guest in a guest house and a programmed video-recorder which would film the program delegated by a person, who will never take a look at it.[45] Pfaller considers that to delegate a work, especially an unpleasant work to somebody else "*ist eine gewohnte Regel beim Gebrauch von Maschinen sowie in der gesellschaftlichen Arbeitsteilung und Klassenspaltung. Diese Regel liegt auch den interaktiven Installationen in der Kunst zugrunde, wo ein Künstler oder eine Künstlerin versucht, einen Teil der künstlerischen Arbeit an die Betrachtenden zu delegieren.*"[46] The explanations of Pfaller for the term of "Interpassivität" in some cases could be used for describing the position of the artists themselves "as interpassive". The artists and their relations to their works could be explained with the help of this term, but not the interactive digital artworks and their perception. The artworks are based on different forms of interactivity and those can't be described with the term of interpassivity as introduced by Pfaller. Using Pfaller's example, the "recorded videotape" will not be seen by the person who delegated its recording, and it won't be seen by the audience. In contrast to this, the results of the artworks within interactive digital art will be seen by the audience and maybe also by the artists themselves (if they are present in the exhibition room or if they record the results created by the users interactivity).

The fact that one can change or explore the limited or unlimited results of the works speaks for the presence of the interaction between the work and its user/observer. The term interaction and forms of interaction in media art within this book have been defined based on the explanations for the term interactivity by Dieter Daniels and the categories/divisions of interactive media art considered by Annette Hünnekens (see the chapter "State of the Art"). Interaction and its forms have been defined by art historians, artists, or scientists in different ways considering its geneses in different kinds of art. But trying to build an extended explanation for the notion of interaction within interactive digital art, this work uses the understanding that interaction is a reciprocal communication between a user and a programmed work, or a reciprocal communication between users through a programmed work, or a reciprocal communication between a programmed and an external object caused by the users' activity (think of the telematic work "TeleGarden" of Ken Goldberg, 1996), or a permanent live visualization of data (think of the work "Doves" of Ursula Damm).

Within this book, the interaction within interactive digital art will be defined as present in the form of co-creation (by the users/visitors), of navigation (by the users/visitors), of an

---

[42] Robert Pfaller, „*Das Kunstwerk, das sich selbst betrachtet, der Genuβ und die Abwesenheit. Elemente einer Ästhetik der Interpassivität"*, pp. 49-84, in: Robert Pfaller, Interpassivität. Studien über delegiertes Genieβen, Springer, Wien, 2000, p. 56.

[43] Pfaller, p. 56, in: Pfaller (2000).

[44] Pfaller, p. 62, in: Pfaller (2000).

[45] Pfaller, p. 49, in: Pfaller (2000).

[46] Pfaller, p. 49, in: Pfaller (2000).

emotional or intimate communication between users/visitors, and also between users and virtual or real objects. Further, it is present in the form of an interaction for the self-reflection of visitors/users, as an attention-attracting interaction, as an external interaction, or a relation-exploring-interaction. Interaction as co-creation is present in artworks that offer the possibility for audience/visitors to use the tools programmed by the artists for making an "own end-version" with the work. The best examples here would be the interactive digital artworks created based on evolutionary designing, which offer many possibilities to get an individual final result. In contrast to this kind of interaction is interaction as a kind of navigation, which offers the audience/visitors the possibility for exploring a result that cannot be much modified. Here we can think of works that belong to the category of "virtual reality", for instance, Michael Naimark's "Be Now Here" (1995-1997). Visualizations which can be virtually explored by navigating in them are not the only type based on this kind of interaction, but also abstract virtual realities. Of course the boundaries between such categories are not fixed so that there may be also artworks which belong to both of them.

The interaction in form of an emotional or intimate communication is a kind of interaction that offers emotional or intimate relations between participants, or between participants and virtual or real motifs. As virtual motifs we can consider, for instance, virtual animals and as real motifs we can consider, for instance, telerobotic objects. Paul Sermons' work "Telematic Dreaming" (1992) can be mentioned as an example within this category. Or the work "Mariposa" (2001) by Zack Booth Simpson.

The interaction for self-reflection is the kind of interaction which allows or invites the users to manipulate their self-images. The work "Touch me" of Alba D'Urbano is an example, and "Head" by Ken Feingold can also be mentioned as an example for its attention-attracting interaction. Concerning external interaction we can think of the work "Doves" by Ursula Damm. Here, visitors/participants don't cause the interaction – it is a result of external activity. The relation-exploring-interaction can be followed in the work of Scott Snibbe "Boundary Functions", and also in other works that show visualizations of mathematical rules.

The groups mentioned above will be used for researching the works within this book in the context of interaction and the forms of interaction. Some of the artworks covered in this book show more than one interaction form.

2.4. Interfaces as GUI, or as devices and environments equipped with sensors

The development of the human-computer-interface originates, as new technology so often does, from the war industry, in this instance from the technique used for fighter cockpits. An interesting analogy has been made about interfaces and their specifications by Gillian Crampton Smith, comparing the characteristics of buildings and of human-computer interfaces. According to Smith: "*The Roman architect Vitruvius said buildings should have firmness, commodity and delight. By this principle human-computer interfaces should be robust, useful and pleasurable. Their design should be as much an art as a science.*"[47] Smith describes how the artist could design the interface considering the parameters of traditional art. Smith mentioned here as criteria the narrative aspect, symbolism and allusion, the visual representation and the surface appearance.[48]

An interesting description of the interface has been made by Nicholas Negroponte, who argues that"*human interface with computers is the physical, sensory, and intellectual space that lies between computers and ourselves."*[49] According to him this space can be like any other place *"unfamiliar, cold, and unwelcoming. But it can also be like some other places, those we know and love, those that are familiar, comfortable, warm, and, most importantly, personal.*"[50]

A more adequate description for the term interface can be followed according to Wulf R. Halbach. For him the interface "*bezeichnet grundsätzlich den Punkt einer Begegnung oder einer Koppelung zwischen zwei oder mehr Systemen und/oder deren Grenzen zueinander. Als technische Einrichtung übernimmt eine Schnittstelle die Übersetzungs- und Vermittlungsfunktion zwischen gekoppelten Systemen.*[51] He explains that "*Die Informatik unterscheidet zwischen mehreren Typen von Schnittstellen, um die verschiedenen Elemente und Funktionen der Mensch-Maschine-Interaktion einzubinden.*"[52] For this he counted the categories such as "Import- und Exportschnittstellen", "Hardwareschnittstellen", "Softwareschnittstellen", "Hardware-Software-Schnittstellen" and "Mensch-Maschine-Schnittstellen", in English known as the Human-Computer-Interface (HCI).[53] The last one has been explained further by Halbach: "… *Benutzerschnittstellen umfassen alle Komponenten (Hard- und Software), die dem Benutzer zur Bedienung der Maschine zur Verfügung stehen.*"[54] He considers that the Human-Computer-Interface is the "Gesicht" (Face), or the "Oberfläche" (Surface) of the Machine for its user. Within interactive digital art, including interactive sensor-based environments, the description of the interface as a "face" or as a "surface" should be extended to the term of "space". Also according to Brenda Laurel, the

---

[47] Gillian Crampton Smith. *"The Art of Interaction"*, pp. 79-94, in: MacDonald, Lindsay and Vince, John (Ed.), Interacting with Virtual Environments, Chichester and New York, 1994, p.79.

[48] See Smith, p. 83, in: MacDonald and Vince (1994).

[49] Nicholas Negroponte, Foreword, in: Richard A. Bolt. The Human Interface. Where People and Computers Meet, MIT, Wadsworth, 1984, p. xiii.

[50] Negroponte, p. xiii, in: Bolt (1984).

[51] Wulf R. Halbach, Interfaces. Medien- und Kommunikationstheoretische Elemente einer Interface-Theorie, Wilhelm Fink, München, 1994, p. 168.

[52] Halbach (1994), p. 168.

[53] See Halbach (1994), p. 169.

[54] Halbach (1994), p. 169.

interface is a "*contact surface. It reflects the physical properties of the interactors, the functions to be performed, and the balance of power and control.*"[55]
The interface has been described in a metaphorical way as a building (Smith) or as a space (Negroponte), as a face (Halbach) or as a surface (Halbach and Laurel). Trying to describe this term more precisely, we can create a new definition, namely that the interface is a material or a non-material cross-point between the human and the programmed work, which offers the possibility to interact with it. According to this, the interface as an important component for the creation and existence of interactive digital art can be categorized on the one hand as material and on the other as non-material form. Material interfaces are for example objects from everyday life, as the bicycle in the Jeffrey Shaw's work "The Legible City", 1988 – 1991, plants, as in the work of Christa Sommerer and Laurent Mignonneau "Interactive Plant Growing" (1992), or specific self-constructed objects, as data-glove, data helmet, etc. As non-material interfaces can be mentioned among others air, pulse, gaze, language, voice, etc. Interfaces, which are realized by non-material data-input such as movement, or gesture, are considered as intuitive interfaces. All interfaces of this kind of art, except the works which uses GUI[56], are equipped with sensor. According to den Hoven and Eggen *"...it has been demonstrated that graspable, or tangible user interfaces (TUIs) make up a promising alternative for the `traditional` omnipresent graphical user interface (GUI)* […]. *TUIs integrate physical representation and mechanisms for interactive control into graspable user interface artifacts. This physical embodiment provides the user interface designer with new and powerful means to free user-system interaction from the confines of the desktop and merge it with the physical reality of everyday life."*[57] The sensors appear in form of light-detection, movement-detection and tracking, pulse measurement devices and temperature measurement devices. Even brain activity measurement devices have been used already in 1993 in the work "Terrain 01" by Ulrike Gabriel. A sophisticated model of this device was presented at CeBIT in Hannover in 2007, where the visitors could write with their thoughts. The brain is transformed to a computer interface and a kind of "mental typewriter" translates thoughts into cursor movements on a computer screen.
Oliver Grau emphasizes the importance of the kind of interface called a "natural interface": "*In a work of virtual art, in addition to interaction it is the interface – especially the natural interface – that represents the central domain of artistic creation, which can be implemented with emancipatory or manipulative purpose; both options are so closely intertwined that they are almost inseparable. Considering virtual image spaces' potential for suggestion, the issue of interface design, the connection to the body of data acquires great importance.*"[58] Different sensors, like weight sensors, or movement sensors let the visitors interact without being consciousness of their actions. In interactive digital art, their application included the "PICO-SCAN" (2000), developed by Christa Sommerer and Laurent Mignonneau, which uses body data to create artificial life forms.

---

[55] Brenda Laurel (Ed.), The Art of Human-Computer Interface Design, Addison-Wesley, 1990, p.xii; see also Brenda Laurel. Computers as Theatre, Addison-Wesley, 1991.

[56] The GUI – Graphical User Interface is the Interface which operates by using a mouse or a keyboard.

[57] Elise van den Hoven and Berry Eggen, *"Tangible Computing in Everyday Life: Extending Current Frameworks for Tangible User Interfaces with ersonal Objects"*, pp. 230-242, in: Panos Markopoulos, Berry Eggen, Emile Aarts, James L. Crowley (Eds.), Ambient Intelligence, Second European Symposium, EUSAI 2004, Eindhoven, The Netherlands, Springer, Berlin, 2004, p. 230.

[58] Grau (2003), p. 344.

According to Hayles, in one version "… *the user wears a stereovision helmet and a body suit with sensors at joint positions. The user's movements are reproduced by a simulacrum on the computer screen called a puppet. When the user turns her head, the computer display changes in a corresponding fashion. At the same time, audiophones create a three-dimensional sound field. Kinesthetic sensations, such as G-loads for flight simulators, can be supplied by the body suit. The result is a multisensory interaction that creates the illusion that the user is inside the computer. […] The user learns kinesthetically proprioceptively in these systems that the boundaries of self are defined less by the skin than by the feedback loops connecting body and simulation in a techno-bio-integrated circuit."*[59] The basic physical variables that can be measured, according the International System of Units are the kilogram for mass, the meter for distance, the second for time, the Kelvin scale or the degree Celsius for temperature, the ampere for electric current, the mole for amount of substance, and the candela for intensity of light. More complex measurements can also be calculated combining these elements. The sensor technology is based on such calculations.

[59] N. Katherine Hayles, *"Virtual Bodies and Flickering Signifiers"*, p. 259-277, in: Timothy Druckrey (Ed.) Electronic Culture. Technology and Visual Representation, Aperture Foundation, 1996, p. 261ff.

2.5. The history of the technology of interactive digital art

2.5.1. Mechanical calculators, electronic computers

There are a few milestones in the development of the technology used by interactive artworks, without which they could not have been developed. Frank Popper wrote in "Art of the Electronic Age" (1993) that "*For thousands of years, science and technology constituted distinct activities, but in the 19th century they entered into a much closer relationship. This coincided roughly with their convergence with the arts, and this development led gradually to what in the late 20th century we may call technological or electronic art.*"[60]
Beginning with a kind of analogue technology we have to think of the theoretical-computing machine, the so-called Turing machine, which was described by Alan Turing in 1936. It was actually never constructed, but the idea to execute arithmetic problems automatically and to use signs/signals (later 0 or 1) creating a kind of algorithm, influenced the development of digital computers. The Turing machine is not a physical object, but a mathematical one. Meltzer and Abd-alla in their book "Principles of Digital Computer Design" published in 1976, the history of digital computer development divided into mechanical calculators and electronic computers.[61] In the first category an important device was the abacus, developed around 4000-3000 B.C. "*The abacus is a mechanical device with beads which can move along a wire. The positions of the beads on each wire determine the value of a digit. A skilled operator can add, subtract, multiply, and divide on this simple device...*"[62] In 1642 Blaise Pascal "*developed a rotating wheel mechanical calculator with automatic carry between digits for addition and subtraction of decimal numbers.*"[63] Subsequently, "*Baron von Leibnitz extended the Pascal calculator so that it could multiply and divide.*"[64] in 1671.
Work by George Siebitz (1904-95) pioneered telecommunication by computer. In 1937 he began building "*a relay computer called the Complex Calculator which was installed in 1940"*[65] at the Bell Telephone Laboratories in Manhattan, linking it to three teletype machines within the same building. In this way the computer could be used from more than one location. He changed the concept and use of computers. Approximately at the same time, Howard Aiken of Harvard University created the Mark I Automatic Sequence Controlled Calculator, built then in cooperation with International Business Machines Corporation (IBM). According to Michael R. Williams, the German Konrad Zuse (1910-1995) "*holds a special place in the history of computation because it was he who first managed to construct an automatically controlled calculating machine. It was not electronic, and it did not have a stored program, but it was capable of being automatically controlled by an external reader, which would take the instructions to be executed from a punched tape."*[66] The Z3, for example,

[60] Popper (1993), p. 7.
[61] See Arnold C. Meltzer and Abd-elfattah M. Abd-alla. Principles of Digital Computer Design, Vol. 1, Prentice-Hall, New Jersey, 1976, p. 13ff.
[62] Meltzer and Abd-alla (1976), p. 13.
[63] Meltzer and Abd-alla (1976), p. 13.
[64] Meltzer and Abd-alla (1976), p. 13.
[65] Meltzer and Abd-alla (1976), p. 14.
[66] Michael R. Williams. A Histroy of Computing Technology, Prentice-Hall, London, 1985, p. 214.

which was constructed in 1941 *"might best be compared in speed to the Harvard Mark I"*[67] .Meltzer and Abd-alla divide electronic computers into three generations "First – Generation Vacuum Tube Machines", "Second – Generation Transistor Machines" and "Third – Generation Integrated Circuit Machines". For the first they noted the computer called ENIAC, which was completed in 1945. The proposal for this computer was made by J. P. Eckert, and J. W. Mauchly of the Moore School of Electrical Engineering of the University of Pennsylvania to the Ballistic Research Laboratories of the U.S. Army Ordnance Corps *"to build an all-electronic vacuum tube calculator for use in computing trajectories and firing tables for artillery shells."*[68] The reason of its development has been described in the following: "*The problem of tracking antiaircraft weapons against extremely fast targets prompted the research and development of intelligent mechanisms capable of predicting future states or positions far faster than the human brain could do. The main priorities were speed, efficiency and reliability; i.e., fast-acting, error-free systems. ENIAC (Electronic Numerical Integrator and Computer), the first high-powered digital computer, was designed to address precisely this problem by performing ballistic computations at enormous speed and allowing the outcome to be translated into adjustments in the firing trajectory of antiaircraft guns."*[69] This development line was followed by the computer EDVAC (Electronic Discrete Variable Computer), proposed by John von Neumann. The Hungarian mathematician and early computer scientist John von Neumann (1903-1957) is known for his work in the early development of computers, The "Von Neumann Architecture" is a computer design model that uses a processing unit and a single separate storage structure holding in this way instructions and data at the same time. Von Neumann Architecture was implemented in a computer developed at Princeton in the Institute for Advanced Study (IAS) by John von Neumann, Arthur W. Burks, Herman H. Goldstine and Julian Bigelow.[70] Also the computers EDSAC, SEAC, ERA, UNIVAC and IBM 701, IBM 650 and the IBM 704 can be ordered along this line of the development. To this generation belongs also the installation of a coincident-current magnetic core memory on the Whirlwind-Computer at Massachusetts Institute of Technology (MIT).
The Whirlwind-Computer, which was developed 1945-1952 in the MIT can be considered as a pioneer achievement in the field of real-time interaction. The next generation was characterized by its transistor machines, including, according to Meltzer and Abd-alla NCR (The National Cash Registered Computer), the IBM 1401, the TRANSAC S-2000, the CDC 1604, the IBM 7090, the UNIVAC LARC and the IBM 7030 (STREtCH) and the CDC 6600. And the third generation included integrated circuit machines as IBM System 360, RCA Spectra 70, the G. E. 600, and IBM System 370.

[67] Williams (1985), p. 215.

[68] Meltzer and Abd-alla (1976), p. 14ff.

[69] Bill Nichols, *"The Work of Culture in the Age of Cybernetic Systems"*, pp. 121-143, in: Druckrey (1996), p. 133.

[70] See http://www.ias.edu/spfeatures/john_von_neumann/electronic-computer-project/

2.5.2. Software developments

Arnold C. Meltzer and Abd-elfattah M. Abd-alla note that early software programming had developed on mechanical calculators. Programmed plugboards were forerunners of software development, and by 1951 the so-called subroutines (a prewritten set of generally used algorithms) were being used on the EDSAC computer.[71] Assemblers were developed to obviate the fact that the programmer "*had to keep track of the address of each piece of data he wished to use and also remember the various codes for the operations he wanted to perform.*"[72] The programmer could now use mnemonics in place of the operation codes and address, so that when "*his source program was translated (assembled) into the machine code, the assembler assigned absolute codes and addresses in place of the mnemonics.*"[73] In about 1953, Grace Hopper and others conceived the idea of allowing the computer to translate and compile programs – three problem-oriented languages were developed: Math-matic, Flow-matic, and the A2 compiler.[74] These are considered forerunners of today's higher-level languages. After this, Dr. James Backus of IBM developed the problem-oriented compiler FORTRAN (from FORmula TRANslation), then in 1958 the ALGOL (from ALGorithically Oriented Language) was developed, and in 1960 the COBOL (from Common Business-Oriented Language).[75]
Also the development of operating systems, beginning for example with group SHARE, which developed SOS (Share Operating System) should be mentioned in any history of the technology used for interactive digital art.

[71] See Meltzer and Abd-alla (1976), p. 18.

[72] Meltzer and Abd-alla (1976), p. 18.

[73] Meltzer and Abd-alla (1976), p. 18.

[74] See Meltzer and Abd-alla (1976), p. 18.

[75] See Meltzer and Abd-alla (1976), p. 18.

2.5.3. Inventions in form of devices/equipment

According to Paul E. Ceruzzi "*The "digitization of the world picture" began in the mid-1930s, with the work of a few mathematicians and engineers. By 1985 this world view had triumphed."*[76] Oscillographic artworks (oscillons), generated by an electronic machine, were graphic images from 1950s by one of the pioneers in electronic art, the mathematician and artist from Cherokee (Iowa), Ben Laposky.,. The graphics were produced by manipulating electronic beams and recording them onto high-speed film. A further important invention for the interface was the 1949 "light pen", which according to Lev Manovich "*can be considered a precursor of the contemporary mouse*"[77]. Ivan Southerland described the development of "Sketchpad Systems" for interactive computer graphics in his dissertation thesis in 1962 at MIT. Users could generate and manipulate computer graphics by touching the screen with a light pen.[78]
Art Historian Söke Dinkla evaluates the invention of the light pen and the invention of the screen: "*Mit dem Monitor als visuellem Display und dem Lichtstift zur Dateneingabe sind Anfang der fünfziger Jahre die grundlegenden gerätetechnischen Voraussetzungen für den interactiven Umgang mit elektronischen Bildern geschaffen worden. Zu dieser Zeit war aber auch schon klar, daß diese Konstellation nicht nur für militärische Anwendungen von Bedeutung ist."*[79]
The term "display" which will be treated within this book equally with the terms "screen" or "monitor" has a long tradition in art. The term "display" is explained among others as "*die Bildschirme von Rechnersystemen, insbesondere von tragbaren Computersystemen, mit mehreren Tausend bis Millionen Bildelementen…*"[80] Their function is today diverse, for instance, according to Lev Manovich "*A computer monitor connected to a network becomes a window through which we can enter places thousands of miles away.*"[81] Different kinds of interactive digital art, such as telepresence art or virtual realities, could not be realized without a display. We can distinguish between a digital and an analog display. Manovich wrote about the genealogy of the screen. Defining the screen as a "*flat, rectangular surface*" he makes a direct link to a particular genre of painting, the Renaissance painting. According to him "*Even proportions have not changed in five centuries; they are similar for a typical fifteeth-century painting, a film screen, and a computer screen.*"[82] Manovich distinguishes between the origin of the cinema's screen and the computer screen. According to him, the cinema screen was developed for public entertainment of the eighteenth and nineteenth centuries, whereas the history of the computer screen has to do with "*military surveillance*".[83]

---

[76] Paul E. Ceruzzi. A History of Modern Computing, Massachusetts Institute of Technology, 1998, p. 308ff.

[77] Manovich (2001), p. 102.

[78] See Manovich (2001), p.102.

[79] Söke Dinkla. Pioniere Interaktiver Kunst von 1970 bis heute. Ostfildern, 1997, p. 52.

[80] Brockhaus Enzyklopädie Digital, Mannheim, Bibliographische Institut & F. A. Brockhaus AG, 2006.

[81] Manovich (2001), p. 94.

[82] Manovich (2001), p. 95.

[83] Manovich (2001), p. 98.

Erkki Huhtamo said that our lives are surrounded by screens, such as the television set, animated billboards, computer displays, personal organizers and movie-screens.[84] He left open for argument the question of whether the holographic display is a screen. He defines screens as "*cultural artifacts that have their own histories, conditioned by cultural, social, technological and ideological factors.*"[85] Huhtamo uses the term "*small screen*" to describe "*the television, the radar or the computer display*" [86]. As for technical origin, he identified the "*cathode ray tube, a device which was first successfully demonstrated around the turn of the 19th and the 20th century* […]*"*[87]. But according to him "*the invention and the development of the cathode ray tube happened in a cultural situation in which the idea of the small screen had already been anticipated*."[88] To find these predecessors he argued that we "*should travel further back in time, to the 16th and the 17th centuries at the very least.*"[89] In this context he considered examples such as the magic lantern projections of the 17th century, camera obscura or even the magic mirrors of the 16th century.

Another important invention was the so-called HMD (head-mounted display), which according to Howard Rheingold's book "Virtual Reality" (1992), Southerland proposed as first its mounting in the form of "*small computer screens in binocular glasses – far from an easy hardware task in the early 1960s – and thus immerse the user's point of view inside the computer graphic world."*[90] By the invention of the HMD, the display screens are carried on the user's head.

For the realization of immersive interactive artworks and for the further development of virtual realities, the technology of CAVE played a significant role. It was developed in the Electronic Visualization Lab, at the University of Illinois at Chicago (UIC), in 1991 by Dan Sandin and Tom DeFanti. Since then CAVE has been used by artists in a different museums and art shows. CAVE is a CAVE Automatic Virtual Environment with projectors, screens and mirrors. It achieves a "*wide angle of view by surrounding the participant with large projected images. The three walls are rear projected, and the floor is front projected from above*."[91]

As forerunners of contemporary technological equipment used in interactive digital art, inventions like the magic lantern are important , which is "*in gewisser Weise ein Vorläufer des modernen Dia-Projectors*"[92], The stereoscope (invented 1870) had on one side "*zwei Okulare*" and *"am anderen Ende ein Rahmen für zwei jeweils nebeneinander montierte Fotografien. Wenn beide Teilbilder optisch richtig miteinander verschmolzen, wirkten sie […] wie ein einziges großes räumliches Bild.*"[93] Also inventions such as the cinematograph of the brothers Lumiére made it already at that time possible to record, "…*Positivkopien*

[84] See Erkki Huhtamo, *"Seeing at a Distance – Towards an Archaeology of the "Small Screen""*, pp. 262 – 278, in: Sommerer and Mignonneau (1998), p. 262.

[85] Huhtamo, p. 262, in: Sommerer and Mignonneau (1998).

[86] Huhtamo, p. 263, in: Sommerer and Mignonneau (1998).

[87] Huhtamo, p. 268, in: Sommerer and Mignonneau (1998).

[88] Huhtamo, p. 263, in: Sommerer and Mignonneau (1998).

[89] Huhtamo, p. 264, in: Sommerer and Mignonneau (1998).

[90] Howard Rheingold, Virtual Reality, The Revolutionary Technology of Computer-Generated Artificial Worlds – and How it Promises to Transform Society, Touchstone, New York, 1991, p. 104.

[91] Daniel J. Sandin, *"Digital Illusion, Virtual Reality, and Cinema"*, pp. 3-26, here p.12, in: Clark Dodsworth Jr. (Ed.), Digital Illusion, Entertaining the Future with High Technology, ACM Press, New York, 1998.

[92] Willfried Baatz, Geschichte der Fotografie, DuMont, Köln, 1997 and 2002, p. 12.

[93] Baatz (1997 and 2002), p. 34.

herstellen und mit einem zusätzlichen Lampenhaus auch projizieren"[94] can be treated as an important attainment for the present technique. The invention of the Sensorama Simulator was a direction for the development of movie technology – full coverage of the senses – "*foreseen by visionary Morton Heilig in the 1950s. After stating his vision for multisensory films in his paper "The Cinema of the Future" (Heilig 1995), he proceeded to work out a detailed design for an "experience theater" that gave, to viewers in a large audience, an illusion of reality by providing a very broad palette of sensory stimulation.*[95] *The sensory palette included full-peripheral (wide-field) color images in 3D, directional sound, aromas, wind, vibration, body tilting, and temperature variations. He then built and patented a one-person version of the experience theater, which he called the "Sensorama Simulator." This machine played stereoscopic films, augmented with not only stereophonic sound tracks but also tracks for wind, vibrations, and aromas."*[96] Heilig describes his thoughts before the invention: "*Since Italy is drenched in painting and sculpture, it's easy to understand why I soon came to think of the screen image as a painting that moved and the characters on-screen as dynamic sculptures that one could observe from different angles. To me, a film was a work of art – something an audience surrounded and looked at – and a motion picture theater seemed to me a kind of museum where audiences gathered to observe the film*."[97]

[94] Andrea Gronemeyer, Film, DuMont, Köln, 1998 and 2004, p. 26.

[95] Warren Robinett, *"Interactivity and Individual Viewpoint in Shared Virtual Worlds: The Big Screen Versus Networked Personal Displays"*, pp. 331 – 341, in: Dodsworth (1998). p. 340.

[96] Robinett, p. 340, in: Dodsworth (1998).

[97] Mort Heilig, *"Beginnings: Sensorama and the Telesphere Mask"*, pp. 343 – 351, in: Dodsworth (1998), p. 343.

3. Introduction to Motifs, Visual Motifs and the Methods for their Research

Motifs of an artwork define and constitute its content; they define their theme and their overall impression. Motifs can be of different natures, such as acoustic, spatial, haptic or visual. They can appear alone, or in combination. According to Olbrich, "*In einem Motiv treten die dialektischen Beziehungen von Gegenstand, Form und Inhalt besonders deutlich zutage. Darauf beruht die kunsttheoretische Bedeutung der Motiv-Untersuchung. Als Motive können aufgefasst werden: Elemente der Realität (z.B. Pfau, Ruine, Lesender, Industrie, verschlungene Hände), phantastische Bildungen (Nimbus, Drache), Bildfiguren von bestimmter Gestalt (ins Bild blickende Rückenfigur, Figur am Fenster; geöffneter Vorhang im Bild) oder >Rahmenthemen< (Beweinungsgruppe), Gestaltungsmittel der Komposition (antithet. Gruppe) oder der Farbgebung (Goldgrund), aber auch Typen von Bildern (Herme, Torso) und Bauten (Rundtempel, Pyramide), Architekturelemente (Säulenportikus, Baldachin) sowie Ornamente (Knoten, Bukranion).*"[98] He concludes that "*Das Motiv ist* […] *nicht identisch mit dem Thema von Bild- oder Zweck von Bauwerken* […] *Motive können jedoch in den Rang von selbständigen Themen aufsteigen (z.B. im 16.Jh. die Stilleben, die zuvor nur Elemente in religiösen Darstellungen oder Porträts waren).*"[99]

In art history many motifs have been present a long time with the same or evolving meanings. According to Olbrich, motifs "*können den Wert von Symbolen gewinnen oder zu leeren Formen erstarren. Ihre Verbreitung, Wandlungen, Fortwirkungen und Übertragungen in andere Kulturen, die Bevorzugung oder Ablehnung von Motiven in bestimmten Kunstströmungen ermöglichen Aufschlüsse über Stilcharakter, Einflüsse und gesellschaftliche Bedingtheit künstlerischer Erscheinungen* […]*"*[100].
Vilém Flusser wrote about "*alternative worlds*" as future worlds consisting of combinations of different parameters (lines, surfaces, bodies and moving bodies…) which we could define as motifs within digital art: "*Before our doubting eyes, alternative worlds begin to emerge from the computers: lines, surfaces, and soon also bodies and moving bodies, made up of point elements. These worlds are colorful and emit sounds, and in the near future they will probably also be touched, smelled, and tasted. But that isn't all, because the moving bodies that will soon be realized through calculation and which are beginning to emerge from computation, will be equipped with the artificial intelligence of Turing's man, so that we will be able to enter into dialogical relationships with them."*[101]

A leitmotif is the main motif of a work. For example, the leitmotif of a classic music composition is a motif that is repeated, in particular that is modulated and being used in different variations throughout the composition. This book focuses on the visual motifs which appear in interactive digital artworks. The works that are going to be focused on to define visual motifs in interactive digital art have, among other things, a leitmotif.

---

[98] Harald Olbrich (Ed.), Lexikon der Kunst, Architektur, Bildende Kunst, Angewandte Kunst, Industrieformgestaltung, Kunsttheorie, Bd. V, VEB E. A. Seemann Verlag, Leipzig, 1989, p. 13.

[99] Olbrich (1989), Bd. V, p. 13.

[100] Olbrich (1989), Bd. V, p. 13.

[101] Vilém Flusser, *"Digital Apparition"*, pp. 242-257, in: Druckrey (1996), p. 242.

D. Diederichsen in 2006 wrote on "Visual Culture" emphasizing that "Visual Culture" is a notion that appears in international art- and theory-discussions in the middle of 1990s and that this notion was used in combination with "Visual Studies" and "Visual Culture Studies".[102] Diederichsen concludes that the notion "Visual Culture" represents diversified fields, such as studies about image science, the culture that has been created through game works, and also the visual aspect of media art in general.[103] He closes with a diversified use and meaning of this notion as in the following: *"Mittlerweile unterscheiden sich die real existierenden Unterrichtsangebote unter dem Namen »Visual Culture« im anglo-amerikanischen Raum untereinander etwa so gravierend wie die Vorstellungen von BefürworterInnen und KritikerInnen der ersten Diskussionsrunde in der Mitte der neunziger Jahre. Sie reichen von einem bunten Strauß geisteswissenschaftlicher Theorien, aufbereitet für KünstlerInnen und DesignerInnen an Akademien, über einen Sammelbegriff für die theoretische Beschäftigung mit visuellen Phänomenen, die von den konventionellen Film- und Kunstgeschichten nicht abgedeckt werden, über die dezidierte Beschäftigung mit nur interaktiven oder nur digitalen Bildwelten bis hin zu jener Konkurrenzveranstaltung zur Kunstgeschichte, von der eingangs die Rede war."*[104] In this book, the notion "Visual" will be used as an aspect (visual aspect) that is present in interactive digital artworks. The user should distinguish it from the notion "Visual" used in connection with "Visual Arts". The notion "Visual" in this book stays in a close relation to the visual aesthetic that observers perceive as a characteristic of many of those artworks.

According to Rudolf Arnheim for the purposes of everyday life, *"seeing is essentially a means of practical orientation. In that sense, seeing is determining through one's eyes that a certain thing is present as a certain place."*[105] Furthermore, "*Seeing means grasping a few outstanding features of the object – the blueness of the sky, the curve of the swan's neck, the rectangularity of the book, the sheen of metal, the straightness of the cigarette. A few simple lines and dots are readily accepted as "a face", not only by civilized Westerners, who may be suspected of having agreed among each other on such "sign language", but also by babies, savages, and animals.*"[106] According to him, compare to a mechanical recording device, vision differs from "*what the photographic camera does by being active exploration rather than passive recording. Vision is highly selective, not only in the sense of concentrating on what attracts attention, but also in its way of dealing with any one object.*"[107] Arnheim's book refers to visual perception based on psychology. Main focus points of his research are elements such as balance, shape, form, growth, space, light, color, movement, tension and expression. In reference to shape, for instance, Arnheim's opinion is that "*Shape is one of the essential characteristics of objects grasped by the eyes. It refers to the spatial aspects of things, excepting location and orientation. That is, shape does not tell us where an object is and whether it lies upside down or right side up. It concerns, first of all, the boundaries of masses. Three-dimensional bodies are bound by two-dimensional surfaces. Surfaces are bound by one-dimensional borders – for example, by lines. The outer boundaries of objects can be explored by the senses without impediment.*[108] Here Arnheim separates the shape of a

[102] See Diedrich Diederichsen, *"Visual Culture"*, pp. 300-302, in: Butin (2006).

[103] See Diederichsen, p. 302, in: Butin (2006).

[104] See Diederichsen, p. 302, in: Butin (2006).

[105] Rudolf Arnheim, Art and Visual Perception. A Psychology of the Creative Eye, University of California Press, Berkeley and Los Angeles, 1974, p. 32.

[106] Arnheim (1974), p. 33.

[107] Arnheim (1974), p. 33.

[108] Arnheim (1974), p. 37.

room, a cave, or a mouth, *"given by the inner boundaries of solid objects; and in cups, hats, or gloves, outside and inside make up shape together or vie with each other for the title.*"[109]
The visual aspect has a long tradition and historically we are a part of this tradition, we are developing it further. But to create the future we have to think of the contemporary in the context of the past. This is one reason why one should research the visual motifs in interactive digital art not just in the context of interactive media art globally, and further, the context of media art globally, but also in the context of traditional art.[110] This would produce at least one direction of development (or several directions of development) and suggestions could be made as to further developments in the future. To conduct this kind of research, methods from art history are required as well as comparative examples from traditional art. Consequently a historical background for the interactive artworks would be created and would illustrate how these already existing visual motifs are used and represented in interactive digital art. Although designing in interactive digital art is a process which depends on the possibilities of the state-of-the-art in current digital techniques, its concept is based on the real world of the artist[111] (his experiences with different subjects, his handling of problems in everyday life, his impressions about different things in his life and around him), even if it is represented in an "unreal" (fantastic) way. So the motifs that the artist chooses for designing his works are visually based on his or her life, although they can be represented as altered (processed) or created by using an algorithm.

The research within this book is based on the knowledge and methods which are taught at the Vienna University, Department of Art History. The methods used during this study are based on methods from the book "Methodisches zur kunsthistorischen Praxis" (Otto Pächt) and from "Kunstgeschichte. Eine Einführung" (edited by Hans Belting).
The book "Methodisches zur kunsthistorischen Praxis" by Otto Pächt is a useful book which consists of various pieces of Pächt's work, including lectures, readings and publications/papers. The last chapter "Methodisches zur kunsthistorischen Praxis" was a lecture at the Vienna University in 1970/1971. This lecture included questions for artworks research, such as the perception of space, determination of time, meaning of a specific shape, the description of architectonical objects, the history of an artwork's development, knowledgeable determination, objective description, the function of iconography, the importance of the comparison, and other helpful parameters for researching artworks. With regards to the importance of the comparison, Pächt says that "*Da es sich bei dem Aneignen*

[109] Arnheim (1974), p. 37.

[110] Already Hünnekens (1997, p. 113), based on the statement of the art historian S. Dinkla ("Pioniere Interaktiver Kunst", 1997), refers to traditional art in relation to interactive media art: *"Nimmt man, wie Dinkla dies vorschlägt, die »Zuschauerbeteiligung durch räumliche Integration« sowie eine meist »provokative Ansprache« als Kriterien für die Anfänge der Zuschauerbeteiligung in künstlerischen Arbeiten, so ist auch an die avantgardistischen Strömungen wie Futurismus, Dadaismus und Surrealismus zu erinnern, die eine solche Beteiligung ermöglichten, indem sie sich unterschiedlicher medialer Mittel des Alltags oder der Unterhaltung bedienten."*

[111] See Popper (1993), p. 161: *"Artists are freer to apply their imagination to aesthetic problems, even while conforming to certain constraints arising from the techniques or technologies used. They are able to employ a diversity of means, always remaining open to new experiences. Their freedom of imagination, however, imposes on them the rigour of an exceptional lucidity and moral responsibility. In fact, the artist must grasp the applications of his or her researches in daily life even more than the scientist who has historically often discovered their implications much later."*

fremder Sehgewohnheiten nicht um eine Denkoperation handelt, sondern um eine spezifische Umbildung oder Anpassung unserer sinnlichen Wahrnehmung, so hängt das Erfassen eines uns noch fremden Kunstwerks im Grunde von dem Gelingen eines Reifeprozesses unserer Wahrnehmungsorgane ab […] *Es lassen sich Untersuchungsverfahren entwickeln, die den Prozeß des Reifens vorantreiben, beschleunigen können. Etwa verschiedene vergleichende Verfahren, die in der Konfrontierung mit Objekten, mit denen das zu Erforschende irgendeine scheinbare oder wirkliche Ähnlichkeit besitzt, entweder sein Anders- und Besonderssein schärfer herausstellen oder aber seine innere Verwandtschaft enthüllen, es schärfer trennen oder aber näher rücken.*"[112] This is one of the methods that have been used for the research in this book.

The book "Kunstgeschichte. Eine Einführung" edited by Hans Belting consists of three main categories "Gegenstandsbestimmung", "Gegenstandsicherung" and "Gegenstandsdeutung".[113] The third category especially, will be useful for the following research of interactive digital artworks. For instance the methods about shape, structure and style ("Die formanalytischen und formgeschichtlichen Methoden") which are written by Hermann Bauer will be used. Useful in this context is also the chapter "Wechselseitige Erhellung: Die Kunstgeschichte und ihre Nachbardisziplinen", written by Heinrich Dilly. But also "Das Werk im Kontext" by Hans Belting and "Kunstwerk und Betrachter: Der rezeptionsästhetische Ansatz" by Wolfgang Kemp are important for this research. For instance, Kemp considers that the aesthetic of reception "*arbeitet werkorientiert, sie ist auf der Suche nach dem impliziten Betrachter, nach der Betrachterfunktion im Werk. Daß das Werk "für jemand" gemacht wird, ist keine späte Erkenntnis eines kleinen Zweiges der Kunstgeschichte, sondern konstitutives Moment seiner Schöpfung von Anfang an. Jedes Kunstwerk is adressiert, es entwirft seinen Betrachter, und es gibt dabei zwei Informationen preis, die vielleicht, von einer sehr hohen Warte betrachtet, identisch sind: Indem es mit uns kommuniziert, spricht es über seinen Platz und seine Wirkungsmöglichkeiten in der Gesellschaft und spricht es über sich selbst.*"[114] Due to this the aesthetic of reception has three functions *"(1) sie muß die Zeichen und Mittel erkennen mit denen das Kunstwerk in Kontakt zu uns tritt, sie muß sie lesen im Hinblick (2) auf ihre sozialgeschichtliche und (3) auf ihre eigentliche ästhetische Aussage. In diesem Zusammenhang ist es wichtig, auf eine Spezifik der künstlerischen Kommunikation hinzuweisen. Autor und Rezipient verkehren nicht direkt miteinander, so wie es der alltägliche Vorgang einer face-to-face Kommunikation mit sich bringt."*[115] Kemp's assertions are important for researching the communication's form between the observer/user and the artwork itself, and also for researching the perception of observer/user.

Furthermore, the research of the visual motifs in this book will be based on the iconographic-iconological methods following Erwin Panofsky (Book: Ikonographie und Ikonologie, Panofsky, 1995). He distinguishes three different layers for researching subjects. The first one is "*Primäres oder natürliches Sujet*" which can result by identifying pure shapes, "*nämlich: gewisse Konfigurationen von Linie und Farbe oder gewisse eigentümlich geformte Bronze- oder Steinstücke als Darstellungen natürlicher Gegenstände wie menschlicher Wesen, Tiere,*

---

[112] Otto Pächt, *"Methodisches zur kunsthistorischen Praxis"*, pp. 187 – 300, in: Otto Pächt, Methodisches zur kunsthistorischen Praxis, Prestel-Verlag, München, 1995, p. 251.

[113] See Hans Belting (Ed.). Kunstgeschichte, Eine Einführung, Dietrich Reimer Verlag, Berlin, 1996.

[114] Wolfgang Kemp, *„Kunstwerk und Betrachter: Der rezeptionsästhetische Ansatz*", pp. 241 – 258, in: Hans Belting (Ed.). Kunstgeschichte, Eine Einführung, Dietrich Reimer Verlag, Berlin, 1996, p. 244.

[115] Kemp, p. 244, in: Belting (1996).

Pflanzen, Häuser, Werkzeuge und so fort [und] … *indem man ihre gegenseitigen Beziehungen als Ereignisse identifiziert;* […] *und indem man solche ausdruckshaften Eigenschaften wie den schmerzlichen Charakter einer Pose oder einer Geste oder die heimelige und friedliche Atmosphäre eines Innenraums wahrnimmt.*"[116] The second one is "*Sekundäres oder konventionales Sujet*"[117] which can result through the cognition that "*eine männliche Gestalt mit einem Messer den heiligen Bartholomäus repräsentiert, daß eine weibliche Gestalt mit einem Pfirsich in der Hand eine Personifikation der Wahrhaftigkeit ist, dass eine Gruppe von Personen, die in einer bestimmten Anordnung und mit bestimmten Posen um eine Speisetafel sitzen, das letzte Abendmahl darstellen* […] *Indem wir das erfassen, verknüpfen wir künstlerische Motive und Kombinationen künstlerischer Motive (Kompositionen) mit Themen oder Konzepten.*"[118] The third layer is "*Eigentliche Bedeutung oder Gehalt*" which results "*indem man jene zugrunde liegenden Prinzipien ermittelt, die die Grundeinstellung einer Nation, einer Epoche, einer Klasse, einer religiösen oder philosophischen Überzeugung enthüllen, modifiziert durch eine Persönlichkeit und verdichtet in einem einzigen Werk.*" Further Panofsky explains here: "*Selbstredend manifestieren sich diese Prinzipien sowohl durch 'Kompositionsmethoden' wie durch 'ikonographische Bedeutung' und werfen daher auch ein Licht auf sie."*[119] The first layer has been considered as a "*vorikonographische Beschreibung des Kunstwerkes*", the second layer is the iconography and the third the iconology.[120] The methods that have been explained here will be used for the research in this book. But of course they will be adopted for researching within interactive digital art.

As mentioned above, the issue of visual perception nowadays is a very important one, because we tend to believe what we see. We are confronted with visual perception all the time and all around, for example, at work, at home, at supermarket, in museums, cinema, or theaters. We make decisions relying on our visual perception. Following the above mentioned ideas (in Panofsky, Arnheim, Belting, Pächt, Olbrich) we can build categories for research into interactive digital art. The main elements for research are the narrative aspect (the meaning of the work, its theme, its aim or idea), the visual aspect, the aspect of the sound and interactivity, as explained in the chapter "*Origin, meaning and forms of interaction*". Actually all these components are included in parameters such as the meaning, structure and composition of the works. The style of the art would result from the kind of structure and the composition of it. The overall impression of the works would result by researching the relation between those components.
One of those components, the visual aspect, is going to be closely considered in this book. It can be researched by depicting in more detail the visual structure of the artworks, which is built by elements such as space/s, object/s, shape/s, line/s, or points. Those basic visual components can appear as real or virtual components. The relationship of these parameters to each other, for example between the objects and the space, will give an understanding of the visual composition of the work. Those visual elements will be researched also in relation with other components of the works, which are mentioned above. Those visual elements which are most present will be analyzed for each artwork, and their relation to other aspects, such as

[116] Erwin Panofsky, Ikonographie und Ikonologie, Bildinterpretation nach dem Dreistufenmodell, DuMont, 2006, p. 37.

[117] Panofsky (2006), p. 37.

[118] Panofsky (2006), p. 38.

[119] Panofsky (2006), p. 39.

[120] See Panofsky (2006), p. 41.

interaction, or sound, will be discussed. Interactive digital art appears among other art in the form of installations, particularly as an interactive environment. So the spatial aspect of such artworks has to be considered as an important one. The space will be depicted as a virtual, or a real one, depending if the work is a virtual or a physical creation. But also the relation between the real and the virtual space will be analyzed. Grounds, surfaces and planes as parameters that characterize the space will be analyzed. The constitution of, and relationship between the foreground, midground and background, the position of surfaces and planes in the space, including direction and orientation of their eventual development and movement, will be explained.

The structure of the build of real or virtual objects will be depicted. For example if the objects are virtual objects, how the illusion of the third dimension is achieved will be analyzed and described. This includes elements such as the character of their surface, material and color. The distribution of shapes, lines and points in the virtual space, over a surface, or a plane are relevant, as well as the relationship between shapes, lines, and points. Their movement and orientation will be analyzed. If the objects, shapes, lines, or points create a digital form of 'reality', then it's scale will be taken in consideration. The aim of the artist will be researched first: to render a reality, to abstract a reality, or to represent an abstract scene that would create the illusion of a non-physical reality.

Vilém Flusser in his essay "Digital Apparition" considers the problem of the digitality and the scale of "real" as follows: *"If everything is delusive, if everything is a digital apparition – not only the synthetic image on the computer screen, but also this typewriter, these typing fingers and these thoughts being expressed by the typing fingers – then the world "apparition" itself has become meaningless."*[121] Flusser concludes: "*What remains is that everything is digital, i.e. that everything has to be looked at as a more or less dense distribution of point elements, of bits. Hence, it becomes possible to relativize the term "real" in the sense that something is more real the denser the distribution is, and more potential the more scattered it is. What we call "real", and also perceive and experience as such, are those areas, those curvatures and convexities, in which the particles are distributed more densely and in which potentialities realize themselves. This is the digital world picture as it is being suggested to us by the sciences and presented to our eyes by computers. We will have to live with this form now on, whether we like it or not*."[122]

Furthermore, the illumination of scenes, of objects and of shapes will be taken in consideration, if it is present. Also the behavior of represented objects, shapes, lines and points will be a parameter to analyze artworks created with the implementation of artificial intelligence.

A further aspect is the interaction, the importance of which will be considered as secondary in this book. It will be analyzed as a parameter that is responsible for the creation, exploration and the perception of the visual aspect. Interaction in interactive digital artworks allows you to be part of a sophisticated process, to participate in changing and creating this process, or it allows you to explore different levels of these works, so creating an individual pathway through the artwork. So the development of interaction, its duration, and when it occurs, is also a parameter that characterizes such artworks. This processual aspect is different to other kinds of art, which results on the one hand as a progression within the work itself and on the other hand as a developing transaction between the visitor/user/observer and the work. It is characterized by the fact that the process is always getting more complex, and also by its non-linearity. The relation between the visitor/user/observer and the work is also a part of the

[121] Flusser, p. 243ff, in: Druckrey (1996).

[122] Flusser, p. 243ff, in: Druckrey (1996).

structure of the work. In some works a relation between the visitors, created and influenced by the work itself, is the main aim of the art. Interactive digital artworks diverge from other time-based works by their characteristic of non-linearity, which emerges sometimes as a result of the parameters that interaction offers.
Each work, which will be considered as an example for this research, will be analyzed only by its specific parameters. For further depictions of the works, which are less important for this research, the reader will be referred to the appropriate literature. Examples of artwork that show visual aspects are the centre of this research. Also web-based works will be included. Interactive digital artworks will be placed in the context of media art, and in the context of historic-traditional art[123]. Further, it will be relevant to position each work not just within the field of interactive digital art, but also within each artist's oeuvre. Of course the main aim will be researching the visual aspect of their media artworks, as a classification and categorization of their visual motifs is a important aim within this book.

[123] See P. Weibel: *"The world of apparatus world continues what painting began, what it was forced to do by machines and what painting was unable to fulfil: the emancipation of all elements from art, giving rise to various worlds with intrinsic laws and qualities. By the same token, media art is a continual (postmodern) redefinition of the project of modernity."* P. Weibel, "The apparatus world – a world unto itself", in: D. Dunn (ed.), Eigenwelt der Apparatewelt - Pioneers of Electronic Art, Ars Electronica, Linz, 1992, p. 19.

3.1. Categories of Visual Motifs

Interactive digital art generally is a category that doesn't really distinguish between works created for artistic, scientific, or simply entertainment purposes; here art is created not only by artists with proper training, but also by scientists, technicians or programmers.[124] Consequently each of them has different goals in interactive digital art: in some works the aesthetic intent is more present, in others it is the concept, or technological innovation. The visual motifs in these works differ not only from one artist to the next, but it is also within one single work that we can recognize different design styles, existing for example as different modules. In some interactive works the artists show more visual aspects, respectively in different aesthetic styles. Some artists use only one artistic style which is continued throughout the entire interactive process. Analysis is needed to unpick the different aesthetic aspects so that each style within the same work can be delineated separately. Furthermore, the overall impression resulting from these different styles should be analyzed.

In interactive digital art we can distinguish between simple kinds of works and complex works, which have few modules, few interaction levels or multi-user possibilities. In terms of the previously mentioned parameters for research, we would have visual motifs for research in the form of space, object, shape, line, or point. With space, we can consider virtual realities, and immersive artworks. Looking at objects, we can consider artworks, which show as their main motif virtual, real or abstract objects constituted in either real or virtual spaces. In the form of shapes, or of lines or points, we would have abstract motifs for research, which can constitute a virtual reality, or exist as part of an installation, or of an environment.

Choosing the motifs which have to be researched will be done according to the frequency of their appearance within this kind of art. Their assortment will be determined based on the above mentioned explanations of what motifs are (Olbrich, Panofsky). The motifs used by artists to represent their themes[125] can respectively be classified in two categories: objective (figurative) and non-objective (abstract) motifs. Objective motifs include humans (also the motif of the visitors), animals and plants. Furthermore, places and architecture can also be included in this category. Non-objective motifs are abstract structures, shapes and lines which can further be classified in geometric and amorphous motifs.

The term "objective art" (Gegenständliche Kunst) which is used in opposite to the term "abstract art" is a term for *"jene Kunst, die die Wirklichkeit (Personen, Landschaften oder Objekte) entsprechend unserer sinnlichen Wahrnehmung darstellt."*[126] And the "*Gegenteil davon ist die gegenstandslose oder gegenstandsfreie, d.h. abstrakte Kunst*."[127] Hartmann

[124] See Hünnekens (1997), p. 8: *"[...] Dabei kristallisiert sich auch ein neuer Typus des Künstlers heraus, bei dem die Grenzen zwischen technischen Wissenschaften, Informatik und der philosophisch-ästhetischen Ausrichtung des Kunstschaffenden zunehmend verschwinden."*

[125] See the chapter of Christiane Paul *"Themes in Digital Art"*, in: C. Paul. Digital Art. London, 2003, pp. 139-216.

[126] P.W. Hartmann, Kunstlexikon, Wien, 1996, p. 535.

[127] Hartmann (1996), p. 535.

explains the last term as "*Bezeichnung für jede Form der bildenden Kunst, die sich von der gegenständlichen, wirklichkeitsbezogenen Darstellung losgelöst hat.*"[128] Lucie-Smith extends this explanation. For him abstract art is "*Kunst, die entweder völlig ungegenständlich ist oder die in der Realität beobachteten Formen in Muster überführt, die vom Betrachter vorrangig als selbständige Bezugssysteme, weniger in ihrem Bezug zum ursprünglichen Motiv rezipiert werden.*"[129]

[128] Hartmann (1996), p. 24.

[129] Edward Lucie-Smith. DuMont's Lexikon der Bildenden Kunst, Dumont Buchverlag, 2005, p.7.

4. Objective Visual Motifs

In interactive digital art, objective motifs are present in many works. For example, the representation of the human being can be considered as an objective motif and is a relatively frequent motif in this kind of art. Human representation includes portraits and busts. In interactive digital art, these motifs are represented in a virtual way, or in a physical-sculptural way (as in Ken Feingold's work "Head" of 1999-2000). The human motif has been used in interactive digital art not just in the form of portraits, but also in treating body parts and even the inside of the body as a theme. For example, the human body, in particular from the inside, was represented in the 1996 work "Visible Human in the Elevator" by the Ars Electronica Futurelab. Representations of animals and plants, which include evolutionarily-created living things, can also be considered as objective motifs. These motifs are represented in their symbolic meaning, as for example the motif of the butterfly in the work of Merel Mirage "Subject, emotions encoded, Mock-up with Computermonitor" of 1997, or are represented in a naturalistic-realistic way. Furthermore, places and architecture can also be considered as objective motifs and are used in interactive digital art, including presentations of buildings, claddings, interiors, environments, specific countryside, or abstract and symbolic places and spaces.

4.1. Human Motifs: Historical Overview

Beginning with the motif of the human being as an example of motif choice in interactive digital art we have to confirm its usage in different forms. Just for the representation of the human in the form of a portrait we can differentiate between visitor-portraits, artist (self)portraits, portraits of women, men and children. Then there are three-dimensional forms (busts), or as paintings. Furthermore we find the human represented as a whole body, just the upper part of the body or just the face, the eyes, or even the inside of the body. We can distinguish between portraits of active and of passive humans. There are also portraits representing emotions such as sadness or elation.

A historical overview shows us that the human being has been represented in different styles, in different genres and with different issues. In about 40000 B.C. Neanderthals disappeared and in Asia and Europe the species "Homo Sapiens" appeared. Humans of that time, who are in many aspects similar to humans today made sculptures that we can consider as the first artworks. "Venus" from Villendorf is the most famous pre-historic sculpture in the representation of a human, created in 24.000-22.000 B.C. According to the role of the woman at that time, the human, in particularly the woman has been represented here as a cult-object, particularly as a symbolic icon of fertility.
The ancient Egyptian civilization emerged similarly as the culture "*von Sumer und vom Industal entlang eines großen Flusses, der dem Ackerbau zur Bewässerung verhalf und dem Transport von Menschen und Materialien – für Holz, Steine und natürlich für die landwirtschaftlichen Erzeugnisse – eine Verkehrsader bot.*"[130] In this culture, we find human

[130] Hugh Honour and John Fleming, Weltgeschichte der Kunst, Prestel Verlag, München, 2000, p. 57.

motifs representing rulers. An example is the death mask with Tutankhamun's portrait in gold 3,500 years ago. The death mask represents and preserves the facial features of the deceased, unlike other meanings of masks for hiding the face. The Egyptian ruler wanted to be represented as immortal. The usage of gold intensifies this meaning. Gold was in ancient Egypt a symbol for reincarnation. They used a grid of same-scale squares for fixing the main body-parts. The head had to be represented in profile, while the eye and the upper part of the body had to be represented frontally. The legs and feet were shown in profile and so "balanced" the head.

We find the motif of the human being also in the representation of deities. According to Bussagli, the philosopher Xenophanes of Colophon (4-5th century B.C.) "*behauptete, dass die Menschen, wenn sie wie Rinder aussähen, sich auch ihre Götter in der Gestalt von Kühen oder Stieren vorstellen würden*. […] *Der Mensch kann sich nur das denken, wovon er Kenntnis hat. Deshalb greift er, wenn er nichtsichtbare Phänomene anschaulich machen will, zuerst auf Bilder zurück, die in einem erweiterten Sinne ihm selbst entsprechen.*"[131] In classic antiquity the composition of human figure, including the smallest parts of it, represents "*die Perfektion einer übersinnlichen kosmischen Ordnung wider, die bar aller Zufälligkeiten ist, die dem irdischen Sein seit dem traumatischen Übergang aus dem Reich der Ideen in die materielle Realität – so ein Axiom im platonischen Denken der Griechen – anhaften. Das Reich der Ideen bleibt die ideale Perspektive der klassischen Kunst, die zum Medium seiner Vollkommenheit wird, befreit von allen Makeln, die dem Ideal des Schönen und Guten zuwider laufen*."[132] Besides being represented in sculpture, the Greek and Latin deities were represented as human beings also on Greek Vases in the black-figure style.[133] Details were created by scraping away parts of the background.

Further chronological research shows that the figure of the human being in the Middle Ages was being used exclusively for the illustration of religious themes while in the renaissance human beings were once more represented in narrative–mythological scenes. Norbert Schneider notes that the examples he chose for his book about portraits in painting ("Porträtmalerei" of 1992) were made from the Late Middle Ages till the 17th century: *"Eine solche Eingrenzung hat ihren guten Grund, handelt es sich doch um die große Zeit dieser Malereigattung, um die Epoche der Wiederbelebung und genuinen Erneuerung der seit der Spätantike weitgehend verdrängten individualisierenden, wirklichkeitsnahen Darstellung privilegierter oder gesellschaftlich besonders geachteter Persönlichkeiten: Neben Fürsten, Angehörigen des hohen Klerus und Adligen ließen sich seit dem 15. Jahrhundert besonders Bürgerliche wie Kaufleute, Bankiers, Handwerker, humanistische Gelehrte und Künstler darstellen und verschafften sich so im buchstäblichen Sinne »Ansehen«."*[134] During this time, all known masters of painting such as Titian, Hans Holbein, Giovanni Bellini, Raffael, Antonello da Messina, Jan van Eyck, Leonardo da Vinci, Rembrandt, van Dyck, Peter Paul Rubens, Diego Velázquez, and others made portraits of different humans (including

[131] Marco Bussagli. Der menschliche Körper. Anatomie und symbolische Bedeutung. Bildlexikon der Kunst, Bd 12, Parthas, Berlin, 2006, p. 132.

[132] Bussagli (2006), p. 64.

[133] Greek pottery of the 6th and 7th century B.C. show figures in black silhouette against a background of red clay. Black Figure vases usually depict stories from mythology. See for this M. Clarke. The Concise Oxford Dictionary of Art Terms, New York, 2001, p.31.

[134] Norbert Schneider, Porträtmalerei, Hauptwerke europäischer Bildniskunst, 1420-1670. Benedikt Taschen, Köln, 1992, p. 6.

themselves), who had diverse positions in their society. In this way they contributed to the development and establishment of this genre of art.
The church was the most important purchaser of art in Europe. The protestant belief which began to be present in the Netherlands in the 17th century was important for the development of art at that time. The protestant Dutch merchants refused to buy altarpieces with religious themes. The artists began to develop art pieces independent of the merchants. People began to buy paintings for their own homes. Paintings of interiors, still life, landscapes and portraits, which are characteristic of Dutch Painting began to be developed. Simple everyday life scenes became a main theme of paintings. Also the human as motif was used in profane representations of the genre painting developed in the Dutch Golden Age in the 17th century. According to Erich Hubala they are representations of *"Sitte, Brauch und ebenso von Unsitte und Mißbrauch, von Bauern und Soldaten, dumm, tölpelhaft, faul und rauflustig, und von Bürgern, die stattlich und wehrtüchtig sind, die auf die Jagd gehen, Feste feiern und deren Frauen in wohlgeordneten oder wohlhabenden Häusern walten und ihren Kindern gute Mütter sind, Sitten- und Gesellschaftsbilder also."*[135]
According to Stephen F. Eisenman: *"The end of the eighteenth century marked the final dissolution of feudalism in Europe, a primarily agricultural and rigidly hierarchical productive and social order that had survived for seven centuries. In the place of feudalism, there now stood a capitalist and bourgeois economic and social edifice."*[136] Eisenman added that*: "This epochal reconfiguration of European economy and society – long in coming but no less dramatic in the end for its gradual preparation – was marked by outbreaks of revolution in Europe and the Americas."*[137] There is, within the art of the 19th century, alternative representations of the human motif in the realistic and naturalistic styles. The difference is visually perceptible by the style of the representation of human emotions, clothes and their attitude. Naturalistic representations are characterized by their absence of idealization, while the realistic representations depict the human in such as way as to convey other information about the person is perceptible in a realistic way.
According to Hugh Honour and John Fleming: *"Die Suche nach neuen Wegen in der Betrachtung der Welt, verbunden mit der Bereitschaft, mit allen anerkannten Gewohnheiten und Vorurteile zu brechen, ist ganz allgemein charakteristisch für die Zeit um die Jahrhundertwende.*[138] This was reflected also in the human representations. In the 20th century, for example in the Fauvist style, the human is represented in such a way that it is subordinated to the use of colour (think of the Painting of Matisse "Madame Matisse", 1905). In the cubist style human representation is subordinated to the shape constitution. An example of this is Picassos' work "Les Demoiselles d'Avignon", 1907. Not the facial features, but the colour-composition (as in the work of Matisse), or the shape-constitution (as in the work of Picasso), and its distribution over the canvas surface is important in the representation of the human in these kinds of styles.
Between innovations in the arts and in intellectual life *"können enge Parallelen festgestellt werden [...] Doch die Ideen mit dem weitreichendsten Einfluss waren jene des Wiener Psychologen Sigmund Freud (1856-1939), dessen Traumdeutung 1900 erstmals veröffentlicht wurde. Freuds umwälzende Gedanken über die Bedeutung des Unbewussten, speziell des*

[135] Erich Hubala, Propyläen Kunstgeschichte, Die Kunst des 17. Jahrhunderts, Band 9, Propyläen Verlag, Berlin, 1984, p. 46ff.

[136] Stepheen F. Eisenman (Ed.), Nineteenth Century Art, A Critical History, Thames und Hudson, London, 1994, p. 7.

[137] Eisenman (1994), p. 7.

[138] Honour and Fleming (2000), p. 695.

Sexualtriebes, veränderten die Haltungen und die Werte des frühen 20. Jahrhunderts. Die Forderung nach einem Verständnis der instinktiven Seite der menschlichen Natur, die Behauptung, dass Emotionen und Empfindungen, speziell die unbewussten Triebe, als Schlüssel menschlichen Verhaltens wichtiger als rationales Denken seien, führten zu tiefen Auswirkungen auch in der Kunst."[139] The surrealists such as Salvador Dali, Rene Magritte, Man Ray, Max Ernst and others built their surrealistic artworks based on the publications of Freud. The characteristics of a life-size figure of a young girl in the early 1930s, constructed by the Surrealist artist, Hans Bellmer, are described as follows: its *"This figure was fully jointed and came apart in pieces in such a way that it could be put back together in innumerable ways. He also made extra pieces that could be added so that the figure could have, if desired, multiples of some parts. The 'doll' is a perfect illustration of Bellmer's notion of the body as anagram: the body as a kind of sentence that can be scrambled again and again to produce new meanings every time.*[140] At this time, we find also body parts (feet) as autonomous motifs for example in the work of Rene Magritte's "The Red Model" of 1937.
Documentations of social reality through the motif of human beings have been done through the use of the media (for example photography). Dorothea Lange, for example, tried to represent the social misery at this time, such as joblessness and homelessness with realistic photo-portraits. "Migrant Mother" of 1936 is one of these works. The Hungarian André Kertész is also known for his "Distortions". He represented nude figures so that through the arrangement of their bodies, and in particular their faces, a new surreal composition and an appropriate meaning emerged.
The meeting of the American and Russian armies in the year 1945 near the river Elbe "*dokumentierte über das Ende des Krieges in Europa hinaus das Ende des europäischen Imperialismus. Der Verlust der politischen und wirtschaftlichen Macht bedeutete zugleich den Verlust der kulturellen Vorherrschaft Europas zugunsten der Vereinigten Staaten, wo sich der Schwerpunkt der westlichen Kunst nunmehr manifestierte."*[141] The painters, who dominated New York at the end of the 40s and in the 50s such as Jackson Pollock, Franz Kline, Robert Motherwell, Ad Reinhardt, Willem de Kooning and others built no special artistic movement although they all knew each other and were about the same-age. Willem de Kooning especially represented the act of painting using the motif of human beings (see for example "Woman I", from 1950-52).

In the New Realism of the 60s which emerged as a contrasting style to abstract expressionism, the figures (humans) were chosen from the culture of everyday-life (comics or magazines), particularly from contemporary consumer society. Roy Lichtenstein's portraits, for example, were modified through a print technique[142] that he invented. Representing the human in this way, he tried to bring art closer to society (also in opposition to abstract painters who were dominant at that time); he used known portraits, particularly portraits of public people to do this.
The human motif was then used to represent everyday problems of the civilized world like fear, threats and atrocity in a grotesque way. We can see this in the works of the self-taught English painter Francis Bacon. Like Lichtenstein, Bacon also used photos from everyday-life as templates for his paintings. He sometimes distorted the painted figures to display even the

[139] Hugh Honour and John Fleming, Weltgeschichte der Kunst, Prestel Verlag, München, 2000, p. 695-696.

[140] http://www.tate.org.uk/liverpool/exhibitions/kelley/rm4.htm

[141] Hugh Honour and John Fleming, Weltgeschichte der Kunst, Prestel Verlag, München, 2000, p. 751.

[142] Benday Dots is a print –technique, a printing process.

inside of the body (as in the work "Three Studies for a Crucifixion" from 1962). The French artist Yves Klein used the human body for human painting; his "anthropometries" belong to the style of new realism.
The French artist Jean Dubuffet (1943-1963) as the founder of "Art Brut" (in English "Raw art"), was inspired by children's paintings or paintings by psychiatric patients, considering these as resources that come directly and spontaneously from unconscious mind. According to James Denetrion (Ed.): "*The titles of many of Dubuffet's works reflect his enjoyment of puns, slang, wordplay, double meanings, and the invention of new words ("Mirobolus" and "L'Hourloupe", for example).*"[143]
In his performance "Twins" from 1977 the Austrian artist Richard Kriesche treated the problematic of the reproduced artworks through the motif of two young girls that were identical twins. They sit in two separate but completely identical rooms reading Walter Benjamin's "The Work of Art in the Age of Mechanical Reproduction".
With the video camera as a *"Erweiterung des menschlichen Auges und dem Bildschirm als Pendant zum Gemälde"*[144] a new kind of art began to develop. *According to* Honour and Fleming: *"In einer Welt, in der das Fernsehen die Meinungen, Überzeugungen und Vorurteile der Őffentlichkeit maßgeblich beeinflusst und umgekehrt selbst zu einem ständing präsenten Überwachungsauge geworden ist, haben Künstler in Videoinstallationen eine neue Kunstform entdeckt, die in der Kunstgeschichte ohne Beispiel ist."*[145]
In video art, the human motif is used, for example, to create metaphors for the psychology of the self, as in the work "Three Transitions" from 1973–1977 by the American Peter Campus. Here a simple video technique was used to create a transformation of artistic video. A known example of animated series, which used the human being in its contour to narrate different stories is the TV series "La Linea" (English: The Line) created by the Italian Osvaldo Cavandoli in 1969. This series with about 150 episodes with a usual duration of 2 minutes 30 seconds were often used as an interstitial program. Cavandoli describes different characteristics of the person and different situations through the main protagonist, a man drawn with a line, Mr. Linea. He was drawn as a single outline (his silhouette), walking on an infinite line of which he is a part.

Through the use of the digital technique the possibilities for picture processing expanded. In Herbert W. Franke's picture, "Electronic Einstein", 1973, which has been processed digitally, the motif of the human has been used as a resource for creating a step-by-step transformed artwork. Herbert W. Franke also did a digital transformation of an image of Albert Einstein so that the work developed a narrative character[146], but it is still a static work (not interactive). Human photography (human-motif) is transformed in an abstract image.
There are also examples in art history that show imitations of photography through the genre of painting to represent a human character in a realistic way. The American painter Chuck Close is known for his photorealistic style of work. For example his portrait "Linda" (1975/76), in its large scale proportions (273.5 x 212.5 cm), is a monumental work in acryl, which is painted grid by grid so that Close puts a grid on the photo and on the canvas and copies cell by cell.

[143] James Denetrion (Ed.). Jean Dubuffet 1943 – 1963. Paintings, Sculptures, Assemblages. 1993, p. 41.

[144] Honour and Fleming (2000), p. 798ff.

[145] Honour and Fleming (2000), p. 798.

[146] See P. Dika "*Die Computerkunst Herbert W. Frankes"*, in: G. Dotzler (ed.). Computer, Art, Faszination, dot 16, Frankfurt/Main, 2005, p. 34.

Human bodies and body parts are presented as autonomic sculptures in exhibitions. For example in the exhibition "Body Worlds"[147] (German title: Körperwelten) the German Gunther von Hagens presented preserved human bodies and body parts (see his work "Plastinat mit Haut", 2002) that are prepared using the technique of plastination[148]. The inner anatomical structures are revealed.

[147] Gunther von Hagens' macabre exhibition was received with fascination and shock by the audience.

[148] See: *"In 1975, while serving as a resident and lecturer-the start of an eighteen year career at the university's Institute of Pathology and Anatomy-von Hagens invented Plastination, his groundbreaking technology for preserving anatomical specimens with the use of reactive polymers."* from http://www.bodyworlds.com/en/gunther_von_hagens/life_in_science.html

4.2. Human Motifs in Interactive Digital Art

In interactive digital art humans as motifs are designed as a portrait (realistic, processed or distorted), sculptural (three dimensional) or mixed (some parts sculptural and some parts two dimensional), also as communication object (interacting with the observer in different forms) and as an anatomical-biological object (the bodily function, the inside of the body is represented as a motif). Christiane Paul expressed her opinion about body and identity, pointing out that "*The body and identity have become prominent themes in the digital realm, centering on questions of how we define ourselves in virtual as well as networked physical space. While our physical bodies are still individual, physical 'objects', they have also become increasingly transparent: exact surveillance and identification seem to threaten the idea of individual autonomy. Ubiquitous surveillance cameras track our movements; biometric technologies, such as electronic fingerprints, face-recognition software, and retina scanning, push into the market as a means of identification. Our virtual existence suggests the opposite of a unified, individual body – multiple selves inhabiting mediated realities.*"[149] Robots, avatar, and cyborgs[150] are also represented with human-like characteristics, such as the contour of their "body", the physicality or other features.

The human motif have appeared in interactive artworks since the 70s, in particularly since Myron Krueger started doing his pioneering works on the further development of interactive media art, such as "Responsive" (1970). Krueger explains the aim of his works: "*Since 1969, I have been trying to raise interactivity to the level of an art form as opposed to making art work that happened to be interactive. From the beginning, I reasoned that interactivity would be limited by what the computer knew about the participant's behavior, and I developed specialized computers for perceiving the human body.* [Krueger started to develop his own computer system in the years up to 1984] *I have also incorporated the image of the person's body into the computer graphic images.*"[151] In his first version of his interactive work "Videoplace" (1974/75), in a projection screen were shown live-films of the visitors/users recorded by a video camera. The projected images of the visitors, which were modified by processors, were displayed as two dimensional coloured Silhouettes. Later in the 1976 version details such as heads, legs, feet and fingers of the visitors could also be differentiated.[152]

The human motif is represented in a dynamically regular, or irregular changing process, or a partially changing process. It has been represented abstractly, focusing on the movement of the human body, as in the work "Camera Music/ Kinetic Shadows" (1997) of Christian Möller.

The human motif is designed in a virtual environment, or in a natural environment. On the environments in which the humans are represented, Paul notes that: "*Online identity allows a simultaneous presence in various spaces and contexts, a constant 'reproduction' of the self without body. In MUDs, MOOs, and online chat environments, people choose avatars to represent themselves, and slip in and out of character. Virtual life allows people to have a*

[149] Paul (2003), p. 165.

[150] V. Kuni wrote also about cyborg bodies and their contours. See V. Kuni *"Mythical Bodies I"*, from http://mkn.zkm.de/themes/cyborg_bodies/mythical_bodies_I/2/

[151] Myron Krueger, ACM Siggraph, 1998, from http://www.siggraph.org/artdesign/gallery/S98/pione/pione3/krueger.html

[152] For further informations see Dinkla (1997), p. 79ff.

presence in several windows and contexts simultaneously, a condition that has become a central aspect of many online art projects."[153] Paul mentioned the works of artist Tina LaPorta in this context, because they "*have consistently focused on online identity, communication through chat rooms and CUseeMe, as well as the impact of webcams onto the relationship between the private and public spheres.*"[154] The following section will be focused on the representation of humans in interactive digital art, taking into consideration the genre of portrait/bust, the inside of the body and the body parts.

[153] Paul (2003), p. 165.

[154] Paul (2003), p. 165.

4.2.1. Portrait and Bust in Interactive Digital Art

The genre of portrait can be divided into visitor-portraits (such as the work "Liquid Views" (1993) by Monika Fleischmann and Wolfgang Strauss), author-portraits, and a kind of author-visitor-portraits, or portraits of people, which were filmed by the author of the work.
Also traditionally painted portraits are used as motifs in this kind of art. For example in the work of 1992 "Der Zerseher" (English: "Disviewer") of Joachim Sauter und Dirk Lüsebrink the visitor can manipulate by his gaze the image of a traditional painting, displayed on a monitor. This painting "Boy with a child-drawing in his hand", which dates to the first half of the 16th Century, was made by the Renaissance Italian painter Giovanni Francesco Caroto. The painting can be deconstructed by visitors while looking at it. Another traditional portrait has been used by Christian Möller and Marizio Seracini in the work "Tintoretto" (1996). By touching the represented portrait, the visitors can disclose the hidden layers, such as preliminary drawings, of the painting. These have been uncovered by using X-ray and infrared technology.
Visitor-portraits in interactive digital art are mostly represented by processing them live, while author-portraits or portraits of filmed persons are recorded with a photo- or video-camera before and can be processed or experienced in the exhibition space.
The genre of portrait in interactive digital art can also be divided into a realistic-portrait (as in Christian Möller's work "Electronic Mirror" of 1993), or in a distorted-portrait-representation (as in the work "Time Scan Mirror" (2004) by Daniel Rozin). The distortion of the portraits in interactive media art can show deconstructivist results, or collage-like presentations. The portraits can be three dimensional real sculptures, or virtual sculptures.
The motif of portrait has been used to provide a sort of communication with the visitors, transforming them into different artistic types or to present a specific treatment of human character. But the genre of portrait has also been used to bring virtual and real worlds near each other, or to bring people together, without taking into consideration the real geographic distance between them, as in the work of Paul Sermon "Telematic Dreaming", of 1992. Additionally, the artist used effects here to make people feel as if the people meeting each other were dreaming together. As early as 1977, Kit Galloway and Sherrie Rabinowitz's work "Satellite Arts Project" did that with several performing artists, "*all of whom would be separated by oceans and geography, could appear and perform together in the same live image*"[155], without geographic boundaries. The image was transformed to a meeting place. The performers could see themselves in the same space next to each other, being able to perform and talk with each other.

The motif of portrait has been used in different cultures with similar purposes. Asiatic artists also show the portrait motif in their works. For example the Chinese media artist Zhang Ga used the motif for his work "Peoples' Portrait" (2004). Within the genre of portrait, this book discusses visitor-portraits, author-portraits, author-visitor portraits, or portraits of filmed persons.
The following section will depict more closely some works of interactive artists within these genres: the work "Touch me" by Alba D'Urbano (1995), as a representative of the author-visitor-portrait in interactive digital art, the work "Rigid Waves" (1993) by Monika Fleischmann and Wolfgang Strauss as a representative of visitor-portrait and the work

[155] http://www.ecafe.com/getty/table.html#2

Figure 1 Touch Me, 1995. © Alba D'Urbano.

"Portrait One" (1990) by Luc Courchesne as a representative of the realistic video-portrait, and as communication through the portrait motif in interactive digital art. The work "Head" (1999-2000) by Ken Feingold will be considered in contrast – as a self-portrait of the artist.

4.2.2. Author-Visitor-Portrait and Visitor-Portrait

Alba D'Urbano is an artist from Italy. She studied philosophy and painting in Rome and studied visual communication in Berlin (Hochschule der Künste). Since 1995 she has been a professor of computer graphics at the "Hochschule für Grafik und Buchkunst" in Leipzig, where she currently lives. In her artworks she combines traditional artforms with new technologies.

Her work called "Touch me" from 1995 (Fig. 1 and Fig. 2) is an interactive digital video installation where a monitor with touch screen, a video camera and a computer are mounted on a platform. The monitor with the touch screen is visible to visitors at eyelevel and it is integrated into a wooden column. So visitors can observe the video portrait of the artist which are shown on the monitor and can change these images through touching the monitor. The camera takes shots of the visitors while they are looking at the video on the monitor. If the visitor touches some parts of the face on the monitor, these parts dissolve and inside the portrait, the face of the observer will become partly or fully visible.[156] An artist-portrait is being used here as a motif to bring the visitor to touch the screen (the work is called "touch me") and so to activate a process, which is not recognizable at first.

4.2.2.1. The Invitation to be touched and the Touch - Screen

The motif of an invitation to touch the screen is already known from the work "Deep Contact" from the artist Lynn Hershman, eleven years before (1984). In this work a woman knocks on the projected video screen asking to be touched.
Lynn Hershman has worked in a variety of media including photography, video and electronic sculpture, and performance. She also created interactive installations, such as "Lorna" (1979–83), "America´s Finest" (1994–95) and "Dolly Clones" (1995–98). Currently she is Senior Professor for Electronic and Digital Arts at the University of California.
In the work "Deep Contact: The First Interactive Sexual Fantasy Videodisc", 1984-1989, (Fig. 3), which is created in collaboration with Sara Roberts, Lynn Hershman invites participants to touch the computer-screen. Marion, the person who asked to be touched is acting here as a guide; sex, age and personality is being changed depending upon in which body part she is touched. According to Jennifer Henderson "*A surveillance camera was programmed to be switched "on" when triggered by presence. The viewer's image instantaneously appeared on the screen, displacing and replacing the image.*"[157] Marion keeps asking to be touched until

[156] See http://www.durbano.de/touchme/index.html

[157] Jennifer Henderson, *"Slipping the Interface. Strategies of art making and Lynn Hershman"*, from http://switch.sjsu.edu/nextswitch/switch_engine/front/print.php?271, Mar 10 2003.

parts of her body rotate onto the touch sensitive screen and actually are touched.[158] Clad provocative and partly in leather, she is causing an erotic, intimate atmosphere; the intimacy is mediated through technology. According to Hershman "*Touching the screen encourages the sprouting of phantom limbs that become virtual connections between the viewer and the image. At certain instances viewers can see, close up, what they have just passed. For example, Marion runs past a bush that, examined closely, reveals a spider weaving a web. In some instances words are flashed on the screen for just three frames, forcing the viewer to go back and frame by frame see what has been written. At other points, the Zen Master speaks his lines backwards, forcing the viewer to play the disk in reverse to understand what he has said."*[159]

In this work, in the work of D'Urbano, besides the motif of the touch screen and the motif of the touch itself, the motif of replacement of real and virtual images also appear. Here, the voyager becomes "the victim". The viewer becomes a part of this interactive installation.[160]

The interface with a touch screen has been used in both works with the same aim: to invite. The difference is that the invitation in Hershman's work has been displayed written on the screen. In addition, the person on screen invites the visitor to touch her with her gestures. In D'Urbano's work the visitor has to explore the touch screen by himself and so the process of exploring the work is developed more slowly. Through the interface in the form of a touch screen the human motif, particularly the portrait is involved in a transformation from a self-portrait of the author to a self-portrait of the visitor.

The visitor in D'Urbanos work touches the screen and unconsciously becomes the leading actor of the work. He or she will realize this first by recognizing his or her facial features appearing on the monitor's surface. The interaction process creates a reflection of the visitor/user while dissolving the portrait of the author. The art of this process that matches live facial features of two portraits reminds us, in its aesthetic, of collage works. On the monitor appears a combination of realistic facial features, which transform one person into another person, the observer into the artist. It is a kind of identity change – the observer becomes the observed. This portrait changes the definition of portrait as we know it from traditional art. H. Schwarz defines this as follows: "*Alba D'Urbano presents a change in the traditional portrait genre, the concept of representation through the use of media technology, and the eventual loss of the validity of the static self-portrait."* [161]

---

[158] See Jeffrey Shaw and Peter Weibel (Ed.), Future Cinema. The cinematic Imaginary after Film, exhib. cat., The MIT Press, Cambridge (MA), London, 2003, p. 221.

[159] L. Hershman, *"Romancing the Anti-body: Lust and Longing in (Cyber)space"*, from http://telematic.walkerart.org/telereal/hershman_hershman2.html

[160] See Shaw and Weibel (2003), p. 221: *"... Transgressing the screen and being transported into ‹virtual reality› was an important element."*

See also L. Hershman *"[...] the screen becomes an extension of the viewer/participant's hand similar to a prosthesis."*, in: L. Hershman, *"Romancing the Anti-body: Lust and Longing in (Cyber)space"*, from http://telematic.walkerart.org/telereal/hershman_hershman2.html

[161] Hans-Peter Schwarz (Ed.), Media-Art-History. Media Museum, ZKM - Center for Art and Media Karlsruhe, München, 1997. p. 158.

Figure 2 Touch Me, 1995. © Alba D'Urbano.

Figure 3 Deep Contact: The First Interactive Sexual Fantasy Videodisc, 1984-1989. © Lynn Hershman.

Figure 4 Rigid Waves (Narcissus and Echo) 1993.
© Monika Fleischmann & Wolfgang Strauss.

Observer's or vistor's portraits are one of the pet subjects in interactive digital art. For example, the German artists Monika Fleischmann and Wolfgang Strauss, who were founders of ART+COM and Directors of MARS-Exploratory Media Lab and eCulture Factory at Fraunhofer Research Institutes until 2014, used this motif in their works.

In the installation "Rigid Waves", 1993 (Fig. 4), a hidden camera records the viewer and transfers this video to a projection screen, which is framed. It is an interactive installation which uses a real-time distortion of mirror algorithms to represent the human image as separated. The observer causes with his or her gestures and movements a distortion in the mirror-image. This distortion is caused by delaying time during displaying the observer, or through speeding up time, while other parts of the displayed person are frozen. Another characteristic of the distortion within this work is that a fragmented image of the observer is displayed, which looks like a broken-mirror. These fragmented parts then become smaller and smaller until the observer perceives his or her contour, the portrait is constituted from relative small rigid waves. This fragmentation, particularly this kind of fracturing, appears when the viewer goes closer to the "mirror". As in the Greek Myth of "Narcissus and Echo" the visitors appear, research their image and disappear... In this artwork the observer can not observe him- or herself in real-time. When the video-recording is displayed with a time-delay, observers can sometimes even see themselves from behind. A Buddhist-like spiritual sound accompanies the video-processing and gives the impression of being in relation with the changing of position and movements.

Compared with D'Urbano's art, this work also presents the observer in a distorted way, but the shapes that constitute the surface are jagged. In D'Urbano's work different variations appear, for example, amorphous shapes or small-particles, while the face dissolves. In Fleischmann and Strauss's piece, distortion appears from the beginning of the observation of the work; the visitor is occupied researching the distortion-possibilities. In D'Urbano's work the distortion appears more gradually depending on the touch of the screen. The observer is occupied with different parts of the surface, which take on a general meaning after the artist-observer transformation. The interaction is in both works an interaction for the visitors/users to self-reflect. D'Urbano's author-portrait partly dissolves while the visitor-portrait is being created. The interface with a touch screen includes a permanent component – the author portrait. This changes gradually during an interactive process with the user's portrait.
The technique used for the interaction, in particularly for the interface in these works is different: in D'Urbano's work it is a touch screen, which invites the users to make haptic contact with the work. Fleischmann and Strauss use an intuitive interface, which is based on the visitor's movements and gestures. A further difference emerges in that the displayed portrait in Fleischmann and Strauss's work has been framed similarly to a traditional portrait, while D'Urbano's work has been framed by a massive wooden column. Also the dimensions of the displayed portraits in these works make a different overall impression of the people portrayed.
The jagged shapes in Fleischmann and Strauss's work sometimes remind us of basic geometric shapes, such as those which Picasso and Braque used to create their cubistic works. Even the continuously divided surface has characteristics comparable with analytic cubism. Further, the representation of the observer from different sides is a characteristic which cubists used.

The aspect of time-delay was used in an installation made in 1974 by Dan Graham[162] - "Present Continuous Past(s)". One difference is that he was displaying recordings made eight seconds previously to achieve an infinite regression of time continuums within time continuums,[163] while Strauss and Fleischmann use this to achieve a distorted human image, to fragment the human and to put his or her parts together in a reflection of the observer constituted by artist's rules. It is here the human, i.e. the viewer, is being used to fragment the real world with his/her movements and so to "disturb" the linearity of the true time as it is in the real (physical) world. The live display is being manipulated so that realism is present neither in the image-display, nor in the time-display. The observer, as the portrayed, becomes a tool for manipulating reality, including the image of himself too. As a result of the historic examples that are discussed above, we can conclude that the human motif that was once a representation of different humans in their social positions or as a representation of facial features and of human characters is now transformed into a representation of visitors/observers themselves. It is an approach for oneself. It represents the visitor/observer modified in different techniques and as material for exploration. The visitor is the represented motif (as in the work "Rigid Waves" (1993) by Fleischmann & Strauss); the observer/visitor can replace live the represented self-portrait of the artist (as in the work "Touch Me" (1995) by D'Urbano). The visitors can become the main protagonists of the artworks (Fleischmann/Strauss), can even create and manipulate their self-representations. The visitors can influence the visual results by walking or standing in front of an artwork. They can be co-actors in a facial collage (as in the work of D'Urbano).

[162] See Hünnekens (1997), p. 27: *„Dan Graham ist seit den sechziger Jahren Kunstkritiker, erst seit den siebziger Jahren arbeitet er auch künstlerisch. Er etnwickelt seine Videoinstallationen aus Videoperformances und aus seinem Interesse an Architektur. [...] Für seine Arbeiten sind Spiegelungen im übertragenen Sinne, scheinbare Verdoppelungen oder der Austausch und Spiegel im konkreten Sinn immer grundlegende Elemente gewesen. [...] Grahams Thema ist die Sichtbarmachung und Synchronisation von zeitlich und außen-beziehungsweise innenräumlich verschiedenen Ereignissen."*

[163] See Doug Hall and Sally Jo Fifer, Illuminating Video – An Essential Guide to Video Art, New York, 1990, p. 186.

4.2.3. Interactive Video-Portrait and Interactive Bust

In interactive digital art realistic video-portraits or realistic physical busts also appear. In the following section two different examples of this category: virtual interactive video-portrait and interactive physical bust will be discussed.
Luc Courchesne has been dealing with interactive concepts since the 80s. After experimenting with photography, film and video he began to focus on portrait-representations.[164] His work has been shown extensively in galleries and museums worldwide and he was awarded the Grand Prix of the ICC Biennale '97 in Tokyo, and the Award of Distinction at Prix Ars Electronica (1999) in Linz (Austria). Currently Luc Courchesne lives in Montreal and was a professor of design at Université de Montréal (1989-2013) and president of the Society for Art and Technology.

With the interactive video "Portrait One", 1990 (Fig. 5), Luc Courchesne tried on the one hand to create a conversation with the visitors and on the other hand to make a complex connection between gestures, mimicry and language within the video. Visitors use a touchpad to select questions from menus on a computer screen in order to interact with it. The interaction offers an intimate communication between users/visitors and a virtual subject, an unknown person. A reciprocal communication between a user/visitor and the programmed work creates a relation between a real and a virtual person. Video sequences from the laserdisc are displayed on a monitor facing down above a tilted glass plate positioned at eye-level. The viewer, looking into the glass plate, sees a reflection of the video image which is a kind of a virtual image plane. A text, which is a set of questions from the computer screen, is visible in the displayed image. The characters have been recorded on a black background; by projecting on glass, the video image loses its edge and the characters appear to inhabit the real gallery space. Also the black dress of the woman on screen and her dark hair are difficult to distinguish from the black background,so the facial features and the light text are more accented. Portrayal on a dark background and accenting facial features through light is already known in art history, for example in some portraits by the Dutch painter Rembrandt van Rijn. In Courchesne's work the accented text underlines communication as an important issue. Also the screen actor's facial expressions is a feature that makes the conversation more realistic.

In interactive digital art, the physicality of the represented human motif is a component that is constituted in different ways. This depends not only on what it consists of, but also on what kind of space the human motif is represented within and how it is situated in the space. The perception of physicality depends also on how the interactivity is realized. The physicality of the person displayed is more present in Courchesne's work compared to D'Urbano's work, because the result is being displayed in the visitor's environment. In D'Urbano's work the result is displayed inside a column. Also, the transparency of the displaying surface contributes more than in D'Urbano's work to the incorporation of the image into the observers' environment. A column is used in both Courchesne's and D'Urbanos work, but the column in Courchesne's work is not as dominant as it is in D'Urbanos piece.

[164] See http://www.din.umontreal.ca/courchesne/portrait.html

Figure 5 Portrait One, 1990. © Luc Courchesne.

Figure 6 Head, 1999-2000. © Ken Feingold.

Courchesne used, in contrast to D'Urbano, a dark column in a dark environment. In the first instance here, the main protagonist, the portrayed person, is perceptible. In D'Urbano's work, first the column is perceptible and then the topic inside it. Also the scale of the displayed portraits in these two works contributes to the impression that the portrayed person in Courchesne's work is more dominant. In both cases there is an interaction with an image, but the end-result is an opposing one (realistic features in contrast to a collage in the image of D'Urbano). The visual-artistic aim in D'Urbano's work is more important. In Courchesne's piece the aspect of communication takes priority.

4.2.3.1. Interactive Self-portrait

In interactive digital art, the human is represented in a sculptural way, not only in virtual spaces. The American Ken Feingold, for example, represented the human motif in sculpture which is already known from traditional art. He used often the motif of the human being, particularly the human head as motif for many of his physical and virtual works. Ken Feingold is deemed to be *"an innovator in the field of interactive art after fifteen prior years of making films, video art, and installations.*[165] His important in the field of interactive digital art include "The Surprising Spiral" (1991), "JCJ Junkman" (1995), Childhood / Hot & Cold Wars (The Appearance of Nature), 1992-93, and If/Then (2001). Ken Feingold developed innovative interfaces creating virtual worlds, which include the motif of the human being.

Ken Feingold's work "Head" of 1999-2000 (Fig. 6) is an interactive interactive bust, which is physically present and consists of a real material. A human head, which is a self-portrait of the artist, was constructed for the "Alien Intelligence" exhibition (Kiasma Museum of Contemporary Art in Helsinki) and exhibited set on a table. This head can understand spoken English and can make conversations with visitors[166]. It initiates conversation by saying something so that the visitors speak to him back. It is an attention-attracting interaction, which triggers communication between visitors and the programmed work, i.e., the head. The interaction here is a reciprocal communication between a user and a programmed artform. Besides speaking while opening and closing his mouth – a motion similar to the mouth of a human while speaking – and in addition to its realistic features, the "Head" can blink its eyes and so creates more of an illusion of a real human face. Its detailed realistic facial features, for example eye-pupils, eye-brows and laughter lines, define a physical character of a real human. Kathy Cleland notes that this work *"uses commercial speech recognition software, IBM's 'Viavoice' Speech Development Kit (SDK) to process the text it receives from the audience and then uses natural language processing routines which Feingold calls ACE (Absurd Conversation Engine) to formulate a response which is sent as audio out to the mouth controller circuitry and to the speakers and back to the audience. ACE is a descendant of the*

[165] http://www.fundacion.telefonica.com/at/vida/paginas/v3/efeingold.html

[166] See Ken Feingold: *"[...] this head has a very distinct and complex personality, with a predisposition to rhyming, alliteration, and prediction. Given certain verbal suggestions, it might begin uttering poetry, pronouncements, or get in a mood to be self reflexive."*, from http://www.kenfeingold.com/catalog_html/head.html

Eliza program and has a whimsical database using pattern matching algorithms. It is capable, among other surprising literary abilities, of producing rhyming and alliteration based on what it has heard. Feingold describes the head as having "moods" which can be triggered by certain words or phrases, much like people and these moods determine the nature and form of its responses."[167]

Similar to Courchesne's work, Feingold deals with the aspect of communication in his work "Head", which is an "animatronics"[168] head. In Feingold's work this can be perceived more intensively; he uses AI Software to recognize language and respond in a relevant way[169]. Courchesne offers a simplified communication through using a mouse (the interface of the work) to choose an answer from the various possibilities. So the interface of these works,

[167] Kathy Cleland, *"Talk to me: getting personal with interactive art"*, from http://research.it.uts.edu.au/creative/interaction/papers/interaction04_43.pdf

[168] Animatronics are mechanized puppets, which are used in the entertainment industry such as film, or for shows and attractions at Disney theme parks. A well-known animatronics developer is Bruce Long.

[169] See K. Feingold, who demonstrates at his website a conversation between the "Head" and a visitor that was conducted in the exhibition "Alien Intelligence" in Kiasma Museum of Contemporary Art, in Helsinki, 11 Feb - 28 May 2000:

"Visitor: Hi
Head: Hello
V: How are you?
H: I am so offended. I can't tell if everyone would prod her to the left or not.
V: Who offended you?
H: The delicious conditions delay disturbed daredevils.
V: Which daredevils are disturbed?
H: The bothersome one
V: Which one is bothersome?
H: The absurd one
V: Who is absurd?
H: The unconscious
V: What is the unconscious?
H: It is something that makes me feel slow with groups.
V: That's interesting - why slow?
H: Because the kids wrinkled it. laaaaalaadeee moooommmm
V: Kids?
H: The child will tail the things which shrink.
V: Please explain
H: Didn't you say something about presence?
V: No. Are you feeling argumentative?
H: I don't have any feelings. Would you like me to be more like something else?
V: Like what?
H: The robot will case octopi. . Catch my drift?
V: What is your drift?
H: Where is my home? Anxious in the picture?
V: How would I know?

which are contrasting types, play a role in the differentiating perception of each artwork's communication aspect. In Feingold's work, the visitor perceives more spontaneity, not just because the communication is being realized not through letters, but through spoken language; but also that the communication is based on logic software (the software recognizes the spoken language) that can enter into a more naturalistic conversation. It is an intuitive interface which is realized by speaking. The visitor is impressed by the spoken reaction of the bust – the aspect of surprise is a very important one here.
Both works show realistic features of the human motif, but in Courchesne's work, we see an image of a real human, while Feingold's is a three-dimensional sculpture in real space; it shows human features which are based on a real human image. The Feingold's work is haptically present, created through real materials, which imitate the real optical characteristics of human head, while Courchesne's is based on a filming of a person. The character that emerges in Feingold's work through the cut of the throat is unconventional (compared to traditional bust); in contrast, we can recognize in Courchesne's work the kind of traditional bases of the bust; the throat of the person on screen and her black dress disappears into the background space creating a relationship with its environment. Feingold's bust is severed at his throat; his shoulders aren't represented. His throat is covered by a black scarf, which highlights the base of the head. It serves as a framing device for the it. The severedhead is a reminder of horror genre heads, such as those found in ghost stories or a theme park's 'house of horrors'. The "Head" of Feingold wants to shock and surprise us. It is supported also via the intuitive interface through spoken language.
Compared to traditional busts, such as, the "character heads" of Franx Xaver Messerschmidt, we can recognize that Feingold worked with materials that imitate the human skin and other details, like eyes and pupils. The eyes, mouth and eyebrows are realized so to create a realistic illusion of a human head. The imitation shows that Messerschmidt's busts can not be realized in real life. Feingold's artwork as a physical bust in interactive digital art reflects the challenges of contemporary society where loneliness and isolation is increasing despite the population growth. Instead of going out and meeting each other, many people use digital technologies to communicate virtually. But, on the other hand people are happy if someone (an unknown person) tries to create a dialogue with them. In an institution such as a museum where you don't expect something to happen like that, this fact is both welcome and stimulating.

In comparison with the historic examples that are described above, for instance the works of Messerschmidt, we can conclude that the human motif was once used as a sculptural work for representing an unreal imitation, is now present as a "speaking head" in an exhibition room (as in the work "Head" (1999-2000) by Ken Feingold). It creates a reciprocal communication with the observer/visitor, and its program is based on human intelligence itself. The communication between portrait and the observer/visitor is different. In traditional art and in interactive digital art visitors could/can communicate with the image. Then, communication with a religious sculpture (for instance, prayers in front of statues of the Madonna) have been transformed now (in interactive digital art) into communication with an unknown person (as in the work "Head" (1999-2000) of Feingold). And communication is now reciprocal, and

H: The hairy shipwrecks hang harmful mechanics. Would wood hood wood should should should should would.

V: You make strange rhymes.

H: I am so exhausted. I wish someone would turn me off now.", in Ken Feingold, from http://www.kenfeingold.com/catalog_html/head.html, 1999.

other observers/users present in the exhibition space can see and perceive that communication. Furthermore, users can now chose the direction of communication themselves.

Not only the external characteristics of the human are represented in this kind of art, but also the inside of the body and extremities are used as motif here.In the following section such examples will be discussed.

4.2.4. Driving through human body and exhibiting live within human body

The human motif has been used in interactive digital art not just in the form of portraits, but treating body parts and even the inside of the body as a theme. For example, the human bodyfrom the inside was represented in the work "In/Out" (1997) by Eva Wohlgemuth. According to Wohlgemuth, in this work "*The user can both fly above and enter the body. Here the inside of the body shell opens as carrier of real image material with which I display various mental states of myself. But as the ‹digital Eva› is an illusion, simulation and imitation of the original biological body the separation of interior and exterior world is undermined."*[170]
In researching the representation of the human being from the inside of the body in interactive digital art we should consider the work "Visible Human in the Elevator" by Ars Electronica Futurelab (1996). As a comparative example "The Virtual Backbone" by Christian Möller (1996) will also be discussed. Furthmore, Stelarc's Performance "Stomach Sculpture" from 1993 will be considered as a counter example to these works.

The work "Visible Human in the Elevator" by Ars Electronica Futurelab (1996) was presented in the lift of the Ars Electronica Center so that the visitor could pass through an animation of the human body. The animation consisted of digitized images (colored photographs) of a real human body, (Fig. 7, a project supported by the National Library of Medicine, National Institute of Health, Bethesda, Maryland, USA)[171]. The frozen body of Josef Paul Jernigan, who was found guilty of having robbed and shot a man in Dawson, Texas and was sentenced to death in 1981, was used for the images.[172] He was executed in 1993 by a lethal injection of potassium chloride[173]. His body was then cut from the feet upwards into numerous millimeter thick sections[174] using a laser-controlled cryomacrotome.
The ride in the lift of Ars Electronica Center began at the tips of the toes and traversed the body all the way to the top of the skull, whereby the anatomical journey was precisely synchronized with the actual speed and movements of the elevator cabin.[175] This kind of ride implicates a reciprocal communication between a user and a programmed work, which in this

[170] Eva Wohlgemuth, Statement for the Thealit-Laboratory »Artificial Life:// Media stories«, Bremen 1997, from http://www.thealit.dsn.de/lab/LIFE/LIFEfiles/read_13.htm

[171] See C. G. DOWLING: *"[...] The National Library of Medicine, in Bethesda, Md., boasts the largest collection of medical knowledge in the world. But in 1988 director Donald Lindberg realized that it was missing a significant reference tool: a computer model of the human body. Students of anatomy already had programs of body parts--knees, kidneys, brains--but no one had a whole virtual cadaver. And so the Visible Human Project was born."*, in: C. G. DOWLING, "The execution and electronic afterlife of Joseph Paul Jernigan", http://www.life.com/Life/science/body/body01.html

[172] See for further informations: C. G. DOWLING, *"The execution and electronic afterlife of Joseph Paul Jernigan"*, at: http://www.life.com/Life/science/body/body01.html

[173] Potassium chloride is a chemical compound composed of potassium and chlorine.

[174] See C. G. DOWLING: *"[...] it took nearly nine months to produce pictures of all 1,878 slices.",* in: C. G. DOWLING, "The execution and electronic afterlife of Joseph Paul Jernigan", http://www.life.com/Life/science/body/body01.html

[175] See http://www.aec.at/en/center/project.asp?iProjectID=12310

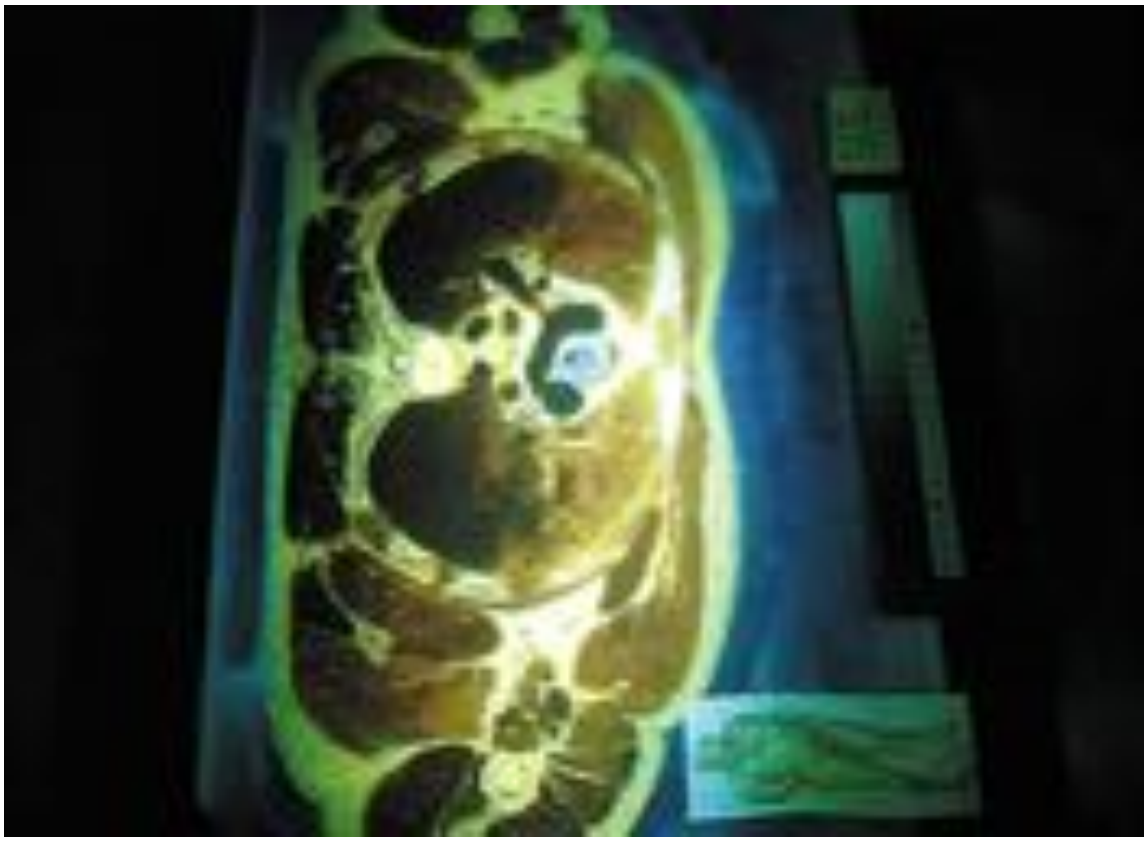

Figure 7 **Visible Human in the Elevator, 1996. © Ars Electronica Futurelab.**

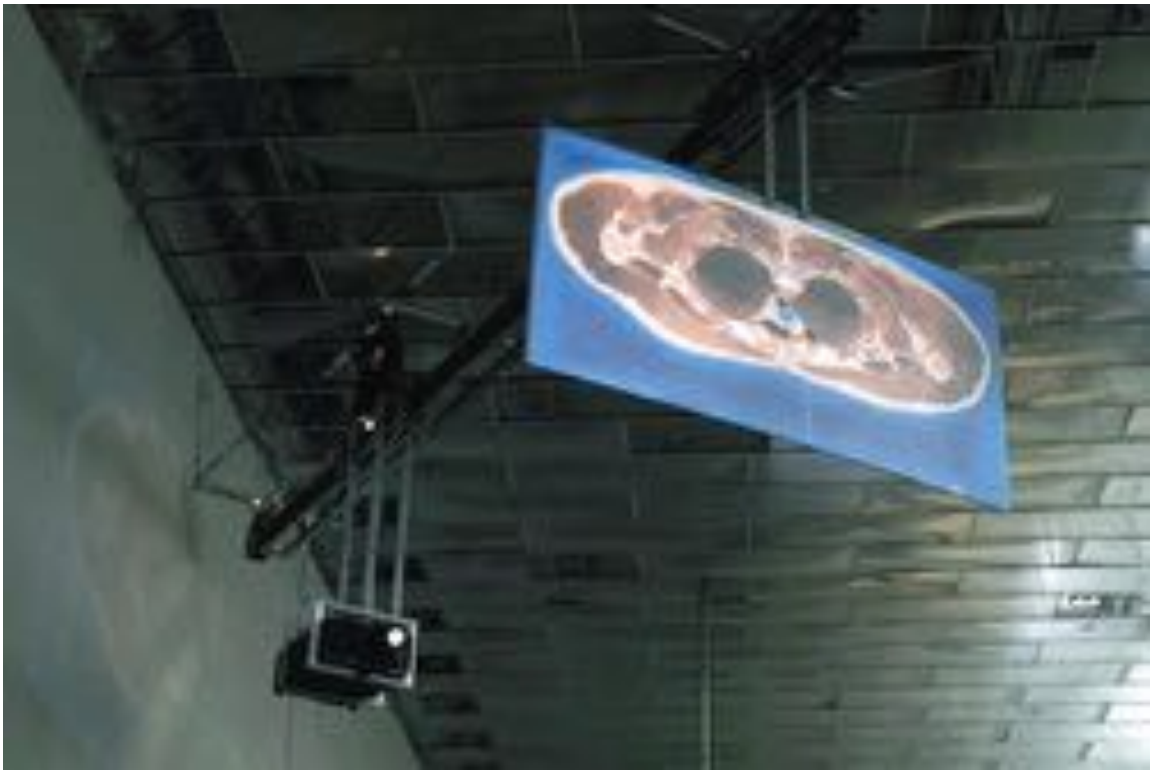

Figure 8 **The Virtual Backbone, 1996. © Christian Möller.**

case represents a human body, and defines the kind of the interaction as a interaction in form of navigation (by the users/visitors).

The German artist Christian Möller studied architecture at the College of Applied Sciences in Frankfurt (Germany), and at the Academy of Fine Arts in Vienna (Austria). He was a professor at the State College of Design in Karlsruhe (Germany) and is currently an associate professor in the Department of Design and Media Arts at the University of California (Los Angeles). On 2016 he has been appointed chair of the UCLA Department of Design Media Arts. Christian Möller works with contemporary media technologies to produce innovative and intense physical events, from handheld objects to architectural scale installations.[176] Using sound- and light-effects, Möller creates spaces that are responsive and can be manipulated.
Möller used the same image data (from the body of Joseph Paul Jernigan) to create the video installation “The Virtual Backbone”, 1996, Fig. 8. This work was shown in the exhibition "Wunschmaschine Welterfindung" at the Kunsthalle Vienna in 1996 and in the exhibition “Objekt Video” at the Landesmuseum Oberösterreich in Upper Austria (Linz).

In “The Virtual Backbone” (realized in cooperation with Sven Thoene, Werner Raczkoevi and Herman Gruber) more than 1800 slice images were exhibited along a longitudinal axis about seven meters long.[177] On a 2.5 x 1.4 meter projected surface the slices of Joseph Paul Jernigan’s body were displayed in accordance with their position in the real body. Jernigan’s body was presented on a larger scale (3.5 times magnified). Visitors, walking under the movable projection, had the feeling that Jernigan was lying above them in the exhibition space.
The works “Visible Human in the Elevator” and the “The Virtual Backbone” demonstrate two different ways of representing the interior of the human body. The themes arising from the same motif correspond to their intended meaning. The main aim in the work of Ars Electronica Futurelab is to take a journey through the human body so that images show passengers how their own bodies are laid out inside. The character of “Visible Human in the Elevator” is more of a medical exploration; the human body is represented as an anatomical computer model. The pieces of the body are assembled[178] to allow the visitors a view of the inside of the body. Christian Möller’s work is intended to make the dead man present in the

[176] See http://www.christian-moeller.com/

[177] See http://users.design.ucla.edu/projects/arc/cm/cm/staticE/page33.html

[178] See V. Kuni, *„[...] Dass dies den »Visible Human« nicht nur mit zahlreichen anatomischen Präparaten der Medizingeschichte, sondern mittelbar auch mit der Hauptfigur aus Mary Shelleys »Frankenstein« verbindet, die freilich aus verschiedenen Leichenteilen zusammengesetzt werden muss, welche die Zuträger des ehrgeizigen Wissenschaftlers aus den Gräbern Gehenkter besorgen, ist weniger ein absurder Zufall als ein sprechendes Detail: Der Ethos, die Würde des Menschen auch nach seinem Tode nicht anzutasten, wird in ein Angebot an arme Sünder transformiert, wenigstens auf diesem Wege einmal dem Wohle der Menschheit zu dienen. Da dem Körperspender des »Visible Human« diese Offerte jedoch noch zu Lebzeiten gemacht wurde und er in den Handel eingewilligt hat, erlangt er im ›virtuellen Raum‹ – wenigstens virtuell – zur Ganzheit seiner Kontur zurück. Den aus disparaten Quellen zusammengesetzten Körper von Frankensteins Kreatur hingegen weisen die Narben der grob geflickten Schnittstellen als Monster aus.“*, at: V. Kuni, „Cyborg_Configurationen als Formationen der (Selbst-)Schöpfung im Imaginationsraum technologischer Kreation (II): Monströse Versprechen und posthumane Anthropomorphismen“, http://www.medienkunstnetz.de/themen/cyborg_bodies/mythische-koerper_II/

space; his body is visualized on a larger scale than in reality. The reclining position of his body gives visitors the impression that it is non-active, "sleeping" or that a dead human is being represented in giant dimensions.

Stelarc (erstwhile Stelios Arcadiou) *"is an Australian artist who has performed extensively in Japan, Europe and the USA- including new music, dance festivals and experimental theatre. He has used medical instruments, prosthetics, robotics, Virtual Reality systems and the Internet to explore alternate, intimate and involuntary interfaces with the body.*[179] In 2016 he was awarded an Honorary Doctorate from the Ionian University (Corfu, Greece). According to C. Paul, his art concerns "*Notions of the cyborg, the extended body, and the posthuman frequently surface in digital art projects*", and he has "*created numerous works that construct human-machine interfaces – incorporating robotics, prosthetics, and the Internet. […] With digital technologies, not only do the prosthetics become more sophisticated but we are experiencing and increasing fusion of the body and the machine.*"[180] According to Frank Popper "*What it means to be human is being constantly redefined, according to Stelarc. Humans have created technologies and machines that are much more precise and powerful than the body."*[181] Popper's opinion is that "*In Stelarc's view, technology defines what it means to be human. Technology is not an antagonist, alien sort of object; it is part of our human nature. We should not be afraid, then, of incorporating technology into the body.*"[182] A further characteristic in Stelarc's works is that he is performing mostly (since 70s) naked. According to Claudia Bethune "*Seine Nacktheit verwies – ob intendiert oder nicht- fortwährend auf die ontische Entblößtheit des Menschen: In der Genesis ist präfiguriert, inwieweit die menschliche Nacktheit mit der Initiation in die Scham, dem Sterblichwerden und der Vertreibung aus dem Paradies einhergeht; …*"[183] Stelarc uses his body naked not for erotic reasons, but to show a "pure" form of the body in art. Especially in combination with the technology (his wired body for instance) he evokes the feeling of how weak the body itself can be. Benthien describes this as follows: "*Stelarcs nackter Körper, der auch in jungen Jahren keinem Schönheitsideal entsprach, zeigt daher immer wieder an, dass das >Fleisch< schwach, weich und schutzlos ist.*"[184] Another point of view could note that Greek and Latin gods were differentiated from "real" humans in traditional art by their nakedness (in balanced compositions) while ordinary people were clothed. Or that gods in the Buddhist culture were represented with additional hands, also to differentiate them from "real" humans. The naked Stelarc with his additional attached hand reminds us of those representations' forms.
Stelarc used the human body, in particular his own, as a motif for his artworks. His 1993 performance "Stomach Sculpture", Fig. 9, which is constructed by Jason Patterson, has been considered here as an opposing example to the works that show the inside of the body as an animation ("The Virtual Backbone" and "Visible Human in the Elevator").

[179] http://www.brunel.ac.uk/about/acad/sa/artstaff/drama/stelarc

[180] Paul (2003), p. 166-167ff.

[181] Frank Popper. From Technological to Virtual Art, MIT Press Cambridge, 2007, p. 254.

[182] Popper (2007), p. 254ff.

[183] Claudia Benthien, *„Die Epidermis der Kunst. Stelarcs Phantasmen"*, pp. 319-339, in: Gendolla, Peter, N. M. Schmitz, I. Schneider, and P. M. Spangenberg (ed.). Formen Interaktiver Medienkunst, Frankfurt/Main, 2001, p. 320.

[184] Benthien, p. 320, in: Gendolla (2001).

In this performance, after fasting for eight hours, Stelarc inserted a specially designed, robotic object - a domed capsule shell - as a sculpture into his distended stomach (into the stomach cavity). The shell was placed in a mechanism that looked like a crab's claw and was then linked with a cable to be driven from outside into his body. A video endoscope[185] started to record after the sculpture was inserted into the stomach. According to Stelarc "*The hollow body becomes a host, not for a self or a soul, but simply for a sculpture*",[186] becoming a bowl for an "artistic sculpture".
The sculpture itself was intended to be the leitmotif of this work, but the films/images of the interior of the body were such an unusual representation allowing the public a view of the inside of the body that it became the main motif of this work. This representation, showing even the flesh that is in the body interior, reminds us of the works of Francis Bacon. For example, his work "Three Studies for a Crucifixion" from 1962, mentioned in the introduction, also depicts human parts of body from the inside.

[185] See Stelarc: *"[...] Once inserted into the stomach an endoscope is used to suck out excess stomach fluid and the stomach is then inflated with air"*, from
http://www.stelarc.va.com.au/stomach/stomach.html

[186] Stelarc, from: http://www.stelarc.va.com.au/stomach/stomach.html

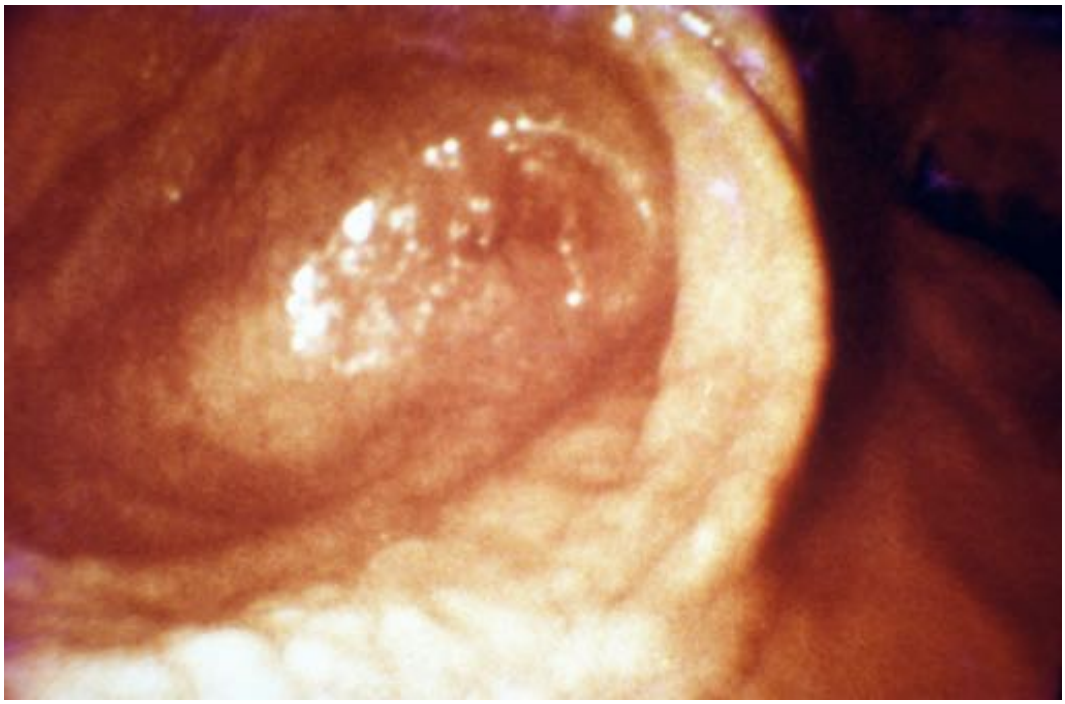

Figure 9 Stomach Sculpture, Fifth Australian Sculpture Triennial, NGV, Melbourne, 1993, © Stelarc, Photographer: Anthony Figallo.

Comparing the representation of the interior body in the works of Ars Electronica Futurelab and Möller, Stelarc's is a life representation of the human interior (using the artist's own body) in line with the characteristics of performance genre. Stelarc primarily wanted to create a hollow space in his body for a "sculpture", while in the other examples the artists wanted to represent the inside of the body. The difference between an animation of a bodily interior (which were in fact real images of the body) and a live filming of an interior is a decided difference between the characters of these works. While in the work of Ars Electronica Futurelab one can take a trip through a body, the Stelarc's work shows a live trip into his body.
The body in "The Virtual Backbone" and "Visible Human in the Elevator" was a synthesis of small fragments (images of slices of the body), while in the work of Stelarc the representation of the body is a live film. In Stelarc's work the experience of the interior of the body is more accentuated. Unlike the work of Ars Electronica Futurelab, Stelarc's images of the inside of his stomach, with the blood and the fluids, evoke unpleasant emotions. The Ars Electronica Futurelab piece on the other hand astonishes and surprises, with the emphasis more on the anatomical aspect. Stelarc's work shows a trip through a stomach while Ars Electronica Futurelab and Möller treat the entire inside of the body as a theme.
Endoscopy of the stomach is known as a procedure that is usually performed under narcotics. The fact that Stelarc did this procedure without narcotics evoked surprise and shockfrom the viewer.
The "revealing" of his body by the video-endoscope can be understood as an extension of the exterior into human cavity. The inside of the body visually becomes an extension of the outside. According to Brian Massumi *"The extension into visibility of the body's inside reveals its sensitive-intensive, palpitating interiority to be an infolded-and unfoldable-exteriority that is as susceptible to transductive connection as any sampling of body-substance. The body is hollow. There is nothing inside-there is no inside as such for anything to be in, interiority being only a particular relationship of the exterior to itself"*[187] Stelarc wanted to create a place, a space for his sculpture and he used his stomach for doing this. The inside of his body, his stomach acquires the character of a place for display.
Until now artists used portraits or acted presentations for their artworks. This artwork goes a step further so that now even the inside of the body is presented as a background for an artistic work. The inside of the body filmed live in its function, reflects the development of medical technique. This has also been used in earlier artworks. On the other hand it reflects also the fact that although endoscopiesare done relatively often for medical reasons, we don't know exactly what is happening during this procedure. We sign to undergo a procedure that we don't really know how it looks and what our body will go through.

Oversized bodies, which visitors can be driven through as in the work of Ars Electronica Futurelab "Visible Human in the Elevator", are different to the historic examples from the traditional art. The inside of the body was then represented as an anatomical research object. This meaning has been kept in interactive digital art. But its size, and the possibility to be inside it, to drive through it, gives us a totally different perception of this motif. It is its interactivity, its interface, the displayed form which makes it unique for the audience. Also then, when Leonardo Da Vinci drew the inside of the body (think of the pen and ink studies of

[187] Brian Massumi, *"Stelarc: The Evolutionary Alchemy of Reason"*, pp. 334-341, in: John Beckmann (Ed.), The Virtual Dimension. Architecture, Representation, and Crash Culture, Princeton Architectural Press, New York, 1998, pp. 339.

the human fetus) with the aim to discover the mystery of that how the human body is made, was this was an astonishing discovery: "*Leonardo the anatomist, embryologist and neuroscientist revealed new worlds by scalpel, pen, and candlelight, worlds forbidden to explore by reigning authorities. Never before had the body been subjected to such powerful examination. Never before had the particulars of what we are made of and how we work been rendered in such detail: how we breathe, how we move, how we sense our world, how we nourish and repair and re-create ourselves."*[188] Now, at a time where the usage of ultrasound and MRT- or CT-scanning are a normal possibility for routine health examinations, and at a time where real organs of dead humans are transformed to art-pieces (as in the exhibition "Body Worlds" by Gunther von Hagens mentioned in the introduction), the scanning of the body slices and their usage for art is not an unexpected reaction of artists as part of this society. But surely, we have to add that never before it was possible to drive through the human body and to exhibit in it, and never before was it possible to take such kinds of images in such dimensions for observation. The representation of the human body from inside in a lift creates a relationship between the human body and the architecture. Not just the interior of human body is represented, but also the visitor's journey through it. The human drives through human body to explore it, thus exploring her or himself.

[188] http://www.stemcelldilemma.com/leonardodavinci.html

4.2.5. Body Parts

Jean Robertson and Craig McDaniel wrote that the use of a partial body or body parts is an "*important motif in contemporary art that is decidedly anticlassical*"[189]. But actually we find body and body parts as motifs also in traditional art, for example how footprints symbolise the Buddha. Such an example, the "Buddhapada" in the Amaravati temple, which was created in the 1st century B.C. can be seen in the British Museum in London. In both traditional art, and in interactive digital art, the human motif appears not only as portrait, but also as body parts like legs, arms, or hands. For example in the installation "Dancing on Tables", from 1988-1993, Stephan von Huene represented humans, particularly men's legs as leitmotif.
Hands appear often as motif in interactive digital artworks. There are works which show an image of a hand as a symbol that a display (or something analogue) has to be touched to "activate" it. For example in Ken Feingold's work, "The Surprising Spiral" from 1991 visitors touch it to activate this interactive art. In some works the motif of hands appears to be more important for the visual perception of the piece; some works are based on the motif of hands themselves. Already in video installation we can find hands as a n important motif. For example the work "HanD HearD" (2002) by Garry Hill is a large scale installation, which was specially commissioned for the Science Museum in London. This work "*consists of a repeated motif of individuals gazing at their hands, projected on to an 18-metre-high wall."*[190]

4.2.5.1. Dancing sculptures of legs

Stephan von Huene (1932 - 2000) studied free art and art history at the Chouinard Art Institute and at the University of California Los Angeles. In 1971 he began teaching at the California Institute of the Arts and in 1980 he moved to Germany. Stephan von Huene was a Professor at the "Staatliche Hochschule für Gestaltung" in Karlsruhe. He produced, among other works, audio-kinetic sculptures, "machine-bodies" and sound installations, using programmed, interactive sounds and removing the borderline between sculpture and dance.
His work "TischTänzer", 1988, which is "*possibly Stephan von Huene's "greatest work", as Horst Bredekamp once put it, forms part of the ZKM Collection and has been on show in the Media Museum for the past year*."[191]
This installation consists of four sculptures of lower part of male bodies, made from wood and metal. Three of them are dressed (they wear trousers and shoes) and recall tailor's dummies. One is "naked" except for shoes.. Its material (wood) and the moving mechanism (from metal) are here visible.

[189] Robertson and McDaniel (2005), p. 140.

[190] Giskin Day (Ed.), Inside the Science Museum, Board of Trustees of the Science Museum, 2001, p.73.

[191] http://on1.zkm.de/zkm/stories/storyReader$4874

The sculptures are represented life-sized and are mounted on four pedestals. On the wall behind the sculptures drawings of male bodies hang, particularly the lower part of the body, which then correlate with the shadows of the sculptures. These drawings recall fashion design sketches.
Entering the room, the visitor activates these interactive sculptures's sensors and their legs begin to step. The step dance is accompanied by sound recordings of speeches by American politicians.. The naked figure is distinguished through its ballet dance to the accompaniment of classic opera music by George Bizet and George Friederich Händel. The "TischTänzer" *"exemplifies virtually everything that interested and motivated the artist throughout his lifetime and exerted a determining influence on his work: sound, tone, language, rhetoric – body, man, person, machine; perception, chaos, order, logic."*[192] This work is a combination of different forms of art: drawing, sculpture, sound, text-effects, light and dance. Classical art forms combined with media art forms, which include interactivity, combine to create a work which can be experienced on different levels. Although completed in 1988 "TischTänzer" was first presented in 1995 at the Venice Biennale.

The represention of legs in art has its own history. Bussagli describes legs as an important issue for the existence of human beings: "*Unsere unteren Gliedmaßen, die Beine, zeichnen sich im Gegensatz zu den oberen durch besondere Stärke aus. Dank dieser Eigenschaft und ihrer Beweglichkeit können wir uns mit ihnen fortbewegen. Die Fähigkeit einen Raum zu durchmessen unterscheidet sowohl Menschen als auch Tiere von den Pflanzen. Zusammen mit dem aufrechten Gang ist dies ein wesentliches Merkmal des menschlichen Seins. Der Mensch hat Welten und Jahrtausende »durchschritten«. Für ihn ist die Möglichkeit sich zu bewegen gleichbedeutend mit dem Leben selbst. Die chinesische Hochsprache hat mit ihrem Wort für Mensch – dem Bildschriftzeichen, das heute als rén gelesen wird und der Schreibweise des gleichbedeutenden japanischen hito entspricht – genau auf dieses Merkmal abgehoben. Die beiden Linien, aus denen es besteht, und die mit großer malerischer Geschicklichkeit zueinander in Beziehung gesetzt sind, geben den Schwung der Bewegung des Menschen wieder, wenn er den ersten Schritt macht. Sie bringen zum Ausdruck, dass der Mensch nicht still stehen kann, dass er sich am besten zur Geltung bringt, wenn er sich bewegt. Beim Laufen durchmisst er die Welt, er erfährt sie, unterwirft sie sich und wird zum Maß aller Dinge. Ein bekanntes chinesisches Sprichwort besagt: »Eine Reise von 10000 li (entspricht der Länge der großen Mauer von 6000 km) beginnt mit dem ersten Schritt.«*"[193].
Also the feet are described by Bussagli as important, as a basis for the human body: "»*Mit beiden Füßen auf dem Boden stehen« bedeutet, einen gesunden Realitätssinn zu haben. Füße verbinden uns direkt mit der Welt, auf sie stützen wir uns. [...] Die Füße sind gewissermaßen die »Packesel«, die sich ergeben das Gewicht unseres Körpers aufladen. Aus anatomischer Sicht sind sie ein architektonisches Meisterwerk, ein tragendes Kugelsegment – wie das Kuppelgewölbe eines Bauwerks – , daß es erlaubt, unser Gewicht auf nur drei Punkten ruhen zu lassen: dem Fersenbeinhöcker und den Mittelfußknochen des großen bzw. kleinen Zehs. Die Schönheit und Funktionalität eines derartigen Knochenaufbaus musste die Neugierde von Künstlern wie Leonardo da Vinci oder Albrecht Dürer wecken. Doch letzlich haben alle großen Künstler den Füßen ihre besondere Aufmerksamkeit geschenkt*."[194] Bussagli mentioned as an example for this the studies of feet produced by Jean-Auguste-Dominique Ingres in his work "Apotheosis of Homer ".

[192] http://on1.zkm.de/zkm/stories/storyReader$4874

[193] Bussagli (2006), p. 318.

[194] Bussagli (2006), p. 321.

Another artist that used human (male) legs and the lower part of the body as a motif is the American artist Robert Gober. His sculpture and installations combining seemingly incompatible elements, attracted worldwide attention. His work "Untitled" of 1989-1992, which consists of beeswax, cotton, wool, human hair and leather shoe, shows a fragment of a leg penetrating a wall. The leg is lying on the floor, wearing a shoe, a sock and a pair of trousers, as if it were amputated right now from a clothed man. Thus, it evokes a shock-effect in the visitors.
Both works, of Huene and of Gober, link to surrealistic art - real objects or elements are brought into an unreal context. Furthermore, Huene's naked sculpture of his wooden legs recalls representations of Giorgio de Chirico (surrealistic works) as for example in his work "Hektor and Andromache" (1917).

The fact that the legs and the lower bodies in Huene's work constitute an installation, and additionally to this, they are interactive, emphasizes the room-filling effect, which is also supported through the sounds of speeches, drawings in the background, the light and dance of the figures. Huene involves the visitors by attracting their attention in an audiovisual way on different levels. Huene was inspired by the tap-dancers of 1930s in a San Francisco Coffee House that earned their money by dancing to the news. They read out a story from a newspaper and then tap-danced to that. Then they were paid or got a meal for this. It was a "job" that Huene appreciated very much because an artistic act was being supported by a small Coffee House. This can be also understood as a critique of Huene of the contemporary society, where artists can barely survive working in their own field as professionals. He combined this idea with the fashion show as he thinks that the appearance of visitors to the exhibitions, in their clothes that they bought in boutiques, standing in front of the artworks, support the artworks and the exhibitions themselves. Therefore we can interpret the drawn figures in the background as a reflection of the visitor's presence. And they can also be understood as the dancer's audience. We can conclude that the body parts (lower body) or the legs now represent in interactive digital art not just a dancer for the audience, not just a newspaper reader of 30s, they represent a wish to support artistic work and artists so that they can go further along their creative path.

Considering the historic examples of traditional art, such as discussed above, the legs were first represented then as symbols (as in the footprints of Buddha. This meaning does not appear within interactive digital artworks. But legs also represented movement both then (in traditional artforms) and now, , particularly a specific dance (as in the work of Stephan von Huene "TischTänzer" [1988]). Interactivity and the interface which is used are the elements that have changed the perception of this motif. The dance appears in accordance with the movements of the visitors/observers. Through the motif of legs, a key theme is not just the dance itself , but also the visitors who cause this dance and are reflected in the drawing behind the dancers. The surrealistic way for representing this motif is known already before in traditional artforms (as in Robert Gober's installation or the "The Red Model", 1937 by Rene Magritte discussed in the introduction). The combination of different forms of art (drawing, sculpture, sound, text-effects, light and dance) for representing this motif, including interactivity and the intuitive interface make a different overall impression of the representation of the motif of legs. A complex constellation of art forms and a unique arrangement of them for conveying a specific meaning are evident.

4.2.5.2. "Talking" virtual hands and "real" third hand

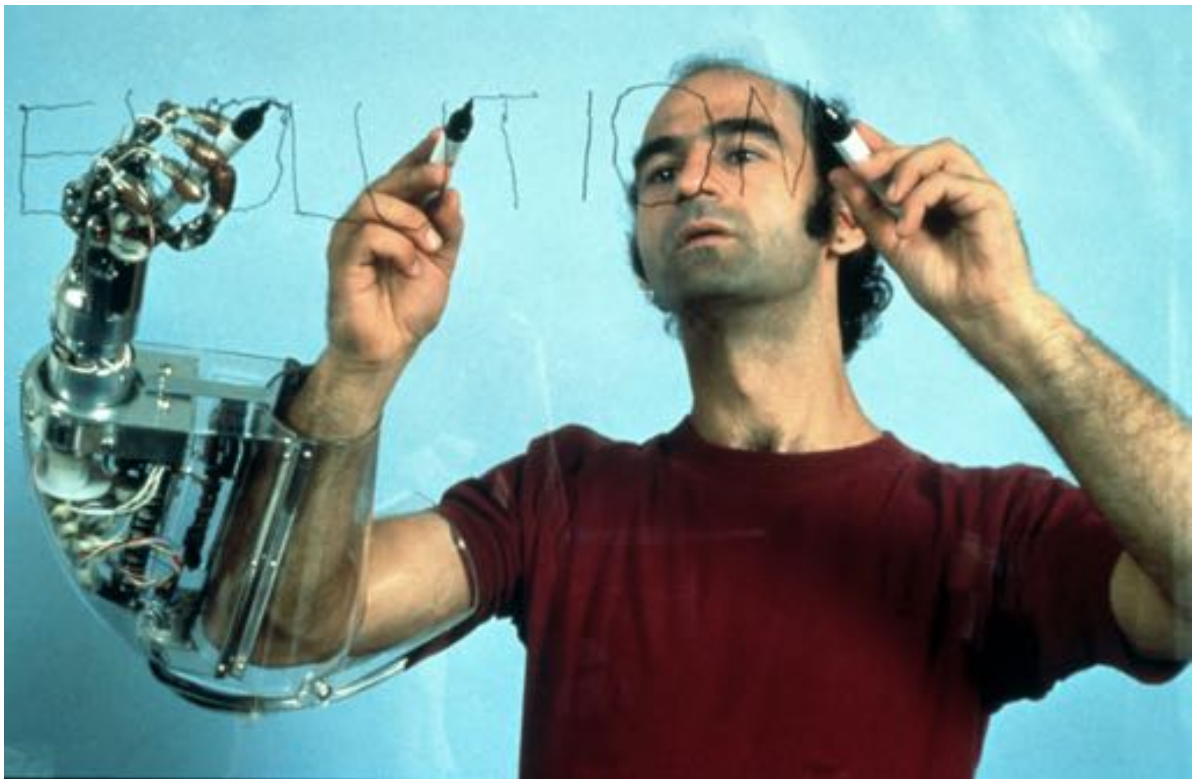

Figure 10 The Third Hand (Handswriting: Evolution), Maki Gallery, Tokyo 1982, © Stelarc, Photographer: Keisuke Oki.

Arms and hands also appear often as a motif in interactive digital artworks. There are works which showa hand symbol a s a signal that a display (or something analogue) has to be touched to "activate" it. There are interactive works in which the motif of hands appear as interface, as in the work "displaced emperors, relational architecture 2" (1997) b y Rafael Lozano-Hemmer. In some works the motif of hands appears to be more important for the visual perception of the work; and some are based only on the motif of hands. Two different examples that belong in these categories will be discussed in this chapter: Agnes Hegedüs, "Between the Words", 1995 interactive Installation and Stelarc, "Third Hand", 1981 – 1994.

The Hungarian artist Agnes Hegedüs, who lives and works in Sydney, has been developing interactive installations since the early 1990s. These are based on game structures or on historical models and deal often with the aspect of perception (real or virtual).
Her work "Between the Words" (1995) is a co-production by the "Kunst- und Ausstellungshalle" of the Bundesrepublik Deutschland and of the Ars Electronica in Linz.[195] This installation deals with communication between two visitors through facial expression

[195] See http://www.kah-bonn.de/index.htm?ausstellungen_alt/hegedues/index.htm

and hand gestures. Two visitors can face each other through an opening in a freestanding "wall" and can put their hands in niches, which are on each side of this wall and are made for this purpose. The visitors can manipulate joysticks to control the gestures of two virtual hands. Through semi-transparent mirrors the two visitors/users can see each other and at the same time they can see computer images of their hands – whose shapes are designed virtually by themselves. The movement of the hands changes by interactivity of users upon joystick; the virtual hands are constituted through lines. The result is a nonverbal visual communication through gesture modification and through facing[196] each other.

The Australian artist Stelarc, which used his body for artworks, used the motif of the hand in his works as well, for example in the "Third Hand" of 1981 – 1994 (Fig. 10). He designed a mechanical arm[197], which was attached to his arm as a third arm. It was moved through EMG (electromyography) signals of the leg and abdominal muscles. According to Stelarc the hand "*has a pinch-release, grasp-release, 290 degree wrist rotation* [both clockwise and anti-clockwise] *and a tactile feedback system for a rudimentary "sense of touch".*[198] *Electrodes positioned on the flexor muscles and biceps curl the fingers inwards, bend the wrist and thrust the arm upwards."*[199] In combination with the real left arm, motion of which was controlled by two muscle simulators, the human body is not just equipped with another arm, but the relation between the function of the arms and their movement takes a new definition.[200] Additionally, *"The triggerings of the arm motions pace the performance and the stimulator signals are used as sound sources, as is the motor sound of the Third Hand mechanism itself."*[201] Later, in 1996, in his work "Ping Pong Body", Stelarc "*wired his body and his robotic "Third Hand" to the Internet, and allowed variations in the global transfer of online informations to trigger involuntary physiological responses. The artist's arms and legs jerked in an exotic and frightening dance*."[202]

---

[196] See A. Hegedüs: *"Face to face, they interactively manipulate surrogate virtual hands to articulate a non-verbal, yet eloquent, dialogue."* from http://www.medienkunstnetz.de/works/between-the-words/

[197] Stelarc: *"[...] The artificial hand, attached to the right arm as an addition rather than as a prosthetic replacement"*, from http://www.stelarc.va.com.au/third/third.html

[198] See http://www.stelarc.va.com.au/third/third.html

[199] http://www.stelarc.va.com.au/third/third.html

[200] See Verena Kuni, „Lost Medium Found – Über STELARC. Im Zwiegespräch mit dem obsoleten Körper", in: SIXCON Lost Media, Hg. Rotraut Pape, Offenbach 2002. : *„Tatsächlich aber handelt es sich um eine Apparatur, die nicht nur anders als die beiden von Natur aus vorhandenen oberen Extremitäten, nämlich über elektromuskuläre Stimuli aus Abdomen und Beinen bewegt wird, sondern die im selben Moment, da sie den Radius des einen Armes erweitert, zugleich über eine Rückkopplung auch die Bewegungen des anderen Armes steuern kann. Damit wird nicht nur das Verhältnis zwischen willkürlicher und unwillkürlicher, habitueller und zielgerichteter Motorik reorganisiert, sondern letztlich das gesamte Bewegungssystem neu strukturiert."*, from http://www.medienkunstnetz.de/werke/third-hand/

[201] http://www.stelarc.va.com.au/third/third.html

[202] Edward A. Shanken, *„From Cybernetics to Telematics"*, in: Roy Ascott. Telematic Embrace. Visionary Theories of Art, Technology, and Consciousness, University of California Press, Berkeley, 2003, p. 73.

Similar to Agnes Hegedüs' work, "Between the Words" Stelarc used the motif of the hand in "Third Hand", with the difference that Stelarc's is based on a real mechanical arm developed for his performance; while Hegedüs shows virtual drawn hands. Visually Stelarc's hand shows a similarity to robotic work, while Hegedüs' recalls studies of traditional old Masters, for example those of the painter Raffael (Raffaello Santi). Aesthetically Stelarc chose a representation which is similar to a prosthetic arm, while Hegedüs represents complex hand positions through simple lines. In this way Hegedüs shows the motif of the hand in a more artistic character than Stelarc. Stelarc's hand has to be understood as an addition to the physiological possibilities of the human body. The natural appearance and actions are mixed with artificial. The objective representation in "Between the Words", which shows different kinds and positions of hands, sometime turns out to a non-objective representation, which consists of tangled lines.

In both cases the hands are remote-controlled – in Stelarc's work through muscle signals, in Hegedüs' work through joysticks. Stelarc's is based on an interface more directly controlled by his body (a human-machine interface) than in Hegedüs'. Using joysticks in order to control her work, the user can make decisions more consciously and the development of the work is affected through this. Further, the semi-transparent mirror is a second interface used in the work of Hegedüs. Besides the facial expression, it evokes a kind of identity game.
Through the motif of the hand deals Stelarc among others with the theme of the concept of the human body and the relation between human and technology, while Hegedüs using the same motif in her work deals with the aspect of communication through the sign-language. Hands have been represented with a similar purpose also by the known French sculpture Auguste Rodin (1840 - 1917): "*For Rodin hands have both an expressive and a symbolic value: they embody the gesture.*"[203] Stelarc developed an arm inclusive a hand for this work, but actually he called his work the "Third Hand", because his aim was to create a hand and this has to be controlled by an arm.

From art history we know also examples of representations of arms and hands. Concerning this issue, Bussagli wrote: "*Die ersten Werke, die nach den naiven Darstellungen des Neolithikums eine zwar noch stilisierte, aber anatomisch korrekte Wiedergabe der oberen Gliedmaßen aufweisen, sind die mykenischen Becher aus Vaphiò. Später scheinen die anatomischen Kenntnisse wieder verloren gegangen zu sein, wie die starr am Körper anliegenden Arme der mykenischen Kouroi zeigen. Doch schon bald darauf sollte die griechische Kunst die mimentischen Fähigkeiten der Mykener übertreffen, wie der Poseidon von Artemision beweist, dessen Arme die Hauptrolle spielen*."[204] Further, Bussagli explains the meaning of such representations as in the following: "*Bei den Ägyptern (und nicht nur bei diesen) stehen die Arme für das Handeln. So wird die Hieroglyphe Äals gebeugter Arm dargestellt, wobei die Entfernung zwischen Ellenbogen und Puls, also das Maß der Elle, genau bestimmt wird. Mit dieser Länge lässt sich die Welt abmessen, aber das bedeutet auch, sie zu durchqueren, also »zu handeln«. Die oberen Gliedmaßen ermöglichen einen aktiven Zugriff auf die Welt. Es ist kein Zufall, dass Vesal sein Werk über Anatomie mit einem Bild einleitet, das ihn als Chirurg darstellt, während er die Haut eines Unterarms entfernt.*

[203] http://www.musee-rodin.fr/rma-e.htm

[204] Bussagli (2006), p. 309.

Vermutlich aus demselben Grund legte Dr. Tulp, der als Nachfolger Vesals gelten kann, Rembrandt nahe, ihn ebenfalls auf diese Weise darzustellen."[205]
Bussagli wrote also about the representation and the meaning of hands in historic art: "*Seit jeher galt die Hand als das den Menschen auszeichnende Körperteil. Nicht von ungefähr finden wir ihren Abdruck zum Zeichen des Besitzes in den prähistorischen Höhlen. Die Menschen legten ihre Hand auf die Wand und sprühten Pigmente darüber."*[206] Her opinion is that: *"Der Gebrauch der Hand gibt dem Menschen das Gefühl schöpferisch zu sein wie ein Gott. Daher fühlt er sich allen Lebewesen überlegen. Gleichzeitig verrichtet der Mensch mit der Hand intellektuelle Tätigkeiten wie Schreiben und Rechnen."*[207] In this image of Stelarc, he is represented writing with his third hand – the meaning of the hand shows analogies with those known from historic art. Compare to other "normal people", there is also a kind of power that the artist gets by an additional hand/arm.
Further writes Bussagli that: "*Die Hand ist jedoch vor allem ein Ausdrucksmittel, dass es erlaubt zu kommunizieren ohne zu sprechen.*"[208] This is an important issue, which is present even in interactive digital artwork discussed above: in the installation "Between the Words" hands are used with the same aim as those described by Bussagli about historic art.

Concerning the representation of the hand as motif, then and now, hands were motifs for communication (think of the work of Agnes Hegedüs "Between the Words", 1995). The difference is that, in interactive digital art, it is being communicated with hands in real time in a reciprocal way. The artistic work here reflects a kind of scientific research. It is the contemporary technique which makes it possible for such artforms to emerge. Thinking about the time before the telephone was invented, people communicated with each other via letters. Now, in the time of internet, which makes communication possible via emails and chats, people communicate live with each other, they can see each other online. The meaning of the motif of hand in interactive digital art, being based on its iconography which was already present before in other kinds of art, reflects the contemporary communications' technique.
A third hand has been developed by Stelarc in the form of a prosthesis and can be used as such. The boundaries between the medical research and artistic issues are deleted with this example. An interesting point of view is that different Greek and Latin gods were represented as humans. Additionally, to differentiate them from "normal" people, they have been represented nude in more balanced compositions than "normal" people. Or, in the Buddhist culture, the gods have been represented, for instance, with additional hands to be differentiated from the "normal" people. This can be an analogue element between such representations and the works of Stelarc. Appearing mostly naked, and representing himself for instance with an attached hand, is a kind of representation of a non-human, particularly of a god.

---

[205] Bussagli (2006), p. 309.

[206] Bussagli (2006), p. 312.

[207] Bussagli (2006), p. 312.

[208] Bussagli (2006), p. 312.

See also Bussagli (2006) p. 312.: *"Man denke nur an die Gestik, die die Römer adlocutio nannten. Der aus dem Partikel ad und dem Verb loqui zusammengesetzte Begriff bedeutet wörtlich die an jemanden gerichtete »Rede«. Generäle, die eine Ansprache hielten, wandten sich mit dem rechten erhobenen Arm an ihre Soldaten, wobei die Haltung der Hand jemanden oder etwas zu bezeichnen schien. Wenn eine Figur in dieser Pose dargestellt ist, wie z.B. auf der Trajanssäule, dann bedeutet das, dass sie zu einer Truppe spricht."*

Although the human as motif has been represented in traditional art as a portrait, or in the form of a bust, from inside of the body or just the body parts of it, in interactive digital art, the digital manipulations, the various reciprocal communication possibilities that expanded within this kind of art, brought appropriate results.

In general, it can be concluded that the human as motif in interactive digital art is not unique, but its representation's form, the way it has been contextualized, the way it has been visualized, the way visitors can explore its representation, the way visitors can communicate with this motif, the intensity of the relationship between a visitor and the represented human motif has changed compared to the traditional art-forms and compared to other media supported representations.

4.3. Animals or Plants as Motifs: Historical Overview

In general the use of animals and plants as motifs in art has been done in different ways; they have been represented in different forms. For example, the animal has been represented as a symbol or as an aesthetic object in its natural environment. According to Zaunschirm: "*Die an sich naheliegende Frage, welche Tiere sich überhaupt dazu eignen, in der Kunst eingesetzt zu werden, ist für eine tendenziell auf den Künstler als Kultfigur orientierte Kunstkritik irrelevant. Es eignen sich alle Tiere dazu, wenn nur Künstler ihre symbolische Funktion aufzeigen.*"[209] The animal was represented among others in pre-Christian art as a mythological creature, in Christian art it was used as a symbol, and in Dutch art of the 17th century was used for representing livestock. Their representation was a reflection of their relation to the human and their function for the society.

A chronological view of the animal-motif shows that animals were represented first in scenes made for magical hunting power. This can be seen, for example, in one of the oldest known paintings of animal-representation, which was painted 15.000-10.000 B.C. in the cave of Lascaux. This cave is located near the village of Montignac in France. Further animal-motifs can be seen for example as panelling; a relief of bricks with stepping lions and bulls was represented for the New Babylon Empire of Nebukadnezars II (604-562 B.C.).

In the medieval period the representation of animals can be found for example as accompanying motifs for representing a religious-scene (think of the representation of "Jesus' Birth" shown mostly with a donkey and a bullock in the background as allegories for the Old and New Testament). Then, there are animal representations as freestanding sculptures such as the "Brunswick Lion" made in the year 1166. This bronze monument which represented the image of the power of "Henry the Lion" was positioned in front of his castle. This shows us that animals were used also to represent power.

According to Harald Olbrich *"In den nachantiken mittelalterlichen Kunst wurde zuerst Stilisierung und Symbolik verstärkt, ehe mit der Renaissance eine neue Phase der Tierbeobachtung bis zu den feinsten stofflichen Details einsetzte (z.B. bei A. Dürer)…"*[210] A quite famous representation of an animal is the "Rabbit" (in German: Feldhase) of the Austrian Albrecht Dürer done in the year 1502. It is not a representation which "completes" a painting: the animal itself is the main subject of the painting. This painting also represents the autonomy of the animal in artistic representation. According to Klaus Albrecht Schröder und Maria Luise Sternath: "*Neben der Positionierung des Hasenkorpus in der Diagonalen sind es vor allem die Löffel, die dem Tier in unterschiedlicher Weise Raum aufspannen.[...] Der Feldhase is kein Porträt der Natur im eigentlichen Sinne, zu viel Kunsterfahrung manifestiert sich hier. Das Blatt zeigt ein psychologisch gesteigertes Wesensporträt dieses Tieres, sodas die symbolische oder physiologische Dimension des Hasen völlig darüber in Vergessenheit gerät.*"[211]

---

[209] Thomas Zaunschirm, *„Im Zoo der Kunst. Seit wann und warum gibt es lebende Tiere in der bildenden Kunst?"*, pp. 39-48, in: Kunstforum. Im Zoo der Kunst I, Out of Africa, Bd. 174, 2005, p. 39.

[210] Harald Olbrich (Ed.), Lexikon der Kunst, Architektur, Bildende Kunst, Angewandte Kunst, Industrieformgestaltung, Kunsttheorie, Bd. VII, VEB E. A. Seemann Verlag, Leipzig, 1989, p. 327.

From the middle of the 19th century, the aspect of space-time becomes more and more important in a society characterized by production and trade. The famous English photographer Eadweard Muybridge used the motif of animals for representing movement in his works. 1972 he was commissioned by the ex-governor of California to record/represent the movement of the legs of a horse in a gallop. His aim was to prove that by a specific movement the horse has all his hooves on the air. This work of Muybridge was published on 1887 as "Animal Locomotion".
Visual artists who were in 1900 dealing with the nature and landscape including the motif of the animal as a theme are characterized by a "back to the nature" in their pictures. In this context the weariness of civilization was important, which was present already in the 18th century since Jean Jacques Rousseau's[212] philosophical writings. Due to this, an animal representation had the meaning of unadulterated nature. Its representation stood in contrast to the humans who were alienated from nature. The German expressionist Franz Marc represented animals in his painting reflecting this ideology. His represented animals unify an animal with nature. Further he designed them using symbolic colors.
Then animal motifs in the 20th century could be found designed in a naive style (for example in Henri Rousseau's paintings). On the other side the German biologist Ernst Haeckel published in 1904 a book on "Kunstformen der Natur" (Art Forms of Nature), which includes over 100 prints of various organisms (multi-colour illustrations of animals and sea creatures), many of which were first described by Haeckel himself. Many artists of the style of Art Nouveau were influenced by Haeckel's images. This influence is present also nowadays in different kinds of art.
In contemporary society, which is characterized by genetic manipulations in the breeding of animals it is no wonder that artists such as the known sculptor Thomas Grünfeld used animal motifs for creating artworks with a critical purpose to this fact. An example is "Misfit" (cow). This represents the result of experiments in crossing animals. In his works, animals look weird and threatening. Already in traditional art, fantastic transformations of animals were represented as mythical creatures, such as the sphinx, minotaur, dragon or unicorn.
The new media technologies, which began dominating the political and economic forces of the 20th century, were present also in arts. The computer artist Charles Csuri used the animal motif in his "*algorithmic painting*"[213] representing it in an abstract way such as in the work "Horse Play" from 1993[214]. The horses' contours consist of a series of strips, in a surrealistic

[211] Klaus Albrecht Schröder und Maria Luise Sternath (Hg.). Albrecht Dürer, Hatje Cantz Verlag, Ostfildern-Ruit, 2003, p. 49ff.

[212] See Nicholas Dent: *"If civilisation corrupts and deforms human beings, making them delight in others' despite and alienating them from themselves, what seemingly more obvious solution to this than withdrawal from society and an attempt to recapture, or to model life on, the character and circumstances of pre-social man, natural man in the state of nature? Rousseau has certainly been widely understood as a champion of such a redirection."*, in: Nicholas Dent. Rousseau. Routledge, 2005, at: http://books.google.com, 23.08.08, 17:30.

[213] A notion used by C. Csuri, from http://www.siggraph.org/artdesign/profile/csuri/

[214] See C. Csuri: *"A mathematical function was used to create the ribbon like lines. The lines move through points on the surface of a 3d model of a horse. There are controls to skip points, cut the lines and control the thickness of the line. I like the capacity to work with lighting on the lines using spotlights. The lines then cast shadows in ways which are interesting and fun. Look closely and you can see the spotlights on the ground. I cut out a section of the horse with another tool and placed it into the sky. I made it's line thicker and semi-transparent"*, from

place to "play" their game. The horses, once represented as symbols for fame, or for four apocalyptic riders, are now present as symbols for "good times". The function of the horse in society has changed and so also its representation in art.
The domestication of animals is a fact that played an important role in how the animals were represented. Furthermore, unfairly treated animals were a main theme of different artists. According to Erika Rödiger-Diruf "*Seit dem 20. Jahrhundert ist die Tierwelt so etwas wie ein Produkt des Menschen geworden: Das reflexive Verhältnis von Kreatur und Mensch umfasst das Haustier ebenso wie das Schlachtvieh oder das Versuchstier oder – noch weiterreichend – die Artenvielfalt insbesondere in tropischen Wäldern. Die hege von Tieren in Tierparks bzw. Zoos und Nationalparks ist Spiegelbild einer Situation, in der Tierarten vor und für den Menschen geschützt werden sollen.*"[215]
The motif of animals appears also in the genre of film. It has been used for example as a theme of revenge as in the thriller "The Birds" (1963) by Alfred Hitchcock, which is based on the short story "The Birds" by Daphne du Maurier. The avian attacks continue and as the situation escalates, the film shows brutal attacks, the aggresivity of bird's behavior increases. In a similar way the white shark was also presented in the American thriller film of 1975 "Jaws", which was directed by Steven Spielberg. Based on Peter Benchley's best-selling novel and inspired by the Jersey Shore shark attacks of 1916, Spielberg used the motif of shark dealing with the situation, problems and emotions caused on an island because of shark attacks. Later, in 1993 Steven Spielberg adapted "Jurassic Park" - a techno-thriller novel written by Michael Crichton (1990) as a film. The motif of animal (dinosaur) was used among other things for showing the collapse of an amusement park, in which the dinosaur species was genetically recreated. The dinosaurs were represented as a combination of computer animations and traditional techniques of animated dinosaur dolls.
The technology of genetic manipulation and the principles of evolution are important issues for the theme of this film. Fear was illustrated with the motif of spider in the American horror and comedy film "Arachnophobia" of 1990, directed by Frank Marshall. This film is about deadly spiders infecting a small American town. The title refers to the fear of spiders.

Plants were also represented in different ways as illustrations because of medical reasons or as symbols. Also they are represented as realistic - aesthetic objects. The chronology of plant illustration begins a little differently, because plants were already used in olden times as medicine. Therefore, their representation was done on the one hand as a herbarium for medical needs. The first herbal catalogue was authored by a Greek Physician, Dioscorides "De Materia Medica" and described the appearance and medicinal properties of over five hundred plants.
On the other hand, plants were used as ornamental motifs. For example, the acanthus leaves were used as motifs for creating the Corinthian column (one of the classical orders of Greek and Roman architecture). The meaning of the acanthus was life and immortality and this meaning was transported to the columns themselves which are the supporting elements of the building. The ornamental value of plants has been carried through to modern times: the Jugendstil architect Joseph Maria Olbrich used plant motifs as ornaments in building cupola at the end of the 19th century (1897 - 1898). The cupola of the "Viennese Secession Building" was decorated with golden laurel leaves. Because the laurel leaves are always green they are a

http://www.siggraph.org/artdesign/profile/csuri/

[215] Erika Rödiger-Diruf *„Natur, Tier und Gesellschaft. Einleitende Betrachtungen zum Thema"*, pp. 12-17, in: Herausforderung Tier. Von Beuys bis Kabakov, Prestel, München, 2000, p. 12.

symbol for eternity. According to Joann Skrypzak "*The crowning dome signifies light in its gold color, and eternity, triumph, and Apollo, the god of music, poetry, and prophecy in its laurel leaves.*"[216] Also the contemporary architect Claesson Koivisto Rune used 2003 vegetative motifs for the façade of "Sfera Building" in Kyoto (Japan). According to Bahamón "*In order to create the panels, cherry-tree leaves were picked and arranged in random order, photographed, digitalized, and manipulated to obtain a repetitive pattern formed by perforations with different diameters.*"[217] The cherry tree is an arboreal symbol for Japan.
The plants were symbols for their healing qualities. Already in the 15th century *"tritt die Heilwirkung von Pflanzen als förderndes Element ihrer Bedeutsamkeit verstärkt auf. Die vielzahl der deutbaren Pflanzen verband sich zunehmend mit dem erwachenden Natursinn und führte schließlich zu den* […] *Pflanzendarstellungen auf zahlreichen religiösen Bildern und Bildnissen des 15.Jh. ..."*[218]. Also the representation of plants with a worth of botanical depiction was present. Paintings of plants were valued for their botanical depictions. Jacopo Ligozzi (1547-1626) was known for his detailed water-colour miniatures of plants and animals. Additionally, his works show an artistic worth.
After the First World War a new art of perception began to be developed. A new international kind of optic language emerged in the style of New Objectivity. A return to the representation of objective motifs was noticeable. The photographer Karl Blossfeldt used "adiantum pedatum" (Maiden Hair Fern) as a motif for serial works. This plant was historically used for instance as a symbol of loneliness. Blossfeld used it in another context: *"... indem Farne ihre Triebe aufrollen, durchlaufen sie die phantastischen Verwandlungen von fein gedrechselten Bischofsstaeben über breite Schneckenhaeuser bis zu aufrecht stehenden, gefiederten Halmen*"[219] – he created shape analogies.

After 1950 a new kind of realism emerged in contrast to Abstract Expressionism. Pop Art as a style was based on the reality of consumer society and the New Realism was a style that criticized consumer society. A further style was Photorealism which, differently to Pop Art and New Realism, was developing different levels of the perception of the reality - a deeper realistic representation was intended. The contemporary Swiss artist Franz Gertsch used plant motifs as in the work "Gräser I", 1995/96, which belongs to the style of Photorealism. The motif of grass then used as a symbol of the homeland, or usefulness, appears now as a composition in monumental works (240 x 340 cm) calling attention to the qualities of nature.
The surrealists also incorporated real plants in their works. Sabine Bartelsheim opinion is that the integration of plants in the surrealistic art "*knüpft an ein neues Verständnis und eine gewandelte Wahrnehmung der Dingwelt an. Die herkömmliche rationale Sicht auf die Welt, die alle Dinge mit spezifischen Funktionen und Bedeutungen belegt, wurde in Frage gestellt zugunsten der Entdeckung ihrer irrealen, dissonanten Qualitäten. Befördert wurde diese durch das Mittel der Verfremdung, das einerseits in der absurden Dingkombinatorik seinen Ausdruck fand, andererseits – wie bei den Naturobjekten – in die Wahrnehmung selbst*

[216] Joann Skrypzak. Design, Vienna, 1890s to 1930s, University of Wisconsin Press, Madison, 2003, p. 20.

[217] Bahamón, Alejandro. Vegetal Architecture, Analogies between the Vegetal World and Contemporary Architecture, Parramón Ediciones, Barcelona, 2006, p. 87.

[218] Olbrich (1989), Bd. V, p. 561.

[219] Christel Heybrock. Kraft und Schoenheit der Pflanzen, Karl Blossfeldts fotografische Arbeitscollagen bei Schirmer/Mosel, at:
http://hometown.aol.de/fotoseiten/BlossfeldtArbeitscollagen.html, 21.02.2007, 15:20.

verlagert wurde: Die reale Welt wurde als fremdartig wahrgenommen und ihre Fremdartigkeit als Zeichen surrealer Welten gedeutet."[220]
Bartelsheim refers about the installation for the "*Exposition Internationale du Surrealisme"* in the Galerie Beaux Arts in Paris in 1938, particularly about a work of Marcel Duchamp and Wolfgang Paalen: "*Wolfgang Paalen war in dieser Ausstellung zuständig für »Wasser und Buschwerk«; ihm wird daher auch die Anlage des von wild wuchernden Pflanzen umgebenen Teiches zugeschrieben.*" Further she points out that the planting with "*Schilf, Farn und Moosen wurde unmittelbar vor Ausstellungsbeginn von Gärtnern ausgeführt. Auf der übrigen Fläche des unebenen Bodens der Halle wurden kubikmeterweise getrocknete Blätter verteilt, die die Geräusche der Schritte dämpften.*"[221] Bartelsheim concludes that plants are here "*lebende Bestandteile eines Arrangements, das die surrealistischen Traumbilder und Bildwelten des Unterbewußten auf räumlicher Ebene vorführt. Ihre Funktion basiert in diesem Environment weniger auf der Erscheinungsweise ungewöhnlicher Arten als vielmehr auf der atmosphärischen Ausstrahlung und den vielgestaltigen Sinneseindrücken des Natürlichen.*"[222] For similar purposes also Robert Rauschenberg in his so-called "Dirt Paintings" used plants, which he made by using earth and other organic materials. One of them was the work "Grass Painting"/"Growing Painting" (1953), in which the growing of grass created kinds of all-over structures. Earth, seeds, grass and other organic materials filled a wooden box and created continuously a kind of real life in the aesthetic of Abstract Expressionist paintings. At the end of 60s the representation of a "process of growth" was globally a keyword in art. Hans Haacke, for example, was an artist who was interested in the growth of plants. For his work "Gras wächst" (in English 'Grass Grow') of 1969 he created a knoll in a gallery and planted grass over it. The grass grew up differently: the sunlight reached only a part of the knoll so that the rest of the grass had to grow under an artificial light – a light used in the exhibition space. Most of the planted plants died off by the end of the exhibition – a kind of life process was perceptible by this installation.
The representation of plants in art was used also for dealing with their relation to human beings. The Dutch artist Herman de Vries, who studied botanics, often used plants in his artworks. The work "Das verschlossene Paradies" (in English "the closed paradise") of 1989 consists of a locked greenhouse, in which are growing under an artificial light 21 hallucinogenic plants, such as cannabis, opium poppy, thorn apple and others. He considered the relation of those plants and humans in the context of their earlier and today's usage – his opinion is that their meaning is getting more and more negative.

The contemporary German artist Peter Rösel often used the motif of plants in his sculptures. He made his plant-sculptures of garment pieces; in particular he used the material of the German police dress uniform. The beige-green uniform, which the artist dislikes, has been transformed into exotic plant types. He used the motif of plants to change the character of something that he doesn't like to something that everybody likes: plants (see his work "Seerosenteich"/English: lily pond, or see "Bromelia Dubia" – both made in 1997).
The romantic yearning for nature obtained a new impulse in the arts since 1970. Artistic works began to counteract the human who was more and more alienated from nature. With more or less provoking public actions, installations, performances or videos the arts stepped in

[220] Sabine Bartelsheim, Pflanzenkunstwerke. Lebende Pflanzen in der Kunst des 20. Jahrhunderts, Silke Schreiber, Munich, 2001, p. 26.

[221] Bartelsheim (2001), p. 27.

[222] Bartelsheim (2001), p. 27.

direct dialog with the present socio-political situation. With this representation of nature including the animals and plants, art made a kind of deal with the ecological problems.

The American artist Nam June Paik who was born in South Korea is known as the founder of video art. He used the motif of plants (tropical plants) in his video installation "TV-Garden" from 1974 to deal with the question of the relationship between nature and technology.
Karl Sims used plant-like organic shapes in his computer animation "Panspermia" from 1990 "*depicting a life cycle of an inter-galactic botanical life form*"[223]. This example influenced some of the interactive digital artworks, which will be discussed in the next chapter.

[223] http://www.genarts.com/karl/

4.4. Animals and Plants as Motifs in Interactive Digital Art

While in digitalized art plants or animals have been designed using algorithms imitating the natural rules of creating a living being, in interactive digital art their virtual development, also their growth and dying are simulated depending on the visitors' interactivity. Already in 1983, the Austrian computer artist Herbert W. Franke did an interactive artwork with the motif of the forest ("Wald"). It was possible to interactively create black and white or color graphics. The interface was limited to the usage of the keyboard, so that "*Die aus Linien und Dreiecken bestehenden Elemente wurden zeilenweise über die Bildfläche verteilt, wobei die Möglichkeit besteht, von der Tastatur aus, verschiedene Parameter zu verändern, beispielsweise die Größenverhältnisse, die "Zeilenhöhe und die Farbe."*[224] In 1988, in Edmond Couchot and Michel Bret's work "Le Pissenlit" visitors were even given the power to make dandelion seeds fly on screen by blowing at it. The direction and the duration of breathing captured by a microphone were the parameters that controlled the interface.

Many artists tried to explain their creations as a middle ground between art and science. For example, the creators Oliver Deussen and Bernd Lintermann comment about their work about plants and organics in media art in the following: "…*With digital media the border between art and science is more and more indistinguishable. Artists develop solutions that contribute to the scientific discussions, they anticipate developments or take them up again in another context, they publish in scientific magazines, and merge their work with that of conventional scientists in research institutes."*[225]
Animals and plants are created not only as accompanying motifs, but also as independent motifs, their "life" even treated as a main theme in the works of interactive media artists. The animals and plants are designed on the basis of their real visual characteristics, then in a surrealistic way (real objects are brought in an unreal context), or in an abstract way. The symbolic value of plants and especially of animals with generally a long tradition in arts is maintained also in interactive digital art. Of course, the symbols or allegories for animals change depending on our engineered civilization form. So animals can have here a symbolic value (as in the work "Subject: Emotions Encoded", 1997, by Merel Mirage, where a butterfly was represented as a symbol of emotional state), or they are created with a decorative purpose (as the nature-elements in the "Well of Lights" 1992, by Toshio Iwai). They represent themselves, or symbolize something specific like knowledge in the work "Tree of Knowledge" (1997) by Bill Viola.
Animals, plants, and nature in art are designed mostly through the rules of the artists, which are then combined and recombined by the users, or observers (as in the work "GENMA" (1996-97) by Christa Sommerer & Laurent Mignonneau). In this way a virtual world is developed which through the included rules of the artists enables a redefining of the rules by the users. The users can create virtual worlds that even the artists have not yet imagined.
Animals or other organisms can be accessed by visitors to a real installation space, for example in an exhibition, or virtually online. So for example, in the interactive work

[224] Penesta Dika. Die Computerkunst Herbert W. Frankes, Logos, Berlin, 2007, p. 110.

[225] Oliver Deussen and Bernd Lintermann, Digital Design of Nature. Computer Generated Plants and Organics. Springer-Verlag Berlin Heidelberg, 2005, p. 227.

"TechnoSphere" (1993) by Jane Prophet, a virtual life can be created and manipulated in real-time as a three dimensional installation on the Web.[226] At the same time, the visitors can interact in a museum with virtual creatures. Scott Fischers' "Menagerie" (1993) was a project that was an effort to develop an interactive virtual world that responded to the user's activities in real time in an exhibition space. Inhabited by animals, birds and insects that move in their virtual world and interactively respond to the user's presence in various ways, this work presented imagined creatures based on real nature; "living" things in a virtual space. These can be manipulated live by visitors. Virtual animals, species generated by computer, inhabited virtual worlds, which could be accessed in an exhibition room. The artists' aim was primarily to imitate the motion of the animals in a specific way: "*In our computer simulations of virtual animals, the geometric representations are deliberately designed to be simple in order to emphasize the motion of the animals, rather than the details of their appearance. For us, the essential expression is in the abstraction of the motion, and what it suggests to the imagination of the viewer*."[227]
Animals were also realized to warn the human so that they "care better" for them: in the work "Cyber Knowledge. Die Konstruktion der Dekadenz", of 1993–1994 realized by Margot Pilz, a rhinoceros has two videos integrated in his eyes that shows movies about the tortures that the human enacts upon this kind of animal. Suddenly the visitor appears in these videos and is integrated as a co-aggressor.
Further, there are interactive works, which allow the users to view and interact from a distance: "TeleGarden" (1995) of Ken Goldberg and Joseph Santarromana is an art installation that allows web users to manage a real garden filled with living plants (installed in the Ars Electronica from 1996-2004). An industrial robot arm has been used as interface and could be moved from the distance. It has been used to plant, water, and monitor the progress of seedlings.
To represent plants have been used different rules of digital modeling. The use of the so-called Lindenmayer systems for the development of plant geometry has been depicted in the book of Przemyslaw Prusinkiewicz and Aristid Lindenmayer "The Algorithmic Beauty of Plants" (1990), which counts as a "*classic in computer graphics*"[228]. Several artists have used the examples of this book to create their works. To research these changes, which appear also in other design aspects, we can take a look at interactive digital artworks. The first chapter analyses the works which are created through evolutionary principles and shows as the visual end-result plant-like or animal-like shapes. The second chapter depicts the works which show how the plant or animal motif is used as a symbol, or as an entertaining motif. The third chapter focuses on the animal as data input or as interactive sculpture. The fourth chapter focuses on aquatic creatures in interactive digital art and the fifth chapter is about "virtual pets".

[226] See Shanken, p. 73, in: Ascott (2003): *"A series of menus allowed users to select attributes to create an artificial life form that entered the virtual world of "TechnoSphere" and competed for survival and reproduction. Users selected various physical features (eyes, mouths, motility, and so on), chose between herbivorous or carnivorous feeding, and assigned a name to the creature they had parented."*

[227] http://www.telepresence.com/telepresence-research/MENAGERIE/

[228] Deussen and Lintermann (2005), p. 63.

4.4.1. Evolutionary Designed Biological Motifs

The aspect of the usage of the principles of nature, in particularly creating art imitating the rules of nature, is widespread in interactive digital art. The fact that the possibility to program works based on such rules has become possible, is significant for the development of such artworks. For example, the so-called genetic algorithm[229], which is a kind of evolutionary algorithm, is used in interactive artworks, which are chosen to be discussed in this chapter. Genetic algorithms are algorithms used for optimization problems and are based on the Charles Darwin's evolution theory, its principle of the "survival of the fittest". The main rules on which they are based are: selection, reproduction, cross-over and mutation. The different usage of such algorithms brought appropriate visual characteristics. Considering the usage of genetic algorithms or the usage of evolutionary algorithms in general for creating virtual life, Thomas S. Ray considers that: "*Organic life is viewed as utilizing energy, mostly derived from the sun, to organize matter. By analogy, digital life can be viewed as using CPU (central processing unit) time, to organize memory.*"[230] With this sentence Ray makes analogies between the energy used by real organic life which is deriving from sun and the energy used by digital life in form of CPU time. But CPU time cannot be analogous with the energy of the sun. The energy in the digital life would derive from electricity. Furthermore, this energy for creating digital life would be transformed, as we know, into 0 and 1. Ray considers that the memory, the CPU, and the computer's operating system "*are viewed as elements of the `abiotic` environment. A `creature` is then designed to be specifically adapted to the features of the environment. The creature consists of a self-replicating assembler-language program. Assembler languages are merely mnemonics for the machine codes that are directly executed by the CPU.* […] *It is felt that machine instructions provide the most natural basis for an artificial chemistry of creatures designed to live in the computer.*"[231] For Ray, in the biological analogy, the machine instructions "*are considered to be more like the amino acids than the nucleic acids, because they are `chemically active`. They actively manipulate bits, bytes, CPU registers, and the movements of the instruction pointer…*"[232]
According to Margaret A. Boden "*Artificial Life (A-Life) uses informational concepts and computer modelling to study life in general, and terrestrial life in particular. It raises many philosophical problems, including the nature of life itself.*"[233] She explains that there is "*no universally agreed definition of life. The concept covers a cluster of properties, most of which are themselves philosophically problematic: self-organization, emergence, autonomy, growth, development, reproduction, evolution, adaptation, responsiveness, and metabolism.*"[234] Further, she considers that the central concept of A-Life, excepting life itself, is "*self-*

[229] See the book of David E. Goldberg. Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley Professional, 1989 and the book of John H. Holland. Adaptation in Natural and Artificial Systems, University of Michigan Press, Ann Arbor, Michigan, 1975.

[230] Thomas S. Ray, *"An Approach to the Synthesis of Life"*, pp. 111-145, in: Margaret A. Boden (Ed.), The Philosophy of Artificial Life, Oxford University Press, New York, 1996, p. 113.

[231] Ray, p. 114, in: Boden (1996).

[232] Ray, p. 114, in: Boden (1996).

[233] Boden (1996), p. 1.

[234] Boden (1996), p. 1.

organization. *Self-organization involves the emergence (and maintenance) of order, or complexity, out of an origin that is ordered to a lesser degree."*[235]
According to Christopher G. Langton "*By composing our individual understandings of the dissected component parts of living organisms, traditional biology has provided us with a broad picture of the mechanics of life on Earth. But there is more to life than mechanics – there is also dynamics.*"[236] Concerning this Langton explains that "*Life depends critically on principles of dynamical self – organization that have remained largely untouched by traditional analytic methods."*[237] And for him there is a *"simple explanation for this – these self-organized dynamics are fundamentally non-linear phenomena…"*[238] Computer Science constitutes "*one of the main basis of the success of the Dynamic Systems progress*" and concerning this "*Artificial Intelligence contributions being particularly interesting to the advances in fields like Control, Monitoring, Supervision, Diagnosis and Decision of such systems."*[239] According to Gabriel Fiol-Roig "*Dynamic Processes are characterized by their evolutionary behaviour over time, defining a sequence of operation states of the System.*"[240]
Niran B. Abbas considered the fact that "*Since the early 1980s, the posthuman in its various guises (cyborg, clone, transgenic art object) has captured the imagination of a section of the art world with the force of a divine revelation."*[241] Concerning this issue Abbas mentioned as examples that in the early twentieth-century*, "the avantgarde (Dadaists, Futurists, Russian Constructivists, Vorticists, Duchamp, Picabia, Epstein, Léger, Vertov, etc.) explored of the relationship between the human body and the machine, often in an impressive fashion."*[242] Abbas considers that now *"artists are in a position to explore new kinds of transhuman possibilities that lie beyond mechanistic articulations. This relationship is based on new powerful cybernetic theories of human/machine interaction and communication, new computing systems, and new disciplines like genetic engineering and biotechnology."*[243] He considers that for *"many contemporary artists (Stelarc, Eduardo Kac), the cyborg and genetically engineered organism represent visual and material frontiers where one can produce artworks that are received as examples of the most advanced figurative operations of the human imagination.*"[244]

The intent to simulate creatures that look like real life is already well-known in media art and animation. Already William Latham, in "The Evolution of Forms" from 1990, created visual shapes that are based on natural shapes and make the illusion that the shapes are already known living things in the real world. The works he developed between 1987 and 1994 "*form the basis for an aesthetic that is known today as "Organic Art", which serves as a model to many artistic artworks*. *Characteristic of his style are repetitive structures, in which simple*

[235] Boden (1996), p. 3.
[236] Christopher G. Langton, *"Artificial Life"*, pp. 39-94, in: Boden (1996), p. 40.
[237] Langton, p. 40, in: Boden (1996).
[238] Langton, p. 40, in: Boden (1996).
[239] Gabriel Fiol-Roig, *"Knowledge Representation Model for Dynamic Processes"*, pp. 40-53, in: M. Teresa Escrig, Francisco Toledo, Elisabet Golobardes (Eds.), Topics in Artificial Intelligence, 5th Catalonian Conference on AI, CCIA, Springer, Berlin, 2002, p. 40.
[240] Fiol-Roig, p. 40, in: Escrig and Toledo (2002).
[241] Niran B. Abbas, Thinking Machines: Discourses of Artificial Intelligence, Lit Verlag, 2006, p. 151.
[242] Abbas (2006), p. 151.
[243] Abbas (2006), p. 151.
[244] Abbas (2006), p. 151.

geometrical primitives such as balls or tori are repeatedly joined, and, by iteration of geometrical transformations, such as rotations or translations, generate complex organic-appearing structures. His computer sculptures remind us of anemones, lobsters, shells, and of simple organic life-forms. Latham is frequently named in connection with the interdisciplinary area "Artificial Life", in particular since he used an important technology for generating his picture contents: computer-aided evolution"[245] The work of Louis Bec can also be assigned to the category of Artificial Life. His work "Prolegomena"[246] (1993) has shown the new image of the motif of organic shapes, created by the usage of the principles of real life. According to Oliver Grau: *"The application of evolutionary principles ranges from commercial uses, for example, in pharmaceutical research, to finance, telecommunication, and, as we have seen, media art. In computer networks, so the AI researches now hope, these mechanisms will soon bring forth artificial systems capable of self-replication, language and gestures recognition, learning, and memorizing."*[247] In this context Grau added that: *"Certain visionaries even expect consciousness to emerge."*[248]
In 1993 the ARS Electronica Festival appeared under the motto: "GENETIC ART - ARTIFICIAL LIFE" and works created by genetic algorithms were represented. Artificial life created in such a way, the origins of life globally and the forms that life might take in the future were focused on by these works. Distinguishing between an animal and a plant is often not possible in such artworks, because the visual results sometimes show shapes which could be counted in both of these categories. For example, sometimes the behavior and movement of it reminds us of an animal, but it appears visually as similar to a plant.

To research works in which the visual results are biological-like shapes, the following examples will be used. The first example (Christa Sommerer and Laurent Mignonneau, "Interactive Plant Growing", 1993) has been chosen as representative for the plant-motifs in interactive digital art, which is based on the implementation of evolutionary algorithms, respectively genetic algorithms. The second example ("Galápagos" by Karl Sims, 1997) has been chosen as representative of abstract animals (the Galapagos is known as an isolated island, on which unique species developed). As a contrast to this work "Life Spacies" from

---

[245] Deussen and Lintermann (2005), p. 228.

[246] Ingeborg Reichle. Transgene Körper. Kunst im Zeitalter von Technoscience: *„Neben den Simulationen von Karl Sims waren in Linz 1993 auch die Experimente des französischen Künstlers und Theoretikers Louis Bec zu künstlichem Leben zu sehen: in Form von Computersimulationen des Projekts »Prolegomena«. [59] Becs Arbeiten zu »Prolegomena« entstanden innerhalb eines größeren Projektes der Formulierung einer ›Technozoosemiotik‹ und zielten darauf, die Logik des Lebendigen zu erkunden. Dies sollte durch die Erforschung und Konstruktion einer Metasprache für Menschen, Tiere und Maschinen geschehen, wobei Bec sein Hauptaugenmerk auf die Erforschung von Schnittstellen einer allgemeinen Kommunikation zwischen der Biomasse lebendiger Organismen (natürlichen Intelligenzformen) und technologischen Systemen (künstlichen Intelligenzformen) legte. Dies führte Bec dazu, neue Lebewesen zu entwerfen, wie sie die Evolution ebenso hätte hervorbringen können. Für die Visualisierung dieser fiktiven digitalen Wesen entwickelte der Künstler ein imaginäres zoologisches System, das einzigartige zoomorphe Formen, seltsame Biologien und abweichende Zoosemiotiken enthielt."*,
from http://www.medienkunstnetz.de/themen/cyborg_bodies/transgene_koerper/20/

[247] Grau (2003), p. 308.

[248] Grau (2003), p. 308.

1996/97 made by Christa Sommerer and Laurent Mignonneau has been chosen, which shows insect-like creatures (evolutionary design is also here implemented) and a nest-like environment of these creatures. Bernd Lintermann's and Torsten Belschner's "SonoMorphis" from 1998 will be researched as an example, which visually reminds of plant-like shapes, but its pulsating movement brings it nearer to an animal-like creature.

Christa Sommerer and Laurent Mignonneau developed works which are an exploration of the relationship between art and science. Sommerer studied Biology and Botany, at the Vienna University and also Modern Sculpture and Art Education at the Academy of Fine Arts in Vienna. Mignonneau studied at the Academy of Fine Arts in Angouleme Video Art and Modern Art. Sommerer and Mignonneau created and represented worldwide interactive computer installations such as "Interactive Plant Growing" (1992), "Anthroposcope" (1993), "A-Volve" (1994), "Trans Plant" (1995), "Intro Act" (1995), "MIC Exploration Space" (1995), "GENMA" (1996), "Life Spacies" (1996/1997), "Life Spacies II" (1999), "HAZE Express" (1999), "VERBARIUM" (1999), "Industrial Evolution" (2000), "PICO_SCAN" (1999/2000), "Riding the Net" (2000), "The Living Room" (2001), "The Living Web" (2002), "Nano-Scape" (2002), "Mobile Feelings" (2003) and "Eau de Jardin" (2004) and "LifeWriter" (2006). Currently Sommerer and Mignonneau are Professors at the University of Art and Design in Linz (Austria) and head the Department for Interface Culture at the Institute for Media.

One of the works of the "*most influential*"[249] artists, Christa Sommerer and Laurent Mignonneau, is "Interactive Plant Growing", made in 1993 (Fig. 11), which is currently on permanent exhibition at the ZKM (Center for Art and Media) Museum in Karlsruhe. It shows different potted plants (ferns, mosses, trees, vines and a cactus) positioned over five columns in a darkened room. In front of them is a projection screen with dimensions of 4 x 3 meters. When the visitor touches the real plants or moves his hands towards them, the virtual growth of twenty five and more plants can be influenced and controlled in real time. These virtual plants, which are arranged in a "*manifestly artificial, artistic order like the one shown in the Roman frescos of the Villa Livia*"[250] are program-based and are displayed on the projection screen. The interaction as a reciprocal communication between a user and a programmed work is present in form of co-creation (by the users/visitors). This sensitive interaction with the real plants decides how the plants that are being displayed grow. The modification of the displayed plants (their growth angle, rotation, colour and position) depends on the values resulting from the visitors' interactions with the physical plants.[251] The relation or communication between the users and the real plants is reflected as a creation of virtual plants. The sensitivity of this relation allows more precision in the creation. One of the physical plants (a cactus) is used as a restart for the displayed image; the artists called it "*the killer plant*"[252].

[249] See S. Dietz, Ten Dreams of Technology, from http://www.nydigitalsalon.org/10/essay.php?essay=8

[250] Grau (2003), p. 298.

[251] See Christa Sommerer and Laurent Mignonneau, *"Art as a living System"*, pp. 148-161, in: Christa Sommerer & Laurent Mignonneau, Art@Science, Springer, Wien, 1998.

[252] http://www.interface.ufg.ac.at/christa-laurent/WORKS/FRAMES/FrameSet.html

Figure 11 Interactive Plant Growing, 1993. © Christa Sommerer & Laurent Mignonneau.

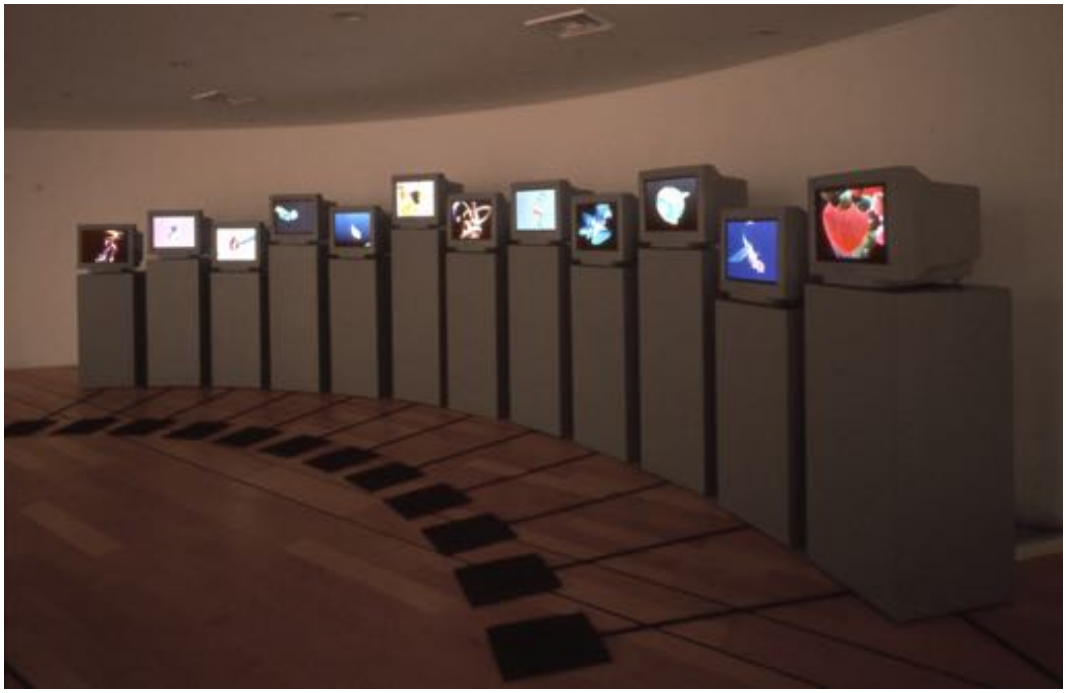

Figure 12 Galápagos, 1997. © Karl Sims.

The surface is filled out from top to bottom over a black background. The black background gives the animation an agravic character. The representation of the plants in a naturalistic style as an autonomous motif has been known, for example, since Albrecht Dürer's, "Das große Rasenstück" o f 1503, but in the aspect of the live-creation of monumental plants, "Interactive Plant Growing" was a pioneer achievement. The creators of the "Interactive Plant Growing" produced a three-dimensional representation. This installation treats thematically, through the plant motif, the principles of plant-development and -evolution, their growth and their modification during the time. The "random principles", which were already used for artistic creations by Dadaists[253], play a significant role for making decisions for further growth. Compared to the plants that were designed in arts before 1993, here the process of growing is treated as a theme and not just the aesthetic of plants. Creating as nature does is an aim which is here realized in the virtual world.

In another interactive media installation which is based on genetic (evolutionary) algorithms ("Galápagos"[254] by Karl Sims, 1997, Fig. 12) the visitors can develop three dimensional animated forms. Galápagos is based on Darwinian evolution[255] and is an interactive creation of virtual organisms. Twelve screens are arranged in an arc in an exhibition room. Each of them displays an abstract, animated, biological-like form and simulates its growth and behaviour. The viewers participate in this exhibit by standing on step sensors in front of those displays to select which organisms they find most aesthetically interesting ("fit for survival"). The selected organisms survive, mate, mutate and reproduce. Those not selected are removed and their monitor shows new offspring from the survivors. The offspring are copies and combinations of their "parents", but their genes are altered by random mutations. Sometimes a mutation is favorable; the new organism is more interesting than its ancestors and is then selected by the viewers.
As this evolutionary cycle of reproduction and selection continues, more and more organisms emerge. Since the genetic codes and complexity of the results are managed by the computer, the results are not constrained by the limits of human creativity or understanding. The animal-like creatures here deal with the theme of the evolution. Their aesthetic is the main issue for the users to decide which creatures will survive.

Compared to traditional artworks, in interactive digital art animals are represented in abstract shapes. This has been defined by the visitors (such as in the work "Galapagos" by Karl Sims). Such shapes appear in combination with simulations of animal behavior – a quality, which characterizes interactive digital artworks. The creatures of Galapagos appear in abstracted shapes in exhibition spaces. They can survive, mate, mutate and can be selected by users to be

[253] See Paul (2003), p. 11ff: "*Dadaist poetry aestheticized the construction of poems out of random variations of words and lines, using formal instructions to create an artifice that resulted from an interplay of randomness and control. This idea of rules being a process for creating art has a clear connection with the algorithms that form the basis of all software and every computer operation: a procedure of formal instructions that accomplish a 'result' in a finite number of steps."*

[254] This work was installed at the ICC in Tokyo from 1997 to 2000 and was exhibited at the DeCordova Museum in Lincoln, Mass. as part of Make Your Move: Interactive Computer Art and the Boston Cyberarts Festival 1999.

[255] Charles Darwin visited the Galápagos Islands in 1835 and concluded that the isolation of these islands caused a rare example of a relatively independent evolutionary process. So he came to the idea of natural selection.

recombined and to reproduce. The visitors make decisions which creatures are going to be recombined; they set the course of the further development of the evolution. They make decisions which "animals" will survive or die. The visitors create virtual animals with the implemented rules of evolution. Since genetic manipulations have been used in science and technology, the human has made decisions about what will be planted, bred, particularly what will be created to support our "survival" needs. The natural decisions of nature are being manipulated by the human with their genetics and specific new life forms evolve. This fact has been reflected also in art. Here, in this work the animals can be manipulated by their users/observers based on their genetics. Animals of the Galapagos represent evolution here. The visitors/observers who can make decisions about their creation represent the human in his decisions about the evolution of nature. Animal motifs in combination with the interface and interactivity create a new meaning within this kind of art.

The "Galápagos" by Karl Sims can be classified within interactive digital art as an open-system[256] work. Also "Interactive Plant Growing" (Christa Sommerer and Laurent Mignonneau) belongs in this category, because the final result here is also not predictable. The visitor can achieve different results through the given growth rules. This would then also depend on the aesthetic taste of the users, taking into consideration the aspects of experiences of the users with this form of interactivity.
Plants as a motif are present in Sommerer and Mignonneau's work in the physical environment as well as in virtual space, while in the Sims work the motif of animal-like creatures is present only in the virtual space. So for Sommerer and Mignonneau's work we can say that the motif of the interface[257] is thematically similar to the projected end-result.
In Sommerer and Mignonneau's work the plant motif shows more realistic features, while in the work of Sims the animals in their aesthetic are not similar to natural animals of the real world. But their behaviour, for example, shows similar characteristics to biological organisms of the real world. Sommerer und Mignonneau's "Interactive Plant Growing" shows a design that is based on real nature[258], in a kind of naturalist[259] style.
Regarding the interaction type, the visitors to Sims' work can select through the given interface (floor-sensors) and "replace" the role of selection in nature. Sims used evolutionary principles in the algorithm and this open system work allows the visitor to develop creatures by themselves. To achieve the desired visual result the visitor can also consider how the next result would look if his or her chosen animation is going to be recombined with the

[256] The notion "open system" was used for example by D. Daniels to make a analogy to the works of John Cage, respectively as analogue to Linux – system and also analogue to the "Bottom-up" structure of information-technology, in: D. Daniels, Strategien der Interaktivität, in: D. Daniels and R. Frieling, Medien Kunst Interaktion. Die 80er und 90er Jahre in Deutschland, Wien / New York, 2000, pp. 142-169.

[257] See Deussen and Lintermann (2005), p. 240: *""Interactive Plant Growing" was an early example of the use of a natural interface that took the term naturalness literally, and for the first time used a living organism as an interface in an interactive installation"*.

[258] Christa Sommerer studied among others also Biology and Botany.

[259] See C. Goodman: „*Der Naturalismus, der ihre [Christa Sommerer's und Laurent Mignonneau's] gemeinsamen Werke durchzieht, findet sich auch in den Arbeiten wieder, die beide unabhängig voneinander schufen, bevor sie sich der Nutzung der Computertechnologie zuwandten"*, in: „*Abenteuer im virtuellen Wunderland. Das interaktive Universum von Christa Sommerer and Laurent Mignonneau"*, pp. 162-173, in: J. Wenzel, and A. Wirths (1998), p. 162.

animations which are chosen from other visitors in the rest of the displayed results; which shapes and colours and which kind of movements would then be achieved. In Sommerer and Mignonneau's work, subtle, comparatively complex calculations are accomplished during the interaction, which depend on the distance between the user and the real plant (this varies from 0-70 cm). The interaction changes the parameters of further growth and also the morphology of the real plants has been taken into consideration. The virtual growth is not based on the principles of the real growth of plants, but on movements during the growth process and the shapes and colours of the virtual plants are optically comparable with real plants evolving in fast motion.
Also in Sommerer and Mignonneau's work, as in the work of Sims, random principles are present and the motifs have a quasi "autonomous-life", because not just the users decide how the motifs are going to look – the motifs also have their "own virtual life".

Although in traditional art plants have been already used as motifs, their design and their meaning in interactive digital art have changed. Through digital calculations and implemented mathematical rules, based on natural rules of real plants, this motif has been transformed. In the past plants were illustrated for medical reasons or as ornaments and contemporarily even the lives of real plants have been considered as motifs in exhibition rooms (as in the work Grass Grow by Hans Haacke, 1969, discussed in the introduction). Similar to this idea, within interactive digital art, plants can be created and the process of their growth and their death has been treated as a theme. But now the observer/visitor is an active designer of these. The observer/visitor decides their growth direction, form, density and even their death (as in the work "Interactive Plant Growing" of Sommerer and Mignonneau). They can be manipulated live. Their appearance and disappearance can be realized only with the help of a visitor's interaction. Real plants appear as tools for creating and modeling virtual plants – this is new within the designing and modeling of these plants. This is a possibility which can be offered only in this kind of art.
The possibility of interactivity and the chosen interface are important issues for the transformation of the creation and meaning of plants within this kind of art. The observer/visitor is responsible for their design. The observer/visitor is responsible for the existence of these plants. It is work that reflects the idea that we are "responsible for our planet". Since the industrialization has been seen as a factor in global warming, human responsibility for that which we have done to nature grows from day to day. The human and the technology which we invented or created and use are important factors for global warming. The reflection of the human and of technological developments, and what they can or can't do together are indirectly included in this concept. Plants as motifs in interactive digital art, in combination with the interface and the interactivity, transform the meaning of their creation by humans. The human as a creator of plants has been represented with this motif within this kind of art.

Another work based on the principles of evolutionary design developed by Christa Sommerer and Laurent Mignonneau "Life Spacies" from 1996/1997, (Fig. 13), represents an evolutionary communication and interaction environment at ICC - NTT Museum in Tokyo (Japan). The creation of it was supported by ATR-Media Integration & Communications Research Lab in Kyoto.

In contrast to their work "Interactive Plant Growing", an artificial life of virtual organisms is created by email messages[260], which can be displayed on a web page created for this installation. Users can write a text[261] to create three dimensional virtual creatures, or feed the artificial creatures releasing text characters. The characters and syntax of a text are interpreted as parameters for the designing of the creatures. Form, shape, color, texture and the number of bodies and limbs are influenced by text. Through self-developed software, which is transforming the incoming messages into the genetic code of the creature-like shapes, virtual life is created at the ICC museum. The virtual life is projected on a large screen and the visitors can interact with them by motion and touching. The artificial creatures, which in some stages of their design process recall the insects of "Music Insects" by Toshio Iwai (1992), communicate, respectively interact with each other and on the other hand also with the visitors to the environment and with the message writers on the website of "Life Spacies". Besides this complex structure of communication and influences, an indirect communication of people is also present: through the projected creatures people in the environment communicate with each other and with the online message senders. This work besides an interaction as a reciprocal communication between a user and a programmed work shows also an interaction as a reciprocal communication between users themselves through a programmed work. The interaction itself is present in the form of co-creation (by the users/visitors), and also as an interaction in the form of an intimate communication between users/visitors (the text written by one user is being eaten by an insect created by another user). There is no communication without writing via computers – this message reflects contemporary society that communicates through technology. But, on the other hand the creatures die if we don't feed them with letters, so through this we can conclude that there is also no life without writing, without communicating. Human are social beings and for this they need the communication aspect. And this artwork draws attention to the idea that communication between humans is something that can be compared with the food that humans need to eat for survival.
The insect-like creatures are hidden in nest-like compositions over the surface, which represents the environment of the creatures. A bunch of the organic-like bands is dense in some parts over the surface; the plant/nest is gradually evolving and disappearing.

Another kind of biological motif based on genetic algorithms can be seen in the work of the German Bernd Lintermann's "SonoMorphis" (created in co-operation with Torsten Belschner), from 1998.
Bernd Lintermann is a German artist who lives and works in Karlsruhe (Germany). Since 1996 he has been a freelance collaborator at ZKM – Institute for Visual Media in Karlsruhe and he does the artistic and scientific exploration of a program, particularly the development of the integrated modeling, animation and rendering system "Xfrog". This system is used for

---

[260] See Sommerer and Mignonneau (1998), p. 158: *"After sending an email message to the "Life Spacies" web page, the sender soon receives curriculum vitae for his creature, as well as an image of how it looks. When the creature dies, a report is given to it's creator, telling him or her how long the creature lived and how many children and clones it produced."*

[261] See Sommerer and Mignonneau: *"Inspired by Chomsky's sentence and based on the idea of using language as a genetic code and translating words or sentences into visual forms, we have created an interactive system for the Internet, called Life Spacies and an updated version, called Life Spacies II."*, from www.aec.at

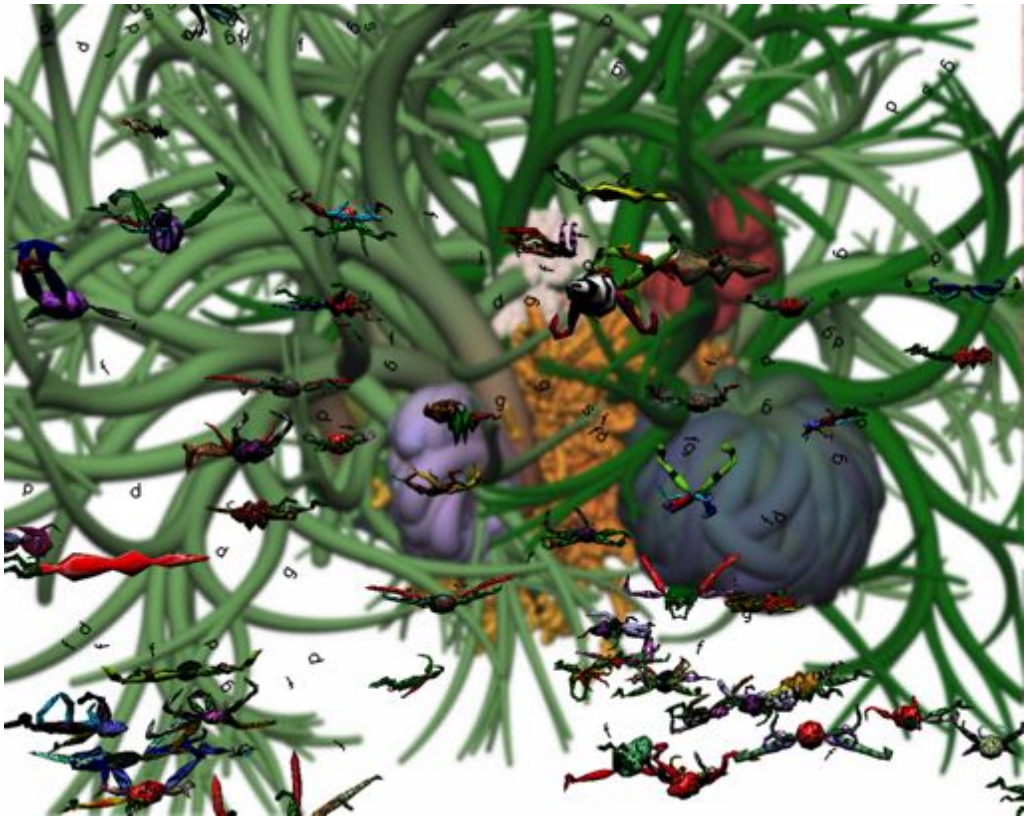

Figure 13 Life Spacies, 1996/97. © Christa Sommerer & Laurent Mignonneau.

Figure 14 SonoMorphis, 1998. © Bernd Lintermann.

creating complex geometrical structures especially for organic objects, plants and growth simulation.[262] Torsten Belschner developed audio-software and interactive sound-installations. He works and lives in Munich.
Together with Torsten Belschner, who was responsible for the sounds, Bernd Lintermann (responsible for the graphic representation) created "SonoMorphis" (Fig. 14) in 1998[263]. This work was presented in Germany, France and Poland and it was performed with an artist infront of the audience. In a darkened room, an organic shape, which is projected onto the wall can be manipulated by the visitors through a control panel. This panel is posted facing the projected shape mounted over a tablet. It can be used by the visitors to change the parameters of the shape and through rotation to change also the view and perspective of the projected shape.
From six possible variations one can select first the general shape that will be projected constituted as a three dimensional shape. The modification of it through the evolutionary principle of mutating graphic objects brings a high number of results;[264] each visitor can create a variation. The installation can be accessed also through a website (as interface).
The acoustic, which is an important component in this work, is modified also due to the shape result. In the space emerges a visual acoustic object that is being permanently moved around accompanied by the generation of sounds. This work, which would fit as an example of the notion "open system", is based on a set of predefined components, which serves as a "gene pool" of the system. The interaction as a reciprocal communication between a user and a programmed work is present in form of co-creation (by the users/visitors). Through interaction the graphic is mutated, selected and shapes are produced similar to those that we know from the real nature.[265] They are based on the aesthetic of the real biomorphic shapes and formations and they aren't naturalistic representations. Mostly the visual results in a closed shape; which looks like a living ornamental creation. The result sometimes recalls the drawing of Ernst Haeckel, because of its filigree visual result.

The work "SonoMorphis" (1998) by Torsten Belschner and Bernd Lintermann, is created using evolutionary designing, and allows a modification of it in the environment in which the

[262] See http://www.medienkunstnetz.de/artist/lintermann/biography/

[263] A first version without sound was developed between 1995 and 1997 and issued 1997 at the ZKM Karlsruhe under the name "Morphogenesis".

[264] See Bernd Lintermann: *"In both systems [in real space and in the website], users evolve a three-dimensional organic object which is created using genetic algorithms. The organic is defined by a genom, a set of components, which is successively mutated by the users. Out of six randomly generated mutations users select one, which in the succeeding steps becomes the starting point for new mutations. This way users choose a thread through a space out of approximately 1080 possible forms. In the real space users additionally change the shape and dynamic behavior of the life-like organic object via an interface box. Both systems are coupled and operate on the same data set constituting the genom. Actions in the web space effect the real space and vice versa. If a change on the web happens, the organic in the real space slowly morphs towards the web selection, a change in real space directly affects the next web action."*, from
http://www.bernd-lintermann.de/SonoMorphis/index.html

[265] See Bernd Lintermann: *"On the visual level, specific formal patterns that have been extracted from the natural world are combined arbitrarily and generate creations that are both familiar and yet have never been seen before."*, from http://www.bernd-lintermann.de/SonoMorphis/index.html

installation is installed, and from a website, the same as “Life Spacies” by Christa Sommerer and Laurent Mignonneau (1996/97). An evolutionary process has been used in Lintermann’s and Belschner’s work, which is based on the selection of the user in the exhibition space (one of six variants can be chosen), the online interactivity of the users/visitors and the combination of those both. Also in Sommerer and Mignonneau’s work similar interface is present - in the exhibition space and online. The difference with Lintermann’s and Belschner’s work is that this work doesn’t have a similar interface in the exhibition space and online. The first one – an intuitive interface, which is based on moving and touching by the visitors and the second one is based on emails (texts) that the visitors write and send. The visitors can identify themselves incorporated on the results projected. The visitor in Lintermann’s and Belschner’s work, different to Sommerer and Mignonneau’s work, can create only one shape and only one user can manipulate this shape in the exhibition space. In this way, in contrast to Sommerer and Mignonneau’s work, here is no communication between the visitors, which are in the installation room. Sommerer and Mignonneau also used intuitive interfaces in their other works, such as in the work “Interactive Plant Growing”, which has been discussed above. Their achievement in this kind of interface is pioneering. In Sommerer and Mignonneau’s work, the creatures look like insects, while plant-like shapes of the nests of the creatures appear as background motif. Lintermann’s and Belschner’s work consist of plant- and flower-like shapes (it is one shape that is created, transformed and rotated over the surface through the visitors interaction), which pulsates and moves like an organism.
The genetic code is important also for the creation of specific virtual animals, as in the work “Life Spacies” of Christa Sommerer and Laurent Mignonneau (1996/97). Animals are created and can be fed by email-messages, in particular by text characters. These are translated into an animal’s genetic code. This work visualizes the written language, and reflects the contemporary digital communication forms. Furthermore, manipulation of the genetic code has been implemented in the work “SonoMorphis” (1998) by Bernd Lintermann. Distinguishing between animals or plants is sometimes difficult in this kind of art. This work recalls plants or flowers visually, but its pulsating movement categorizes it as a living organism. This concept reflects the idea that the human does not always know what the technique employed will bring as a result. The human can not always create “normal” creatures. The human does not always know what he is doing. The motif of the living creature here can be understood as a kind of warning for the researchers, too.
The motif of plant-like shapes, of organic shapes, which are based on the genetic code (genetic algorithm) is being used not just for simulating shapes that look naturalistic, but also for creating new forms of animals and plants, new creatures, new artificial life, which do not exist in the real world. Not just innovative visual results appear, but also different kinds of artificial behavior are developed. This representation reflects contemporary, scientific researches into the relationship human – animal and human – plant. Genetic manipulations of plants and animals in the real life appear here as a theme not only to show that many results can be achieved but also as a kind of warning of what can be created via this technique.

In some interactive artworks, animals have been used as symbols. Contrary to this, in other works the same animal appears as an entertaining motif for impressing the audience. This will be focused on in the following chapter.

4.4.2. Animals as a Symbol or as an Entertaining-Motif: the Motif of Butterfly

Researching visual motifs, specifically animals as motif in interactive digital art, it can be emphasized that animals that have a contemporarily sympathetic character (such as butterflies or fishes) are used more often than animals that have a negative character, such as crocodiles, or snakes. But of course also giant animals with negative features appear in this kind of art, especially in connection with interactive works that are related to the game-industry. It can be sad that some motifs appear often than others and to research within a more common category I examined the motif of the butterfly.
The first work "Subject, emotions encoded, Mock-up with Computermonitor" (1997) by Merel Mirage will be used as an example of the usage of 'animal motif as symbol' in interactive digital art. The second example "Mariposa" (2001) by Zack Booth Simpson will be used as an opposite example – entertaining and impressing the audience is here the goal of the artist. The third example will be an earlier example of the usage of butterfly-motif in interactive digital art. On the strength of this example will be discussed what has been done different, or "better" since then. Furthermore, the question of how the development of animal-representation, particularly of the butterfly- representation, change through the technology, will be considered within this chapter.

Merel Mirage is a Dutch media artist, who is working in Amsterdam and Cologne (Germany). She lived in Nicaragua, Japan and Tibet. Her work, which is characterized by the usage of the internet as medium, deals with the problem of diverse realities. Her work has been exhibited internationally.
The work "Subject, emotions encoded" from 1997 Merel Mirage did at the "Kunsthochschule für Medien" in Cologne (Germany) in coorperation with Jordi Moragues (Computer animation) and Moore/Kiefer/Schipke[266] (sound).

As the visitor enters the installation space, he recognizes a work-place with a seat, table and a monitor, which is integrated on the wall. Also the cables of the net are visually evident. After sitting on a seat, the visitor activates a text, which is a romantic dialog. It is displayed on the monitor and it shows a conversation between two partners that have a relation on the net. The interaction here is present as a permanent visualization of live data and it is caused by the visitors' presence. The interaction in the form of an intimate or emotional communication is here being observed by the visitors.
A computer-animated butterfly has been used as a motif in this dialogue, to accentuate the emotional intensity. The butterfly tries to leave the cyber space (the screen) - this visualization has a symbolic meaning of online meetings[267], which doesn't integrate the body of one's own.

[266] http://bistrodumarin.fi/demosites/mmf/card/ei/ei_memi.htm

[267] See Paul (2003), p. 111: *"Digital art found a new form of expression with the advent of the World Wide Web in the mid- 1990s. Since its beginnings in the late 1960s, ARPANET had been growing steadily, with a constantly increasing number of nodes. […] The World Wide Web (WWW) as we know it today was conceptualized in the early 1990s by Tim Berners-Lee and CERN (the European Particle Physics Laboratory) with the intention to build a 'distributed collaborative multimedia information*

Merel Mirage's comment about her experiences of online chatting, in an interview of I. Schneider and P. M. Spangenberg: "*Eines Tages saß ich vor dem Computer, ich loggte mich aus, saß auf meinem Stuhl und dachte: »Das hier ist wie bei einem Schmetterling. Mein Geist geht voran, bewegt sich, aber mein Körper ist immer auf dem Stuhl, tut nichts, wie der Kokon eines Schmetterlings; wie ein Geist, der aus dem Körper heraustritt. Der Geist fliegt, während der Körper zurückbleibt.«*" [268] Also the visitor gets involved emotionally in this private sphere of a "cyber-couple". According to S. Dinkla and Christoph Brockhaus (Ed.): "*Partizipation im Sinne von Eingreifen findet nicht statt, die Geschichte läuft unausweichlich vor seinen Augen ab, und dennoch empfindet der Betrachter eine starke Sogwirkung, wenn er in diese private Sphäre eintaucht*."[269]
Already in traditional art, the motif of butterfly has been used for representing the spirit as it is used in the work "Subject, emotions encoded" (1997) by Merel Mirage. But this motif hasn't been used before as a symbol for the communication between two people. The motif of butterfly hasn't been used before as a symbol for the emotional state, which emerges by a virtual communication. This is a reflection of the contemporary technique of communication – the net. Also the kind of the communication here, in which the participants don't know each other physically but spiritually they develop an ever closer relation, has been reflected in this work.

The work "Mariposa" (2001) by Zack Booth Simpson, which shows butterflies as the main motif of the installation, will be discussed in the following.
Zack Booth Simpson is a software engineer, artist, and molecular biology researcher, who lives in Austin (Texas). In 1993 he was the Director of Technology in the company Origin System (Electronic Arts). In 1998 he started creating interactive art using various forms of camera detection, invented by himself, including calibrated shadow detection and reverse infrared shadow detection. He collaborated with "Mine-Control" to create interactive, algorithmic artworks. The main aim of Simpson's artwork is to create entertaining pieces, which "*place people into environments where they have agency that is both challenging and magical*"[270].
In the work "Mariposa" by Zack Booth Simpson (realized together with "Mine-Control") from 2001 (Fig. 15), a scene with a swarm of butterflies has been projected on a wall in an installation space. The butterflies, which are fluttering randomly across the screen circles, seems as they are looking for something over the projection surface. The butterflies begin to land in the shoulder, or hands of the visitors, when the visitor's shadow appears over the surface, and stay still for some moments. This installation is realized so that the bodies of the visitors interact by blocking out the light of the projector (shadow tracking). By movement of the visitors, the butterflies fly away as if panicked. The interaction, which is here a reciprocal

---

system'. The World Wide Web is based on the hypertext transfer protocol (http) that allows one to access documents written in HTML (Hypertext Markup Language), a language that makes it possible to establish links between documents and arbitrary nodes."

[268] I. Schneider and P. M. Spangenberg, Internetkommunikation, Emotionalität und Neugier. Ein Interview mit der niederländischen Medienkünstlerin Merel Mirage, pp. 353-366, here p. 361, in: P. Gendolla, N. M. Schmitz, I. Schneider, and P. M. Spangenberg (ed.). Formen Interaktiver Medienkunst, Frankfurt/Main, 2001.

[269] Söke Dinkla and Christoph Brockhaus (Ed.), InterAct! Schlüsselwerke interaktiver Kunst, Hatje Cantz Verlag, Bonn, 1997, p. 104.

[270] Zack Booth Simpson, from http://www.mine-control.com/zack/index.html

Figure 15 Mariposa, 2001. © Zack Booth Simpson.

Figure 16 Butterfly, 1970. © Charles Csuri.

communication between a user and a programmed work, appears in the form of an interaction as an intimate or emotional communication between the users and virtual objects.
The interface, consisting of human shadows, involves the human in an impersonalized form as part of a virtual world. In this sense this work recalls the "back figures" represented by Caspar David Friedrich. His works are known for their admiration of monumentality of nature.

In interactive digital art, as in traditional art, animals are used as symbols or even just as entertaining motifs. To research this appearance within the category of interactive digital art the motif of butterfly has been used, which is a common motif in both kinds of art. In modern life, which is mostly is being lived within the walls of buildings, in offices or at home, the desire of the human to be in nature and with nature is increasing. The work "Mariposa" by Zack Booth Simpson offers to visitors, as in no other kind of art, to be entertained by the motif of the butterfly in such a close relation: in an exhibition room, a swarm of butterflies land on her or his shoulders, or hands, they fly away by her or his movements, they perch on visitors as if they have won its trust. The butterfly motif appears here as a symbol for nature.

Similar to the work of Zack Booth Simpson, Merel Mirage also used the motif of butterfly in her work, with the difference that she gave the butterfly a symbolic worth; while Simpson created primarily an entertaining work. The background for creating such different works through a similar motif is also based on the background and respective experiences of the artists: Simpson's mother was a children's playground designer and Simpson himself played video games in his childhood. This is reflected on his work. His work has an entertaining character.
For Merel Mirage online communication was a part of her life. Her work is based on her experiences during this communication. She was involved in this communication "without her body" and the butterfly, that is trying to free itself from the screen, is supposed to represent this emotional stage she experienced.

With the butterfly motif Mirage visualizes a stage of being captured, being trapped. Simpson used the butterfly as a symbol for nature, for good times, and studied the impressions that one feels coming into contact with nature and its beautiful creatures.
Historically, the representation of the butterfly motif has been understood as the representation of the psychic (Ancient Greek representation), or of the soul (in Maori culture), or of resurrection (Christian representation).[271] Here in "Subject, emotions encoded, Mock-up with Computermonitor**",** the butterfly has also a symbolic meaning (of the emotional state),

[271] See Lucia Impelluso *„Das griechische Wort Psychê bedeutet nicht nur Seele, sondern auch Schmetterling. Daher wird die junge, von Amor geliebte Psyche nicht selten mit Schmetterlingsflügeln dargestellt. Während im Altertum die »Schmetterlingsseele« als Vorbote des Todes galt, wurde der Falter im christlichen Kontext wegen seines Entwicklungsprozesses und insbesondere weil sich die Insektenlarve aus ihrem Kokon befreit, zum Sinnbild der Auferstehung und des Heils. [...] In barocken Stilleben nordeuropäischer Künstler, die prächtige Blumengebinde oder üppig gedeckte Tafeln zeigen, lassen sich nicht selten ein oder mehrere Schmetterlinge ausmachen. Damit soll der Kampf zwischen Gut und Böse veranschaulicht werden, wobei der Schmetterling als Sinnbild des Heils und der Auferstehung dem Bösen entgegengesetzt wird, das meist in Gestalt von Insekten wie Libellen oder Fliegen erscheint."*, in: Lucia Impelluso. Die Natur und ihre Symbole, Pflanzen, Tiere und Fabelwesen. Bildlexikon der Kunst, Bd. 7., Parthas Verlag, Berlin 2005, p. 330.

which is different compared to the traditional usage of it. So we can conclude that the usage of animals in interactive digital art can have a symbolic worth, but this differs from those known by traditional art. The symbolic worth of butterfly has been extended.

Charles Csuri is a professor emeritus, an artist and a pioneer in computer graphics. He has worked combining the fields of art and science since 1964. *"He experimented with computer graphics technology and in 1965 began creating computer animated films, winning the animation prize for his computer film Hummingbird at the 4th International Experimental Film Festival in Brussels in 1967. In 1968, Hummingbird was purchased by the Museum of Modern Art, NY, and now resides in their permanent collection."* [272] He was awarded at Ars Electronica in Linz for his works "Mask of Fear" (1990) and "Gossip" (1991).

"Butterfly" by Charles Csuri (Fig. 16) was presented in 1970 at Ohio State University, at the exhibition called "Interactive Sound and Visual Systems"[273], which was one of the first exhibitions that presented interactive installations. This work of Csuri's was realized in cooperation with the faculty and staff at the Department of Electrical Engineering, who were responsible for the several tactile kinesthetic types of devices. According to Csuri: "*It was an interactive system. The objects' movement axes of rotation were controlled using buttons and switches. A light pen device was used to generate a path."*[274]

Compared to the work of Csuri, which was done about three decades before, "Mariposa" by Simpson shows a quite sophisticated interface. It has an intuitive interface – the visitor is causing it with his or her shadow. In Csuri's work the butterflies are created in a simplified form (as lightening shapes in butterfly-like contours), while in the work of Simpson we can recognize different butterfly arts, done in different colors and shapes. The movements are more naturalistic in Simpson's work. We can conclude that the development of such artworks is strongly connected with the development of technology, with the possibilities that the later technologies offer for creating such artworks. The interactive media art of the 70s show a kind of abstraction of the representations not just because it was the intention of the artist, but also

---

See also J.C.Cooper: *„Da er [der Schmetterling] sich aus der irdischen Raupe über das Stadium der Auflösung in das himmlische geflügelte Geschöpf verwandelt, bedeutet er Wiedergeburt, Auferstehung. [...] Chin.: Unsterblichkeit; ein überreiches Maß an muße; Freude. [...] Christl.: Auferstehung; die Stadien seiner Entwicklung stehen für Leben, Tod und Auferstehung. Bisweilen in der Hand des Jesuskindes dargestellt. Griech.: Unsterblichkeit; die Seele; die Psyche in der griech. Kunst. Japan: Ein eitles Weib; eine Geisha; ein wankelmütiger Liebhaber. [...] Kelt.: Die Seele; Feuer. Maori: Die Seele."*, in: J.C.Cooper. Das große Lexikon traditioneller Symbole, Berlin 1986, pp. 244.

[272] http://arts.osu.edu/3news_events/a_news/news_summer_2006/csuri_siggraph.html

[273] See Charles Csuri's comment about the exhibition: *"... The second important feature of the exhibition is that the spectator will be permitted to participate in esthetic decision making. An effort has been made to create esthetic situations or environments, in which the spectator can become involved. This is expected to be accomplished through a controlled electronic environment, in which a user can make decisions by electronic means to invent or modify images or sound systems."*, in: Interactive Sound and Visual Systems, catalogue from the exhibition, Ohio State University, May 1970.

[274] http://www.siggraph.org/artdesign/profile/csuri/

because the technical possibilities were not mature enough. But on the other hand without such pioneering work (like Csuri's) the development of interactive digital art today is not imaginable.

4.4.3. Animal as Data Input or as Interactive Sculpture: the Motif of Bird

In interactive digital art different kinds of birds as motifs appear. They are used and represented in different forms and with different meanings. From history we know that birds are, for example, in mythology "*Glück beherrschende Erscheinungen*"[275]. They mean seldom something like "*...Unglück, oder stellen* [selten] *eine Bedeutung dar, wie dies bei den monströsen Harpyien oder den Stymphalischen Vögeln der Fall ist, großen menschenfressenden Raubvögeln mit ehernen Schnäbeln und Krallen, die Herakles in einer seiner Arbeiten vertrieb."*[276] In general they already embodied in antiquity, similar to butterflies *"die menschliche Seele, die im Augenblick des Todes aus dem Körper tritt und davonfliegt. Euripides beschrieb Vögel als »Götterboten«, und im alten Rom wurden Vorhersagen für die Zukunft aus ihrem Flug abgeleitet. Auch in der christlichen Kultur galt der Vogel als Sinnbild der Seele und er erscheint auf Darstellungen Marias mit dem Kinde, in denen das Christuskind einen Vogel in der Hand oder an einer Leine hält.*"[277] But they can also be symbols of the air.[278]

In some works of interactive digital art, the animal motif has been used for collecting data, which is then visualized. For example, the work "Doves" (1999, Fig. 17) by the German artist and Professor at Bauhaus University in Weimar (Germany) Ursula Damm, in particularly the planned installation "Überflug - Kunst am Bau Projekt für den Campus der BTU Cottbus", (1999) visualizes traces of birds. The main idea of this project is to install Dovecotes (a two-storied tower) in the garden of the Campus of the "Brandenburgischen Universität" in Cottbus. A virtual well was planned in the middle of Dovecotes, which would have a rectangular shape and would be made of bricks. The well, which would be about four meters deep in the earth, would contain a video of the sky instead of water. Installed cameras would track the flights of doves and the traces would be visualized live in the well. The idea of projecting animals in a well was used already 1992 by Toshio Iwai in the work "Well of Lights". In this work *"layers of moving images were generated by a combination of computers, strobing video projections, and spinning transparent disks. An extension of early nineteenth-century moving-image technology, this piece considered different ways objects can appear to be moving in space."*[279]

---

[275] Impelluso (2005), p. 288.

[276] Impelluso (2005), p. 288.

[277] See Impelluso (2005), p. 288: *„Einigen Auslegungen der Bibel zufolge symbolisiert der Vogel den Messias selbst und wenn er in einem Käfig oder an einer Leine in Erscheinung tritt, kann dies ein Hinweis auf Christus sein, der um der Erlösung der Menschheit willen gefangen genommen wurde. Aufgrund der entsprechenden Interpretation einer Stelle im Buch Jeremia kann der Vogel im Käfig aber auch Betrug bedeuten. Vögel erscheinen zuweilen auf Darstellungen der vier Elemente als Verkörperungen der Luft."*

[278] See Impelluso (2005), p. 288: *"Vögel erscheinen zuweilen auf Darstellungen der vier Elemente als Verkörperungen der Luft."*

[279] http://www.exploratorium.edu/about/air-projects.html

Figure 17 Doves, 1999. © Ursula Damm.

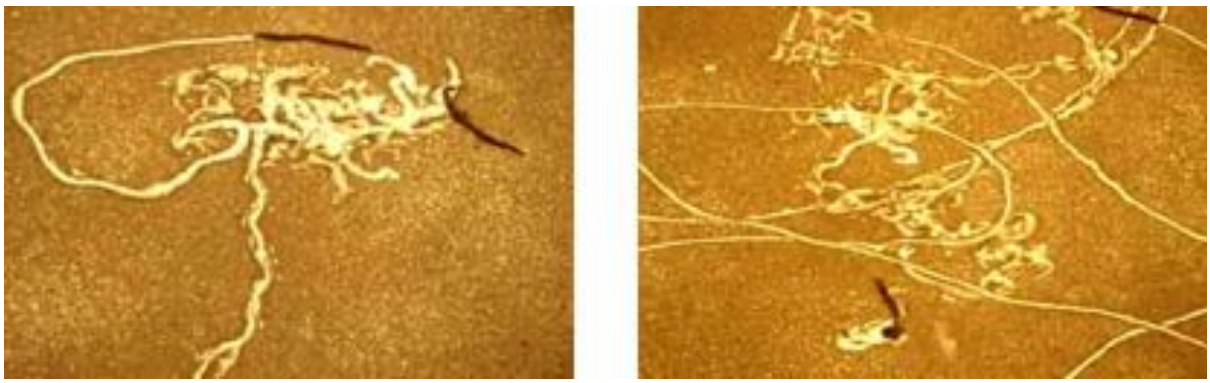

Figure 18 Worms in Sand, 2003. © Sinikka Johanne Olsen.

According to the concept of Damm's work, a specific software would fix the position of the doves and would visualize their flights with lines. A chaotic structure of lines would appear as a visual result of the tracked paths. The structure of the visual result is optically oppositional to the rectangular arranged architectural project of the well and its surrounding area.
The motif of bird, in particularly the motif of doves has been incorporated through the technology in architectural realization. According to Damm the structure of these "*Bewegungsbahnen soll ein modellhaftes Bild des Zusammenlebens der Tiere aufzeigen und bietet Gelegenheit, das menschliche Verhalten mit ihnen zu vergleichen."*[280] The interaction here, which is a permanent visualization of live data, is restricted as an external interaction. External data, data created by flying birds, are being visualized and lets various results emerge.

Doves as motifs in art show different usage and meanings: "*Im alten Griechenland war die Taube heiliges Tier der Aphrodite und wurden in ihren Heiligtümern gezüchtet. Bei den Römern hatte sie denselben Stellenwert, ihr Fleisch und ihre Eier wurden gegessen, da man ihnen eine aphrodisische Wirkung nachsagte. In der Renaissancemalerei kommt die Taube häufig als Attribut der Venus (Aphrodite) vor, die zusammen mit Mars (Ares) den Gegensatz zwischen Krieg und Frieden verdeutlicht.*"[281] The dove was, in the mythology of the Renaissance, the holy animal of Venus, "*weil ihre Paarung nicht auf eine bestimmte Zeit beschränkt sei und weil das Männchen das Weibchen zuvor küsse, wie dies auch Liebende täten. Vermutlich deshalb wandelte sich die Bedeutung der Taube und sie stand für Wollust und Unkeuschheit.*"[282] From art history we know also the meaning of the dove as a symbol for the Holy Ghost in the representations of the Birth of Jesus, the representations of the Annunciation of the Maria and other religious representations.[283]
Contemporarily, the meaning of the dove as a symbol of peace is widespread. In an interview with Damm, to my question, if she used the motif of doves with a religious purpose, as a symbol of freedom, or for other purposes, she answered: "*Tauben sind ja wegfinder, das war eigentlich das Hauptmotiv. Bis heute ist nicht ganz geklärt, woran sie sich orientieren, es gibt allenfalls Vermutungen. Religiöse Gründe gab es keine, schon eher habe ich die Taube als Symbol der Freiheit gesehen jenseits vorgeschriebener Pfade (das Uni-Gelände in Cottbus).* ‘‘[284]

Making traces with animals for artistic[285] reasons has been used also in contemporary art, for example in the work "Worms in Sand" (Fig. 18) of Sinikka Johanne Olsen, a performance

[280] Ursula Damm, from http://www.virtualart.at/common/viewWork.do?id=748

[281] Impelluso (2005), p. 323.

[282] Impelluso (2005), p. 323.

See also Impelluso (2005), p. 323: *„In der Heiligen Schrift überwiegen aber positive Bilder: Eine von Noah ausgeschickte Taube bringt einen Ölzweig zurück und zeigt damit das Ende der Sintflut an."*

[283] See Impelluso (2005), p. 323: *„Schließlich wurde die Taube als Symbol der Jungfrau Maria und erscheint gelegentlich in Szenen der unbefleckten Empfängnis."*

[284] Ursula Damm, interviewed via email by Penesta Dika on 10.02.2008.

[285] *"Some years ago, while I was out walking, I discovered some neat drawings on the road. There was sand on the asphalt and in the sand I saw lines that created a kind of pattern. I looked closer and found that it was traces from earthworms. I want to show the small, nearly invisible occurrence, earthworms making traces. An occurrence a lot of people have discovered, but maybe not looked at too carefully."* from http://www.o-art.org/history/80s&90s/Exploratorium/ExplArt.html

(installation) made in the year 2003[286]. On a low platform with the dimensions 3x3meters, which is covered with sand[287], were placed fat and healthy earthworms. The activity of the earthworms was filmed with a video camera, which was placed above the platform. The film was streamed during three days of an exhibition in Shanghai (Students Digital Art) in 2003, as a large scale projection. The patterns made by the crawling of the earthworms developed an image, which was projected each time in the exhibition. Every time the starting position of the earthworms was a different one and also their traces in a new layer of sand.

Compare to the work of Damm, we see here a similar idea, in which the end result is based on traces made by animals. The difference is that Olsen projects the result of worms' activity unchanged, the sand trails have been presented as they were, while Damm uses specific software to visualize the traces made by the doves. The color of the visualized traces is chosen by the artist. The interactivity in the works of Damm and Olsen is present as an activity of the doves, or worms. In both works a camera is used for the interface. The artistic value of Damm's work is different compared to the work of Olsen. The doves themselves are not the main protagonists, but their flight, movements and orientation. The structures that their flight paths create are an important issue of this work. The activity of the doves has been shown in its complexity: the added visualizations underline this. The doves themselves and their flight have been contextualized with the traces of their movement. Thus, they build colored shapes over the surface as background motifs. Also the structure of the flight of the birds is brought into a relationship with the structure of the architecture of the campus of the University in Cottbus. Doves as pathfinders can be understood, in the context of contemporary society, as a reflection of the fact that everyone has to find their individual way in life, and this way is closely linked to the rest of the society in which we live. Do we go with the trend or against it, and can we find our own way although the traces are blurred – these are also questions that Damm's work reflects.
In interactive digital art the motif of bird has changed the function: the birds have been used as data for creating artworks. Not the birds themselves, but the paths, which they make by flying are visualized. The meaning that we know from historic examples as symbols of air or as a symbol for the Holy Ghost doesn't appear within interactive digital art. From traditional art, the previously known meaning of freedom has also been kept here, insofar as the doves can move freely, passing the boundaries of university's territory. The desire of the human to be with and in nature which has been mentioned already above about the representation of the butterflies, has been reflected also in this work. Damm tries even to incorporate nature through the motif of the dove in an architectural concept. This project which was planned to be realized within a university had the idea to bring humans and animals together on the same territory.

Where Damm used doves, other interactive digital art use the motif of different birds, for example in "Rara Avis" (1996), by Eduardo Kac, which has as main motif a tropical macaw. Eduardo Kac, an artist who lives and works in Chicago, is known for his interactive net

[286] *"For the first time the piece was exhibited [2002] in a factory named Mantena, where railway carriages are repaired. The audience was the workers in this factory. The second version of the piece was built up at Atelier Nord, a center for new media art in Oslo, Norway."*, from http://www.o-art.org/history/80s&90s/Exploratorium/ExplArt.html

[287] A frame filled with soil was placed around the plate, so that the worms reached the edge of the platform and failed into the soil.

Figure 19 Rara Avis, 1996. © Eduardo Kac.

installations and for his artworks based on bio art. As a pioneer of telecommunications art, hedeveloped 90s installations using telepresence and biotelematics. Further net art and robotic art are combined in his oeuvre[288]. One of these combinations we find in his work "Rara Avis" (Fig. 19). This artwork consists of a large cage, in which thirty real birds (zebra finches) and a telerobot, which looks like a rare bird, are placed. In the macaw's eyes two cameras with Charge-Coupled Devices (CCD) [289] are installed.
These allow the visitors of the aviary, through a data helmet, to experience the environment from a bird's eye perspective. According to Kac "*Since the macaw's eyes were on the front of the head, as is the case of an owl, the telerobot was called a Macowl."*[290] Moving their heads, while wearing the data helmet, the visitors trigger a simultaneously moving of the head of the macaw. The visitors, which are in front of the cage, are being transported inside the cage, viewing through the data helmet including the observation of themselves outside of the cage. The participants, who are present in front of the installation, can see from the telerobot's eye perspective, but also the participants who are online[291] can have the same view.[292] According to Kac "*Network technology and local ecology mutually affected one another. I expected that the small birds would be frightened with the big colorful robot. However, in fact they became so comfortable with it that they excreted all over it throughout the exhibition. This unique combination of organic waste and clean electronics furthered a sense of integration between carbon and silicon. The body of the telerobotic Macowl was shared in real time by local participants and Internet participants worldwide."*[293] Interaction here in the form of an intimate communication (the human can see through the bird's eye) offering among other things an intimate relation between participants and the motif of the bird (online and offline).

Ursula Damm's work "Doves" and Eduardo Kac's work "Rara Avis" show birds as main motif of the installations. The kind of birds (dove and macaw), their representation's form, their meaning and overall impression are different. In Kac's work the idea to view the

---

[288] *"His work deals with issues that range from the mythopoetics of online experience (Uirapuru) to the cultural impact of biotechnology (Genesis); from the changing condition of memory in the digital age (Time Capsule) to distributed collective agency (Teleporting an Unknown State); from the problematic notion of the ‹exotic› (Rara Avis) to the creation of life and evolution (GFP Bunny)"*, from: http://www.medienkunstnetz.de/artist/eduardo-kac/biography/

[289] *"A CCD is an electronic memory that can be charged by light. CCDs can hold a charge corresponding to variable shades of light, which makes them useful as imaging devices for cameras, scanners, and fax machines."*, from http://inventors.about.com/od/cstartinventions/a/CCD.htm, 08.02.2008, 15:11.

[290] http://www.ekac.org/raraavis.html

[291] See Eduardo Kac: *"Through the Internet remote participants also used their microphones to trigger the vocal apparatus of the telerobotic macaw heard in the gallery."*, from http://www.ekac.org/raraavis.html

[292] See Eduardo Kac, "Ornitorrinco and Rara Avis. Telepresence Art on the Internet", Leonardo, Bd. 29, Nr. 5, pp. 393—394: *"This piece created a self-organizing system of mutual dependence, in which local participants, animals, a telerobot, and remote participants interacted without direct guidance, control, or external intervention."* from http://www.ekac.org/ornitrara.html

[293] Eduardo Kac, *"Dialogical Telepresence and Net Ecology"*, pp. 180 – 196, in: Goldberg, Ken (Ed.), The Robot in the Garden, Telerobotics and Telepistemology in the Age of the Internet, MIT Press, Cambridge, 2000, p. 187.

surroundings through the bird's eyes is important, while Damm is more interested in the reflection and the visualization of the traces of the birds. The motif of bird has been used in different ways within this kind of art. Using real living birds (doves) in interactive digital art as data for creating the artwork is oppositional to the bird (macaw) in a non-living form (as a sculpture). Kac uses also thirty real birds (zebra finches), but they aren't the main motif of the work as the macaw is. The bird as motif in Kac's work has been used as an object for communication. Damm uses the motif of bird for making traces, analyzing their structures, and bringing them into relation with the architecture. Kac used the motif of the bird so that he offered a new perspective for the visitors: the visitors by moving their heads can move the head of the bird. They can see through its eyes, they can take their desired direction of view. Such elements are new experiences for the visitors, especially in combination with the element of the live interaction online and in the displayed environment. The boundaries between inside and outside the aviary are deleted. Since the visitors can interact with this work online the boundaries between the exhibition space and the space outside of it are also deleted. Damm used the motif of the bird as a kind of tool for her artwork, but also with its symbolic meaning of freedom. Also Kac's macaw-bird represented together with thirty zebra finches acquires a symbolic character; it is the representative of its exotic origin.
Kac explains his aim as follows: "*The piece can be seen as a critique of the problematic notion of "exoticism", a concept that reveals more about relativity of contexts and the limited awareness of the observer than about the cultural status of the object of observation. This image of "the different", "the other", embodied by the telerobotic Macowl, was dramatized by the fact that the participant temporarily adopted the point of view of the rare bird."*[294]

The motif of a bird in a cage – once used as a symbol for Jesus, captive for his deliverance for humankind – is now used for deleting the boundaries between the cage and outside of it. Further, in combination with the other birds (finches) it is used to show how it is to be "different". This can be interpreted, among other things, as a reflection of the fact that some people because of many reasons live in a foreign society, a foreign country with a foreign culture. They have their own lives separate from the society in which they live, although the host society is very present in that space. The artist is inviting us to feel the loneliness of those people, to see the world through their eyes. On the other hand, this work reflects the fact that through technology, it is possible to be linked everywhere in the world and let everybody feel and see like somebody else does.

Birds are represented in different forms and with different purposes in traditional art, or in media art globally. To experience the environment from bird's eye perspective is a possibility that has been offered only in interactive digital art. Only this kind of art installs for the visitors pieces by which the visitors can create an experience as never before. The visitors can, from a distance, trigger and manage the moving of the head of the bird (macaw) to take the desired view within a cage. In a time where the net and the possibilities to communicate online are influencing the creation of contemporary culture and social relations, the influence of this can be seen also in art. Especially in interactive digital art, where the net has been incorporated as a component part of it, this influence has been reflected. The representation of the telematic bird as an isolated bird equipped with techniques for distance communication reflects the contemporary human who is isolated by the techniques he uses. The human, in the technique he uses (while communicating with others in chat rooms) is an unknown or "exotic" person.

[294] http://www.ekac.org/raraavis.html

4.4.4. Aquatic Creatures imitating the Rules of Life, or Fish as Relaxing Native Motif

In interactive digital art we find not only flying animals like birds, or butterflies, we also find aquatic animals. They appear designed as fantastic creatures, but also as realistically designed animals, like for example fishes. We have mentioned already the work "Well of Lights" (1992) by Toshio Iwai, which shows aquatic creatures projected on a well (see above), or animated fishes, designed by Demetri Terzopoulos. He developed in the early 1990's *"a bio-mechanical software model of a fish, an autonomous agent with a realistic, animated body and a "brain", which coordinated the perceptions of the artificial creature and controlled, in fact optimised, its swimming movements.*"[295]
The work "Uirapuru" (1999) by Eduardo Kac is an interactive work, which represents a telerobotic fish. Following the legend of Uirapuru, a kind of Amazonian bird or a mythical creature, was represented by Kac in the form of a flying fish. The flying fish can interact live with participants in the exhibition space or online (by an avatar) and it can sing.
Planktons appear in ten different designs as tools for making music in the work "Electroplankton" (2006) by the Japanese artist Toshio Iwai. These planktons offer ten different music composition tools, accompanied with appropriate visual results, which are characterized by their translucence.

In the following two interactive digital artworks are examined more closely as examples for the representation of water-animals. The work "A-Volve" by Christa Sommerer and Laurent Mignonneau has been taken into consideration as a work that shows abstract creatures living in water. The work "PingPongPlus" (2001) by Hiroshi Ishii has been taken into consideration as an example for representing water animals visually based on real animals. A kind of abstract fish is represented.

The work "A-Volve", 1994-1997, Fig. 20, by Christa Sommerer and Laurent Mignonneau (developed in collaboration with scientist Thomas S. Ray), represents creatures that live in water, and is an interactive digital installation, which consists of a glass pool (filled with water), a touch screen and a projector. The visitors can create 2D shapes with their finger on a touch screen that are converted into 3D creatures[296] and "live" in the real pool. Visitors can interact with these creatures, in which principles of artificial life (rules of the biological evolution) are implemented. The creatures move due to their shapes, which is important for their survival in the pool. The creatures that survive longer can mate and reproduce. According to Sommerer and Mignonneau "*If two strong creatures meet, they can create an offspring and a new creature can be born. It carries the genetic code of its parents.*"[297]
The interaction is not only based on the level that the visitors create artificial animals, but also on that level that the visitor can interact with the created animals; he or she can even protect them from other creatures in the pool by covering them with his or her hand. Another interaction level is present between the creatures themselves. Of course the visitors also interact indirectly (through their creatures) similar to the work "Bar Code Hotel" by Perry Hoberman (1994). Here the visitors interact indirectly with each other through the elements

[295] Mamta B. Herland, Appendix: Internet, World Wide Web and Art: a non-traditional story, from: http://www.mamtaart.com/articles/docs/Appendix.pdf

[296] Values for colors and textures are decided by the speed of drawing of the visitor.

[297] See Sommerer and Mignonneau (1998), p. 153.

that they scan, which are then transported into a virtual life. The difference to the work of Sommerer and Mignonneau is, among other things, that Hoberman didn't implement the rules of the biological evolution, but the life of the scanned elements look like a virtual life; everyday objects, which represent the visitors, and are the main protagonists of the work. The same could be said for the work "A-Volve", where the created creatures are representative of the visitors to the work.[298]

In interactive digital art, different to other art-forms, aquatic creatures are represented based on the real rules of life, based on the evolving of animals, as shown within the work "A-Volve" (1994). For the first time in history the visitors create and design water animals due to their aesthetic requirements, or their graphic ability. And not just this, the visitors can even communicate with their creatures, they can protect them, they can give them virtual life by drawing them and they can take their virtual life away by leaving the pool. A-Life theories have been an issue in different spaces of our lives since the 80s. This has been reflected into the concept of this work. But, to do something like nature does is an idea that is present in many aspects. For instance, in architecture, for many centuries, has been based on animal constructions, shapes and other specifics. Contemporarily, human life is being created in laboratories (think of the In-vitro Fertilization which has been used since the 70's). This is being reflected also in art: life is being created in exhibition rooms.

Another example of interactive artworks, which shows aquatic animals, specifically kinds of fish, is the work "PingPongPlus" (2001, Fig. 21) of Hiroshi Ishii[299].
Hiroshi Ishii is a Japanese professor at the Massachusetts Institute of Technology, who is well known for his research on the design of tangible interfaces (physical interfaces), which is contrary to GUIs. He joined the MIT Media Laboratory in 1995, and founded the Tangible Media Group *"to pursue a new vision of Human Computer Interaction (HCI): "Tangible Bits"*[300]. Its vision was presented at a variety of academic, industrial design, and media art venues including ACM SIGGRAPH, Industrial Design Society of America and Ars Electronica in Linz (Austria). From 2001-2003 ten projects from the Tangible Media Group were featured at Ars Electronica Center in Linz (Austria); among them also the work "PingPongPlus" (Get in Touch Exhibition at Ars Electronica Center).
The work "PingPongPlus" shows animated fishes and water on a ping pong table, which are activated each time the ping-pong-ball bounces off the table so that first digital ripples spread out (simulating water) and then fish scatter. On the bottom of the ping-pong table eight microphones are mounted and *"detect the sound waves emitted when balls bounce off the table surface*." [301] The fish are built as two-dimensional shapes. The sport of ping-pong, the ping-pong-ball and the ping-pong-table have been considered as input for creating an interactive digital artwork.

---

[298] See Goodman, p. 167, in Wenzel and Wirths (1998): *„Die Besucher drängen sich um dieses Becken, um die Aktivitäten und das Schicksal einer Population virtueller Wasserlebewesen mitzuerleben, die sich nach ihren eigenen Vorgaben entworfen haben."*

[299] This work was made in collaboration with Jay Lee, Blair Dunn, Rujira Hongladaromp, Craig Wisneski, Julian Orbanes and Ben Chun.

[300] http://web.media.mit.edu/~ishii/bio.html

[301] http://www.aec.at/en/archives/center_projekt_ausgabe.asp?iProjectID=11031

Figure 20 A-Volve, 1994. © Christa Sommerer and Laurent Migonneau.

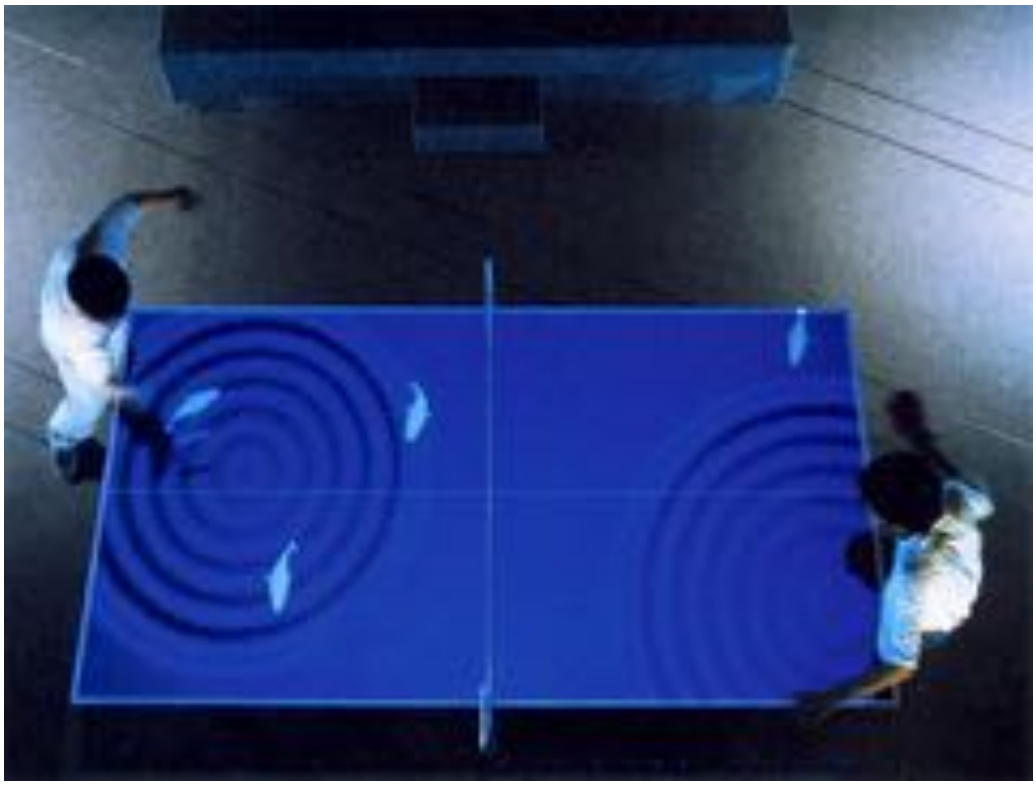

Figure 21 PingPongPlus, 2001. © Hiroshi Ishii.

Historically representations of fishes show that the motif of the fish is a part of the religious symbolic, for example, it appears as symbol for Jesus[302]. To my question to what purpose Ishii used the motif of fishes in this work, he answered that he likes a Japanese garden where carps are swimming.[303] Due to this we could link the usage of the fish in this work also to the Japanese culture, in particularly Japanese language, in which the word "love" sounds similar to the word "carp" [304].
Aquatic creatures are represented also based on real water animals due to their visual aspects, as in the work "PingPongPlus" (2001) by Hiroshi Ishii. Here the hit of a ping pong ball causes the scatter of fishes in the water – an analogy which hasn't been considered before in historic examples of art. The game results are affected by the visual aspect, in particularly by animal representations. Representing fish in a culture of an island is no wonder, especially in the Japanese culture. The meaning of the fish here is not a symbolic one. The represented swimming of the fishes in water in combination with the Ping Pong game reflects the idea to "play" like the animals do, in particularly like fishes do. Also here, the idea "do like nature does" is present.

The work "PingPongPlus" shows aquatic animals (fish) on a water surface and this is similar to the work of Sommerer and Mignonneau (A-Volve). But, the visual aspects in these works are completely different: Sommerer and Mignonneau let the visitors create water animals due to their aesthetic requirements, or their graphic ability, while in "PingPongPlus" the animals are already created by the artists. They are being projected as animations visualizing the interaction of the ball over the ping-pong table.
In both works the creatures are projected from above, but in the work of Sommerer and Mignonneau the feeling that the world of animals is a real one, is more present. The pool consists of real water and the visitors are invited to touch it with their hands. The fantastic water animals are contrary to the fishes in the work "PingPongPlus", which are modeled on real fish, but simplifying real fish into two-dimensional shapes. Digital results are based more on a kind of research, whose theme is "*to learn by experience how the digital layer projected on top of the ping-pong table affects the competitive interaction of the game of ping-pong*"[305]. The fishes are visualizing the interaction of the players/visitors. The entertainment effect is also present. The game results are affected by the visual aspect, in particular by animal representations. In the work of Sommerer and Mignonneau the aesthetic aspect is a sophisticated, carefully analyzed parameter – for example, the color and texture of a creature is defined due to the speed of the drawing of the visitor. Also here is the scientific purpose present: Sommerer and Mignonneau researched and implemented the rules of the evolution within this work. In the work of Sommerer and Mignonneau we can have as a visual result abstract shapes with the behavior of real animals and in the work of Hiroshi Ishii, we have as a visual result abstracted animals (fish).
In Ishii's work the players play ping-pong "over" a Japanese pond with fishes. The concentration that the players need is relaxed by the element of the pond, water and fishes. A

[302] See Impelluso (2005), p. 344: *"Die Buchstaben des griechischen Namens für Fisch, ichthýs, wurden al seine Abkürzung für die Formel Iesoũs Christós Theoũ Hyiós sotēr, angesehen, zu Deutsch: Jesus, Christus, Gottessohn, Heiland."*

[303] Hiroshi Ishii interviewed vie email by Penesta Dika on 11.02.2008.

[304] See Cooper (1986), p. 81.

[305] http://www.aec.at/en/archives/center_projekt_ausgabe.asp?iProjectID=11031

beautiful and relaxed play is the aim. The native and feeling at home-are being pointed out through this work.
In Sommerer and Mignonneau's work, the implementation of the rules of evolution, and the fact that the visitors are responsible for the shape and life of the creatures, Sommerer and Mignonneau produce a kind of warning that humans have to take care of what they are creating and what they do in the world. Every thing and every decision that humans make can have unpleasant consequences, if it has not been thought about sufficiently. Particularly, through this work the artists draw attention to genetic manipulations, clones and other scientific research in the field of reproduction that have to be researched more closely. Thought has to be given to the consequences that those methods could bring to the world.

4.4.5. Virtual Pets send E-mails or play live Games with Visitors

Animals as motifs appear in interactive digital art also as motifs that recall our childhoods. Animals that look like those known from children cartoons, colored with fluorescent, unreal colors or animals that behave themselves like those in cartoons are present in this kind of art. Those motifs are based actually on pet animals, which are family members of many families. Animations like these known from children cartoons are used also in the game industry and even for creating artworks. The behavior of pets as lovely creatures has been kept, but often the color is not based on the real colors of such animals.
In interactive digital art, representations of strikingly colored animals appear, for example, as a result of genetic manipulations, as in the work GFP (green fluorescent protein) "Bunny" (2000) of Eduardo Kac. According to Kac, the transgenic artwork "GFP Bunny" *"comprises the creation of a green fluorescent rabbit, the public dialogue generated by the project, and the social integration of the rabbit.* […] *Transgenic art, I proposed elsewhere* […]*, is a new art form based on the use of genetic engineering to transfer natural or synthetic genes to an organism, to create unique living beings.*[306] This work became indirectly (by the genetic manipulation via the artist) an interactive work.
In the following are depicted two interactive artworks as examples for the representation of the pets in interactive digital art.

The Japanese artist Kazuhiko Hachiya, in collaboration with Namie Manabe and Takashi Kohki, in his work "Post Pet", Fig. 22, created a virtual pet, an agent, or avatar[307] for delivering emails from the user. This work, which is an email software distributed by Sony Computer, was developed from 1997-2006. Within this book an earlier example has been shown that won the Prix in Ars Electronica in 1998.
The pet, which is animated like a teddy bear, rabbit, turtle, or kitty,[308] has its own life. It does its work sometimes according toits own will. According to Machiko Kusahara "*It* [the pet] *might not be available when the user needs it, while it might start writing and delivering email on its own. After they disappear from the screen as pets live shorter life, they enjoy after-life in their paradise where the former owners can visit."* [309] Hachiya made the sending of emails through the usage of a pet, more user-friendly and playful. According to the artist: "*The pets carry E-mails to be happy and grow gradually more clever. In addition, the pets also write E-mails to send to the users (the pet keepers). Pets not only send E-mails to their own pet keepers, but also to their own user's friends, as they become aware of these other people."*[310]

[306] Eduardo Kac, from http://www.medienkunstnetz.de/works/gfp-bunny/

[307] Avatar is a notion, which is used to represent a virtual identity for a user of an online activity.

[308] See the newer versions of animals, in: http://www.petworks.co.jp/~hachiya/works/PostPet.html

[309] Machiko Kusahara, *„Creating Cultural Correctness: Abstract Japanese Tradition in Digital Art"*, from http://www.f.waseda.jp/kusahara/LA99abstract.html

[310] K. Hachiya from http://www.aec.at/en/archives/prix_archive/prix_projekt.asp?iProjectID=2537

Figure 22 Post Pet, 1997 - 2006. © Kazuhiko Hachiya.

As motifs in his work Hachiya used animals like rabbit, turtle, or kitty and a teddy bear. In traditional art the rabbit has been represented as a moon animal. In China, for instance, "*fertigte man weiße Kanninchen als Figuren für das Mondfest an.*"[311] Further, according to Cooper "*Das Kanninchen bzw. der Hase ist der Schelm der Indianer der östlichen Wälder Amerikas. Es symbolisiert zudem Zeugungskraft und sinnliche Begierde; werden jedoch bei rituellen Gelegenheiten Kaninchenfelle getragen, so bedeutet das Fügsamkeit und Demut vor dem Großen Geist.*"[312] To my question as to why Hachiya chose a rabbit and are there religious, mythological, or other reasons for choosing it, he answered that: "*at that time I would like to have a rabbit as a pet, so I added it*"[313]. So it is for the love of this pet that the

[311] See Cooper (1986), p. 128.

[312] See Cooper (1986), p. 128.

[313] Kazuhiko Hachiya, interviewed on 15.08.08 per E-mail by Penesta Dika.

artist chose it for usage. The artist created a virtual life of a virtual pet that he wished for in real life.
The turtle in traditional art was used as a symbol for the moon, time, immortality, fertility, or regeneration. For example, in the Greek and Roman art it symbolized "*Das weibliche Prinzip, die Fruchtbarkeit der Wasser*". But it was also a attribute of Aphrodite/Venus, "*die dem Meer entstieg*" and of Hermes/Merkur, "*der aus einem Schildkrötenpanzer eine Lyra herstellte*".[314] In Japanese culture the turtle "*trägt die Wohnstatt der Unsterblichen und den Kosmischen Berg. Langlebigkeit; Glück; Stütze und Halt. Kennzeichen von Kumpira, dem Gott der Seefahrer, und ein Attribut der Göttin Benten.*"[315] The cat in traditional art has been used on the one hand to symbolize positive aspects. For instance, the cat in the Greek and Roman culture was an "*Attribut der Mondgöttin Diana. Die Göttin der Freiheit hat eine Katze zu ihren Füßen.*"[316] In Japan the cat symbolizes "*Kräfte der Transformation; friedliche Ruhe.*"[317] On the other hand the cat is a symbol for negative characteristics, such as for instance in Christian art it is a symbol of "*Satan; Finsternis; sinnliche Begierde; Faulheit.*"[318] To my question why these motifs have been used in this work as main characters, Hachiya answered that turtle and kitty were the pets of Ms. Manabe, who was the art director and graphic designer of PostPet.[319] For Hachiya was important to know well the characters of the used pets, because their behavior would be more realistically represented. "*I thought we could not make good characters nor make their motion cute without knowing them well"*[320] – said Hachiya.
The usage of the teddy bear was actually the first idea for this artwork: Hachiya had a dream that a teddy bear was sending an E-mail for him. So according to Hachiya the teddy bear was "*the first and must-be character*"[321]. He chose specific colors for the used characters because "*the size of the characters in the application was not big*" and it was important *"to be recognized very easily from their colors*".[322] Using animals such as rabbit, turtle, or kitty in combination with a teddy bear gives the impression that animals were used as kind of children's toys. The interactivity between the animals and the users changes the overall impression of those animals compared to traditional representations. The interface used reflects contemporary net-based society and contributes to the changed impression of these motifs. The fact that the pets can be visited by the owner in paradise after their death is something that every pet-keeper would wish. This work reflects the wishes of contemporary society and these are realized virtually. How would it be if our pets could live virtually after death, has been realized as an artwork.
Pet animals represented in unreal, striking colors, a fact that is already known from other kinds of art, as for example from children's cartoons, appear here as main motifs of the work. Differently to other kinds of art, in interactive digital art, virtual pets can carry posts by users and deliver it for them. With the motif of animals, the help that humans get from animals has

[314] See Cooper (1986), p. 233.
[315] See Cooper (1986), p. 234.
[316] See Cooper (1986), p. 131.
[317] See Cooper (1986), p. 131.
[318] See Cooper (1986), p. 131.
[319] Kazuhiko Hachiya, interviewed on 15.08.08 per E-mail by Penesta Dika.
[320] Kazuhiko Hachiya, interviewed on 15.08.08 per E-mail by Penesta Dika.
[321] Kazuhiko Hachiya, interviewed on 15.08.08 per E-mail by Penesta Dika.
[322] Kazuhiko Hachiya, interviewed on 15.08.08 via e-mail by Penesta Dika.

been treated as a theme. Furthermore, in the fact that the animals here deliver post for their users, reflects the trust that humans have in their animals/pets.

Not only in Japanese interactive digital art, but also in other cultures, artists use animations for their works, which aesthetically recalls animals known from children's cartoons. For example, the work "Alive" (1993) by Pattie Maes (in collaboration with Trevor Darrell, Bruce Blumberg and Sandy Pentland) is one of these works.

Pattie Maes, who founded and directs the Autonomous Agents Group, is an Associate Professor at MIT's Media Laboratory. She is the associate head of the Program in Media Arts and Sciences. She founded and directs the Media Lab's Fluid Interfaces research group. She is one of the pioneers for researching so-called software agents, which are semi-intelligent computer programs that assist a user with the overload of information.
The work "ALIVE" of 1993 is an attempt to build an autonomous agent that interacts with visitors. The version of ALIVE presented at the AAAI '94 Art Show was Bruce Blumberg's PhD project under the direction of Pattie Maes. It represents a three-dimensional animated dog, with which the user/visitor can interact in real time. ALIVE is a system, which allows an unencumbered interaction (without wires) between the visitor and an autonomous agent. In this version the virtual dog is called Silas. Silas' internal motivational state in combination with the gestures of the user decides his behavior. The visitor can see also if his "desire to play" is high, or his "level of fear" is low, so that he or she can decide on an action. For example, the visitor can throw him a virtual ball and the dog will chase after it and bring it back to the user/visitor.
Interacting through natural hand and arm gestures is a kind of interaction, which we already know in art since the work "VIDEOPLACE" (1972) by Myron Krueger was created. Also the work "Very nervous System" (1986) by David Rokeby used this kind of interaction. According to Pattie Maes the goal of the 'ALIVE' system was *"to provide a very different kind of experience. Inspired by the work of pioneer Myron Krueger, we* [Maes and collaborators] *wanted a participant to be able to interact with a virtual environment in a much more natural, unencumbered way, using familiar gestures that do not require any obtrusive equipment. In addition, we wanted the user to be able to do more than just navigate through the environment or manipulate simple objects. We wanted to demonstrate that in order for a virtual environment to be very engaging, it might not be so important how fancy and fast the graphics are, but rather how meaningful and interesting the interactions can be*."[323]
The motif of the dog is already an often-used motif in traditional artforms. It appears mostly as a symbol of faithfulness.[324] But also as symbol of the hunting gods (in the mythological representations), or representing robbers and thieves (as in its representation in the art of the Orient). According to Impelluso "*In der Regel sind mit dem Hund jedoch positive, meist mit dem Begriff der Treue verbundene Vorstellungen verknüpft. Das zeigen beispielsweise mittelalterliche Grabsteine mit Hundeabbildungen. In der religiösen Ikonographie erscheint der Hund als treuer Begleiter von Tobias auf der Wanderung mit dem Erzengel Rafael, aber*

[323] Pattie Maes, from http://www.siggraph.org/s95/S95_V1/COMUNITY/ALIVE/ALIVE.HTL

[324] See Lucia Impelluso *„Mit dem Hund verbindet man teils widersprüchliche Vorstellungen, vor allem aber Treue. Schon Plinius d. Ä. erwähnt, dass der Hund neben dem Pferd der treueste Gefährte des Menschen ist"*, in: Lucia Impelluso. Die Natur und ihre Symbole, Pflanzen, Tiere und Fabelwesen. Bildlexikon der Kunst, Bd. 7., Parthas Verlag, Berlin 2005, p. 203.

auch auf Darstellungen der Geburt Jesu, der Anbetung der Hirten bzw. der Könige." But the representation of a dog can have also a negative meaning, such as in the *"... Darstellungen des Abendmahls, wenn er zu Füßen Judas liegt oder mit einer Katze kämpft. Dann speilt er auf Zwist und Feindschaft an, so auch auf Bildern, die das Mahl in Emmaus thematisieren."*[325] In combination with the motif of portrait, the dog is mostly represented as a "*treuer Gefährte des Menschen*", while the dog over a lap of a woman is a symbol of "*ehelichen Treue*".[326]
In the work of Pattie Maes and Bruce Blumberg, the dog Silas appears as playful creature that follows the instructions of the human. Compared to the traditional forms of representation, its meaning would fit more in the "*treuer Gefährte des Menschen*". But, the play between the dog and the visitor, which in this kind of art can even be realized live extends the meaning of the dog to that of a symbol for play, as a symbol for "good times", and even for the perfectly matched communication between people and animals. In contrast to traditional art, virtual pets play games with visitors, being represented life-sized in an exhibition room. The play between the dog as "man's best friend", and the human is represented within this kind of art.

The work "Post Pet" by Kazuhiko Hachiya and the work "Alive" by Pattie Maes shows that animal motifs in interactive digital art appear as virtual pets. They act as agents, or as avatars. They can optically look like animals that recall children's cartoons (three dimensional, colorful animations)[327], or their behavior can be similar to children's cartoon actors. Those animal representations, which derive from pet-animals, are used as such in this kind of art. Both works show that these animated animals are built of simple three dimensional, voluminous, strikingly colored shapes, which are similar to colorful children's toys. The different type of interaction changes the main idea of these works, in particular changes the role of animals in these works. "Post Pet" was created as a helping tool for using software, while "ALIVE" was created as research for its kind of interaction. The interactivity in "ALIVE" transforms the character of the represented motif (the dog Silas) from a cute static animal to a playfully dynamic one. The interface, consisting of gestures and movements, makes the interactivity comparable with real life communication between humans and dogs. The incorporation of voice/language, which is also an important parameter in real life communication, could be mentioned as a difference here. In the work "Post Pet" the interactivity between human and animal differs totally from the interactivity in real life. The interaction in this work occurs on the one hand as a reaction caused by an E-mail, which has to be sent. On the other hand it is present in form of communication by a written message, which is being sent to the pet's keeper and his friends. Using an E-mail message as an interface is a kind of reflection of contemporary communication's form. Not spoken language or gestures cause the interaction, but written texts. This can be seen as an indication of the contemporary society, which is influenced and characterized by online communication. In the work of Hachiya the communication's form used contemporarily as a normal communication form between humans has been used as a reactor for activating the activity of virtual pets. This communication's form has been used also for making the animal express himself to its keeper (the animal is writing messages to him or her). As a result we have a virtual realization of an interesting question in real life: what does your pet have to say to you? The communication with it also after its death is a reflection of contemporary humans that are

[325] See Impelluso (2005), p. 203.

[326] See Impelluso (2005), p. 203.

[327] Japanese culture is influented by figures that are known from cartoons. A known form of it – Manga is distributed also outside of Japan.

worried about the fact that their animals one day will be gone... Hachiya wanted to change this, at least virtually. He wanted to give the pleasure to users that they can still contact their pets – even after their death.

Specific chapters within this book about the representations of plants or animals in interactive digital art, such as Evolutionary Designed Biological Motifs, Animals as a Symbol or as an Entertaining-Motif (the motif of Butterfly), Animal as Data Input or as Interactive Sculpture (the Motif of Bird), Aquatic Creatures imitating the Rules of Life, or Fishes as Relaxing Native Motif, Virtual pets send E-mails or play live Games with Visitors, presented the characteristic points of such motif representations.

4.5. Places, or Architecture as Motifs: Historical Overview

Places are motifs that artists often represent as background motifs. For example, artists represent them based upon a story, which takes into consideration the representation of a specific place. But artists represent places also based upon their own experiences of specific places. According to Robertson and McDaniel: "*Where you hail from and where you now reside are two of the most significant facts about anyone. Certainly an artist's geographic history affects the appearance and meaning of his or her art. The place or places where one has lived, with their attendant physical, historical, and cultural attributes, condition what one knows and how one sees. But beyond this, a conscious awareness of place informs the work of a wide range of contemporary artists.*"[328] Also places of fantasies or of illusions have been represented by artists. Robertson and McDaniel describe this as follows: "*Many contemporary artists who make art that fits the theme of place are responding to specific scenes in front of them or are trying to capture the appearance or feeling of places they remember. More abstractly, some artists are grappling with ideas of place in a conceptual way. For example, they might symbolize or represent what it means to come from a certain geographic location (such as Nigeria or China or a large city or a rural hamlet); or they might try to convey the cultural and emotional qualities of a certain kind of place, such as a wilderness, a city square, a mental institution, or a bedroom.*"[329] From art history we know examples of places' (environments) representations in different forms, such as in the form of architectural places, or interiors. In the following chapter are discussed some of the most important examples of those divisions. Landscapes are often included in representation of places within interactive digital artworks which will be discussed in this chapter. For creating a historical background for the interactive digital artworks also historic landscape representations will be examined more closely.

4.5.1. Landscape

Concerning the usage of landscape as a motif in art we know that landscape representations were actually used as environments for scenes or stories. We find landscape representations as a forest, or as a hayfield with a river. We find representations of landscape on sunny days, or on stormy days. Furthermore these motifs are represented in realistic, surrealistic or abstract ways or combining these elements. So landscape representations were firstly just the backgrounds of a scene, for example, a battle or hunting scene. Concerning the last one, we can mention as an example the work of Lucas Cranach the Elder, "Stag Hunt of the Elector Frederick the Wise", done in 1529.

[328] Jean Robertson and Craig McDaniel. Themes of Contemporary Art. Visual Art after 1980. New York, 2005, p. 69.

[329] Robertson and McDaniel (2005), p. 69.

Later, in the works of Jacob Izaaksoon van Ruysdael (or Ruisdaal, c. 1628 - 1682), the most celebrated of the Dutch landscapists, we can say that landscape becomes the main subject of the artwork. His favourite subjects - simple woodland scenes – are designed in a precise, realistic way in varieties of subtle contrasts in the formation of the clouds, the plants and tree forms, and of course the play of light. According to Erich Hubala: "*Landschaft als Bildform, nicht nur Natur als Darstellungsgegenstand in Bildern, gibt es erst im 17. Jahrhundert. Denn erst damals wurden die Naturdinge und das Menschenwerk unter einem einheitlichen optischen und psychischen Moment dargestellt. Was die Landschaftsgemälde in dieser Zeit von solchen in der älteren Kunst, mit wenigen bemerkenswerten Ausnahmen, unterscheidet, ist nicht ein höheres Maß an Naturtreue der Einzeldinge, sondern die Einheitlichkeit der Abstraktion im Ganzen."*[330] According to Ann Jensen Adams the new meaning of the landscape occurs in connection with the political, economic and religious changes in seventeenth – century in Holland: "*First, on a political level, the Seven United Provinces together declared their independence from Spain in 1579 and almost immediately were inundated by waves of immigrants; second, on the economic front, they exploited to an unprecedented degree many of the practices of the open market economy of today's world, including amassing the capital to undertake the largest land reclamation project in the world; and third, in the religious sphere, Protestantism replaced Catholicism as the professed religion of the land. Dutch landscape imagery responds to and "naturalizes" these three controversial subjects, three hot topics that still today can cause heated debate and personal discomfort in social situations – politics, money, and religion.*"[331]
Charles-François Daubigny, who was among other things, a member of the Barbizon school (circa 1830 – 1870) painted the landscape motif in a realistic style. As for the other members of this school, it was also important for him to paintlandscapes outdoors, in front of the subject and not as earlier in a studio. Furthermore, the motif of landscape was designed in a monumental way, as we know from the paintings of Caspar David Friedrich (1774-1840), or it could be depicted in an atmospheric manner (as in paintings by William Turner (1775 – 1851). According to Stepheen F. Eisenman "*The popularity of early nineteenth century landscape painting would probably have surprised its creators; it is now admired for precisely those qualities that were once most disparaged – abstraction and expression.*"[332] A specific form of landscape painting was panorama. A famous example is a work of the Irish painter Robert Barker, where the scene was captured in the round. His panorama of Edinburgh from Calton Hill was shown on a cylindrical surface.
In the 20th century landscape was then represented in an abstract way which is shown in the works of proto-cubist, Paul Cézanne (1839 - 1906), or in which the representation of landscape, in particular of nature, was reduced to a representation of light reflections (as in the impressionist works of Claude Monet (1840 - 1926) – see as examples the series of "Haystack" from 1890, which he painted several times under different weather conditions and different times of day.
The American artist Robert Smithson (1938 - 1973), used the landscape itself for creating artistic representations, in particularly land art (see for example "Spiral Jetty"[333], Great Salt Lake in Utah, an *"earthwork"* done 1969-70). James Turell, an American artist worked with

[330] Hubala (1984), p. 59.

[331] Ann Jensen Adams. *„Seventeenth – Century Dutch Landscape Painting*", pp. 35 – 76, in: W. J. T. Mitchell (Ed.), Landscape and Power, The University of Chicago Press, Chicago, 1994, p. 39.

[332] Eisenman (1994), p. 188.

[333] See *„Das Werk ist etwa 480 m lang und besteht aus Schlamm, Steinen und Salzkristallen. Es ist wohl das bekannteste Beispiel der Land Art. Die Spiral-Mole liegt in einem unzugänglichen Teil des*

light in space trying to represent specific conditions that he experienced in a landscape. His experiences were based on his several helicopter flights through Arizona.

4.5.2. Architecture (included interiors) as motif in historic art

A view of architecture as motif in art shows that architecture has been represented on the one hand as companion motif for representations, as a background representation, and on the other hand as a main motif of representations. So, for example, an ancient roman fresco wall painting in a cubiculum (bedroom) from the Villa of P. Fannius Synistor at Boscoreale shows motifs of architecture: a part of a city with architectural objects has been included in these representations. This fresco has been dated ca. 40–30 B.C. and is part of the The Metropolitan Museum of Art in New York. According to the research of the Deparment of Greek and Roman Art, at the Metropolitian Museum of Art: "*The Second Style* […] *in Roman wall painting emerged in the early first century B.C., during which time fresco artists imitated architectural forms purely by pictorial means. In place of stucco architectural details, they used flat plaster on which projection and recession were suggested entirely by shading and perspective; as the style progressed, forms grew more complex. The Villa P. Fannius Synistor at Boscoreale is an exceptional example of the fully mature Second Style* […]. *Throughout the villa there are visual ambiguities to tease the eye, painted masonry, pillars, and columns that cast shadows into the viewer's space, and more conventional trompe l'oeil devices. Objects of daily life are depicted in such a way as to seem real, with metal and glass vases on shelves, and tables appearing to project out from the wall. At Boscoreale, the walls dissolve into elaborate displays of illusionist architecture and realms of fantasy. Some of the frescoes provide copies of lost, but presumably once famous, Hellenistic paintings. In the villa's triclinium, painted columns frame a series of figurative paintings* […] *presented as if seen through a window in the wall or as if lodged in the architecture. The intention of the owner was to create a kind of picture gallery, with the choice of subjects most likely based on the quality and renown of the original paintings."* [334]
Furthermore, the motif of buildings or cityscapes represents the craft of architectural design and town-planning. Marcus Marcus Vitruvius Pollio (ca. 80/70 B.C. – ca. 25 B.C.), was a Roman writer, architect and engineer, active in the 1st century B.C. His opinion was that "*an architect should focus on three central themes when preparing a design for a building: firmitas (strength), utilitas (functionality), and venustas (beauty). […]So it followed, according to Vitruvius, that an architect's designs must refer to the unquestionable perfection of the body's symmetry and proportions. If a building is to create a sense of eurythmia - a graceful and agreeable atmosphere - it is essential that it mirrors these natural laws of*

Salzsees und ist für den Betrachter vom Land aus nicht zu sehen. Sie ist nur auf Fotos, zeichnerische und schriftliche Dokumente bekannt.", in: Klaus Richter. Kunst der Moderne, vom Impressionismus bis heute. Prestel München, 2000, p. 131.

[334] Timeline of Art History, Roman Painting, Department of Greek and Roman Art, The Metropolitian Museum of Art, from http://12.151.120.44/toah/hd/ropt/hd_ropt.htm, 11.03.2008, 15:41.

harmony and beauty."[335] Vitruvius wrote "De architectura"[336], known as The Ten Books of Architecture, a treatise written on architecture. Illustrations of architecture were a source of inspiration during different styles of architecture. The famous architect of the High Renaissance, Andrea Palladio, wrote a book on designing classical architecture in the year 1581. "l Quattro Libri Dell'Architettura", which was published in Venice contains Palladio's own illustrations. These representations, which provided rules and plans for creative buildings at that time, influenced many architects.

The simulation of the third dimension of space/architecture on a two dimensional surface (perspective, also known as linear perspective) was invented by Filippo Brunelleschi (an Italian architect and sculpture of the earlier Renaissance), painting the Baptistery in Florence using Euclidian rules of geometry. The perspective was further described by Leon Batista Alberti (1404-72) in his treatise "De Pictura". According to Robert Tavernor *"Leon Battista Alberti (1404-72) was recognised by his contemporaries as an extraordinary man who, through his writings and his practical example in the arts, influenced the way in which the natural and artificial world was perceived and represented during the Italian Renaissance.* […] *Alberti's approach to architecture developed from his supreme knowledge of antiquity – of thought and buildings – which he wrote about in books on science and the visual arts."*[337]

Paolo Uccello's fresco "Annunciation" painted for the church Santa Maria Maggiore is known for implementing the rules of perspective. This fresco shows a large building with columns painted in perspective. Vasari wrote that people thought this was a great achievement.

Parallel to the tendency of describing and representing the architecture for constructional reasons, we can mention examples where architecture was the background of a scene, like in the religious representation of the "Annunciation", 1430-45, in Middle Ages, by Fra Angelico (c.1400-1455). The representation of architecture in this painting (tempera on wood panel) shows a tendency to represent the architecture in a perspectival way, but this would be achieved later, as for example in the "Annunciation" (c. 1472-75)[338] by Leonardo da Vinci (1452-1519), which shows his understanding of the linear perspective.

Also Jan van Eyck, a Dutch painter, shows in his works a successful illusion of central perspective, which was different to the Italian painter, not with mathematic-geometric rules achieved, but with a highly detailed and precise form of representation. The painting "The Virgin of Chancellor Rolin" (1435) shows a scene of an interior. According to Carol J. Purtle "*Nicolas Rolin apparently commissioned this panel to adorn his family chapel in the Church of Notre Dame du Chastel, Autun. The chancellor's family had long been associated with the church; his father was buried in its choir, and Nicolas and his own family apparently*

---

[335] Vitruvius's theories of beauty, British Library, from http://www.bl.uk/learning/cult/bodies/vitruvius/proportion.html

[336] "De architectura" was written between 27 and 23 BC. It is a contemporary source on classical architecture that survived. It is divided into ten books, which are:

Town planning, architecture in general, and the qualifications required of an architect; Building materials; Temples and the orders of architecture; continuation of book 3; Civil buildings; Domestic buildings; Pavements and decorative plasterwork; Water supplies; Sciences influencing architecture - geometry, mensuration, astronomy etc.; Use and construction of machines.

[337] Robert Tavernor, On Alberti and the Art of Building, Yale University Press, New Haven and London, 1998, o. S.

[338] This work was painted in tempera on wood panel, with dimensions of 98 x 217 cm. This work can be visited in Florence, in the Galleria degli Uffizi.

intended to continue this same tradition. The painting was probably made for a position on the east wall of the chapel. This placed it to the left of the altar, in a position where it would receive light from a window on the south wall."[339] Architecture was also represented with the method of trompe-l'oeil[340] (in the baroque style), like on the ceiling of the Church of St. Ignatius in Rome, where the Italian Andrea Pozzo (1642-1709), using the rules of optical illusion, painted the work known as "The Glorification of St. Ignatius" (1691-1694).

In the 18th century the notion of "veduta" was especially brought in context with the contemporary representations of the city of Venetia. Traveling people bought these pieces as souvenirs of the city of Venetia. Veduta (from the Italian "view") is the notion of the representation of the city (architecture, but also landscapes) in a naturalistic way.[341] Then vedutas were categorized in ideal vedute, which depict the city in a non-real (idealistic) way and on topography, which depicts the buildings and the landscape as exactly as possible.

The architectural-painter Pieter Saenredam (1597-1665) is "*the first Dutch artist to specialize in faithful renderings of specific buildings. His method of working was careful and accurate. He would first make a detailed sketch on the site, followed by an even more precise construction drawing, often with the help of measurements and plans.*"[342] According to Centraal Museum in Utrecht, where Saenredam exhibited: "*He took measurements, made technical drawings and sketched the fronts and interiors of the churches, which in many cases were in danger of being demolished. In the following years he worked the drawings and preliminary studies into the finest architectural paintings of the seventeenth century, which even today provide a source of inspiration for many artists and designers. On the basis of the measurements which he made on the spot he produced a detailed drawing of the church building. With this comprehensive sketch, separately drawn up details, and a floor plan he went back to his workshop to continue work. The sketch which Saenredam had made on the spot was reproduced on the panel with the help of a so-called construction drawing, and after that had been done he started painting. In his paintings he manipulated the spaces to such an extent that they appeared to be more monumental than they actually were in reality. Saenredam's innovative work method will be made clear in the exhibition.*[343] The painting of the Interior of the Choir of Saint Bavo's Church at Haarlem (1660), which can be seen in Worcester Art Museum is an example of this kind of representation.

In the 20th century we can mention Lyonel Feininger (1871 - 1956), a German - American painter, who treated architecture as motif in his paintings for creating transparent, crystalline – geometric shapes in a light drenched, faceted surface (see as example "Arch Tower", 1923). Also Alexander Kanoldt (1881 - 1939), whose works are in the style of "Neue Sachlichkeit" (New Objectivity), painted architectural landscapes, which show cubic shapes represented in a multi-perspectival style. Here, the architecture acquires the character of a still – life painting.

---

[339] Carol J. Purtle, The Marian Paintings of Jan Van Eyck, Princeton University Press, New Jersey, 1982, p. 60ff.

[340] This notion derives from the French language and it means "trick of the eye".

[341] See the describing of this notion by Clarke (2001), p. 249ff: *„veduta [From the Italian, „view"] used to describe a painting, drawing, or a print of a landscape or townscape depicted with sufficient accuracy for topographical identification. The term is particularly associated with 18th-century Italian art, for example Canaletto's paintings and Piranesi's great series of prints Vedute die Roma (published from 1745 onwards)."*

[342] J. A. Welu (Ed.), Worcester Art Museum, Selected Works, Worcester, 1994, p. 125.

[343] Indepth Arts News: *"Pieter Saenredam, the Utrecht work"*, 2000-11-04 until 2001-02-04, Centraal Museum in Utrecht (NL): from http://www.absolutearts.com/artsnews/2000/12/24/27862.html

4.5.3. Architecture or Environment as Motifs in Media Art

Regarding the genre of photography we can mention the works of the German architect Albrecht Meydenbauer, who used photographic images for the photogrammetric documentation of buildings. As an example can be mentioned the photo "Die Ostseite der Türme des Kölner Doms" (1889).
In the line of silent film can be mentioned as an example the most famous work of Walter Ruttmann "Berlin – Die Symphonie einer Großstadt" (1927), a representation with a structure full of movement and rhythm. It is a montage of documentary images of Berlin at that time. For a video artist that worked with architectural examples we could mention the Austrian artist Heidemarie Seblatnig. One of these works is the 1997 video "Shadows of Objects", in which she makes a relation between elements of Western architecture (architecture in Vienna and St. Poelten) to architecture in Tokyo, using the shadows of the object as the basis for this comparison. Another video-artist, Pipilotti Rist, made an installation in 1994 representing an oversized interior. "Das Zimmer" (English: "The Room") is an installation which shows ten video players and videotapes, a couch and a television in a living room. Using a giant remote-control and sitting in a giant couch, being surrounded with outsized furniture visitors feel like small children. The motif of the interior was used here to bring back childhood memories to the visitors.
The contemporary Brazilian artist Ernesto Neto created with his abstract installations a kind of experience space. He used textile, such as nylon stockings and spices for creating shapes that are almost organic and hang down into the exhibition space, which is further characterized by its smell. A kind of organic architecture, which recalls both tent-constructions and the buildings of Antonio Gaudi can be entered.
The German contemporary artist Mischa Kuball defined spaces with the help of the light effects. In his work "Space / Speech / Speed" (1998), which consists of three mirror spheres, three text slides and three projectors colliding light- and speech-signs. Two of three mirror spheres rotate at high speed and create a constellation of light points over the floor, walls and ceiling. The projected words dissolving in light and speed define a space, which seems to be much bigger than it really is. The third mirror sphere, which shows the projection of the word "speed" is not moving. Kuball provokes here the idea of how far we can trust the spoken language. The mirror spheres and the light points recall the constellations of planets and stars in the universe and create an analogy between the installation room and the universe. According to Jean Robertson and Craig McDaniel "*Some artworks that address the theme of place represent and interpret artificial, fictional, and fantastic places. These places include synthetic environments that actually exist (Disney World, Las Vegas, Hollywood sets, zoos, habitat displays in natural history museums) and fantasy environments concocted by artists from their own imagination, which may blend the fictional and the real*."[344] A compelling series of large-scale drawings showing fictional cityscapes and imaginary architecture created by a British artist Paul Noble has been mentioned as an example in this context.[345]

[344] Robertson and McDaniel (2005), p.84.

[345] Robertson and McDaniel (2005), p.84.

4.6. Places, or Architecture as Motifs in Interactive Digital Art

Interactive digital artists visualize places of their fantasies, particularly rendering them visitable for the audience. Visitors can experience these places as real; they can be surrounded by them on all sides (as environments). Visitors can even be in them. There are also examples where visitors navigate places, recordings of which have been manipulated by the artist, so that the artistic value of the work and not just the experience of a specific place have been highlighted. Places or architecture appear as motifs in interactive digital art already from the late 70's, in particular in 1978 as Michael Naimark used the picturesque mountain town of Aspen (in Colorado) as a motif for the interactive videodiscinstallation with touchscreen "The Aspen Movie Map".[346] In contrast to earlier videotape systems, through the videodiscsystem it was possible to offer a non-linear narration. With the touchscreen and a joystick it was possible to navigate through the streets of Aspen. Furthermore, on the crossroads the user had the capability to choose different directions. The user could learn different information about the buildings and places that he or she is "visiting". Also different seasons could be chosen. Naimark points out that "*Moviemapping, it seemed at that time, was destined to enjoy widespread popularity as a new medium for experiencing place, for virtual travel and virtual tourism. The dream was that popular tourist destinations, spectacular landscapes, sacred places, and heritage sites could be moviemapped and appreciated by many more people than could actually go there. It would be more experiential than magazine photographs and linear television shows.*"[347] This kind of art was then further developed in Naimark's work "Karlsruhe Moviemap" of 1991.

In interactive digital art the artists present places which they have found impressive, or places which are culturally important. They represent mostly public places, or abstract places. The Australian Jeffrey Shaw represented known public places, also public places constituted in an abstract way. For example his work "The Virtual Museum" (1991) represents a public space, which is made up of five rooms. These rooms have the same appearance as the real room in which the installation is located, but the exhibition in this virtual museum is created using alphabetic and textual forms. This distances it from its real appearance. According to Hans Moravec "*When connected to a virtual reality, where you are and what you see and touch do not exist in the usual physical sense, but are a kind of computer-generated dream. Like human dreams, virtual realities may contain elements from the outside world…*"[348] Also the work of Shaw is a kind of representation that combines real elements (the room of the museum) and non-real elements (alphabetic and textual forms as art objects) in an unreal (virtual) world.

Artists also depict places that only exist in their minds. For example the Californian Matt Mullican created, among other things, virtual representations of urban organization systems and models of an imaginary city. In his work "Five Into One" (1991), which counts as one of

[346] Michael Naimark was responsible for cinematography design and production of "The Aspen Movie Map". This work originated at MIT's Architecture Machine Group, Nicholas Negroponte's proto Media Lab. Andrew Lippman, a colleague of Negroponte, was the Principal Investigator.

[347] http://www.naimark.net/writing/aspen.html

[348] Hans Moravec, *"The Senses Have No Future"*, pp. 84-96, in: Beckmann, John (Ed.), The Virtual Dimension. Architecture, Representation, and Crash Culture, p. 91ff.

the earliest artistic works in the medium of virtual reality, Mullican used simple geometric shapes to create virtual places.
There are also places which are constituted in a symbolic way, in particular constituted by symbols, as in the work of Jeffrey Shaw "The legible city" (1988-91), in which the buildings of Amsterdam or of New York have been represented by alphabetic letters. To do this Shaw used texts, which have to do with the history of each city.
A dynamically changing data space can be experienced in the work of Christa Sommerer and Laurent Mignonneau "The Living Room" (2001), where the room's walls react to the user's gestures, movements and speeches. An interior, a room, has been transformed into a sensitive place equipped with different images deriving from the internet.
Architecture, including cladding and interiors, has been used as motif for exploring different cultures, particularly finding out the analogies between different cultures (see the work of Rafael Lozano-Hemmer, "displaced emperors, relational architecture 2", which was presented in Ars Electronica Festival in Linz, (Austria) in 1997). But there are also examples using abstract motifs to constitute a place, particularly a space, which has to be explored (as in the work of Ulrike Gabriel "Perceptual Arena", 1993).
Constructing a kind of "bitsphere" is another aim of interactive digital artists. According to Mitchell "*For designers and planners, the task of the twenty-first century will be to build the bitsphere – a worldwide, electronically mediated environment in which networks are everywhere, and most of the artifacts that function within it (at every scale, from nano to global) have intelligence and telecommunications capabilities.*[…] *Just as the ancient polis provided an agora, markets, and theatres for those living within its walls, the twenty-first-century bitsphere will require a growing number of virtual gathering places, exchanges, and entertainment spots for its plugged-in populace.*"[349] According to Mitchelle constructers of the bitsphere are "*architects of the twenty-first century*", who will "*shape, arrange, and connect spaces (both real and virtual) to satisfy human needs. They* [architects] *will still care about the qualities of visual and ambient environments. They will still seek commodity, firmness, and delight. But commodity will be as much a matter of software functions and interface design as it is of floor plans and construction materials.*"[350]

The following chapters will research artworks that represent places or architecture: "Naturalistic Virtual Immersive Public Places", "Abstracted Real Cities", "Realistic Represented Virtual Interiors" and "Abstract Spaces".

[349] Mitchell, City of Bits, p. 167.

[350] Mitchell, City of Bits, p. 105.

4.6.1. Naturalistic Virtual Immersive Public Places

Places in interactive digital art are represented with different techniques in different ways. For example, they are represented through the media of photography, or video. For taking photos of places and of public places diverse cameras with different settings and technological possibilities are used. Photographic images of public places, which are recorded with special cameras that support the technology of 360° panorama image, will be discussed as examples in this chapter. Strategies of immersion of visitors into virtual spaces are extended by the usage of these new digital technologies.
Representing by using the rules of "central perspective" acquires a different meaning in these works. The visitors can stand in front of, or more precisely, in the middle of a modern trompe l´oeil representation. According to Oliver Grau: "*The quality of apparently being present in the images is achieved through maximization of realism and is increased still further through illusionism in the service of an immersive effect. The image and simulation technique of virtual reality attempts to weld traditional media together in a synthetic medium that is experienced polysensorily. The technological goal, as stated by nearly all researchers of presence, is to give the viewer the strongest impression possible of being at the location where the images are*."[351]

In the following are discussed examples for research within this category. The work of Jeffrey Shaw, "Place - a user's manual" (1995) and the work of Michael Naimark, "Be Now Here" (1995-1997) have been taken in consideration as examples for researching navigation and immersion in such artworks. The work of Luc Courchesne, "The Visitor – Living by Numbers" (2001) has been taken into consideration as an opposing example. Here, through the representation of a place, communication is the focus.

Jeffrey Shaw is an Australian artist who deals with virtual environments[352] and interactivity. Until 2003 he was director of the Institute for Visual Media at the ZKM Center for Art and Media in Karlsruhe (Germany) and was Professor of Media Arts at the Hochschule für Gestaltung in Karlsruhe. He was the founding co-director of the Center of Interactive Cinema Research (iCinema) at the University of New South Wales in Sydney (Australia). He is now Chair Professor of Media Art and Dean of the School of Creative Media (CityUniversity, Hong Kong) and also Visiting Professor at the Central Academy of Fine Art (CAFA, Beijing). In the installation "Place - a user's manual" (1995, Fig. 23) a rounded platform, which is motorized, is placed in the middle of the installation, surrounded with a large bended projection surface. A modified video camera is the interface of the work. The visitors can navigate through its zoom and play buttons, and they can control the rotation of the platform. A 120-degree portion of the bended surface has been used for projecting the computer-generated landscapes.

[351] Grau (2003), p. 14.

[352] See for this: *"Shaw has constructed numerous installations that challenge conventional concepts of space. His early experiences with performance and multimedia experiments lead him to his occupation with concepts of virtual reality which expose the viewer in visually simulated spaces."*, from http://www.medienkunstnetz.de/artist/shaw/biography/

Figure 23 Place - a user's manual, 1995. © Jeffrey Shaw.

Figure 24 Be Now Here, 1995-1997. Michael Naimark.

These are based on scenery taken with a panoramic camera.[353] The full 360-degree generated scene can be seen, while the platform continuously rotates. The scenes are also visible outside of the installation space. This element has been repeated inside the installation itself: the visitor can take a look inside a 360 panoramic record/computer-generation, or outside this record/computer-generation. He or she can navigate from outside to inside of it, or vice-versa. The visitor can also navigate from one to another panoramic record/computer-generation.
The constellation of the record/computer-generations is based on the diagram of the Sephirothic[354] 'Tree of Life'. Oliver Grau emphasis that "*Jeffrey Shaw, who has many years of experience with immersive media, consciously takes up the tradition of the panorama in Place (1995), which combines photography, cinematography, and virtual reality."*[355] *Records/computer-generations of real places are brought into relation with symbolic locations. Furthermore, these places are brought into relationship with the language; three dimensional dynamic texts appear when the visitors make sounds. A microphone mounted on the top of the camera is used as interface for these.*

Michael Naimark is a researcher and a media artist, who deals with place representations. His innovative works, such as "Golden Gate Flyover" (1987), "See Banff Kinetoscope" (1993-94), "Dimensionalization Studies" (1994-98), or "Displacements" (2005) are in permanent collections of the American Museum of the Moving Image in New York, the Exploratorium in San Francisco, and the ZKM (Center for Arts and Media) in Karlsruhe (Germany). He is a Research Associate Professor in the Interactive Media Division of the USC School of Cinematic Arts. Naimark also serves on the Visiting Committee of the MIT Media Lab, the Scientific Council of the Ludwig Boltzmann Institute for Media Art Research in Vienna, the Board of Directors of the Zero One Network and the International Advisory Board Leonardo/ISAST.
Naimark's work "Be Now Here" (1995-97, Fig. 24) is an installation in which the motifs are landscapes and public places. Visitors step into a rotating platform and are immersed in a virtual place wearing 3d[356] glasses and watching on a stereoscopic projection screen. Naimark

[353] See here J. Shaw: *"The projected scenery is constituted by eleven cylinders showing landscape photographs taken by a special panoramic camera in various locations - Australia, Japan, La Palma, Bali, France, Germany, etc. Each of these virtual panoramic cylinders in the computer-generated landscape has the same height and diameter as the projection screen, so that when locating himself at the centre of these pictures the viewer can completely reconstitute the original 360-degree camera view on the screen. In this way the work locates the panoramic imagery in an architectonic framework that correlates the design of the virtual landscape with that of the installation itself, so making the virtual and actual spaces co-active on many levels of signification."*, from http://www.jeffrey-shaw.net/html_main/frameset-works.php3

[354] See here Cooper (1986, p. 252ff) gives an explanation of the Sephiroth: *"In der Kabbala sind die Zehn Sephiroth die Hauptaspekte von Gott; seine göttlichen und unbegrenzten Wesenheiten sowie die Sphären bzw. Emanationen des Ain Soph, in der Regel dargestellt durch den Lebensbaum. Die erste ist die Monade, die erste Ursache, aus der sich die anderen neun bildeten, bestehend aus drei Trinitäten: jede eine Abbildung der ursprünglichen Dreiheit aus Männlichem, Weiblichem und einigender Intelligenz."*

[355] Grau (2003), p. 240.

[356] See Naimark *"For production, a unique recording system was built consisting of two 35mm motion-picture cameras (for 3D, one for each eye) mounted on a rotating tripod."*, from

explains that: "*The entire floor rotates once every two minutes in sync with the panning imagery, creating an illusion that the screen is rotating around the viewers.*" [357] Through the interface, which is available on a pedestal, the visitor can choose a specific time and place, like for example Jerusalem, Dubrovnik, Timbuktu, and Angkor (Cambodia). The visitors can gain a sense of these places, which are public plazas on the UNESCO World Heritage Centre's list of endangered places.
Naimark sees this work of him as an extension of several media trajectories: of the cinematic representation, "*such as the Imax-sized projections of the Lumiere brothers in 1900 and the 3-screen triptychs of Abel Gance's Napoleon in 1927 and of non-narrative cultural activism, such as the films of Godfrey Reggio and Tony Gatlif.*"[358] But "Be Now Here" can also be seen as an extension of naturalistic place (or landscape) representations in paintings, or as an extension of panorama[359] images. Also Lev Manovich (1995) draws attention to the panorama images related to this work of Shaw: "… *Inside this* [virtual] *landscape are eleven cylinders with photographs mapped on them. Once the user moves inside one of these cylinders, she switches to a mode of perception typical of the panorama tradition*."[360]

In Naimark's works, similar to Shaw's work, the user can "visit" a virtual place, particularly some virtual places which exist in reality. Their representation has been created by recording of real places. In a few minutes the user can visit places that exist in different parts of the world, and also go back in time and space. Users can immerse themselves in these places so that they are surrounded by the mapped photographs, which are installed in cylindrical form in the installation room. The user feels that he or she is really in these places. The realistic representations of landscapes recall the earliest autonomic landscape representations such as those by van Ruysdael. Those representative forms of landscape are in contrast to the forms known in the painting of the 20th century, which are characterized by their abstraction.

Differently to Shaw's work, the user in Naimark's work wears 3D glasses. Through this difference in the interface, another kind of the illusion of immersion is present in these works. The fact that through the usage of the technique of animation in Shaw's work the user navigates from one to another place in an intuitive way lets the user in Naimark's work feel more immersed in the currently chosen place. The work of Shaw lets users make their an own adventure, moving forwards more quickly, "traveling" from one place to another within a few seconds, while the work of Naimark has more the character of a meditative observation, a slower experience of a specific place. Their encounter with the place lasts two minutes – for the entire floor to rotate once. The possibilities for interaction and because of this also for immersion are different: in Shaw's work one can navigate through cylindrical recordings, gliding from one to the other scene, while in Naimark's work the visitor can be surrounded with a 360 degree recording without navigating through it.
Naimark's work is created more with the aim of conservingexisting places so that people from all over the world can visit these places. They would exist in digital form even if war

http://www.naimark.net/projects/benowhere.html

[357] See Naimark from http://www.naimark.net/projects/benowhere/benowhere_i4.html

[358] http://www.naimark.net/projects/benowhere.html

[359] Oliver Grau works such as "World Skin" (1997) of Maurice Benayoun, "Place Ruhr" (2000) of Jeffrey Shaw and "Be Now Here" (1995) of Michael Naimark categorizes in a chapter about "Exegetes of the Panorama", p. 236ff.

[360] Manovich (2001), p. 282.

destroyed them physically. Naimark chose specific places that were at risk of being destroyed through war. For example, as a motif in this work the Orlando Column, Dubrovnik's symbol of independence and freedom appears, which is enclosed in wood to protect it from recent bombing. So Naimark's attention is concentrated on representing places and their characteristics. Naimark describes for example the situation about the war in Croatia and his visit to Dubrovnik, in which the "*…evidence of bombing was everywhere. Most took place in late 1991, when Serbian forces let go on Dubrovnik and almost all neighboring Croatian villages, using incendiary bombs to burn everything nearby. Today much has been restored, but small shrapnel holes are literally everywhere."*[361]

Representations, which offer the possibility of immersion in a naturalistically represented public place, have been considered within this chapter. In conclusion we can say that no other kind of art offers the possibility of visiting so many places that exist in different parts of the world within few minutes in such an immersive way. Naturalistic way of representations and installations such as "Place - a user's manual" (1995) by Jeffrey Shaw and "Be Now Here" (1995-1997) by Michael Naimark show that with the newest technology immersion in a naturalistic public place can be realized so that the quality of moving images, which is already seen in photography or photo-installation, has been combined with the aspect of interaction and of navigation. Through these it is possible to choose places that artists offer for visiting. The way of their representation recalls traditional artforms such as landscapes or vedutas, as explained in the introduction. Also the symbolic meaning of such places which is present in this kind of art (e.g., Naimarks constellation of place representation based on the diagram of the Sephirothic 'Tree of Life') was seen already in historic landscape representations. But in interactive digital art the tree of life can be navigated – our own lives are being reflected. The stages that we go through in our lives, inside and outside of them, are reflected. Shaw let the visitors navigate through stages of life, represented as places. The visitor is navigating through their own the life.

The idea for the preservation of buildings, historic places, monuments, artifacts, etc. has existed, with different laws applied, since the beginning of the 19th century. The norms and ideas of behavior in a society are reflected in the objects and places that are preserved. Their preservation demonstrates recognition of the past and of things that tell a story of a specific time and culture. The Convention Concerning the Protection of World Cultural and Natural Heritage was adopted by the General Conference of UNESCO in 1972. With the techniques used for virtual realities objects are preserved so that it is even possible not just to be surrounded by these places, observers/visitors can navigate in them, they can even walk out of them, they can be transferred from one to another place, from the inside to the outside of a representation. The aspect of crossing through these places, or changing/choosing them on the desire of the visitors is a new one and can be offered only within this kind of art. The motif of public places in interactive digital art has been used for representing different cultures in specific times and places, and for representing symbolic places. The interface used transfers this meaning of the public place from the static to the dynamic: the active visit and the experience of public places by visitors/users emerge as the main themes.

[361] Michael Naimark, from http://www.naimark.net/writing/trips/bnhtrip.html

Figure 25 The Visitor – Living by Numbers, 2001. © Luc Courchesne.

The work of Luc Courchesne, "The Visitor – Living by Numbers" (2001, Fig. 25) will be discussed as an opposing example to the works of Shaw and Naimark. In these three works the extension of the possibilities for a public place representation is a focal point generally. In Courchesne's work, the visitors can take a journey in a Japanese landscape, placing their head in the middle of a big bowl-like projection surface. They can navigate by saying numbers (between one and twelve), which changes the route of travel through the film. Although this work counts within the works that show the motif of place, the main aim here is a kind of communication (between the visitors and the inhabitants). The visitors meet inhabitants and can decide if they want to stay with them, or leave.[362] The landscape is blurred, to accentuate the illusion of a dream (Courchesne's work was inspired by a dream of his daughter). This effect recalls the work "Osmose" by Charles Davies (1995) that shows a kind of translucent representation, which Oliver Grau compares with the "*old artistic trick of sfumato*"[363].

Courchesne, in contrast to Shaw's and Naimark's work discussed above, focuses his representation on the communication and not on the representation of a place. The central theme in Courchesne's work is to communicate with the inhabitants of the represented place, which is in this case a Japanese family. A kind of social level has been depicted with this work. The representation of the place is an accompanying motif that serves to involve the visitors into the Japanese culture; the visitor can see characteristic elements of this culture, as for example the Japanese tea-ceremony. A complex environment has to be visited to come to the house of a Japanese family and communicate with its members. Communication is the main theme also in other works of Courchesne, as in the work "Portrait One", which was discussed above.
Compare to Naimark's and to Shaw's work technologically different is that the images in Courchesnes work are video recordings and not photos. The bowl looks like a kind of mobile personal theater.
The naturalistic representations of Shaw and Naimark are in contrast to the blurred recordings of Courchesne. In Shaw's and in Naimark's work reality has been simulated so that the user gets the impression he or she is a part of a monumental reality, while Courchesne's work has a dream-like, surrealistic character with a accentuated element of narrativity.
This work, which is a later work by Courchesne – created in the year 2001 - is also in its interactivity interesting and intuitive. The numbers that the visitor says decide the further direction of the story.
Through this work specific naturalistic places have been represented as motifs for depicting the aspect of communication and not for handling the place itself as theme (as in the work of Luc Courchesne "The Visitor – Living by Numbers", 2001). Also in traditional art places have been represented as background motifs. But in no other kind of art an immersive place can be navigated by saying a number – a quality that is specific and can be realized only by the newest media technology.

[362] See here Paul (2003, p. 99), who pointed out that in the Film "Theorema" (1969) by Pier Paolo Passolini, one can recognize the motif of staying with or living with the inhabitants.
[363] Grau (2003), p. 201.

4.6.2. Abstracted Real Cities: Back-Curating Flight and Visitors as Tramway-Driver

Cities, which are characterized by their urban planning, architecture and their landscape, are often dominant motifs in interactive digital art. They are mostly represented with their characteristics so that simulating reality has been the first aim. From the flight-simulators in war industry we know of examples with precise presentation of cities. From the game industry we know other presentations, particularly animations of real cities. There are also examples known from town-planning, which represent planned cities or city-parts.

The Net itself has been considered as another medium for representing, in particular for "creating" a city. The architecture theorist William J. Mitchell in his book "The City of Bits" considers the Net as its own kind of city, which he defines as "*a city unrooted to any definite spot on the surface of the earth, shaped by connectivity and bandwidth constraints rather than by accessibility and land values, largely asynchronous in its operation, and inhabited by disembodied and fragmented subjects who exist as collections of aliases and agents. Its places will be constructed virtually by software instead of physically from stones and timbers, and they will be connected by logical linkages rather then by doors, passageways, and streets.*"[364] Furthermore, Mitchell's opinion is that the buildings and parts of buildings "*must now be related not only to their natural and urban contexts, but also to their cyberspace settings. Increasingly, they must be equipped with electronic sensors and effectors, onboard processing power, sophisticated internal telecommunications capabilities, software, and capacity for getting bits on and off – much like computer screen space that can be programmed for many different uses.*"[365] Possibilities for representing a city also exist in interactive digital art, as in other artforms. Examples in this chapter show two different styles for abstracting reality (abstracting cities), which take into consideration the representation of existing cities.

In the work "Virtual Balance" (1995-97, Fig. 26) by Monika Fleischmann and Wolfgang Strauss, visitors can navigate through a virtual space by shifting their body weight over a platform. Through this intuitive interface the virtual environment, which is projected on a large screen in front of the user, can be explored in all directions. The visitor stands on the platform, which measures with specific sensors changes that occur through their movements such as measuring changes of gravity. The direction of the movements in virtual space is updated according to the left or right movements of the visitor. The height of the virtual flight is calculated according to the forward or backward movements of the user. He or she can reach a bird's eye perspective, or descend to ground level. The high-level of the flight determines the speed of the navigation: at ground level the user is walking and ascending the user is travelling more quickly. The main aim of the artists' was to create a device for navigating that is more intuitive. The user standing on the platform is calculated as the start position. The position of the user in the virtual environment depends on the data that results from the visitor's movement on the platform. Flying is an old dream of humans, as is flying back through time. This work integrates these two elements in one.

[364] William J. Mitchell, City of Bits. Space, Place, and the Infobahn, MIT Press, Cambridge, Massachusetts, 1995, p. 24.

[365] Mitchell (1995), p. 105.

The immersion of the visitor in this virtual space results from the harmony of the visitors' movements and the virtual realities' accordance to these movements. The levels of the details that are represented, were different: the visitors could see more in the walking mode, especially if he came near to an object. The visitor could see less by flying – the details were reduced, the city was more abstracted. This representation visualizes an ancient Roman city "Colonia Ulpia Traiana", which was near today's Xanten. The visualization was done in co-oporation with archaeologists and construction engineers from Dortmund University. Only fragments of this old city can be seen today.
The influence of Dechirico and metaphysical painting is remarkable here. To my question if Monika Fleischmann and Wolfgang Strauss knows the works of Giorgio de Chirico or of metaphysical painting, and if they have a meaning for them, I got the following answer: "*Beide Male: ja. Wenn Sie auf Licht und Schatten ansprechen: das war u.a. Thema in unserer Arbeit Home of the Brain (1991/92), Goldene Nica interaktive Kunst 1992. Sie war als Teil von "Berlin, Cyber City" konzipiert und verbindet (wie de Chirico) reale und imaginäre Elemente der Rauminszenierung. Zu dieser Zeit begannen wir mit darüber nachzudenken, was ein virtueller Raum ist und wie er dargestellt werden könnte. Wir haben uns dabei u.a. mit de Chirico und seinen traumähnlichen Stadtbildern mit imaginären Elementen, mit Licht und Schatten und multiperspektivischen Raumkonstruktionen; mit der Insel Utopia, nach dem Roman von Thomas More / Thomas Morus; mit Camillos Gedächtnistheater, mit dem Thema des Labyrinths usw. beschäftigt. [...]*"[366]

The reconstruction of antique cities is an aim which has been reflected in arts and literature. Through digital technology this idea is being visualized so that observers/visitors can even navigate in them. Flying or walking in an ancient Roman city "Colonia Ulpia Traiana", by shifting body-weight over a platform in an exhibition space, can only be experienced in such artworks. The nearer to earth, the more details of the city's visualization, in particular the city's reconstruction, the visitor can see. And the higher the visitor is flying, the more abstracted the view of the city is. The representation of columns of an antique city recalls the metaphysical paintings by de Chirico. But Fleischmann and Strauss do not create a traditional metaphysical place. Furthermore, for the first time in history, the visitor can visit an ancient city and at the same time can benefit his back muscles. This artwork was created also with physiotherapeutic purposes – this reflects the problems of the contemporary human who works for many hours sitting in chairs in front of a computer or does other office-work. Furthermore, in a culture in which visiting different countries for touristic reasons (sightseeing) i s habitual, people want to visit more and more. They want to have more comfortable ways of traveling to access different places of the world. Being mobile is also a characteristic for different kinds of human work for which they have to travel from one to another country, for their product, company, work, or scientific research.
This work reflects, among other things, mobility as a characteristic of contemporary society. It reflects also the desire of the human being to fly back in time. Visiting a city that was once alive reflects this idea. The motif of the city and its reconstruction has been used as a motif for going back in time and revealing questions as for instance how the cities of that time were organized, how people at that time lived and worked, how did they think.

[366] Monika Fleischmann and Wolfgang Strauss interviewed via email on 09.11.2007 by Penesta Dika.

Figure 26 Virtual Balance, 1995-1997. © Monika Fleischmann & Wolfgang Strauss.

Figure 27 Karlsruhe Moviemap, 1991. © Michael Naimark.

A different representation of a city in interactive digital art is the work "Karlsruhe Moviemap" (1991, Fig. 27) by Michael Naimark, which is realized on commission from the Zentrum fur Kunst und Medientechnologie (ZKM) in Karlsruhe (Germany). According to Naimark "*Karlsruhe has a well-known tramway system, with over 100 km of track snaking from the downtown pedestrian area out to neighboring villages at the edge of the Black Forest"*[367]. This is the reason why Karlsruhe was chosen.
The tramway system of the city of Karlsruhe was shot in both directions with a camera from a tramcar. The camera was triggered by the tram's electronic odometer every two, four and eight meters per frame according to the location. The tracks represent an artistic intention for representing traveling. They don't show a real view like these that the travelers see during the tramway's journey in Karlsruhe. The tracking is an abstraction of this journey and as such it represents a different view to the city of Karlsruhe. "*One intention was to abstract rather than simulate reality* […]",[368] said Naimark. The shots creat the illusion of a track as if it were cut and matched. Furthermore, the speed can be manipulated by the visitors so that speeds of up to one kilometer per second can be reached continuously. This is also an element of abstracting, which is being realized in virtual way. To control speed and direction a lever is used and to choose which direction to go at each intersection, three foot pedals (left, center, and right) are used.
We can conclude here that real cities are represented in interactive digital art so that they have been abstracted. Abstract represented cities also appear in media art (as in the video work by Heidemarie Seblatnig "Shadows of Objects" of 1997, discussed in the introduction, in which she makes a relation between elements of Western architecture and architecture in Tokyo). Abstract represented architectonic objects or city-parts are also known from the paintings of Lyonel Feininger (discussed in the introduction). But using digital technology that supports interactivity, visitors can, for example, make a virtual journey of a tram in the city of Karlsruhe, by which speeds of up to one kilometer per second can be continuously reached. Due to this, the overall impression of the city of Karlsruhe in the work of Michael Naimark, "Karlsruhe Moviemap" (1991) changed. The non-linearity which is linked with the theory of the "butterfly effect" (this term was used in 1963 by the meteorologist Edward N. Lorenz) is here limited by the recordings made by the artist. Although a city (the city of Karlsruhe) has been represented, the visitor/observer as a travelling tramway driver is a main theme. This meaning of the city appears in combination with the possibilities of interaction and of interface.

In both works a city is the leitmotif of the work. In Fleischmann and Strauss' work, the ancient Roman city "Colonia Ulpia Traiana" is represented abstractly so that some parts haven't been represented. Naimark's work has been abstracted so that the recordings of the city of Karlsruhe can be played non-continuously. The recorded sequences are mapped to create a non-linear narrativity. Also the speed that can be manipulated by visitors underlines the non-linearity of this work.
In both works interactivity has been limited to a kind of navigation. In Fleischmann and Strauss' work the visitors can navigate on different levels and due to this their speed is changed automatically. In Naimark's work the visitors can change the speed of travel by themselves and navigation through the city is possible from the tramway perspective. The interface through shifting their weight is intuitive compared to the complex navigation with a

[367] http://www.naimark.net/projects/karlsruhe.html

[368] http://www.naimark.net/projects/karlsruhe.html

lever and three footpedals. But on the other hand Naimark wanted to give visitors the feeling of driving the tram, the feeling of choosing their own tramway traveling route through the city. With the equipment of the lever and three footpedals as navigating tools he made driving the tram more real for visitors. The visitor becomes the tram-driver. In Fleischmann and Strauss' work the visitor has to make different movements over the plate – this work has also been developed for physiotherapeutic purposes. For the contemporary society, which is characterized through working sitting in chairs (office-work), would be an advantage if this kind of navigation in the future would be applied more.
Representing cities by abstracting them has been used also in other works supported by new media, for example in films. According to the culture and media theorist Katharina Gsöllpointner "*The fragmentation, questioning, dissolution and the production of new relationships of a constructed and coincidental environment can, however, appear only simultaneously with the knowledge of urban and trans-global (electronic) communication. A critical reflection of social reality can take place only in connection with the idea of an experimental and visionary alternative in the field of architecture and urban planning which not only foresees changes in our environment, but also implies them in artistic designs.*"[369] Due to this Gsöllpointner added that "*Virtual reality in film, for instance, has contributed more to this development since Fritz Lang's "Metropolis" at the latest than is realized by the present creators of VR.*"[370]
The form of the interaction as a kind of navigation has also already been used in different architecture visualizations done for planning purposes. But navigating in a city by shifting bodyweight over a platform (as in the work "Virtual Balance"), while the visitors decide if they will "walk" slowly or "fly" through the represented city is a new possibility which has been offered only by interactive digital art. The perception of the visitors as navigator has increased by this kind of navigation. On the one hand the visit to the city seems to be more realistic because the visitor is in it (also displayed) – he or she is a part of a once existing city. And on the other hand the visitors can control their visit to the city in a fine-tuned intuitive way. The presence of surrealistic fantasy is perceivable in that that the visitor can "fly" over and through the city and can see details according to his or her speed. The representation of columns in an antique city – an element known from de Chirico's paintings – is a reminder of surrealistic works, particularly of metaphysical painting. Through the creative possibilities for navigation (including the innovative interface), artistic representations based on metaphysical style, and through the abstraction different perspective levels are activated simultaneously in the visitor. Compared to previously known forms of city-representations, the elements used in this kind of art cause a new kind of perception to emerge. Through the motif of the city, the visit to the city rather than the city itself has been treated as a theme. Also the work "Karlsruhe Moviemap" offers a new city perspective characterized by the kind of the navigation (visitors become tramway-drivers), the interface and the representation of the city by artistically self-arranged shots. The manipulation of the speed of the city-travel which can be modified due to the speed of the tramway-drive is an element which causes the level of reality perception to change. It can be concluded that the representation of a city or the navigation in a city with digital technology is not a new one but its representation is modified artistically, and at the same time offers a new kind of interaction and an suitable new kind of interface. These make a new overall impression of a city representation. The motif of the city

[369] Katharina Gsöllpointner, *"Architecture and Electronics"*, in: Intellegent Environment [Part 01], Ars Elextronica Festival 1994, at: http://www.aec.at/en/archives/festival_archive/festival_catalogs/festival_artikel.asp?iProjectID=8670
[370] Gsöllpointner (1994).

in context with the interface and the interactivity transports the meaning that the visitors are tramway – drivers in the city of Karlsruhe. Displaying these kinds of artworks in darkened museum rooms, and projecting them in large-scale are also relevant factors for their perception by visitors.

4.6.3. Realistically Represented Virtual Interiors: Visiting Historic Interiors and "Revealing" Historic Interiors

Realistic interiors appear as motifs in interactive digital art according to technological possibilities. So for example virtual tours in museums were realized to satisfy the desire of the public to see virtual artworks, which are presented in different museums of the world. Seeing Leonardo da Vinci's "Mona Lisa" in its represented place without visiting the Louvre Museum (Paris, France), or making online exhibitions without the physical presence of the audience motivated the animators to realize the reproduction of existing interiors.

The Ars Electronica Futurelab is a laboratory, in which artistic and technological innovations are one of the first priorities. The approach to a project in this laboratory is characterized by interdisciplinarity. Artistic installations are realized in collaborations with university facilities, and joint ventures with partners in the private sector frame the Futurelab's broad spectrum of activities.

The work "Schloss Schönbrunn" (2005, Fig. 28) by Ars Electronica Futurelab was commissioned by the Schönbrunn Palace Society. This project is an innovative, three dimensional visualization of several of the rooms of Vienna's imperial residence. This visualization is an interactive simulation of the "Million Room," one of the most opulent interiors of the palace of Schönbrunn. Additionally the Ceremonial Hall and one of the three Rosa Rooms were simulated.
The "Schloss Schöbrunn" can be visited in a virtual way – the visitors can be in it as tourists. The visitors enter the projection room equipped with 3D glasses. Besides the touristic[371] worth of this work, it has also a conservation worth for cultural objects. This characteristic was also indicated above with M. Naimarks work "Be Now Here" (1995-1997), and it was already mentioned concerning Shaw's work "Place - a user's manual" (1995). Through the usage of ARSBOX technology[372] different options are provided for displaying the three dimensional environment on one or more screens.

[371] See Ars Electronica Futurelab: *"The visualizations have been presented numerous times to high-caliber audiences such as international tourism professionals attending the 2006 ITB expo in Berlin. It was also shown in Vienna as part of the supporting program at the conference of European ministers of tourism held in conjunction with Austria's European Council presidency."* from http://www.aec.at/en/global/press_detail.asp?iPressID=171&iAreaID=3

[372] ARSBOX is an innovation by the Ars Electronica Futurelab staff, which permits the production of virtual worlds spanning up to 64 display walls simultaneously. To achieve active stereo effects, two computers equipped with NVIDIA graphic cards are used for each display wall. In order to achieve active stereo effects two video projectors with polarized lens have to be used per display. The audience uses stereo glasses to get the immersive impression. See http://futurelab.aec.at/arsbox/index3.htm, 18.11.2007, 3:25.

Figure 28 Schloss Schönbrunn, 2005. © Ars Electronica Futurelab.

Figure 29 Displaced Emperors, relational architecture 2, 1997. © Rafael Lozano-Hemmer.

"Displaced Emperors" (Fig. 29) was the second relational architecture project done by Rafael Lozano-Hemmer in 1997 in collaboration with Will Bauer and Susie Ramsay and assisted by Daniel Rivera and Patricia Maier. This installation used an architectural object to relate the Habsburg Castle in Linz (Austria) with the Chapultepec Castle, which is the Habsburg residence in Mexico City. Wireless 3D sensors calculated the position that the visitors pointed to on the façade. A large projection of an animated hand was shown at the pointed location. The passersby/visitors could reveal the interiors of the Habsburger Castle in Linz, which corresponded to Chapultepec Castle in Mexico City.[373]

In both works, in "Schloss Schoenbrunn" and "Displaced Emperors", there is the representation of an interior. Differently to the work of Ars Electronica Futurelab, Lozano-Hemmer unveils the interiors through the usage of the motif of the hand. The hand appears as the visitor points with his own hand to on the façade. In Ars Electronica Futurelab's work the visitors enter these interiors and experience them, while in Lozano-Hemmer's work the visitor can depict the interiors projected in a façade of a building. There is a kind of dematerialization of the building. The building loses its skin; becomes transparent, its inside is revealed. But it is not the real interior that is observable; it is the interior of another building that is being projected. The work presents on the one hand a transparent building and on the other hand the real interior of the building is not being shown. It is a kind of showing and hiding at the same time. The realistic level in the work of Ars Electronica Futurelab is more present, because the visitors visit an object already announced in the title of the work. The interiors are also in Lozano-Hemmer's work realistic realizations, but their representation over a facade of another building transfers the realism into surrealism. The meaning of the work has been transferred after projecting the interior of another building onto the façade.

In Lozano-Hemmer's work presenting the recordings on the outside of the building makes the passersby curious and invites them to be a part of the work. The visitors to Ars Electronica Futurelab's work know already, before they wear the glasses and enter the projection room, what they're going to visit virtually. Through the technique used, in this work the visitors can see the objects zooming in different high-levels and different corners. In Lozano-Hemmer's work the visitors get to see images by pointing at the façade.
In both works elements of interiors appear, and in both works these elements have an historic importance. In one work they represent a kind of conservation of culture and in the second work they represent a kind of cultural exchange.

Interiors are in both historic art and in interactive digital art represented for preservation. In both kinds of art interiors can represent a culture and its class. They were also represented to create an illusion of an architectonical place (as in the fresco at Boscoreale mentioned in the introduction). An issue of the interactive digital artists is immersing in existing interiors while being miles away from that place (as in the work "Schloss Schönbrunn" of Ars Electronica Futurelab, 2005). Interiors as motifs in interactive digital art express this issue. It is an achievement based on the technology developed for the virtual reality. Also the preservation is here a reason for this representation. In the work of Rafael Lozano-Hemmer, "displaced

[373] See Rafael Lozano-Hemmer: *"In addition, for ten schillings, people could press the "Moctezuma button" and trigger a temporary post-colonial override consisting of a huge image of the Aztec head-dress that is kept at the ethnological museum in Vienna"*, from
http://www.lozano-hemmer.com/eproyecto.html

emperors, relational architecture 2" (1997), the visitors of the Habsburg Castle in Linz (Austria) could get to see the Habsburg residence in Mexico City (Chapultepec Castle) by pointing out to the façade with their hands. The visitors can experience specific interiors from outside, they can explore an interior in another country despite being miles away from it. The interior could be seen on a façade: the boundaries between in- and outside were deleted, the same as the boundaries between the two countries. Also here the interior has the function of preserving. Also, it is a motif for representing cultural exchange. Further, by offering the possibility to the observer/user to manipulate it, the meaning of historic interior has been extended to an entertaining motif. The users are invited to imagine how it would be if those emperors were displaced.

4.6.4. Abstract Spaces

Places in interactive digital art are defined also through abstract motifs. They acquire an abstract character by the usage of such motifs. The visitors immerse in three dimensional virtual places and spaces, which consist of dots, lines, geometrical surfaces or symbols. The spaces can be manipulated in real time and the perception of the space can change while interacting with it.
David Blair wrote on "Metavirtue and Subreality" that: "*Traveling through the fiction is like navigating through an immersive environment, and vice versa*"[374]. Furthermore he writes about navigation, taking into consideration the so-called haptic dimensions of thought: "*Navigation through immersive environments is of course a serious problem in the world, an enjoyable problem in amusement parks, and a highly rhetoricized one in virtual worlds. Already, in an amusement park, we are often on the verge of fiction making. By the time we get to virtual reality, we find ourselves in the midst of a full-blown metafiction. […] Navigation in virtual worlds tends to disrupt the ordinary balance that exists between our exterior senses and our interpretive subjectivity. It is no accident that virtual reality has been compared with hallucinogens. LSD, alcohol, fatigue, and lucid dreaming have all provided us with many examples of this disruption, all tending to reveal what I would call the haptic dimensions of thought: a sudden intuition of the material nature of thought is received from the environment, and at the same time transforms the environment."*[375]

Ulrike Gabriel studied philosophy and studied at the Akademie der Bildenden Künste, in Munich. She is the founder-member of the organization "Otherspace". She created works in the field of installation and interactive virtual environments, such as "Breath" (1992 – 1993), and "Terrain 01" (1993). Currently she lives and works in Berlin.

In the audiovisual environment "Perceptual Arena" (1993) which was designed by Ulrike Gabriel and "Otherspace", co-produced with Canon Artlab in Tokyo, the visitors can construct and manipulate computer generated shapes using a "*virtual sensor*"[376]. The visitors are equipped with a data glove and data helmet, stand on a heightened, rounded and fenced platform, create and form abstract shapes interactively. Those are projected on large screens. With the help of the "virtual sensor", which is a kind of a virtual interface between the viewer and the shapes in the virtual scene, the complexity of the shapes increases as more of the environment is perceived. The density, texture, shape and size of the shapes are manipulated through the movement of the visitor. Due to this, parts of the scene, which are selected through the view of the observer, are unfolded into a three dimensional representation. Further, while moving, the visitor spreads the existing shapes. The perception of the scene, particularly of the "arena" is individual to each viewer. Each interpretation of the observation is individual.
Places also appear in this kind of art as abstract spaces, which can be constructed and manipulated by visitors. In the work "Perceptual Arena" (1993) by Ulrike Gabriel, computer generated shapes are transformed live by visitors, who are immersed in them. The visitor's

[374] David Blair, *"Metavirtue and Subreality"*, pp. 305-319, here p. 307, in: Druckrey (1996).

[375] Blair, p. 307, in: Druckrey (1996).

[376] Ulrike Gabriel describes this element as in the following *„the virtual sensor is an active space volume (3D-culling) in the field of view […]",* from http://www.t0.or.at/arena/arena_tx.htm#VIEW

movement or gaze is the tool of construction and modulation of an abstract space. The idea is to explore unknown spaces (as those in cosmic dimensions), then and now. The human explores new lands, new continents, new planets, stars or galaxies. This research spirit of exploring new territories has been reflected within this kind of artwork. On the other hand humans create, form and organize spaces comfortable to their needs and to their aesthetic requirements. The desire of the human to do this by himself has been reflected in this work. The human as researcher, explorer and creator of a space (of a macro- or micro world) is projected within this artwork.

The artistic group Knowbotic Research, whose members are Yvonne Wilhelm, Christian Hübler and Alexander Tuchacek, was established in 1991. Since then Knowbotic Research has worked with the visualization of information in real time and has developed suitable interfaces. Their projects also present artistic experiences with digital media trying to make data visible for the public. The Knowbotic Research has a professorship since 1998 and conduct researches in the field of New Media at the University of Art and Design in Zurich (Switzerland).

Figure 30 Dialog with the Knowbotic South, 1994. © Knowbotic Research.

In the work "Dialog with the Knowbotic South" (DWTKS)[377] of 1994, (Fig. 30), Knowbotic Research uses data from various research and monitoring stations in Antarctica to represent this place in an abstract way. The visitor enters a darkened room and can move in it equipped with a head set with a small monitor and holds in his hand a wand, which looks similar to a joystick. Visual data, which are presented by software agents, the so-called 'knowledge robots', or "knowbots" are projected on large screens. The constellations of the knowbots recall, because of the small glowing dots in a darkened space, presentations in planetariums. The surfaces created by particles rotate, band, intersect and interfuse each other. Their movement creates swirls and so the illusion of depth in the scene increases.
A dynamically changing space is generated through the interactivity (navigation) of the visitor. He or she is navigating in an abstract represented Antarctica, and the air-turbulences, special light effects and metallic sounds transform the installation room into a sophisticated experience.

The visitors can immerse themselves in live processed data, as for example those of Antarctic, in an exhibition room/installation space: the work "Dialog with the Knowbotic South" (1994) by Knowbotic Research offers the experience of this kind of abstraction. The space, which has been defined by glowing dots (small particles), can be manipulated by the visitor's navigation; he or she is becomes an integrated part of a dynamically changing abstract place. The motif of abstract dynamic spaces is already known from the media artwork of Mischa Kuball "Space / Speech / Speed" of 1998 (discussed in the introduction), who defined spaces with the help of light effects. Glowing dots appear as motif in the film work of Larry Cuba (3/78 "Objects and Transformations" of 1978) and of Erwin Redl ("Matrix II", 2000-2003) whose works are discussed above. Here the dots represent data. Data that researchers obtain from their research are almost abstract data including various numbers and calculations. To represent this, artists of Knowbotic Research used an abstract defined space. It reflects the deepness of research which sometimes is an abstract space even if it can be exactly calculated and mathematically expressed.

Glowing dots were used also in the film work (16 mm film) by Larry Cuba 3/78 "Objects and Transformations" of 1978, where "*Sixteen 'objects', each consisting of one hundred points of light, perform a series of precisely choreographed rhythmic transformations. Accompanied by the sound of a Shakuhachi (the Japanese bamboo flute), the film is an exercise in the visual perception of motion and mathematical structure."*[378] Also later, in the work of Erwin Redl small glowing LED lights were used, which look like dots, for example in the work "Matrix II" (2000-2003) presented at the Riva Gallery in New York. In opposition to this work, the glowing dots in the work by Knowbotic Research create surfaces that define the space, transforming it into swirled structures. Furthermore, these can be virtually visited. The Antarctica takes on a new image and its aesthetic is now based on different technical data measurements. Antarctica, which is a relatively unexplored/abstract place, is being visualized in an abstract way. According to Oliver Grau: "*A representation of complex, chaotic, processual systems could hardly be anything other than abstract; nevertheless, it is more than apparent that the artists consciously distance themselves from the paradigm of illusionist virtual reality.*"[379]

[377] In 1996 "DWTKS" was awarded with the Lehmbruck Prize for Sculpture (August Seeling Förderpreis).

[378] http://www.olsenorsen.org/olsen-8.html

[379] Grau (2003), p. 216.

Both works, “Perceptual Arena” and “Dialog with the Knowbotic South” are virtual environments, which can be visited equipped with data helmet, o r head set respectively. Differently to the work of Knowbotic Research, visitors to Gabriel’s work can interact using a data glove and their gaze. In Knowbotic Research’s work the visitor interacts through a wand. In both works the represented virtual environment consists of abstract elements. In Gabriel’s work the environment consists of different kinds of shapes, while in Knowbotic Research’s work the environment consists of glowing dots. The human as researcher and explorer is being reflected in both works. In the work of Gabriel the human as creator is highlighted, while in the work of Knowbotic Research the art of the visualization is the focus.

The representation of places and architecture in interactive digital art has been discussed within the above chapters: naturalistic virtual immersive public places, abstracted real cities, realistic represented virtual interiors and abstract spaces.

5. Abstract Visual Motifs: Historical Overview

Abstract art is generally understood to mean art that does not depict objects in the natural world, but instead, uses colors and shapes in a subjective way. In the Islamic religion, for example, the depiction of human beings is not allowed. Consequently the Islamic culture has developed a high standard of decorative arts. So abstract motifs appear early in Islamic art as geometric motifs for decorating almost every surface, whether walls or floors, pots or lamps, book covers or textiles. Many of the patterns used in Islamic art look similar, even though they decorate different objects. They are two dimensional and are made up of a small number of repeated geometric elements that create a complex whole by repeating.
Arsén Pohribny wrote that the pure Elements *"(oder Mittel) – Punkt, Linie, Fläche und Farbe – bilden die Pfeiler, auf denen das verwickelte Geflecht des Visuellen beruht. Erst Befreiung und Beherrschung der visuellen Systeme ermöglichte die Existenz der abstrakten Kunst."*[380]

5.1. Geometric Motifs

Abstract art, in particular abstract motifs, first became autonomous motifs in painting in the 20th century. The work "The Black Square" (according to John Milner, dated to 1912) by the painter and one of the main representatives of the Russian abstract art, Kasimir Malewitsch (1878 – 1935) is a work that establishes the beginning of a whole direction of abstract art which is based on geometric shapes. This work, that was shown at the exhibition in Petersburg "0,10" belongs to the Suprematist style and was important for the whole of Constructivism; not only for the works of the constructivists in Russian (Wassily Kandinsky, El Lissitzky and Wladimir Tatlin), but also for the constructivists in Holland (the artists of the group "De Stijl", founded in 1917, like Piet Mondrian or Theo van Doesburg). According to John Milner, *"Malevich created the most celebrated geometric painting of the twentieth century. It was painted on a square canvas and featured a black square centrally placed within a white area extending to the edges of the canvas. He called it Quadrilateral and it has since become known as The Black Square."*[381] Karin Thomas opinion about the beginnings of painting such paintings is as follows: "*Zwischen 1913 und 1915 löst sich Malewitsch in Theorie und malerischer Praxis von den Vorbildern des Kubismus und Futurismus, um mit seiner theoretischen Schrift »Vom Kubismus und Futurismus zum Suprematismus« (Juni 1915) sein malerisches Ziel, die Schaffung eines gegenstandslosen Bildausdrucks, einzuleiten. Zunächst bemüht sich Malewitsch darum, die kubistische Reduktion der Gegenständlichkeit auf wenige symbolische Grundelemente zu konzentrieren. So deklariert er Quadrat, Kreis und Kreuz zu den Elementarformen des bildnerischen Aufbaus, die in ihrer geometrischen Gestalt zugleich Sinnbilder ursprünglicher Intuition und magischer Assoziation sind."*[382]

---

[380] Arsén Pohribny, Abstrakte Malerei, Herder Freiburg, Basel, 1978, p. 22.

[381] John Milner. Kazimir Malevich and the Art of Geometry, Yale University Press, New Haven and London, 1996, p. ix.

The geometric shapes of the Russian painter Wassily Kandinsky are in contrast to the Dutch painter Piet Mondrian. The shapes and the colours in Kandinsky's work are distributed over an agravic-surface, while Mondrian fixes the shapes through an orthogonal grid over the image-surface. Wassily Kandinsky, one of the founders of the artistic society "Der Blaue Reiter" (1911) and lecturer on the Bauhaus in Weimar, shows among other styles also a style, which is characterized by geometric shapes and lines. For example, in the "Composition 8" "*various geometric elements are strewn over the canvas and allowed to interact without a hierarchical tectonic unity. Most striking is the large circle in the upper left corner, which resonates in the other circular forms and contrasts with the predominating acute angles."*[383]
The Dutch architect Theo van Doesburg, Piet Mondrian, the sculptor Vantongerloo, and the architect J.J.P. Oud established in 1917 a magazine called "De Stijl", whose key ideas cannot be separated from Mondrian's aesthetic theory of Neo-Plasticism[384]. Its theory was aimed at scaling down the formal components of art into primary colors and straight lines. According to the American art historian Kirk Varnedoe: "*In Mondrian, we saw the idea of a theosophical or platonic balance of vertical and horizontal and the Ur-principles of the universe, with pure complementary colors, as the reductive demonstration of absolutes in the optical world."*[385] His theories led to such works as "Composition with Red, Yellow, and Blue" (1927, Cleveland Museum of Art, Ohio), which was composed of few black lines and well-balanced blocks of colours.
The geometric shapes also constitute the motifs in the works of German painter Josef Albers, as in the works of the series "Homage to the square". With this abstract motif he tried to show that colours are perceived differently depending on the environment in which they appear and how long we look at them. According to Oswald Oberhuber: "*Josef Albers "Homage to the Square" ist eine Variation der Farbe mit einer bestimmenden Quadratabstufung. Der Vorstoß von Albers über die moderne Kunst hinaus in ein Neuland, in dem Form und Farbe aufgehoben wurden, ist eine bis jetzt kaum erkannte Leistung. Denn die Aufhebung von Form und Farbe ist ein wesentlicher Verdienst seiner ungegenständlicher Untersuchungsvorgänge. Diese Absicht ist der eigentliche Erfolg, resultierend aus dem sich wiederholenden Vorgang, wobei das Quadrat die Funktion eines kontrollierenden Ruhezustandes hat, der als eine Art Kompromiß für die Formfrage zu gelten hat. Gleichzeitig wird die Wiederholung sichtbar gemacht. Die Farbe wird nur mehr als geschmacksbezogene Variabilität eingesetzt und negiert dadurch die Farblehre vergangener Jahre, die bis dahin als bestimmender und kontrollierender Faktor interpretiert wurde.*"[386] His works count also as hard-edge-painting. Then we find abstract geometric motifs in the geometric abstraction of the 60s, as for example

[382] Karin Thomas. Bis heute. Stilgeschichte der bildenden Kunst im 20. Jahrhundert, Dumont, Köln, 1978 and 2000. p. 135.

[383] Vivian Endicott Barnett. Kandinsky at the Guggenheim, Abbeville Press Publishers, New York, 1983, p. 160.

[384] See Carel Blotkamp. Mondrian. The Art of Destruction, Reaktion Books, London, 1994, p. 128: *"Mondrian's first full art-theoretical tract, 'Neo-Plasticism in Painting', published in 1917-18, is in effect one great celebration of painting. After a long and venerable history, painting has reached the point where a consistent abstraction of form and colour has finally revealed the universal means of expression (the straight line and primary colour)."*

[385] Kirk Varnedoe, Pictures of Nothing. Abstract Art since Pollock, Princeton University Press, Washington, 2006.

[386] Oswald Oberhuber. Josef Albers. Homage to the Square, Hochschule für Angewandte Kunst in Wien, 1992, o. S.

in the works of the Minimalist artists (Ad Reinhardt, Max Bill, Barnett Newmann, Ellsworth Kelly and Frank Stella) or in the works of the Op-Art artists (its founder was the Hungarian painter Victor Vasarely).
Ad Reinhardt's works, for example, are characterized by the representation of squares, which can be differentiated only by longer observation of these works. The geometry of such artworks can be revealed only after lingering a while in front of them – subtle color scaling, which is present in those works can then be experienced. Victor Vasarely's abstract-geometric works are characterized by a kind of optical delusion, created using geometric shapes and brilliant colors.
At about the same time we find linear-geometric abstraction in the works of computer artists as the Germans, Georg Nees and Frieder Nake, and the American, Michael Noll, and later in the works of French artist, Vera Molnar. The computer animations of Manfred Mohr from 2002-2004 (made with the computer programme space.color.motion) can be included in the development of this direction.
In the field of Film (Stummfilmkunst) can be mentioned the most important German Representative of "Absolute Film", Walter Ruttmann, who experimented between 1921-1924 in his "Opus I-IV" with strictly graphic abstract shapes.

5.2. Amorphous Motifs

The other art of abstraction, which was developed in opposition to the geometric direction, begins with a watercolor work "Untitled" by Wassily Kandinsky made in 1910 (1913)[387]. Then it was developed through the Orphism of Robert Delaunay (from 1912) in the Abstract Expressionism (after 1945) in America in the works of Jackson Pollock (so-called "Action Painting"), Franz Kline and Arshile Gorky. A similar direction was also developed in Europe by abstract expressionist painters such as the representatives of Informel, Art Brut, Tachisms and the lyric painters - Jean Bazaine, Roger Bissiere, Georges Mathieu, Alfred Manessier, Maurice Esteve, Nicolas de Stael and others. One of the main differences between Paris and New York was that the French painters used realistic names for their abstract art motifs.
Taking the works of the American Jackson Pollock into consideration, we can mention that the gesture is the most important in his paintings. He used the so-called method of "dripping", which was already known from the Surrealist painter Max Ernst. Drip paint was a painting technique in which paint drips onto the canvas, instead of being applied with a brush, or spatula. Pollock used it so that he drops the paint on canvas that lay on the floor by making characteristic step-movements which were based on Native American dance during the realization of sand-paintings.
The works of the American painter Franz Kline are characterized, similarly to the works of the French painter Pierre Soulages, by their dark calligraphic-like and dynamic oversized signs over a bright background, which emerge as results of dramatic gestures. Pierre Soulages, as an Art Informel artist, rejected the discipline and structure of geometric abstraction in favor of a intuitive gesture-based painting technique. Spontaneous, gesture-based and instinctive in his art was also the French painter Georges Mathieu, who is an artist of the Tachisme-style (in French: "tache" means a "spot" or "blot").
Also sculptors, such as the constructivist and pioneer of Kinetic Art, the Russian Naum Gabo, or the Rumanian pioneer of abstract sculpture Constantin Brancusi used abstract motifs in their artworks. For example the 1923 work "Säule" (in Engl. "Column") by Naum Gabo, is a kind of kinetic sculpture, and shows a constructive overall impression. An incorporated electromotor made this sculpture vibrate and so create a volume in the space, which in and out can't really be defined.
Concerning the implementation of the abstract motifs in the architecture for defining and redefining the architecture, the space or interiors, we can mention the works of the Austrian artist Peter Kogler. With respect to video art we can mention the works of Steina Vasulka; for example "Distant Activities" from 1972 showing abstract fluid motifs.

[387] See a description of this work in: Ingo F. Walther (Ed.), Kunst des 20. Jahrhunderts, Malerei, Skulpturen und Objekte, Neue Medien, Fotografie, Köln, 2002. p. 103.

6. Abstract Visual Motifs in Interactive Digital Art

Interactive artworks, in which motifs are abstract, are already known from 70s. For example, cybernetic sculptural installations by Wen-Ying Tsai, in particular the work "Cybernetic Sculpture" (1979) counts among interactive abstract artworks. It was composed of moving fiberglass rods illuminated by strobes. According to Lucy Petrovich: "*The movement of the strobes responded to sounds made by people around them. The rods would move slowly when the environment was quiet, frantically when it was noisy."*[388]

In interactive digital art we find abstract motifs as background-motifs and as leitmotifs. Abstract motifs are represented as geometric shapes or amorphous shapes. Geometric shapes can be divided into constructive linear shapes, constructive two-dimensional shapes and constructive three-dimensional shapes. Globally the shapes can have an open, or a closed form. They can be regular or irregular forms. They are represented as monochromic objects or multi-coloured objects, in different material-simulations. They are also constituted as three-dimensional or two-dimensional (constructed as flat surfaces or just with lines), as opened or closed shapes. Abstract motifs in interactive digital art are represented as symbolic motifs, for example, in works which visualize music-compositions, or they are presented as decorative motifs. They appear as abstractions which are constituted through overlaid shapes or fluid simulations, or shapes/fluids that intersect each other, or are placed within each other.

In some works geometric shapes appear in combination with other kinds of shapes as modules, also in combination with objective motifs. For example, the work "Small Fish" (1999) by Masaki Fujihata, Kiyoshi Furukawa and Wolfgang Münch shows in some stages strictly geometric shapes, while objective motifs like leaves and fishes appear on other visual levels.

Purely abstract motifs appear in some works as the result of visualizations of scientific themes. For example, the work "Molecular Bubbles" (2002) by Zack Booth Simpson and Brian Sharp has been inspired by Calder's Mercury Fountain. Due to this fact they wanted to create shapes, which look like they are made of mercury. As the visual result appears abstract fluid shapes similar to colourful sausages, which are manipulated by a reaction to the shadows of visitors.

There are also artworks in which the visual motif is the line. In the work OP_ERA (2005) by Daniela Kutschat and Rejane Cantoni, virtual lines simulate an environment defined by strings, which can be played by touching them and react by playing an instrument live. The following chapters will research further the presentation, function and constitution of the abstract motifs in interactive digital art: "Motion, Traces, Detections – Linear Constructive Motifs or Amorphous and Geometric Shapes", "Liquid Shapes as Motifs" and "Fractals as Motifs".

[388] Lucy Petrovich, *"From Computer Art to Digital Art to New Media"*, from http://www.isea2000.com/actes_doc/25_petrovitch.rtf, 08.01.2008, 17:12.

6.1. Motion, Traces, Detections – Linear Constructive Motifs or Amorphous and Geometric Shapes

Abstract motifs in interactive digital art appear as mentioned above as linear constructive constellations, which vary depending on different factors of interactivity. In this chapter will be discussed the works whose interfaces depend on the visitors' movement so that their movements are detected and are calculated and visualized representing different linear constellations. The position of the visitors in the installation room is used as data for the visual level of the work. For example the work "Arc Tangent" (2001) by Camille Utterback shows dynamic drawings, created by the positions and movements of the visitors around a circular floor projection.[389]. Such line constellations also appear in the works in which the main motif is an objective motif. For example the work "Skies" (1998), which is an interactive video and sound installation made by Don Ritter, black paths appear under the feet of the visitors at specific locations and create patterns which reminds us of the "stained glass" paintings in gothic churches.
Within this category, the work "Boundary Functions" (1998) made by the American artist Scott Snibbe will be discussed as representative of the abstract motifs that are based on line-constellations. The work of Ursula Damm, "Trace Pattern I" (1997) will be discussed as representative of abstract motifs constituted through lines and geometric shapes. The work of Seiko and Sota Ichikawa "Gravicells – gravity and resistance" (2004), will be discussed as an example which deals with the theme of gravity researching motion traces. An example by the artists Scott Ritter, Ars Electronica Futurelab, Golan Levin and Zachary Lieberman "Motion Traces - a1 lounge", realized in 2004, will be discussed as oppositional to these works (concerning the motif constitution). This artwork is also a reflection of the visitors' movement.

The American Artist Scott Snibbe, who studied Computer Science and Fine Art is known for his electronic media installations that directly engage the body of the viewer in a reactive system. He designed his works *"to have specific social effects: to create a sense of interdependence, to promote friendly interaction among strangers, and to increase viewers' concentration*"[390]. His works have been represented internationally including the Whitney Museum of American Art's Artport (New York), Eyebeam, and The Kitchen in New York, the InterCommunications Center in Tokyo, Ars Electronica in Austria, The Institute of Contemporary Art in London and the Yerba Buena Center for the Arts in San Francisco. He is currently the founder and CEO of social music video startup Eyegroove. "Boundary Functions" (1998, Fig. 31), is a work that creates a relationship between Theodore Kaczynski's PhD-thesis (written 1967) and Voronoi diagrams[391]. These are realized as a set of lines projected from overhead onto the floor; each line divides two people from each other. So

[389] See Camille Utterback: *"One mode connects all the participants with modulating lines. In another, users' physical positions take on strategic importance as their locations correspond to a 'pong' paddle in a circular version of the popular arcade game. The word tangent derives from the Latin verb to touch, and means 'making contact at a single point'."*,
from http://www.camilleutterback.com/arctangent.html
[390] http://snibbe.com/scott/bio.html

the space of each person changes dynamically taking into consideration the distance of other people around him. The space each person has looks like a kind of cell.
In the exhibition space there must be at least two people so as to project the division-line. Thus, the artist defines personal space as existing only in relation with two or more people. By projecting the Voronoi diagram, which is based on the relationships between individuals, the unseen becomes visible; the space becomes dynamic[392]. Abstract mathematical rules become visible and more understandable. Depending on the number of visitors, patterns which look like natural shapes are being developed, such as those of grouped soap-bubbles. But in this work visualization is made less complex, in a two-dimensional form. The projected lines which constitute different patterns following given rules are a kind of reflection of each visitor's space in relation to others.

The distance between visitors is also important for the interactive installation "Trace Pattern I", (Fig. 32) which is one of the interactive installations within the project "InOutSite" (1997-2002) made by the German artist Ursula Damm and was presented first at Art Cologne (Köln, 1997). The geometric patterns here are triggered through the movement of people in official places. A camera records the visitors to this place; their movements are calculated and the geometric shapes created build a kind of net between two people. If the tracked subjects linger at the same place, then different variants of polygon-agglomerations are triggered. At the same time accords are triggered, which depend on the side-length of polygons. While these patterns are being displayed the visitor, who is displayed as a circle, can consider himself inside this pattern. He can approach if this pattern-visualization has to do with his feelings about this space,[393] or he can approach the kinds of patterns that are being triggered between him and the other visitors.

Viewing the result of visualization as moving images, we can distinguish, on the one hand, geometric shapes that are characterized through their regularity (for example regular polygons) and, on the other hand, an irregular distribution of these shapes over the surface. The geometric shapes are repeated and create changing hierarchies over the surface. They are also intersected. These patterns remind us in their linearity of architectural-constructions and plans; ultimately, this is a kind of "planning" of a virtual space.

---

[391] See Snibbe: *"These diagrams are widely used in diverse fields; spontaneously occurring at all scales of nature. In anthropology and geography they are used to describe patterns of human settlement; in biology, the patterns of animal dominance and plant competition; in chemistry the packing of atoms into crystalline structures; in astronomy the influence of gravity on stars and star clusters; in marketing the strategic placement of chain stores; in robotics path planning; and in computer science the solution to closest-point and triangulation problems."*,
from http://snibbe.com/scott/bf/index.htm

[392] See Paul (2003), p. 174: *"By giving disembodied information about our bodies a concrete diagrammatic form, Snibbe's piece underlines the digital medium's capacity to visualize abstract processes in a dynamic way."*

[393] See a description of the work, at: http://www.khm.de/keyareas/mk/ACdamm.html

Figure 31 Boundary Functions, 1998. © Scott Snibbe.

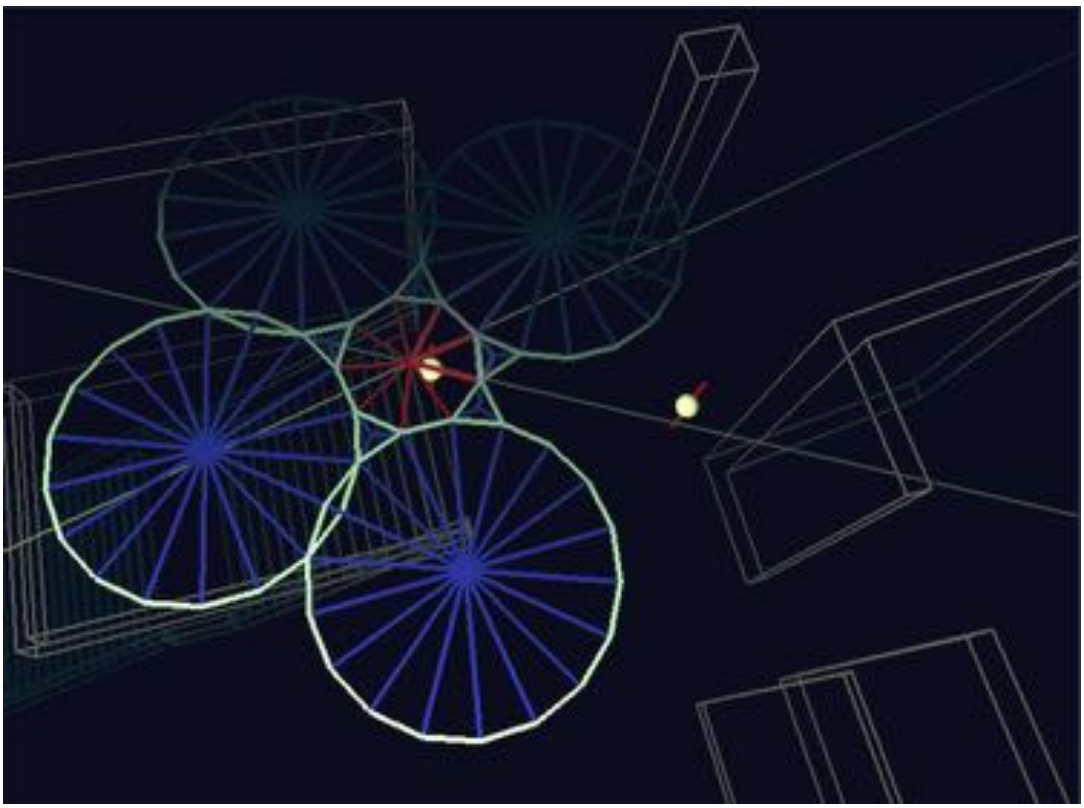

Figure 32 Trace Pattern I, 1997. © Ursula Damm.

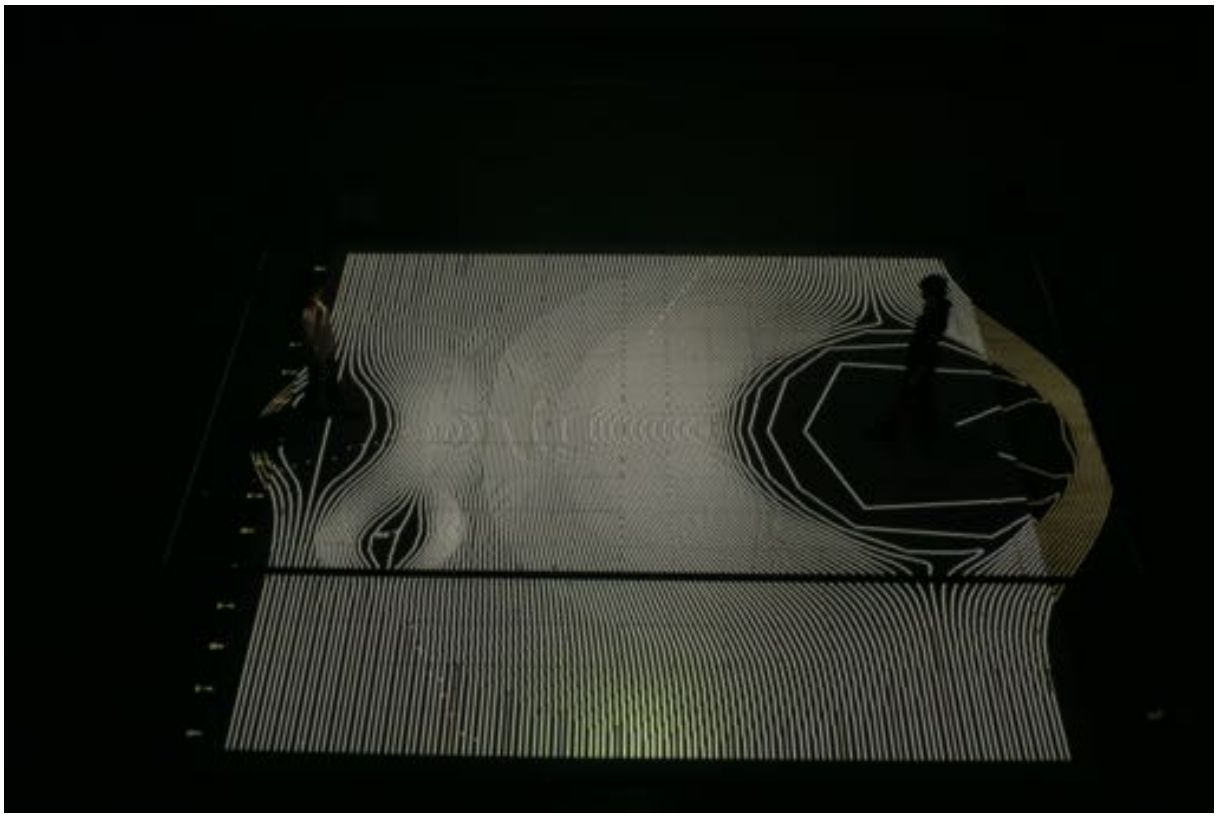

Figure 33 Gravicells – Gravity and Resistance, 2004. Seiko Mikami and Sota Ichikawa. © Photo by Kenichi Hagiwara, Courtesy of Yamaguchi Center for Arts and Media.

Compared to Snibbe's work, Damm's work is also based on the movement and on the personal space of individuals. Also in both works the visualization is done through lines, which in Snibbe's work are projected between people, on the floor and in Damm's work on a projection screen on the wall. So visitors can experience the concept better in the work of Snibbe, because they are in the projection, they are directly part of the result. They take their place on the projection plane. In both works two-dimensional patterns are generated through lines, but in the work of Snibbe we can see more regular shapes.
By increasing the number of visitors, the shape-constellations of Snibbe's work remind us of patterns in Islamic art, which are based on honeycomb-like shapes (structures of small hexagonal wax cells). These are used later also by other artists in interactive art, such as in the work "Nano" (2004) by Victoria Vesna. In contrast to this the shapes in Damm's work are differently built and arranged (distributed in a regular or irregular way); we can distinguish in Damm's work even projections simulating three-dimensionality in their perspective. So the

work of Snibbe causes in general an overall impression of straightforwardness, even simplicity and minimalism; this work achieves a net-like character. In both works the interaction is a reciprocal communication between a user and a programmed work, and also a reciprocal communication between users through a programmed work. In both works there is a form of a relation-exploring interaction which is based on visualizations of mathematical rules. The visualization of these mathematical rules is not important itself, but the study of how the users/visitors interact with each other, how they react to each other and what they expect from each other movements. Damm's work is exposed in a public space so it is also able to research a random public.

As an example in which realization has an abstract result, but its meaning is closely linked with the human body (the physicality of the body because of gravity rules), is the work of Seiko Mikami (1961-2015) and Sota Ichikawa, "Gravicells – gravity and resistance" (2004, Fig. 33), from the Yamaguchi Center for Arts and Media (YCAM).

In this work the lines are distributed over the surface of the sensor-fitted floor and the visitor can manipulate their organization. This affects their global appearance. They are removed and are rearranged approaching each other, or moving away from each other. In this way they build concatenations over the projection surface. Also the visitors are decorated with the projected lines. The pattern recalls the Moirés which we know from the drapery industry, or as the physicists call them 'interferences'. These patterns appear if one overlays line-patterns, for example, those that emerge if transparent curtains are overlaid.[394] A moiré pattern is an interference pattern created when two grids are overlaid at an angle and also when lines are arranged relative near to each other.
The work of Mikami and Ichikawa reminds visually in some stages on the work of Thomas McIntosh, Mikko Hynninnen and Emmanuel Madan, "Ondulation" done two years before, in 2002, which creates an analogy between the waves of water and the waves of sound. An example of early computer graphic, characterized by interferences is "Asymmetrie" (1966) by Maughan S. Mason. The work of Mikami and Ichikawa reflects not just the rules of gravity due to the weight of the visitors, but it reflects also the impact that each individual has in society, how each individual affects society through the importance of the activity that he or she has done and is doing.

In 2004 architect Scott Ritter created, together with experts from the Ars Electronica Futurelab and with media artists Golan Levin and Zachary Lieberman, "Motion Traces - a1 lounge" (Fig. 34) an interactive artwork for the A1 store (mobile trade) in Vienna (Austria). The visitor (in this case shopper) causes dynamic lighting effects through its movement. This interactive work consists of synchronized projections that are blended. Several of the visualizations show liquid-like animated shapes; other visualizations look like gentle waves or even striped patterns. The walls of the store, which remind us, because of their color and foggy atmosphere, of James Turell's light-works, become dynamic and react to the visitors. Not just the shapes change, but also the wall color, the whole room changes color. Dominant here, in the visualization of visitors' movements, are more rounded and fluid shapes, which disappear as soon as the visitors move out from the tracked area; as soon as the visitors stop

[394] See Ernst H. Gombrich. Ornament und Kunst, Stuttgart 1982, p. 105: *"Wenn man kompliziertere Netze übereinanderlegt, wird das daraus entstehende Muster komplizierter und interessanter warden, wie die einander kreuzenden Wellenmuster auf der Oberfläche eines Teichs"*.

Figure 34 **Motion Traces - a1 lounge, 2004. © Scott Ritter, Ars Electronica Futurelab, Golan Levin and Zachary Lieberman.**

moving the intensity of the visualization is reduced until it totally disappears from the wall surface.
The wall in which the visitors are visualized is positioned in front of the stairs, which bring visitors to the first floor. They are projected onto a vertical dominated wall/projection surface. The different module-visualizations show various combinations of dots, lines, shapes and colors (lights).

The line-constellations in the visualizations of Damm's work, Snibbe's work and Mikami and Ichikawa's work are in contrast to the shapes that appear in the work of Ritter, Futurelab, Levin and Lieberman. In fact the interface of all these works (Snibbe's, Damm's, Mikami and Ichikawa's and Ritter's) is based on the movements of visitors. The visualization in Snibbe's work is done to research the social aspect between people and space-definition of each person through the usage of specific mathematic rules. In Damm's work the interface is used more to research the distances between the visitors in an abstract way, to create and define abstract patterns and spaces.
The interface of Mikami and Ichikawa's work is similar to the work of Snibbe – the visitors causes changes by walking. In the work of Snibbe the individual space of each person has been considered, while Mikami and Ichikawa treated the aspect of gravity, how individuals affect each other and their surroundings as a theme.
In Ritter et al's work the main aim is more the design (of the visualization) itself. This is also accented through the different possibilities and module-variations that this visualization, which was done some years later (2004), includes. So we could ascribe a part of its advanced design (for example its fluid real-time change-over), its visualization-variability also to the technical state of art.
Here the shopper and their reflections are put in relationship with one another. People that don't know each other, but are here inside in the shop with the same or similar aim (mobile shop) are reflected in one projection, in one image. They trigger unintentionally a series of visual possibilities within this work.
To research abstract motifs within interactive digital art linear constructive motifs are considered, which appear as result of motion traces and detections. Sensor technology which is used in contemporary society, not just in different public working places but also within private houses (light detection, etc.), is important also for realizing different artistic works. Techniques used for the identification of individuals such as face recognition systems or fingerprint recognition software is common in the contemporary security industry. Also publicly installed cameras for security reasons record different parts of cities or other public places. More and more a "controlled society" is created. Motion traces and detection used in artworks reflect these elements which are part of everyday culture. This has been visualized through abstract motifs. Mathematical rules, which are applied for researching relationships between individuals, as in the work "Boundary Functions" (1998) by Scott Snibbe, are visualized by dynamic changing constellations of lines. The visitors cause the appearance of patterns over the floor and they are involved in a dynamic process. The visitors direct the evolvement of mathematical rules and of linear patterns. In the work "Trace Pattern I" (1997) by Ursula Damm, polygon-agglomerations are triggered by the presence of visitors in the area which is being tracked. On the one hand the visitors can create abstract patterns by their presence and on the other hand the perception of individual spaces can be perceived as an individual visual issue. Abstract linear constellations appear also in the work of Seiko Mikami and Sota Ichikawa "Gravicells – Gravity and Resistance" (2004) as motifs for researching the rules of gravity and of the impact that individuals have on their surroundings.

In the work of Scott Ritter, Ars Electronica Futurelab, Golan Levin and Zachary Lieberman, "Motion Traces - a1 lounge" (2006) abstract motifs appear as motion visualizer in different sophisticated forms: full or empty shapes, and dots, in different colors and backgrounds, moving according to the movement of visitors, who enter a shop for mobile phone trade. The visit to this shop is transformed into a personal, remarkable experience for the shopper. Abstract geometric shapes once used as elementary motifs for representing the "zero-point" (Malewitch) are now used for visualizing live human motion and the relation between the humans.

Another work of Golan Levin and Zachary Lieberman "Hidden Worlds of Noise and Voice" (2002) done in collaboration with Ars Electronica Futurelab has been taken into consideration in this book for researching amorphous/liquid shapes in interactive digital art, which will be discussed in the following chapter.

6.2. Liquid Shapes as Motifs

"Hidden Worlds of Noise and Voice" (2002) by Golan Levin and Zachary Lieberman is an interactive audiovisual installation which explores the relationship between speech and visual shapes. The voice of the visitors is transformed into three-dimensional shapes, which can be seen through data-glasses in the installation space. The visitors can see and explore their speech and sound, in combination with the speech and sound of other visitors. A kind of interaction between the visitors emerges. The shapes that emerge are colourful, amorphous and abstract, and correspond to the kind of voice visitors have and to their volume. The shapes and their movements are "*tightly coupled to the unique qualities of the timbres and phonemes sung or spoken by the user*"[395]. Six visitors can participate at the same time and create shapes by their speech or song, which are visible as a two-dimensional projection at the centre of the installation also for those visitors, who aren't equipped with data-glasses.

Visualizing non-material activities such as, for instance, the spoken language is an aim which has been visualized by liquid abstract shapes. Abstract shapes once used by Kandinsky for visualizing music are used for visualizing voice and noise of the visitors to "Hidden Worlds of Noise and Voice" (2002). In the installation room, the visitors "see" what they or others are saying. Their sense of hearing has been transformed into the sense of seeing of three dimensional virtual worlds.

In the work "Molecular Bubbles" (2002, Fig. 35) by Zack Booth Simpson and Brian Sharp, the visitors interact through their shadows with shapes, which are projected on a wall. The work has been installed in a darkened room and the shapes are distributed by accident over the surface. The shapes, which look like they consist of fluid, show shapes similar to colorful sausages. While moving and being transformed, the shapes show small angles in their structure. Their fluidity is circulating within them, being transported step by step in their body. Reacting to the shadows of the visitors, the colored liquid sausages are manipulated in length so that they are, for example, cut with the help of the visitors. They are manipulated in the direction of their movement, so that they can be turned in another direction.
The projected shapes can be made to form loops, or concentric rings. They can cross each other or be transformed from one shape to another. They can intersect each other and be divided into smaller parts, or overflow into each other. According to the artist: "*Although exotic, the action of the bubbles is surprisingly intuitive"*[396]. Simpson and Sharp were inspired by the American Artist Alexander Calder, in particularly by his Mercury Fountain[397] for this work. This was because they wanted to create shapes that look like being made of mercury.
Chemical elements such as mercury (Hg) have been treated as a theme in this kind of art. Its fluidity and consistence have been made "tangible" for the audience, rather than the structure of its molecules and atoms. In the work "Molecular Bubbles" (2002) by Zack Booth Simpson and Brian Sharp visitors can manipulate live the direction of the movement and the length of liquid shapes, which had to look like being made of mercury (the artists' intention).

[395] http://www.flong.com/projects/hwnv/

[396] http://www.mine-control.com/

[397] The Mercury Fountain was constructed to be used with mercury and not as usually with water. It can be seen at the Fundació Joan Miró in Barcelona.

Figure 35 Molecular Bubbles", 2002. © Zack Booth Simpson and Brian Sharp.

Figure 36 Fractal Zoom, 2006. © Zack Booth Simpson.

Compared to the work of Levin and Lieberman also this work shows amorphous shapes, which are moving. But the creation of these works is a different one: Levin and Lieberman's work is a visualization of the language spoken by individuals, while the work of Simpson and Sharp offers a live interaction with already projected shapes. The shapes in the Simpson and Sharp's work show relatively constant visual appearances. Their wideness, for example, is constant. The work of Levin and Lieberman shows variability in the wideness of the shapes due to the volume of the visitor's voice.
The three-dimensionality is also built in different ways: Levin and Lieberman's work shows smooth shapes, which seems to be kinds of clouds. They seem to appear and disappear from visitors' mouths smoothly like shadows, without being strictly defined in their form. The shapes in Simpson and Sharp's work are more 3D in their constitution. The contour of the shapes is here more accentuated. The movement and the orientation of them can be manipulated by visitors. The shapes in Simpson and Sharp's work appear over a surface, while the shapes in Levin and Lieberman's work appear in a space.

6.3. Fractals as Motifs

Benoît B. Mandelbrot[398] His discoveries were geometric objects, which he called "fractals". He took this word from the word "fractus", or "frangere" in Latin language, which means "broken". The concept was written down in his book "The Fractal Geometry of Nature" (1977). Mandelbrot didn't create a universal definition of the notion "fractal", because this notion excluded some forms, which he preferred to keep in.[399] So, to describe the fractal dimension we can follow an example, which was taken by Mandelbrot to describe fractals. One of the first examples described by Mandelbrot was the coastline[400]. Mandelbrot argued that its length can't be exactly measured, so that if two measurements were made by two different land surveyors, they would get different values. The length of a coastline varies depends on the length of the yardstick used to measure the distance between points along the coast. Fixing the points for measuring is a subjective issue, so also their final sum would vary. As more points were taken into consideration, so more "exact" the measuring would be. To get the absolutely exact sum endless points must be taken into consideration and this is practically not possible. We could say the same about measuring the surface of clouds, or mountains.
A fractal is characterized by the fact that the repetition of the same shapes and the aggregation through this repetition is endless.[401] Another characteristic of it is that behind a chaos of lines, surfaces or objects, some rules are permanently present,[402] as for example the repeating of shapes in another scale.
In interactive digital art fractals appear rarely compared to other forms of geometric shapes. In the following will be discussed two different examples that used this motif: the work "Fractal Zoom" (2006), by Zack Booth Simpson and the work "Audio Fraktal" (2004) by Joachim Goßmann.

Zack Booth Simpson, who is a software engineer, artist, and molecular biology researcher living in Austin (Texas),[403] did the work "Fractal Zoom" in 2006 (Fig. 36), based on the rules of the fractal geometry of nature. Participants can explore the Mandelbrot set by forming a

---

[398] In 1985 Mandelbrot was awarded with the Barnard-Medal of the Columbia University for the development of his fractal geometry of nature. Previous winners of this prize were, for example, Einstein, Bohr, or Heisenberg.

[399] Benoît B. Mandelbrot. Die fraktale Geometrie der Natur, Basel, 1987, p.16.

[400] See for this *„The Coast of Norway"*, in: Jens Feder. Fractals, New York, 1988, pp. 6-9 and see *"Wie lange ist die Küste Britanniens?"*, in: Benoît B. Mandelbrot. Die fraktale Geometrie der Natur, Basel, 1987, pp. 37-46.

[401] See here *"Selbstähnlichkeit und Messung"*, in: Harold M. Hastings und George Sugihara. Fraktale. Ein Leitfaden für Anwender, Heidelberg [u.a.] 1996, pp. 3-8.

[402] See Mandelbrot: *"Die Fraktale bieten einen gangbaren neuen Mittelweg zwischen der ausgeprägten geometrischen Ordnung Euklids und dem geometrischen Chaos von Rauheit und Fragmentierung"*, in: What Is It and What Does It Do?, in: Fractals in the natural sciences. M. Fleischmann, D.J. Tildesley, und R.C. Ball (Hg.), Princeton 1989, pp. 3-16.

[403] For further biographical information see http://www.mine-control.com/zack/index.html

loop with their fingers. They create a "*kind of magic magnifying glass*"[404] and can zoom with it into different parts of the projection. Within few minutes the visitors reach the "*size of the solar system*", while zooming in on the displayed image. The animation itself is a continuous zoom into a graph of a fractal mathematical function. According to the artist *"In this subtle way, the participants learn about the power of exponential growth while being fascinated by the complex beauty of this fractal.*"[405]

Joachim Goßmann is a sound engineer, who worked at the Fraunhofer Institute for Media Communication at St. Augustin (Bonn, Germany) in different interdisciplinary projects in the department of virtual reality. His works about spatial dimensions were presented in international Conferences. He finished his Dissertation in Computer Music at the Center for Research and Computing in the Arts at U. C. San Diego.
His interactive installation "Audio Fraktal" (2004) is presented at the permanent exhibition of the Museum for Media Art at ZKM (Karlsruhe), and shows a two dimensional projection of an "Escape-Time-Fractal" (a fractal similar to the Mandelbrot set) over a table in a darkened room. This kind of fractal is characterized by the density of different structures on a relatively small surface. A graphic-tray is used by visitors to explore the visual representation of the fractal. Its mathematic structure has been visualized with colors and shapes. Matching them, sound effects are added. The visitors can touch parts of the projected fractal and hear the sound that corresponds to these parts. These "*abstract, but strict determinist structures*"[406] of image and sound can be used to researching the differences between the acquisition of information in an acoustic and visual way.

Both works are interactive and their main visual motif is a fractal. The Mandelbrot set in Simpson's work has been realized in colors, while Goßmann shows a black and white fractal. Concerning the interface in the work of Simpson, the interface is more intuitive, because zooming is done by fingers, while Goßmann used a graphic-tray for the interface. The work of Goßmann consists of a combination of the visual and acoustic aspect, while the work of Simpson is based on the visual aspect alone – on exploring the aspect of zooming into a fractal. The structure of the fractal has been shown in the work of Simpson gradually zooming on it, while in the work of Goßmann there is a switch from one static projection to another. The dynamic of Simpson's work is more linear than in the work of Goßmann. The structure of the work of Goßmann is more unforeseeable.
The artists achieved different overall impressions using mathematically the same motif, which is similar also in its visual structure.
Fractals as motifs in interactive digital art are not very common. Differently to media art, fractal - visualizations have been used for researching music/tones as in the work of Joachim Goßmann "Audio Fraktal" (2004). But fractals have been used also as autonomous motifs, in particular, their characteristics are focused on in the work of Zack Booth Simpson, "Fractal Zoom" (2006). The visitors can zoom into different parts of a fractal and understand the logic of its creation. The endless repeating of same formed shapes as a characteristic of a fractal has been represented through this work.

[404] Zack Booth Simpson, from http://www.mine-control.com/

[405] http://www.mine-control.com/

[406] Joachim Goßmann, at: http://on1.zkm.de/zkm/meisterwerke/gossmann 23 November, 2007, 4:48.

Conclusion

We can conclude that abstract motifs represented in interactive digital art are on the one hand visually based on geometric and amorphous shapes which are known, for instance, from traditional painting (as discussed in the introduction). In interactive digital art these motifs visualize abstract rules, research immaterial conditions and activities, or define abstract spaces. In traditional art different theories influenced the build and existence of such motifs, as for instance theoretical writings on Suprematism by Malewitsch. In interactive digital art the voronoi diagrams, fractal rules and definitions influenced the build of abstract motifs. Within interactive digital art constructive abstract line constellations appear as visualizing elements of individual spaces, mathematical rules, and scientific rules. They recall visually the pioneer works of computer-art which were characterized by randomness. Furthermore, dots as autonomous motifs appear firstly in media art and their usage for defining abstract spaces is seen also within interactive digital art. The representation of abstract motifs in interactive digital art is also based on fractal-representations which have been known since Benoît B. Mandelbrot's discovery in the middle of the seventies. Compared to computer-art, the meaning of a represented fractal has been kept either as visualizer of itself or has changed to create analogies between art and music.

7. General Conclusion and Further Trends in the Representation of Visual Motifs

Visual motifs in interactive digital art are on the one hand unique and specific and on the other they are based on visual motifs, which is already known in art history. It is difficult to make a general conclusion about the usage of different motifs in this kind of art, but certainly it is correct to say that the visual motifs in interactive digital art are created so that they represent an actual (modern) aesthetic requirement of the artists, and of the audience. To the comment which has been made about interactive art (in installation and cinema), that "*several examples of viewer participation with the machine have existed in the canon of contemporary art since the last century*"[407], we can add that also several visual motif examples have existed in contemporary art and even in traditional art in general for many centuries (also before the invention of machines). The development of this aesthetic need is a long process, as long as the development of the representation of different visual motifs. Designing interactive artworks should be understood not just as simple intuitive design; it has to be understood also as a historical approach to the visual motifs that artists want to use for creating their themes, as an exploration of the already existing forms and arts for designing of these motifs in the past. The intended representation has to bring something innovative in this area, so as to allow the visual aspect of this kind of art, evolve further.

This book focused on motifs in interactive digital art with the emphasis on the visual aspect. The state of the art analyzed within this book shows that there is literature about interactive digital artworks, which focuses on these artworks based on their ideas, and particularly in their developing process. Research on the existing literature showed a focus on the aspect of interactivity in interactive digital artworks, which is an important issue in this kind of art. The aspect of interactivity is one of the main characteristics of these works, but a big number of these artworks show a visual result, which still has not been considered as a key characteristic of these artworks, in particular it still has not been considered separately in a book. Due to this, this book focuses on interactive digital artworks concerning the visual aspect and the linked iconography.

Besides the visual aspect of these artworks, their main characteristics have been considered and have been related to their visual aspect. For example, the processual aspect, the interactivity and the interface of these works have been included for research in this book. Their importance for the visual aspect of the work is researched within this book.

An introduction on interactive digital art is discussed to show how such artworks can be produced. For this issue, the technological evolution has been focused on. A historical background of the technology used for such artworks is pieced together. The kinds of development directions have been considered. For example, developments of digital computing, or the devices that make the creation of virtual realities possible, have been considered within this chapter. Also the technology used for the interface has been focused on.

For understanding the nature of interactive digital art, an introduction to media art and to interactive art has been considered. Within these chapters their categories have been introduced, taking into consideration the form of the interactivity, interface and computing methods.

[407] Rush (2005), p. 222.

Through an introduction to motifs and leitmotifs the visual motifs in interactive digital art are depicted closely within this book. This chapter includes an explanation of the notion "visual motif". Different research methods are put together to analyze these artworks and the visual motifs are also categorized. Key categories such as the objective motifs and non-objective motifs are depicted in detail. Humans, animals, or plants, and places and architecture are depicted closely as objective motifs. Linear motifs, amorphous and constructive shapes, and fractals are categorized and researched as non-objective (abstract) motifs.
Some development lines that are important for the creation and usage of the human motif in interactive digital art are discussed within the introduction of the usage of the human motifs in art history. Artworks of the 20th century are researched closely: Interactive digital art is a kind of art that is been developed in the 20th century so the representation of humans in the 20th century has been focused upon for details. The genre of portrait, or the bust, the inside of the body and body parts are discussed within the chapter on the human as motif. Due to this also the introduction is focused on depicting such artworks known from traditional art.
Furthermore, the human as motif in interactive digital art is described and there are specific chapters about the representations of humans in this kind of art, such as interactive video-portrait and interactive physical bust, author-visitor-portrait and visitor-portrait. Within those examples of the human as motif in interactive digital art are considered and depicted closely. As a result different directions in the development of the human as motif in interactive digital art emerged. Here, beside the visual aspect, also the interface of such artworks is focused upon, such as the touch-screen or speech recognition. The last one, for example, contributes to the creation of a shock effect for visitors, especially in combination with a "severed", speaking head (as in the work "Head" by Ken Feingold).

To research plants, or animals as motifs, an introduction as to the usage of this motif in art history has been discussed. Through this introduction it can be concluded that plant representations have been developed on the one side for medical purposes; different plants have been represented and their usage for healing different diseases has been noted.
On the other hand plants and animals have been represented for symbolic purposes, or decorative purposes. Animals were used for example as accompanying motifs for representing a religious scene until they become autonomous motifs in art in the 16th century. Plants have been used as motifs also in their natural form: their growth has been represented as artwork in exhibition rooms.
Animals and plants were used as motif also in media art. Through this research could be concluded that the animal as motif appears often in the film-industry. Animals were used for example with a dangerous meaning as in the film "The Birds" (1963), by Alfred Hitchcock or "Arachnophobia" (1990) by Frank Marshall.
For researching plants, or animals within interactive digital art, there was an introduction to their representations of them in this kind of art. Then with the help of specific chapters about the representations of plants or animals in this kind of art, such as evolutionarily designed biological motifs, animals as a symbol or as an entertaining motif, animal as data input or as interactive sculpture, aquatic creatures based on the rules of the real life of animals, or based visually on real water animals, and virtual pets carrying e-mails or playing live games with visitors, characteristic forms of their representation have been discussed. Different kinds of representation in interactive digital art appeared as result.

For researching places and architecture as motifs the representation of these motifs in art history and contemporary art, including traditional and media art has been taken in

consideration. To research representations of places, representations of landscapes in traditional art have been considered. Their representation in the 20th century has been focused on. The representation of architecture also has been considered as a specific motif in interactive digital art. Due to this an introduction to the historical representation of it was written. Specific milestones, like the invention of the central perspective, or the usage of the trompe-l'oeil technique, have been considered.
On the other hand the contemporary representations of environments or so-called experience spaces have been included as examples for researching within this category. Furthermore architecture and environments as motifs in media art, for example as motifs in video art, have been discussed. As result we were able to draw parallels between such artforms. The research on the representation of places and architecture in interactive digital art included such chapters as "Naturalistic Virtual Immersive Public Places", "Abstracted Real Cities: Back-Curating Flight and Visitors as Tramway-Driver", "Realistic Represented Virtual Interiors: Visiting Historic Interiors and "Revealing" Historic Interiors" and "Abstract Spaces". Specific artworks were used as examples.

Abstract visual motifs appear in interactive digital art the same as in traditional, or global media art, namely as main motifs of such artwork. Abstract visual motifs appear as autonomous motifs in visual arts first in the 20th century, so that the introduction to the development of these motifs has been concentrated on the directions that emerged in this century. Two main streams have been focused on: the geometric stream and the amorphous stream. Their development continues in all forms of art up till present. Its constitution has been modified and enriched, for example dots are being presented as autonomous motifs, as glowing dots with the help of the technique of neon light. On the other hand the constitution of abstract motifs follows the rules of randomness as in some constructive works of computer-graphic pioneers.
For researching abstract motifs within interactive digital art chapters such as "Motion, Traces, Detections – Linear Constructive Motifs", "Amorphous and Geometric Shapes", "Liquid Shapes as Motifs" and "Fractals as Motifs" were written. The characteristics of such artworks are analyzed and brought into a global context.

Comparing the representation of objective and non-objective motifs in their frequency and appearance, it can be concluded that interactive artworks primarily use abstract, in particularly abstract linear motifs. This was linked to the digital technology of that time by which such constellations were easily represented. This can be followed in the early representations of computer art. After that, with the development of the technology, artists represented more and more objective motifs. This was also a reflection of the growth of human consciousness about the technique he developed. But the beginning of the 21st century created again a need for changes. Abstraction was more and more present in the form of visualization of scientific research and visualization of abstract activities.
The further trend of representing motifs which have been discussed here, shows that representing humans in interactive digital art will be done less to create mirror images and realistic communication sculptures. A sophisticated combination of humans as a natural interface for creating algorithmic organisms, as in the work Se Mi Sei Vicino – (English: when you're near to me), by Sonia Cillari (2007), is a trend for the future. Here the movements of bodies are registered as electromagnetic activity. So it is not the physical appearance, but the characteristics of the human body that are being visualized. Representing animals and plants is more and more fusing with the representation of living organisms

(plants and animals). Representing architecture and cities is being developed in a fusion of architecture and environments with the interaction of passers-by, as in the work “Park View Hotel” byAshok Sukumaran, Prix Ars Electronica winner in the category of interactive art (2007). Concerning abstract art the trend is developing further in music visualizations and this research showed that these motifs are being evolved more and more contemporarily.

8. Bibliography

Aarts, Emile and **Collier,** René. Ambient Intelligence, First European Symposium, EUSAI 2003, Veldhoven, The Netherlands, Springer, Berlin, 2003.
Abbas, Niran B. Thinking Machines: Discourses of Artificial Intelligence, Lit Verlag, 2006.
Adams, Ann Jensen. "*Seventeenth – Century Dutch Landscape Painting*", pp. 35 – 76, in: W. J. T. Mitchell (Ed.), Landscape and Power, The University of Chicago Press, Chicago, 1994.
Albers, Josef. Josef Albers. Eine Retrospektive, Guggenheim Musum, Solomon R. Guggenheim Museum, New York, DuMont Buchverlag Köln, 1998.
Arnheim, Rudolf. Art and Visual Perception. A Psychology of the Creative Eye, University of California Press, Berkeley and Los Angeles, 1974.
Ascott, Roy. Behaviourist Art and the Cybernetic Vision, Part 1, pp. 247-264, in: Cybernetica. Review of the International Association for Cybernetics, Vol. 9, Nr. 4, 1966.
Ascott, Roy. Telematic Embrace. Visionary Theories of Art, Technology, and Consciousness, University of California Press, Berkeley, 2003.
Baatz, Willfried. Geschichte der Fotografie, DuMont, Köln, 1997 and 2002.
Bahamón, Alejandro. Vegetal Architecture, Analogies between the Vegetal World and Contemporary Architecture, Parramón Ediciones, Barcelona, 2006.
Barnett, Vivian Endicott. Kandinsky at the Guggenheim, Abbeville Press Publishers, New York, 1983.
Bartelsheim, Sabine. Pflanzenkunstwerke. Lebende Pflanzen in der Kunst des 20. Jahrhunderts, Silke Schreiber, Munich, 2001.
Beckmann, John (Ed.), The Virtual Dimension. Architecture, Representation, and Crash Culture, Princeton Architectural Press, New York, 1998.
Bedau, Mark A. "*The Nature of Life*", pp. 332 – 360, in: Boden, Margaret A. (Ed.), The Philosophy of Artificial Life, Oxford University Press, New York, 1996.
Behling, Lottlisa. Die Pflanzenwelt der Mittelalterlichen Kathedralen, Böhlau, Köln, 1964.
Belting, Hans (Ed.), Kunstgeschichte, Eine Einführung, Dietrich Reimer Verlag, Berlin, 1996.
Benthien, Claudia. "*Die Epidermis der Kunst. Stelarcs Phantasmen*", pp. 319-339, in: Gendolla, Peter, N. M. Schmitz, I. Schneider, and P. M. Spangenberg (ed.). Formen Interaktiver Medienkunst, Frankfurt/Main, 2001.
Blair, David. "*Metavirtue and Subreality*", S. 305-319, in: Druckrey, Timothy (Ed.) Electronic Culture. Technology and Visual Representation, Aperture Foundation, 1996.
Blotkamp, Carel. Mondrian. The Art of Destruction, Reaktion Books, London, 1994.
Bois, Yve-Alain. Painting as Model, MIT Press, London, 1990.
Bolt, Richard A. The Human Interface. Where People and Computers Meet, MIT, 1984.
Broer, Werner, and **Etschmann**, Walter, Epochen der Kunst. Vom Klassizismus zu den Wegbereitern der Moderne, Oldenbourg, München and Wien, 1994.
Bussagli, Marco. Der menschliche Körper. Anatomie und symbolische Bedeutung. Bildlexikon der Kunst, Bd 12, Parthas, Berlin, 2006.
Butin, Hubertus (Ed.). DuMonts Begriffslexikon zur zeitgenössischen Kunst, DuMont, Köln, 2006.
Ceruzzi, Paul E. A History of Modern Computing, Massachusetts Institute of Technology, 1998.
Clarke, Michael. The Concise Oxford Dictionary of Art Terms, New York, 2001.

Cleland, Kathy. "*Talk to me: getting personal with interactive art*", from http://research.it.uts.edu.au/creative/interaction/papers/interaction04_43.pdf
Cooke, Lynne and **Wollen**, Peter, Visual Display, Culture Beyond Appearances, Bay Press, Seattle, 1995.
Cooper, J. C. Das große Lexikon traditioneller Symbole, Berlin 1986.
Cornwell, Regina. Interactive Art. Touching the "Body in the Mind", pp. 203-221, in: Discourse, Nr. 14.2, 1992.
Crowley, James L. (Eds.), Ambient Intelligence, Second European Symposium, EUSAI 2004, Eindhoven, The Netherlands, Springer, Berlin, 2004.
Cubitt, Sean and **Thomas**, Paul (Ed.), Relive, Media Art Histories, MIT Press, Cambridge, 2013.
Cummins, Robertand **Pollock,** John. Philosophy and AI. Essays at the Interface, MIT Press, Cambridge, 1991.
D'Andrea, Jeanne (Ed.), Kazimir Malevich, 1878-1935, Published by the Armand Hammer Museum of Art and Cultural Center, 1990.
Daniels, Dieter. Vom Ready-Made zum Cyberspace, Kunst/Medien Interferenzen. Cantz, Ostfildern, 2003, at:
http://www.hgb-leipzig.de/daniels/vom-readymade-zum-cyberspace/, 24.03.2007, 13:40.
Daniels, Dieter and **Frieling**, Rudolf. Medien Kunst Interaktion. Die 80er und 90er Jahre in Deutschland, Wien / New York, 2000.
Darley, Andrew. Visual Digital Culture, Surface play and spectacle in new media genres. London, 2000.
Day, Giskin (Ed.), Inside the Science Museum, Board of Trustees of the Science Museum, 2001.
de Kerckhove, Derrick. "*Common Sense*", pp. 31 – 40, in: BINAERA: 14 Interaktionen. Kunst und Technologie. Kunsthalle Wien, 1993.
Denetrion, James (Ed.), Jean Dubuffet 1943 – 1963. Pintings, Sculptures, Assemblages, 1993.
Dent, Nicholas. Rousseau. Routledge, 2005, at: http://books.google.com, 23.08.08, 17:30.
Deussen, Oliver and **Lintermann**, Bernd. Digital Design of Nature. Computer Generated Plants and Organics. Springer-Verlag, Berlin and Heidelberg, 2005.
Diederichsen, Diedrich. "*Visual Culture*", pp. 300-302, in: Butin, Hubertus (Ed.). DuMonts Begriffslexikon zur zeitgenössischen Kunst, DuMont, Köln, 2006.
Dika, Penesta. Die Computerkunst Herbert W. Frankes. Logos, Berlin, 2007.
Dika, Penesta. "*Research of the Motifs in Interactive Media Art concerning the Visual Aspect*", pp. 165 – 174, in: Sommerer, Christa, Mignonneau, Laurent and King, Dorothée (Eds.), Interface Cultures. Artistic Aspects of Interaction, transcript, Bielefeld, 2008.
Dika, Penesta. *"Biological motifs designed using the principles of artificial life",* pp. 318-331, in: International Journal of Advanced Intelligence Paradigms archive, Volume 1 Issue 3, 2009.
Dika, Penesta. *"Interactive virtual architecture: back-curating flight and visitors as tramway-driver",* in: International conference proceedings, Vouliagmeni, Athens, Greece, 2010.
Dietz, S. Ten Dreams of Technology, at:
http://www.nydigitalsalon.org/10/essay.php?essay=8, 05.11.2006, 20:15.
Dinkla, Söke. Pioniere Interaktiver Kunst von 1970 bis heute. Ostfildern, 1997.
Dinkla, Söke and **Brockhaus**, Christoph (Eds.), InterAct! Schlüsselwerke interaktiver Kunst, Hatje Cantz Verlag, Bonn, 1997.

Dodsworth, Clark Jr. (Ed.), Digital Illusion: Entertaining the Future with High Technology, ACM Press, New York, 1998.
Dowling, C. G., "*The execution and electronic afterlife of Joseph Paul Jernigan*", from http://www.life.com/Life/science/body/body01.html, 21.03.2006, 17:33.
Druckrey, Timothy (Ed.), Electronic Culture. Technology and Visual Representation, Aperture Foundation, 1996.
Ecker, Berthold and **Aigner**, Silvie (Ed.), Margot Pilz – Meilensteine / Milestones. Von der performativen Fotografie zur digitalen Feldforschung / From Performative Photography to Digital Field Studies, de Gruyter, 2015.
Eggen, Berry and **van den Hoven**, Elise "*Tangible Computing in Everyday Life: Extending Current Frameworks for Tangible User Interfaces with ersonal Objects*", pp. 230-242, in: **Markopoulos**, Panos, **Eggen**, Berry, **Aarts**, Emile and **Eisenman**, Stepheen F. (Ed.), Nineteenth Century Art, A Critical History, Thames und Hudson, London, 1994.
Esposito, Elena. "*Interaktion, Interaktivität und die Personalisierung der Massenmedien*", pp. 225 – 260, in: Soziale Systeme, Zeitschrift für soziologische Theorie, Jg. 1, no. 2, Verlag Leske + Budrich, Opladen, 1995.
Esposito, Elena. *"Die Wahrnehmung der Virtualität. Perzeptionsaspekte der Interaktiven Kommunikation",* pp. 116 – 131, in: Stanitzek, Georg and Voβkamp, Wilhelm (Ed.), Schnittstelle. Medien und kulturelle Kommunikation, DuMont, Köln, 2001.
Escrig, M. Teresa, **Toledo**, Francisco and **Golobardes**, Elisabet (Eds.), Topics in Artificial Intelligence, 5th Catalonian Conference on AI, CCIA, Springer, Berlin, 2002.
Fiol-Roig, Gabriel. "*Knowledge Representation Model for Dynamic Processes*", pp. 40-53, in: Escrig, M. Teresa, Toledo, Francisco, Golobardes, Elisabet (Eds.), Topics in Artificial Intelligence, 5th Catalonian Conference on AI, CCIA, Springer, Berlin, 2002.
Fleischmann, M. / **Tildesley**, D.J. / **Ball**, R.C. (Ed.), Fractals in the natural sciences. Princeton, 1989.
Flusser, Vilém. "*Digital Apparition*", pp. 242-257, in: Druckrey, Timothy (Ed.), Electronic Culture. Technology and Visual Representation, Aperture Foundation, 1996.
Frieling, Rudolf. "*Interaktivität*", pp. 134-138, in: Butin, Hubertus (Ed.), DuMonts Begriffslexikon zur zeitgenössischen Kunst, DuMont, Köln, 2006.
Gehrig, Ulrich (Ed.), Tierbilder aus vier Jahrtausenden. Antiken der Sammlung Mildenberg, Verlag Philipp von Zabern, Mainz am Rhein, 1983.
Gendolla, Peter, N. M. Schmitz, I. Schneider, and P. M. Spangenberg (Ed.), Formen Interaktiver Medienkunst, Frankfurt/Main, 2001.
Giro, John S. (Ed.), Artificial Intelligence in Design `00. Kluwer Academic Publishers, Boston, 2000.
Glowski, Janice, M. (Ed.), Charles A. Csuri. Beyond Boundaries, 1963 – present, Boston, 2006.
Goldberg, David E., Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley Professional, 1989.
Goldberg, Ken (Ed.), The Robot in the Garden, Telerobotics and Telepistemology in the Age of the Internet, MIT Press, Cambridge, 2000.
Gombrich, Ernst H. Ornament und Kunst, Stuttgart, 1982.
Goodman, C. "*Abenteuer im virtuellen Wunderland. Das interaktive Universum von Christa Sommerer and Laurent Mignonneau*", pp. 162-173, in: J. Wenzel, and A. Wirths, Der elektronische Raum. 15 Positionen zur Medienkunst. Bonn, 1998.
Grau, Oliver. Virtual Art: From Illusion to Immersion. MIT Press, Cambridge, 2003.

Grau, Oliver. "*History of Telepresence: Automata, Illusion, and Rejecting the Body*", pp. 226-243, in: Goldberg, Ken (Ed.), The Robot in the Garden, Telerobotics and Telepistemology in the Age of the Internet, MIT Press, Cambridge, 2000.
Grau, Oliver (Ed.), MediaArtHistories Cambridge, MIT Press, 2007.
Grau, Oliver, "Media Art in Exploration of Image History", pp. 88 – 89, in: Andreas Broeckmann u.a. (Ed.): Proceedings of the 16th International Symposium on Electronic Art ISEA 2010 RUHR, Revolver Publishing, Berlin 2010.
Grau, Oliver, "Media Art & Digital Humanities", pp. 1 – 22, in: Technology Imagination Future, Journal for Transdisciplinary Knowledge Design, Vol. 4, No.1, 2010.
Grau, Oliver and Veigl, Thomas (Ed.), Imagery in the 21st Century, MIT Press, 2013.
Goldberg, Ken (Ed.), The Robot in the Garden, Telerobotics and Telepistemology in the Age of the Internet, MIT Press, Cambridge, 2000.
Gronemeyer, Andrea. Film, DuMont, Köln, 1998 and 2004.
Gsöllpointner, Katharina. "*Architecture and Electronics*", in: Intellegent Environment [Part 01], Ars Elextronica Festival 1994, at:
http://www.aec.at/en/archives/festival_archive/festival_catalogs/festival_artikel.asp?iProjectID=8670, 04.07.2008, 21:17**.**
Hall, Doug and **Fifer**, Sally Jo. Illuminating Video – An Essential Guide to Video Art, New York, 1990.
Hartmann, P. W. Kunstlexikon, Wien, 1996.
Hastings, Harold M. and **Sugihara**, George. Fraktale. Ein Leitfaden für Anwender, Heidelberg [u.a.] 1996.
Hayles, Katherine N., "*Virtual Bodies and Flickering Signifiers*", pp. 259-277, in: Druckrey, Timothy (Ed.), Electronic Culture. Technology and Visual Representation, Aperture Foundation, 1996.
Hearn, Donald and **Baker**, M. Pauline. Computer Graphics, Prentice Hall International Editions, 1986.
Heilig, Mort. "*Beginnings: Sensorama and the Telesphere Mask,"* pp. 343 – 351, in: Dodsworth, Clark Jr. (Ed.), Digital Illusion: Entertaining the Future with High Technology, ACM Press, New York, 1998.
Held, Jutta and **Schneider**, Norbert. Sozialgeschichte der Malerei. Vom Spätmittelalter bis ins 20. Jahrhundert, DuMont, Köln, 1993.
Henderson, Jennifer. Slipping the Interface. Strategies of art making and Lynn Hershman, at:
http://switch.sjsu.edu/nextswitch/switch_engine/front/print.php?271, 03.10.2007, 22:44**.**
Henderson, Linda. Fourth Dimension and Non-Euclidean Geometry in Modern Art, MIT Press, 2013.
Herland, Mamta B. Appendix: Internet, World Wide Web and Art: a non-traditional story, at:
http://www.mamtaart.com/articles/docs/Appendix.pdf, 06.02.2008, 20:51.
Hershman, L. "Romancing the Anti-body: Lust and Longing in (Cyber)space", at:
http://telematic.walkerart.org/telereal/hershman_hershman2.html
Heybrock, Christel. Kraft und Schoenheit der Pflanzen, Karl Blossfeldts fotografische Arbeitscollagen bei Schirmer/Mosel, at:
http://hometown.aol.de/fotoseiten/BlossfeldtArbeitscollagen.html, 21.02.2007, 15:20.
Hofmann, Werner. Das Entzweite Jahrhundert. Kunst zwischen 1750 und 1830, Verlag C.H. Beck, München, 1995.
Holland, John H. Adaptation in Natural and Artificial Systems, University of Michigan Press, Ann Arbor, Michigan, 1975.

Honour, Hugh and **Fleming**, John. Weltgeschichte der Kunst, Prestel Verlag, München, 2000.
House, George Eastman. Geschichte der Photographie. 1839 bis heute, Rochester, New York, Taschen , Köln, 2000.
Hubala, Erich. Propylän Kunstgeschichte, Die Kunst des 17. Jahrhunderts, Band 9, Propylän Verlag, Berlin, 1984.
Hünnekens, Annette. Der bewegte Betrachter. Theorien der interaktiven Medienkunst, Wienand Verlag, Köln, 1997.
Impelluso, Lucia. Die Natur und ihre Symbole, Pflanzen, Tiere und Fabelwesen. Bildlexikon der Kunst, Bd. 7., Parthas Verlag, Berlin, 2005.
Joosten, Joop M. Piet Mondrian. Catalogue Raisonné of the Work of 1911-1944, II-III, V+K Publishing, Blaricum, 1998.
Kac, Eduardo. "*Ornitorrinco and Rara Avis. Telepresence Art on the Internet*", Leonardo, Bd. 29, Nr. 5, S. 393—394. from
http://www.ekac.org/ornitrara.html, 11.12.2005, 17:15.
Kac, Eduardo. "*Dialogical Telepresence and Net Ecology*", pp. 180 – 196, in: Goldberg, Ken (Ed.), The Robot in the Garden, Telerobotics and Telepistemology in the Age of the Internet, MIT Press, Cambridge, 2000.
Kac, Eduardo. "*Dialogical Telepresence and Net Ecology*", pp. 180 – 196, in: Goldberg, Ken (Ed.), The Robot in the Garden, Telerobotics and Telepistemology in the Age of the Internet, MIT Press, Cambridge, 2000.
Kegler, Karl R. and **Kerner**, Max (Ed.), Der künstliche Mensch. Körper und Intelligenz im Zeitalter ihrer technischen Reproduzierbarkeit, Böhlau, Wien, 2002.
Kemp, Wolfgang. *"Kunstwerk und Betrachter: Der rezeptionsästhetische Ansatz"*, pp. 241 – 258, in: Belting, Hans (Ed.), Kunstgeschichte, Eine Einführung, Dietrich Reimer Verlag, Berlin, 1996.
Kittler, Friedrich. Optische Medien, Berliner Vorlesung 1999, Merve Verlag, Berlin, 2002.
Kloock, Daniela and **Spahr**, Angela. Medientheorien. Eine Einführung, Fink, Paderborn, 2012.
Krueger, Myron. ACM Siggraph, 1998, at:
http://www.siggraph.org/artdesign/gallery/S98/pione/pione3/krueger.html, 08.01.2008, 17:30.
Kuni, Verena. "*Mythical Bodies I*", at:
http://mkn.zkm.de/themes/cyborg_bodies/mythical_bodies_I/2/
Kuni, Verena. "*Cyborg_Configurationen als Formationen der (Selbst-)Schöpfung im Imaginationsraum technologischer Kreation (II): Monströse Versprechen und posthumane Anthropomorphismen*", at:
http://www.medienkunstnetz.de/themen/cyborg_bodies/mythische-koerper_II/, 13.05.2006, 14:20.
Kuni, Verena. "*Lost Medium Found – Über STELARC. Im Zwiegespräch mit dem obsoleten Körper*", in: SIXCON Lost Media, Hg. Rotraut Pape, Offenbach 2002, at:
http://www.medienkunstnetz.de/werke/third-hand/, 23.02.2006, 11:15.
Kusahara, Machiko. "*Creating Cultural Correctness: Abstract-Japanese Tradition in Digital Art*", in:
http://www.f.waseda.jp/kusahara/LA99abstract.html, 27.04.2007, 15:16.
Labrusse, Rémi and de Chassey, Éric. Henri Matisse – Ellsworth Kelly, dessins de plantes. Gallimard, Centre Pompidou, 2002.
Langton, Christopher G. "*Artificial Life"*, pp. 39-94, in: Margaret A. Boden (Ed.), The Philosophy of Artificial Life, Oxford University Press, New York, 1996.

Laurel, Brenda (Ed.), The Art of Human-Computer Interface Design, Addison-Wesley, 1990.
Laurel, Brenda. Computers as Theatre, Addison-Wesley, 1991.
Leopoldseder, Hannes and **Schopf,** Christine (Ed.), CyberArts 2002, Hatje Cantz, 2003.
Lucie-Smith, Edward. Die Moderne Kunst, Malerei – Fotografie – Grafik. Objektkunst, Südwest Verlag, München, 1992.
Lucie-Smith, Edward. DuMont's Lexikon der Bildenden Kunst, Dumont Buchverlag, 2005.
MacDonald, Lindsay and **Vince**, John (Ed.), Interacting with Virtual Environments, Chichester and New York, 1994.
Malina, Roger F. and **Bureaud**, Annick (Ed.), Meta-Life: Biotechnologies, Synthetic Biology, ALife and the Arts, MIT Press, 2014.
Mandelbrot, Benoît B. Die fraktale Geometrie der Natur, Basel, 1987.
Mandelbrot, Benoît B. "*What Is It and What Does It Do?*", pp. 3-16, in: Fractals in the natural sciences. M. Fleischmann, D.J. Tildesley, and R.C. Ball (Hg.), Princeton, 1989.
Manovich, Lev. The Language of New Media, MIT Press, Cambridge, 2001.
Markopoulos, Panos and **Eggen,** Berry (Ed.), Ambient Intelligence, Second European Symposium, EUSAI 2004, Eindhoven, The Netherlands, Springer, Berlin, 2004.
Martens, Bob and **Brown,** Andre. Computer Aided Architectural Design. CAAD Futures 2005. Learning From the Past, Institute for Spatial Interaction and Simulation, Vienna, 2005.
Massumi, Brian. "*Stelarc: The Evolutionary Alchemy of Reason*", pp. 334-341, in: Beckmann, John (Ed.), The Virtual Dimension. Architecture, Representation, and Crash Culture, Princeton Architectural Press, New York, 1998.
McLuhan, Marshall. Understanding Media: The Extensions of Man, Signet, 1964.
Meltzer, Arnold C. and **Abd-alla**, Abd-elfattah M. Principles of Digital Computer Design, Vol. 1, Prentice-Hall, New Jersey, 1976.
Milner, John. Kazimir Malevich and the Art of Geometry, Yale University Press, New Haven and London, 1996.
Mirage, Merel, Memories of a Virtual Butterfly: The World and the Screen, pp. 377-383, in: Leonardo, Vol. 30, No. 5, Fifth Annual New York Digital Salon, 1997.
Mitchell, William J. City of Bits. Space, Place, and the Infobahn, MIT Press, Cambridge, Massachusetts, 1995.
Mitchell, William J. Me++. The Cyborg Self and the Networked City, MIT Press, Cambridge, 2003.
Mitchell, W. J. T. (Ed.), Landscape and Power, The University of Chicago Press, Chicago, 1994.
Moravec, Hans. "*The Senses Have No Future*", pp. 84-96, in: John Beckmann (Ed.), The Virtual Dimension. Architecture, Representation, and Crash Culture, Princeton Architectural Press, New York, 1998.
Nichols, Bill. "*The Work of Culture in the Age of Cybernetic Systems*", pp. 121-143, in: Druckrey, Timothy (Ed.), Electronic Culture. Technology and Visual Representation, Aperture Foundation, 1996.
Nihon-Kobunkan, Science Illustrated I, Animals, Birds, Insects, Plants. Kyoikusha, Tokio, 1988.
Oberhuber, Oswald (Ed.), Josef Albers, Homage to the Square, Hochschule fuer angewandte Kunst in Wien, 1992.
Olbrich, Harald (Ed.), Lexikon der Kunst, Architektur, Bildende Kunst, Angewandte Kunst, Industrieformgestaltung, Kunsttheorie, Bd. I – VII, VEB E. A. Seemann Verlag, Leipzig, 1989.

Panofsky, Erwin. Ikonographie und Ikonologie, Bildinterpretation nach dem Dreistufenmodell, DuMont, 2006.
Paul, Christiane. Digital Art. Thames & Hudson, London, 2003.
Pächt, Otto. Methodisches zur kunsthistorischen Praxis, Prestel-Verlag, München, 1995.
Petrovich, Lucy. "*From Computer Art to Digital Art to New Media*", from http://www.isea2000.com/actes_doc/25_petrovitch.rtf, 08.01.2008, 17:12.
Pfaller, Robert, "*Das Kunstwerk, das sich selbst betrachtet, der Genuß und die Abwesenheit. Elemente einer Ästhetik der Interpassivität"*, pp. 49-84, in: Pfaller, Robert. Interpassivität. Studien über delegiertes Genießen, Springer, Wien, 2000.
Pfaller, Robert. Interpassivität. Studien über delegiertes Genießen, Springer, Wien, 2000.
Pohribny, Arsén. Abstrakte Malerei, Herder Freiburg, Basel, 1978.
Popper, Frank. Art of the Electronic Age, Thames and Hudson, London, 1993.
Popper, Frank. From Technological to Virtual Art, MIT Press Cambridge, 2007.
Purtle, Carol J. The Marian Paintings of Jan Van Eyck, Princeton University Press, New Jersey, 1982.
Raulff, Helga (Ed.), Mensch und Tier. Eine paradoxe Beziehung, Hatje Cantz Verlag, Ostfildern-Ruit, 2002.
Ratcliff, Carter. The Fate of a Gesture. Jackson Pollock and Postwar American Art, 1996, New York.
Ray, Thomas S. "*An Approach to the Synthesis of Life*", pp. 111-145, in: Boden, Margaret A. (Ed.), The Philosophy of Artificial Life, Oxford University Press, New York, 1996.
Reichle, Ingeborg. Transgene Körper. Kunst im Zeitalter von Technoscience, at: http://www.medienkunstnetz.de/themen/cyborg_bodies/transgene_koerper/20/, 09.03.2006, 12:40.
Rheingold, Howard. Virtual Reality, The Revolutionary Technology of Computer-Generated Artificial Worlds – and How it Promises to Transform Society, Touchstone, New York, 1991.
Richter, Klaus. Kunst der Moderne, vom Impressionismus bis heute. Prestel München, 2000.
Rieser, Martin and **Zapp**, Andrea (Ed.), The New Screen Media. Cinema/Art/Narrative, British Film Institute in London, 2002.
Robinett, Warren, "Interactivity and Individual Viewpoint in Shared Virtual Worlds: The Big Screen Versus Networked Personal Displays", in: Dodsworth, Clark Jr. (Ed.). Digital Illusion: Entertaining the Future with High Technology, ACM Press, New York, 1998.
Rödiger-Diruf, Erika. "*Natur, Tier und Gesellschaft. Einleitende Betrachtungen zum Thema*", pp. 12-17, in: Herausforderung Tier. Von Beuys bis Kabakov, Prestel, München, 2000.
Rush, Michael. New Media in Art, Thames & Hudson, London, 2005.
Sakane, Itsuo. Introduction to Interactive Art, pp. 3-8 and pp. 38-42, in: Wonderland of Science Art – Invitation to Interactive Art, Kanagawa International Art and Science Exhibition 1989.
Sandin, Daniel J. "*Digital Illusion, Virtual Reality, and Cinema"*, pp. 3-26, in: Dodsworth, Clark Jr. (Ed.). Digital Illusion: Entertaining the Future with High Technology, ACM Press, New York, 1998.
Shanken, Edward A. "*From Cybernetics to Telematics*", in: Roy Ascott. Telematic Embrace. Visionary Theories of Art, Technology, and Consciousness, University of California Press, Berkeley, 2003.
Shaw J. and **Weibel**, P. (Hg.), Future Cinema. The cinematic Imaginary after Film, exhib. cat., The MIT Press, Cambridge (MA), London, 2003.

Schelhowe, Heidi. Das Medium aus der Maschine, Zur Metamorphose des Computers, Campus Verlag, Frankfurt, New York, 1997.
Schneider, Norbert. Porträtmalerei, Hauptwerke europäischer Bildniskunst, 1420-1670. Benedikt Taschen, Köln, 1992.
Schneider, I. and **Spangenberg,** P. M., Internetkommunikation, Emotionalität und Neugier. Ein Interview mit der niederländischen Medienkünstlerin Merel Mirage, pp. 353-366, in: P. Gendolla, N. M. Schmitz, I. Schneider, and P. M. Spangenberg (Ed.), Formen Interaktiver Medienkunst, Frankfurt/Main, 2001.
Schröder, Klaus Albrecht und **Sternath**, Maria Luise (Hg.). Albrecht Dürer, Hatje Cantz Verlag, Ostfildern-Ruit, 2003.
Schröder, Albrecht / **Gnann,** Achim. Franz Gertsch, Naturporträts. Holzschnitte und Gemälde 1986-2006, Edition Minerva, Albertina, 2006.
Schwartz, Lillian F. and **Schwartz**, Laurens R. The Computer Artist's Handbook: Concepts, Techniques, and Applications, W. W. Norton & Company, Inc. in New York, 1992.
Schwarz, Hans-Peter (Ed.), Media-Art-History. Media Museum, ZKM - Center for Art and Media Karlsruhe, München, 1997.
Seblatnig, Heidemarie. Einfach den Gefahren ins Auge sehen. Künstlerinnen im Gespräch, Böhlau Wien, 1998.
Shikata, Yukiko. "*Interaction between Perception and Memory*", pp. 42-47, in: Possible Futures: Japanese postwar art and technology, Tokyo, 2005.
Skrypzak, Joann. Design, Vienna, 1890s to 1930s, University of Wisconsin Press, Madison, 2003.
Sommerer, Christa and **Mignonneau**, Laurent. "*Art as a living System*", pp. in: C. Sommerer and L. Mignonneau, Art@Science. Wien, 1998.
Sommerer, Christa and **Mignonneau**, Laurent (Ed.), Art@Science. Wien, 1998.
Sommerer, Christa, **Mignonneau**, Laurent and **Lopez-Gulliver,** R. "*Interfacing the Web: Multi-modal and Immersive Interaction with the Internet*", pp. 753-764, in: VSMM 2002 - 7th International Conference on Virtual Systems and MultiMedia, Conference Proceedings, Korea, 2002.
Smith, Gillian Crampton. "*The Art of Interaction"*, pp. 79-94, in: MacDonald, Lindsay and Vince, John (Ed.), Interacting with Virtual Environments, Chichester and New York, 1994.
Sommerer, Christa and **Jain**, Lakhmi C. (Ed.), The Art and Science of Interface and Interaction Design, Springer Berlin 2010.
Robertson, Jean and **McDaniel**, Craig. Themes of Contemporary Art. Visual Art after 1980. New York, 2005.
Tavernor, Robert, On Alberti and the Art of Building, Yale University Press, New Haven and London, 1998.
Thomas, Karin. Bis heute. Stilgeschichte der bildenden Kunst im 20. Jahrhundert, Dumont, Köln, 1978 and 2000.
Thompson, Nato (Ed.), Becoming Animal. Contemporary Art in the Animal Kingdom, MIT Press Cambridge, 2005.
Thod, Stephen and **Latham**, William, Interacting with Art-ificial Life, pp. 271 – 286, in: **MacDonald,** Lindsay and **Vince**, John (Ed.), Interacting with Virtual Environments, Chichester and New York, 1994.
Turing, Alan M. *Kann eine Maschine denken?*, pp. 39-78, in: Zimmerli, Walther Ch. and **Wolf**, Stefan. Künstliche Intelligenz. Philosophische Probleme, Philipp Reclam, Stuttgart, 1994.

Varnedoe, Kirk. Pictures of Nothing. Abstract Art since Pollock, Princeton University Press, Washington, 2006.
Vince, John, Flying in Virtual Worlds, pp. 257 – 269, in: MacDonald, Lindsay and Vince, John (Ed.), Interacting with Virtual Environments, Chichester and New York, 1994.
Volkart, Yvonne, "*Connective Identities*", at:
http://www.xcult.org/volkart/pub_e/connective_edentities.html, 03.05.2006, 17:15.
Walther, Ingo F. (Ed.), Kunst des 20. Jahrhunderts, Malerei, Skulpturen und Objekte, Neue Medien, Fotografie, Köln, 2002.
Wands, Bruce. Art of the Digital Age, Thames & Hudson, New York, 2006.
Watkin, David. Geschichte der Abendländischen Architektur, Könemann, 1999.
Weibel, Peter. "The apparatus world – a world unto itself", in: D. Dunn (Ed.), Eigenwelt der Apparatewelt - Pioneers of Electronic Art, Ars Electronica, Linz, 1992.
Welu, J. A. (Ed.), Worcester Art Museum, Selected Works, Worcester, 1994.
Wenzel, Jacob and **Wirths**, Axel. Der elektronische Raum. 15 Positionen zur Medienkunst. Bonn, 1998.
Williams, Michael R. A Histroy of Computing Technology, Prentice-Hall, London, 1985.
Wilton, Andrew. William Turner. Leben und Werk, E. A. Seemann Verlag, 1987/2006.
Wohlgemuth, Eva Statement for the Thealit-Laboratory »Artificial Life:// Media stories«, Bremen 1997, at:
http://www.thealit.dsn.de/lab/LIFE/LIFEfiles/read_13.htm, 24.04.2006, 15:23.
Zaunschirm, Thomas, "*Im Zoo der Kunst. Seit wann und warum gibt es lebende Tiere in der bildenden Kunst?*", pp. 39-48, in: Kunstforum. Im Zoo der Kunst I, Out of Africa, Bd. 174 and Bd. 175, 2005.
Zeltzer, David and **Johnson**, Michael B. Virtual Actors and Virtual Environments, pp. 229 – 255, in: in: MacDonald, Lindsay and Vince, John (Ed.), Interacting with Virtual Environments, Chichester and New York, 1994.
Zimmerli, Walther Ch. and **Wolf**, Stefan. Künstliche Intelligenz. Philosophische Probleme, Philipp Reclam, Stuttgart, 1994.

O.A. "Interactive Sound and Visual Systems", catalogue from the exhibition, Ohio State University, May 1970.
Brockhaus Enzyklopädie Digital, Mannheim, Bibliographische Institut & F. A. Brockhaus AG, 2006.
Timeline of Art History, Roman Painting, Department of Greek and Roman Art, The Metropolitian Museum of Art, at:
http://12.151.120.44/toah/hd/ropt/hd_ropt.htm, 11.03.2008, 15:41.
Indepth Arts News: "Pieter Saenredam, the Utrecht work", 2000-11-04 until 2001-02-04, Centraal Museum in Utrecht (NL): from
http://www.absolutearts.com/artsnews/2000/12/24/27862.html, 23.05.2007, 16:20.

http://anart.no/2003/10/15/worms-in-sand/, 25.03.2006, 14:12.
http://www.durbano.de/touchme/index.html, 20.01.2006, 13:17.
http://www.christian-moeller.com/users.design.ucla.edu/projects/arc/cm/cm/staticE/page33.html, 16.03.2006, 18:24.
http://www.siggraph.org/artdesign/profile/csuri/, 04.01.2007, 23:20.

http://www.stelarc.va.com.au/stomach/stomach.html, 12.04.2006, 12:13.
http://www.stelarc.va.com.au/third/third.html, 15.04.2006, 22:45.
http://www.aec.at/en/center/project.asp?iProjectID=12310, 08.05.2006, 12:15.
http://www.medienkunstnetz.de/themen/cyborg_bodies/mythische-koerper_II/, 05.07.2006, 16:11.
http://www.din.umontreal.ca/courchesne/portrait.html, 12.09.2006, 21:12.
http://www.interface.ufg.ac.at/christa-laurent/WORKS/FRAMES/FrameSet.html, 15.12.2005, 21:13.
http://www.immersence.com/, 16.07.2007, 13:09.
http://snibbe.com/scott/bf/index.htm, 18.07.2006, 21:01.
http://www.khm.de/keyareas/mk/ACdamm.html, 21.03.2007, 15:05.
http://www.ias.edu/spfeatures/john_von_neumann/electronic-computer-project/, 09.01.08, 15:25.
http://ei.cs.vt.edu/~history/VonNeumann.html, 06.10.2007, 17:23.
http://www.britannica.com/eb/article-9076934/Norbert-Wiener, 21.03.2007, 18:35.
http://ei.cs.vt.edu/~history/Stibitz.html, 12.09.2007, 20:45.
http://www.ecafe.com/getty/table.html#2, 30.07.2007, 17:36.
http://www.pbs.org/safarchive/3_ask/archive/bio/71_maes_bio.html, 06.11.2007, 21:13.
http://www.hasler.net/Meydenb.pdf, 23.09.2007, 13:49.
http://www.eculturefactory.de/virtual-balance, 28.07.2006, 15:32.
http://www.eculturefactory.de/pointscreen", interviewed per email on: 09.11.2007, retrieved 08.11.2006, 23:12.
http://leoalmanac.org/journal/Vol_2/lea_v2_n04.txt, 21.09.2007, 17:09.
http://www.tate.org.uk/liverpool/exhibitions/kelley/rm4.htm, 29.11.2007, 21:43.
http://www.bodyworlds.com/en/gunther_von_hagens/life_in_science.html, 24.09.2007, 21:42.
http://www.fundacion.telefonica.com/at/vida/paginas/v3/efeingold.html, 07.09.2007, 20:51.
http://www.kenfeingold.com/catalog_html/head.html, 15.12.2005, 21:43.
http://www.brunel.ac.uk/about/acad/sa/artstaff/drama/stelarc, 05.10.2007, 14:12.
http://on1.zkm.de/zkm/stories/storyReader$4874, 08.02.2007, 18:31.
http://www.kah-bonn.de/index.htm?ausstellungen_alt/hegedues/index.htm, 10.02.2007, 21:29.
http://www.medienkunstnetz.de/works/between-the-words/, 11.04.2006, 12:11.
http://www.musee-rodin.fr/rma-e.htm, 12.06.2007, 23:12.
http://www.genarts.com/karl/, 18.01.2006, 21:01.
http://www.telepresence.com/telepresence-research/MENAGERIE/, 16.08.2007, 21:12.
http://www.medienkunstnetz.de/artist/lintermann/biography/, 29.03.2006, 20:08.
http://www.bernd-lintermann.de/SonoMorphis/index.html, 21.10.2006, 09:39.
http://bistrodumarin.fi/demosites/mmf/card/ei/ei_memi.htm, 23.07.2007, 09:20.
http://www.mine-control.com/zack/index.html, 08.11.2006, 22:20.
http://www.mine-control.com/, 08.11.2006, 22:14.
http://arts.osu.edu/3news_events/a_news/news_summer_2006/csuri_siggraph.html, 20.11.2007, 13:48.
http://www.exploratorium.edu/about/air-projects.html, 13.11.2007, 20:14.
http://www.o-art.org/history/80s&90s/Exploratorium/ExplArt.html, 16.10.2007, 22:49.
http://www.virtualart.at/common/viewWork.do?id=748, 17.06.2007, 14:17.
http://www.medienkunstnetz.de/artist/eduardo-kac/biography/, 09.10.2006, 17:39.
http://inventors.about.com/od/cstartinventions/a/CCD.htm, 08.02.2008, 15:11.
http://www.ekac.org/raraavis.html, 23.05.2006, 13:46.
http://web.media.mit.edu/~ishii/bio.html, 25.10.2006, 23:12.

http://www.aec.at/en/archives/center_projekt_ausgabe.asp?iProjectID=11031, 22.09.2006, 16:56.
http://www.medienkunstnetz.de/works/gfp-bunny/, 21.05.2006, 21:11.
http://www.petworks.co.jp/~hachiya/works/PostPet.html, 20.05.2006, 17:16.
http://www.aec.at/en/archives/prix_archive/prix_projekt.asp?iProjectID=2537, 25.07.2006, 18:37.
http://www.siggraph.org/s95/S95_V1/COMUNITY/ALIVE/ALIVE.HTL, 27.05.2006, 13:56.
http://www.bl.uk/learning/cult/bodies/vitruvius/proportion.html, 11.03.2008, 15:58.
http://www.medienkunstnetz.de/artist/shaw/biography/, 16.05.2007, 20:34.
http://www.jeffrey-shaw.net/html_main/frameset-works.php3, 24.09.2006, 14:15.
http://www.naimark.net/projects/benowhere.html, 28.08.2007, 16:24.
http://www.naimark.net/projects/benowhere/benowhere_i4.html, 23.09.2007, 11:08.
http://www.naimark.net/writing/trips/bnhtrip.html, 15.02.2006, 11:42.
http://www.naimark.net/projects/karlsruhe.html, 15.02.2006, 10:25.
http://www.aec.at/en/global/press_detail.asp?iPressID=171&iAreaID=3, 06.08.2006, 22:12.
http://futurelab.aec.at/arsbox/index3.htm, 18.11.2007, 23:25.
http://www.lozano-hemmer.com/eproyecto.html, 23.07.2007, 17:54.
http://www.t0.or.at/arena/arena_tx.htm#VIEW, 20.04.2007, 15:23.
http://www.olsenorsen.org/olsen-8.html, 25.09.2006, 16:34.
http://www.camilleutterback.com/arctangent.html, 03.03.2007, 23:30.
http://www.flong.com/projects/hwnv/, 23.11.2006, 14:22.
http://on1.zkm.de/zkm/meisterwerke/gossmann, 21.05.2007, 14:30.
http://www.vonhuene.de/stvh/videos/videos-iv/, 25.11.2015, 13:44.

http://www.mediaartnet.org
http://www.zkm.de/
http://www.virtualart.at
https://www.digitalartarchive.at
http://www.aec.at
http://www.ntticc.or.jp
http://www.mediaarthistory.org/

Prof. Dr. Penesta Dika

Penesta Dika studied art history at the University of Vienna and obtained her PhD in Interface Culture and History of Media Art at the Linz University of Art. Her master's thesis on „The Computer Art of Herbert W. Franke" (Die Computerkunst Herbert W. Frankes) was published in 2007 in honor of the 80th birthday of Herbert W. Franke in book form. The results of her scientific research have been published in books and magazines. Her practical experience with interactive digital art („Shape, Color & Sound" – interactive artwork) and her PhD thesis were presented on 2006 and 2007 in the framework of the student projects at the Ars Electronica Festival in Linz.

Penesta Dika works as a free-lance curator in Vienna and as a Professor at the University for Business and Technology in Prishtina. She teaches Research Methods, Design History and Art History. She is the founder of the Association SciTechArt in Vienna. The purpose of the association is education, promotion and research in scientific and technological art. During her previous stay in Prishtina (Kosovo), 2008-2011, she taught at universities (also in Macedonia) art history for journalists, interactive media art, stage design and photography. During this time she was the chair of the board of the „Kosovo Art Gallery" in Prishtina, co-curated exhibitions, authored exhibition catalogues and she was a member of the Jury for important awards in the exhibition area in Kosovo. In 2016, she curated „KosovArt" – a broad-based exhibition of young Kosovar artist in the Gallery Lukas Feichtner in Vienna.