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published on netzspannung.org:
<http://netzspannung.org/about/mars/publications/publications-2005-1-en.pdf>
30 May 2005

First published: Paul Fishwick (ed.): Aesthetic Computing. Cambridge:
MIT Press, 2005.



Fraunhofer Institut
Medienkommunikation

The Exploratory Media Lab
MARS Media Arts & Research Studies

PUBLIC SPACE OF KNOWLEDGE – ARTISTIC PRACTICE IN AESTHETIC COMPUTING

Monika Fleischmann and Wolfgang Strauss

“It is probably not enough to ask that only media authors and especially media artists should investigate the structure of the programmable machine. Much rather, the question is how artists can today still stand before a canvas at all or still work on a block of stone at all without understanding the cultural history of the programmable machine – with its all-pervasive influences on contemporary society and our existence – as a conscious background to their own work and to their own life.” (Trogemann 2004)

1 Introduction

In this article we aim to place our culturally and aesthetically motivated research and development of new interfaces and interactive systems within the context of aesthetic computing, a concept put forward by Paul Fishwick. As media artists and researchers at the Fraunhofer Institute for Media Communication (IMK), we investigate the influence of digital transformations through computers and networks on society. In doing so, we make use of public space onsite and on the Internet as a field for experimentally testing and evaluating new forms of communication. Our interest is in creating new accesses to space and the public with a view to enabling expanded horizons of perception and experience. Our objective is to build up exemplary action spaces that can be physically experienced so as to visibly point up the effect of the technologies on the informed body. In this way the concept of visualisation familiar to computer science is put into a sensory and cognitive context, for, after all, an important role of media art is to show how we understand what we see and perceive.

For us, the notion of aesthetic computing implies giving computing a meaning and shape, and also investing the process of interaction with diverse and unforeseeable forms. In the process of producing and exhibiting interactive works, the relationship between imagination and information, between language (code) and material (interface), is the fundamental basis of the artistic or applied development in question.

It would go beyond the bounds of this article to discuss in detail aesthetics as a concept. But as the philosopher Wolfgang Iser has stated, the notion, which has traditionally been understood as the philosophy of art, has changed with the effects of the New Media on visual culture and our perceptual system: “Vision was traditionally favored because of its hallmarks of distance, precision and universality, because of its capacity for determination and its proximity to cognition. (Today) other senses have attracted new attention. Hearing, for example, is being appreciated (...) because of its essentially social character in contrast to the individualistic execution of vision, and because of its link with emotional elements as opposed to the emotionless mastery of phenomena through vision. Touch has found its advocates in the same way, due both to new developments in media technology and to its emphatically corporal character – this again in contrast to the “pure”, uninvolved character of vision.” (Iser 1995) We suggest that some further concepts should be added to this expanded perceptual system: immediacy and real time, presence and tele-presence, navigation and control.

These days almost all distances have been eliminated. The extent of the terrorist attack on the World Trade Center on 11 September 2001 in New York or of the catastrophic tsunami, the tidal wave caused by a massive earthquake, on 26 December 2004 in the Indian Ocean is almost immediately apparent, with the horror of them being brought almost in real time into every living room by television and the Internet. Both tragedies unleashed a flood of images, making it impossible not to be involved. Only the missing smell of the place, the composed cropping of the images, and the possibility of switching off the TV or PC preserve a certain distance. On the other hand, the break-up of the (extended) family, and the anonymisation both of society and of the working environment give rise to an increased desire to participate in events that can be shared with others. The yearning for presence and being in the world has come about through a lack of social communication. The missing nearness is supposed to be made good by the communication media, which are themselves partly the cause of the loss, and which trigger a renewed flood of information. This flood of information calls for new control and navigation systems, which can

help provide orientation. The interaction of an expanded, complex and contradictory perceptual system is the starting point of our own position, interests and questions.

Our work, therefore, involves investigating perception and its transformation by communication technologies. Our artistic works are mirrors for the viewer, who observes himself. One of our first interactive artworks “Liquid Views” (Fleischmann/Bohn/Strauss 1993) addresses the story of Narcissus and the psychological area of self-recognition and identity as they are discussed in various theories of perception. “Energy_Passages” (Fleischmann/Strauss 2004) reflects a medially constructed reality. “Home of the Brain” (Fleischmann/Strauss 1992), like our “knowledge discovery tools” (Strauss/Fleischmann 2002), presents digital navigation systems. Body-related interfaces, such as the motion platform “Virtual Balance” (Strauss/Fleischmann 1996), the “PointScreen” system with the “Info-Jukebox”, which works without being touched through the body’s electrostatic energy field (Strauss/Fleischmann et al. 2003), or the performative installation “Murmuring Fields” and the eMuse system (Strauss/Fleischmann et al. 1999a) deal with information that is directly inscribed into the body.



Figure 1: Silicon Senses - a multimodal interface allows access to a digital system in many different ways

Our current research topic, “Knowledge Media – Knowledge Arts”, is concerned with developing systems and presenting data spaces as new forms of access to information and knowledge. As research artists we see ourselves at the interface between art, technology and society, locating our own position where architecture, design, computer science, art and society intersect. Under the heading of “Mixed Realities” we are working on concepts connected with the layering and penetration of real and digital spaces, which we call “knowledge spaces”.

2 Space of Knowledge

Our concept of *Space of Knowledge* refers to a hyperdatabase-supported architectural space, in which both explicit and implicit knowledge is present. (Fleischmann/Strauss et al. 2002). The aim is to lay the foundations for integrating our memory into the architectonic space in a multimodally perceptible form, in order to discover new forms of accessing knowledge and to enable greater use of the architectonic space in the context of sensory memory. Our motivation to build *Space of Knowledge* is grounded in New Media art, architecture and design, and relates to the notion of mnemotechnique. (Matussek 2004) Below, three interferential layers of *Space of Knowledge* will be outlined, which build on our current research and development of digitized architectural space.

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- » 1. The “information space” is primarily where the infrastructural network of a digital archive is created.
- » 2. The “explorative space” offers online knowledge tools such as *Semantic Map* and *Timeline*, which support the intuitive discovery of information.
- » 3. The “participation space” is where non-material and performative interfaces provide experimental access to Mixed Reality space.

Interconnecting these layers gives rise to a new understanding of the term “Mixed Realities” as space fused or furnished with data. (Strauss/Fleischmann 2001)

3 Information Space: a digital archive – the hyperdatabase

In this section we discuss the archivist's role when building an online archive and information space. We present "netzspannung.org", an online archive for media art.

The age-old idea of a comprehensive information and knowledge space can today be realised through graphical interfaces on the monitor screen. The educational platform "netzspannung.org" puts media art in the context of topical questions and issues in theory and research. Among other things, the platform presents a comprehensive text and video archive of material from the fields of cultural history, media theory and computer science in a distributed system on the Internet, which is personalisable and which reacts automatically to new incoming information. (Paal 2001) It contains lecture series and text compendia such as *Iconic Turn 2002-03* and *Digital Transformations* (Fleischmann and Reinhard 2004). Published in two languages – English/German – and aimed at both a national and an international audience, the online archive makes an important contribution in supporting the continuing education and training of teachers and students.

Our motive in creating netzspannung.org was to build up a lasting information space on the development of media art and digital culture. Very quickly we had to realize that we were getting ensnared in a vast bewildering network of information sources. An information space that has an unlimited number of information points and links must draw on more than one powerful database. The development of distributed applications – hyperdatabases – is, therefore, the pivot and central feature of the infrastructure of our platform, which should react to changes in the information space. For example, when a new information offer is being registered, each relevant information unit should be supplied automatically with the new information. In developing the platform in this way, we were mindful of a "future forecast" by Marvin Minsky in the 1980s, who sketched out the future of the information space with a fictional conversation between two readers in a library: "Can you imagine that they used to have libraries where the books didn't talk to each other?" (according to Kurzweil 1991)

New technologies in man-machine communication, invisible computers, mobility and sensor data will have to be more thoroughly incorporated into existing research with information systems, giving rise to a series of new, in particular personalised, applications. After all, the question of relevant information always depends on the person, on the situation, and on their spatial and temporal context. Normally, information on the Internet is based on hypertext structures, extended by links referring to further information already defined by initial authors. In addition, the knowledge tools of netzspannung.org can be used to edit information, to introduce or depict information from the Internet in another context and thus to create new knowledge, supported by our cross-platform application environment (Paal et al. 2005). Only information that can be personalised in this way introduces the concept of interactivity for online archives. Unlike approaches to personalisation in commercial applications, which are mainly geared to observing and monitoring the (buying) behavior of users, personalisation with netzspannung.org means primarily providing members of the community with individual virtual workspace on an educational platform that can be accessed free of charge. (Hirsh 2000)

It was not an easy task to develop the concept and implement the Internet platform netzspannung.org based on the needs of a diverse community and within an interdisciplinary team of artists, theorists and computer scientists. Software philosopher Ted Nelson opened up our mind when speaking about the requirements of database people, which were unlike the needs of artists: "... you need to decide in advance what all of your fields are going to be. That is how it is in the database world, you have to decide all of that in advance. ... For some of us, ideas keep changing. You have to be able to change those fields all the time. That is where the database guys get off the boat." (see Engelbart 2000) This is why we had to define a system which was able to adapt the infrastructure to the ongoing input of members online. Nelson was one of the first to point out distributed networks of individually powerful computers as a potential for creating social forms directed by the individual members. His concepts of interconnections and parallelism of structure inspired Tim Berners-Lee and others for the World Wide Web. What Nelson is talking about is not just a technology, but a community of network culture. Howard Rheingold writes in *Tools for Thought*: "Ted Nelson is voicing what a few people have known for a while, from the technical side – that the intersection of communication and computer technologies will create a new communication medium with great possibilities. But he notes that the art of showing us

those possibilities might belong to a different breed of thinker, people with different kinds of motivations and skills than the people who invented the technology.” (Rheingold 2000)

With this in mind, the netzspannung.org team developed a three-layer model of the netzspannung.org platform architecture as a “distributed community engine”. It represents the open, documented interfaces that allow users to implement their own projects. The architecture can be understood as a “network operating system”. The base is an “Internet hard disk” that allows the storing of standard formats like XML but also self-defined data models. The base has an interface that connects to an “application layer”. On top of the application layer is an “interface layer” for creating individual interfaces. The architecture supports various well-known database-system protocols, making it very flexible and offering different layers of complexity. (Paal 2001) The netzspannung.org community of artists and scientists have used the platform technology as an underlying technical infrastructure for their individual projects in the last few years. (see MARS artists)

Our vision was to build up the netzspannung.org online archive in order to interconnect different people and disciplines so that they could learn and acquire knowledge about the intersection of art, science, technology and communication. Today the Internet platform comprises not only a high-quality collection of information on digital culture and media arts, but also links up this information, sets it in various contexts, and makes it available online as a constantly expanding information space, accessible via knowledge discovery tools. (Novak et al. 2003), Large volumes of data have to be broken down into a wealth of individual elements, isolated, grouped, put into context and constituted into complete entities. The “knowledge discovery tools” of netzspannung.org do precisely this, thus demonstrating visual database exploration techniques online.

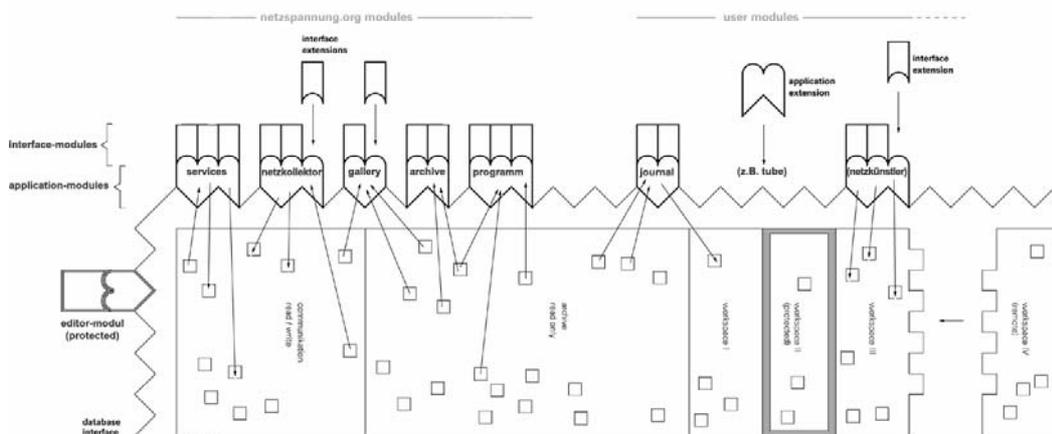


Figure 7.2 Schematic drawing of netzspannung.org platform architecture

4 Explorative Space: Knowledge Discovery Tools

Just as large telescopes help astronomers to see the stars, digital cultures need new instruments to be able to see, survey and evaluate the rapidly growing volumes of data. The problem of finding information in large-scale digital archives, which are highly heterogeneous in terms of content, has hitherto been solved by entering specific search queries in search engines. But how can you find information, whose existence you can only guess at? What do you do if you don't know exactly what you are looking for? How can you see what is available in an archive? How can you be inspired by what is there?

Our knowledge discovery tools filter relevant content out of the flood of information and interlink a network of meanings. “I know what you are looking for”, these tools say, which derive from a vision of Tim Berners-Lee. In his article “The Semantic Web” (Berners-Lee et al. 2001) on the future of the Internet, the inventor of the World Wide Web assumes that without the help of software assistants the potential of the Internet and of online archives will be unminable for the individual. Development regarding the network of meanings is based on the interaction of three

technologies: 1. software agents, which unlike the present-day search engine trawl through information in line with our interests. 2. A machine-readable language capable of representing the semantic content of documents, and 3. ontologies, i.e. semantic networks, which – but only where standardization brings more benefits than it brings about disadvantages – are based on the standardization of meaning.

The netzspannung.org archive provides content from a whole range of disciplines such as media art, IT, design and theory. The aim of netzspannung.org is, therefore, to develop cross-disciplinary forms of contextualisation and visualization by using techniques for finding patterns and trends in large data sets. Knowledge discovery tools are user interfaces for mining data, which permit a ‘dynamic zoom’ on large volumes of data and facilitate the visualization of heterogeneous data resources displayed in semantic context.

Here we describe the knowledge discovery tools, based on pattern recognition and machine learning, which have been developed at the MARS lab. So far three different interface techniques have been implemented:

- »
- » 1. The *Semantic Map* compiles content into clusters and facilitates an explorative navigation of interdisciplinary relationships based on semantic interrelations.
- » 2. The *Timeline* interface arranges content in parallel into various categories and time (x-, y-grid) in order to identify chronological relationships between different fields of content.
- » 3. The *Knowledge Explorer* is a more complex tool for communities of experts. Experts can use it to structure data pools, but also create personal knowledge maps and share them with other members of the community, who can then tap into uncharted pools of information. (Novak 2002)
- »

Below, the Semantic Map will be described in more detail as an example of the knowledge discovery tools. The Semantic Map is a tool which evaluates, structures and visualizes semantic links between individual documents in the netzspannung.org database. During the first stage of the data-processing process, the brief descriptions of all netzspannung.org’s database entries are analyzed in terms both of the words used and of their absolute as well as relative frequency, with very frequent words that are irrelevant to the content (e.g. “the”, “with”, etc.) being filtered out. This process generates – among other things – a list of the most important words. These words are weighted by our editorial staff and used for the graphical visualization: they form the titles of the clusters. The database entries are graphically arranged in a map by using a neural network. With the help of the so-called Kohonen Map (Kohonen 2001), the system allocates each database entry on the basis of the text analysis to a cluster, at the same time relating it to all the other database entries in accordance with their semantic proximity.

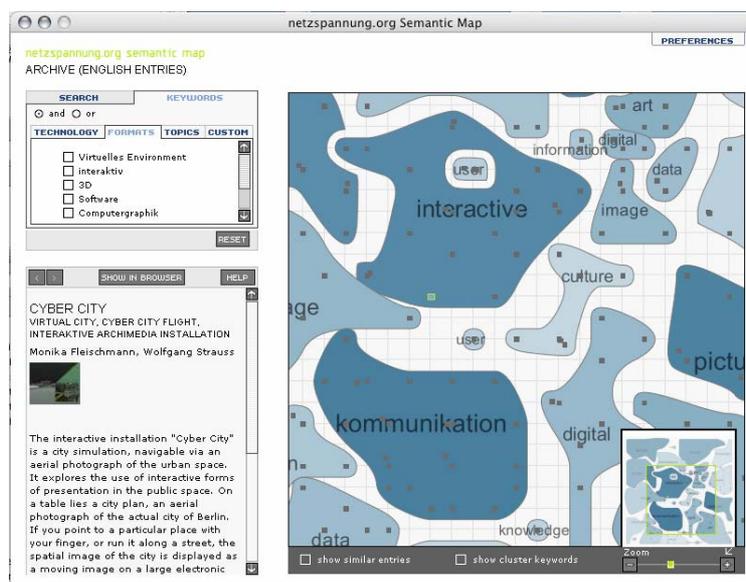


Figure 7.3 Semantic Map Interface (GUI)

The Semantic Map is, therefore, a map that allocates netzspannung.org's database entries to the clusters that are closest in terms of content, and which indicates the interrelations among the database entries. This form of contextualization and visualization provides users with different access points for "rummaging through" the content of netzspannung.org's database and discovering new content. The Semantic Map offers surprising perspectives on individual works of media art by creating connections between individual projects, which are combined into different clusters, constantly rearranged in terms of key concepts.

5 Participation Space: 'Mixed Reality' Architecture to Enter

The question of how online archives can be implemented on both metaphoric-virtual and physical-real levels as accessible and tangible 'space of knowledge' is approached through our Mixed Reality methods for permeating and layering physical and electronic spaces.

We are pursuing the idea of creating networked 'space of knowledge' that are constructed by overlapping the physical and electronic domains. These are places and spaces that are accessed via experimental interfaces, which link real and virtual space. We extend, therefore, the notion of Mixed Reality, which Paul Milgram (Milgram et al. 1994) defined as a spectrum extending from real to virtual experiences, with augmented reality and augmented virtuality bridging the two. In our Mixed Reality approach, physical space and data-space are layered onto each other, resulting in a dynamic, spatial database, which can be entered.

The term underlying this, Mixed Reality, describes the overlaying of real and virtual spaces to achieve the integration of multi-layered levels of reality. It denotes a situation in which the user's action space is composed of elements from different existential categories (material, electronic, natural, artificial, etc.). This Mixed Reality combines real spaces, objects or people with electronic illusion spaces and enables interaction with digital representations. Space, spatial memory and the relation of body to space are the basis for a body- and space-oriented interface.

The interactive Mixed Reality space appears as a room furnished with data. The notion of the room stands for physical interaction space. Data-furniture is both physical objects networked with computer systems or digital artefacts linked to the physical environment. The notion of data-furniture connects experience of mnemotechnics and cognitive science for the interface. It is a spatially organised information architecture, in which data is revealed through users' movement and action in the combined real-virtual space, and through interaction with other users. Data-furniture depicts digital information as visible, audible, tangible and touchless interface objects integrated in architectural space.

A production system for the real-time processing of the most diverse data formats was developed: eMUSE – the electronic multi-user stage environment (Strauss et al. 1999). It enables the creation of a mixed-reality space continuum in which an enterable audio archive – the Murmuring Fields installation – as an interactive sound space for multiple users can create the impression of a concert space. (Fleischmann et al. 2000) The interactive space appears as a room furnished with data. The notion of the room stands for physical interaction space. Data-furniture is both physical objects networked with computer systems or digital artefacts linked to the physical environment. The notion of data-furniture connects experience of mnemotechnics and cognitive science for the interface. It is a spatially organised information architecture, in which data is revealed through users' movement and action in the combined real-virtual space, and through interaction with other users. eMUSE not only integrates several people live in a shared space and represents them in a virtual environment, but it also allows the collaboration of spatially remote users via the Internet. Related scientific or artistic works are e.g. MIT's KidsRoom, (Bobick 1999) and David Rockey's Very Nervous System (1986-90).

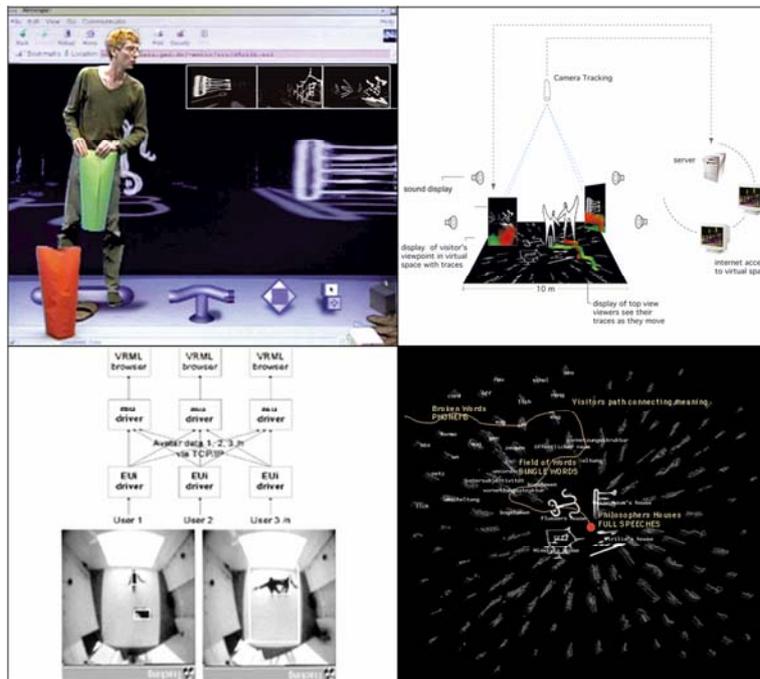


Figure 7.4 Staging the Space of Mixed Reality

With *Murmuring Fields*, we developed a performative audio archive and a sound space for the Mixed Reality stage. Data space and action space are interconnected by an optical tracking system. Performers experience and compose the sound space through movement. The performer's body becomes a musical instrument. In *Murmuring Fields* the virtual space is structured in four zones with statements from the scientists and philosophers Vilém Flusser, Marvin Minsky, Joseph Weizenbaum and Paul Virilio in different languages such as English, German and French. By moving around, performers trigger the spatially arranged soundscape. Depending on speed and direction of movement, new meaning is created as the temporal structure of sentences, words, syllables appear in a different way. Sound follows movement and generates a dynamic circuit based on mnemonics as a spatial dramaturgy.

Theatre scholar Ulrike Hass referred to her observation as: "Shifting the limits of the narrative": "The Mixed Reality stage turns everybody more or less into an actor and, at the same time, reduces the difference between the theatre and everyday life". Ulrike Hass believes that a similar change is taking place in the theatrical narrative. She observes an expansion of the theatrical space, of the physical action and of perception. "This Mixed Reality stage is so special because it is relatively free from images. Here, the sound experience turns into the object of interaction." This is also a difficulty for the audience as long as it only has an observing position. Hass mentions three important points, which single out the *Murmuring Fields*: 1. The relation between digital and virtual space. 2. The increased status of space in comparison to image. 3. The Mixed Reality space as an expansion of physical action and perception. (Strauss/Fleischmann 1999b)

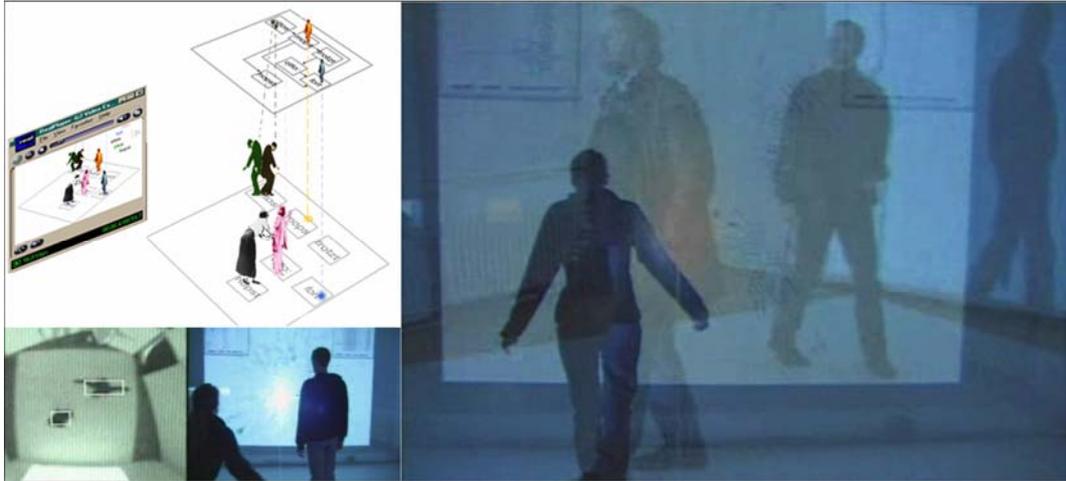


Figure 7.5 Interaction and Movement on the Mixed Reality stage: watching oneself from the outside

The body is the location for all experiences. From a performative perspective, the body, materiality, mediality and interactivity are at the heart of man's observations. The body is the interface, the link to everything in the world. In this respect, we are pursuing the view that sensory experiences and conceptual reflection come together in the "sensory thought process of the body", a view which epistemologist George Lakoff, among others, discusses in *Philosophy in the Flesh. The Embodied Mind*. (Lakoff 1999). Maurice Merleau-Ponty talked about the body as "flesh," made of the same flesh of the world, and it is because the flesh of the body is of the flesh of the world that we can know and understand the world. (Merleau-Ponty 1968). For Merleau-Ponty, consciousness is not just something that goes on in our heads. With his concept of the lived body, Merleau-Ponty overcomes Descartes' mind-body dualism. Rather, our intentional consciousness is experienced in and through our bodies.

6 Public Art: Spaces of Knowledge on the Road

The project *Energy-Passages* (Fleischmann/Strauss 2004) is a participative mixed-reality installation in public space. Here we investigate questions of knowledge discovery, using specially developed software tools to enable the theme of information to be experienced by the visitor. The urban staging of an "information flow" confronts the visitor in front of Munich's House of Literature with the medially mediated communication of a mass medium – the daily newspaper, which we characterize as public linguistic space.

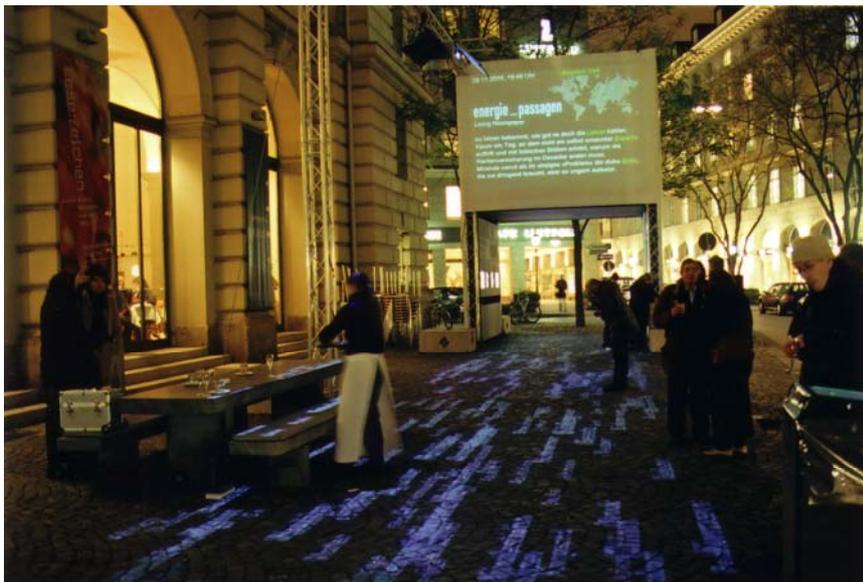


Figure 7.6 Energy_Passages: Information Flow

Especially children, elderly people, artists and female passers-by walked enthusiastically through the flow, as if it were a shower of light and energy. We conducted informal usability studies on people who experienced the exhibit. By watching onsite as well as through a webcam online and by talking to the “performing” visitors, we improved in the first days e.g. the graphics of the touch screen interface, the colours of the selected word in the information flow, the setting of the microphones and the information on the screens in and on the cube accordingly. Not only during the four weeks of the exhibition, but still today we receive feedback, on the basis of our documentation and video online, from renowned experts from Germany and abroad.

Sherry Turkle, Professor of Sociology at the MIT, sent a statement: “The notion of a spatial experience of the discourse of the news within a city space and the possibility of deconstructing the newspaper captures the fragmentation of how media is experienced by citizens in a culture of simulation. It thus mirrors and concretizes an important cultural and political moment, turning it into an object for reflection.” (Turkle 2004). Christiane Paul, New Media art curator at the Whitney Museum in New York, wrote: “Energy_Passages” literally reinscribes the passages of energy that inform our daily life onto the street, allowing passers-by to “perform” the events of the day in their multiple semantic connections.” (Paul 2004)

The technical carrier constructions for “Energy-Passages” are the installation’s architecture, which forms an ensemble of external buildings, an electronic front garden in an urban space. Together with the existing furniture in the form of stone tables and benches by Jenny Holzer, this reading garden has developed into an external space for the House of Literature, which specifically relates to it.



Figure 7.9 Energy_Passages: Overlaying and highlighting the carved words from artist Jenny Holzer

Under the heading of “Ortstermine 2004 – Kunst im öffentlichen Raum” [Local appointments 2004 – The arts in public space] in Munich, a virtual, sensory and cognitively perceivable urban space was developed, which was mainly created by algorithms, visualization and a new type of – ontological – interface. This new urban space is clearly understood to be different from spaces existing in the world of goods, with its advertising messages and images. The theme of the flow in the form of a large image creates a public and media space which is designed by text, language and light, and which is directly on one’s way and can be walked into in the form of a materialized archive.

7 Conclusions

In presenting some of our approaches and concepts, we hope that the perspectives of aesthetic computing, as they are – initiated by Paul Fishwick and others – discussed today, lead to a theory and practice that sees the production of programme structures as universal principles and archetypical ways of thinking, combining them with contemporary art theories and aesthetics theories, as Georg Trogemann, professor of computer science at Cologne's Academy of Media Arts, has called for in his article *Müssen Medienkünstler programmieren können?* (Trogemann 2004). The distinction still prevalent in our imperceptibly developing digital culture between practical engagement (computing) and critical media- or art-theoretical reflection (aesthetics) could be overcome through the discourse on aesthetic computing. As Trogemann writes, a theoretically underpinned approach already existed in the 1960s and 1970s in Germany "in the form of a "generative information aesthetics", which attempted to combine algorithmics and aesthetics, and which was substantially moulded by the physicist, semiotician and philosopher Max Bense and his pupils. Bense combines the natural sciences, art and philosophy in a joint perspective, pursuing a definition of rationality which as existential rationalism could overcome the division between scientific and arts thinking.

For media artists, the basis of a theory and practice of aesthetic computing must be an investigation of the medium of the computer and its special medial sense. (Schiesser 2004) The concept of the special sense of the media, shaped by the Zurich cultural historian Giaco Schiesser, assumes that all media have some special character and that media function not only to transmit messages, but are also – as Friedrich Nietzsche and Herbert Marshall McLuhan already recognised – involved in the content of the message. Thus they not only convey meaning, but are also involved in creating meaning. Accordingly, artistic works in the area of aesthetic computing must lead to a synthesis of sensory perception and cognitive insight, for they should yield up new ways of thinking and models of experience, for example new cartographic and navigational instruments, thus creating the basis for innovations.

Alongside the genuine task areas of the individual disciplines of media art and computer science, specific research collaboration should be defined in the field of aesthetic computing between the natural sciences and the arts, and specific support instruments should be designed for this. Aesthetic computing to foster innovation.

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Iconic Turn – The “Iconic Turn” lecture series, which ran for three semesters, was organized by the Burda Academy for the Third Millennium in collaboration with the Human Sciences Centre of Ludwig Maximilian’s University (LMU), Munich, Germany. In its role as cooperation partner, netzspannung.org recorded the individual contributions to the “Iconic Turn” lecture cycle at Ludwig Maximilian’s University, Munich, and streamed them live. The event took place from Summer Semester 2002 to Summer Semester 2003.
<http://netzspannung.org/positions/lectures/iconic-turn/>

IMK – The Fraunhofer Institute for Media Communication (IMK) undertakes research and development in the area of new digital media in all their facets: including content design, production, distribution, and interaction. The key objectives of the IMK are to expand the range and functionality of digital media, to examine their creative and social possibilities, to develop innovative solutions, and to open up new fields of application.
<http://www.imk.fraunhofer.de/>

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Bense, Max: <http://www.medienkunstnetz.de/artist/bense/biography/>

Energy_Passages: Refer to the project description and technical explanation: <http://www.energie-passagen.de/projekt.htm>

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Hyperdatabase: the concept of the hyperdatabase was outlined by Prof. Hans-Jörg Schek of the Swiss Federal Institute of Technology (ETH), Zurich: <http://www-dbs.inf.ethz.ch/>

MARS artists: e.g. Shu Lea Cheang realized: Carry On <http://netzspannung.org/carryon/>
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Marshall McLuhan, Herbert: stated "the medium is the message".

Murmuring Fields – Mixed Reality Installation, 1999, <http://www.arena.kth.se/murmur.html>
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netzspannung.org – online archive on media art and digital culture <http://netzspannung.org>

Nietzsche, Friedrich: the half-blind Friedrich Nietzsche saw that the medium of the typewriter itself "plays a part in writing our thoughts".

Semantic Map – Knowledge Discovery Tool <http://netzspannung.org/about/tools/semantic-map/>

Timeline – Knowledge Discovery Tool
<http://netzspannung.org/about/tools/timeline/?lang=en>

Very Nervous System. <http://homepage.mac.com/davidrokeby/vns.html>