

ALL WE NEED IS THINKING SPACE - GENERATIVE INTERACTIVITY IN DIGITAL ART

Abstract

This presentation at the *Generative Art Summit* discusses the impact of *Generative Art* at the nexus of art, technology, and interactivity, particularly within the *Art&Science* framework. While the focus of *Generative Art* has been on predetermined, algorithms, *Fleischmann and Strauss'* approach departed from generative methods by emphasizing interactivity and audience participation as integral elements of the creative process. Influenced by post-reunification Germany and the rise of the Internet, their work highlighted performative interfaces where audience engagement actively shaped the artwork. Key projects such as *Between 0/1*, *Genetic Modification*, *Home of the Brain*, and *Energy Passages* illustrate how their research and practice created dynamic *Thinking Spaces* that invited reflection, public debate, and personal discovery. This generative interactivity transforms passive observation into co-creation, allowing viewers to not only interact with the artwork but to reflect on their role within it, offering a meaning-finding, evolving experience that extends beyond the moment of engagement.

Keywords: Art & Science, Audience Participation, AI, Digital Art, Generative Art, Interactivity, Non-linear Processes, Performative Interfaces, Public Engagement, Thinking Space, Virtual Reality.

FROM SYSTEMS TO EXPERIENCES

Generative Art is a unique form where the artist creates a system—such as a set of rules or a computer program—that autonomously generates works of art. At this Generative Art Summit in July 2024, hosted by the Academy of the Arts in Berlin, we honor Herbert W. Franke, a true pioneer in this field. Franke, the founder of Ars Electronica in Linz, Austria, was a key figure in shaping early generative art. We first met him in 1988 at ART+COM, the Berlin-based research institute that we co-founded. His work inspired us but also marked the beginning of our artistic divergence from traditional generative methods.

While Franke's work was an exploration of generative art systems, we were interested in the intersection of digital and physical interactivity. We began to develop tactile, interactive, and non-linear approaches to digital art that invited participation. Our focus shifted to creating performative interfaces where audience participation shaped the artwork. It was more than a game; it was an improvisational and exploratory process that allowed participants to discover their own narrative within the generative framework.

Our early work at ART+COM focused on exploring the computer as a medium for communication and artistic expression. Working with a transdisciplinary team, we set out to pioneer new forms of interaction and design, ultimately contributing to the development of our digital future. One such milestone was *Home of the Brain* (1990), an early virtual reality installation that was awarded the prestigious Golden Nica at the 1992 Prix Ars Electronica. This project made pioneering use of data gloves and glasses, highlighting the potential of virtual reality as both an artistic medium and a tool for philosophical environmental exploration. Other early projects further illustrated the potential of *Human-Computer Interfaces* and generative processes, including *Berlin-Cyber City* (1989) and the real-time radiosity light and shadow experiments in *Pool Office* (1989-90), the real and virtual design of Hewlett Packard's Berlin headquarters. These works were among the first to merge real and virtual environments, using cutting-edge technology to create immersive, interactive experiences, but also gave rise to the scientific visualization of real environmental data, such as light or pollution.

Since the late 1980s, our work has focused on developing interactive art and performative interfaces that actively engage the audience. In these systems, the viewer's interaction not only shapes their experience but also plays a critical role in determining the state of the artwork itself. The process is non-linear and unpredictable, creating room for discovery and deeper personal engagement. This emphasis on interactivity reflects the growing interconnectedness of the digital and physical worlds, with the artwork leaving an impact on the viewer, encouraging reflection and engagement long after the initial interaction has ended. Ultimately, we see these works as creating *Thinking Spaces* - environments where artificial and natural intelligence intersect, and where viewers are invited to co-create meaning in an ongoing, dynamic dialogue with the artwork. This is at the core of our artistic approach: to facilitate spaces for thought and interaction that transcend the boundaries of traditional art forms and challenge the roles of both artist and viewer in the creative process.

BETWEEN ZERO AND ONE – DIGITAL TRANSFORMATIONS

Physicist *Herbert W. Franke* used computers and algorithms to turn mathematics into art, pioneering generative photography and working with mainframe computers in the 1950s and 1960s. His early work influenced modern *Generative Art*, which today typically emerges through digital codes or analog rules. In our series, entitled *Between 0/1 (1988)*, we used random numbers to transform *Euclidean* geometry into dynamic, ever-changing shapes. This created a zone of internal dialogue that emphasized the spatio-temporal Gestalt of forms.

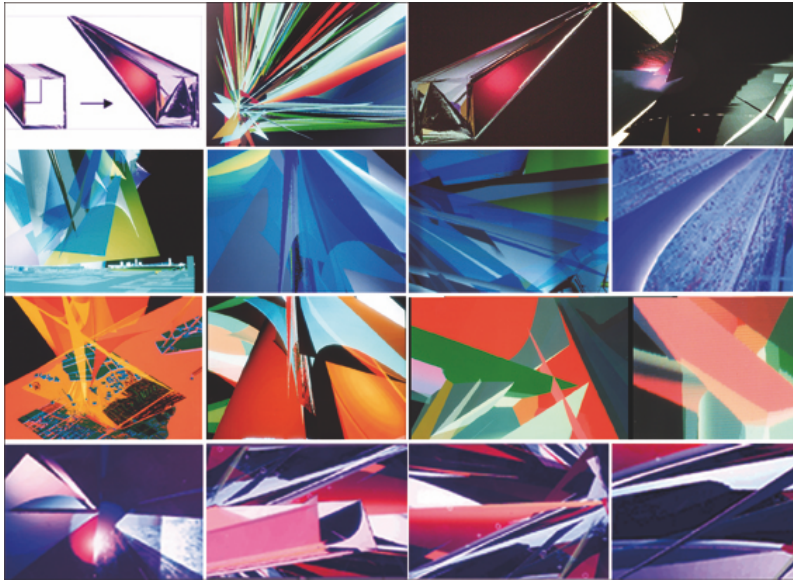


Figure 1. Between 0/1: Mix (1988) © Fleischmann & Strauss

Image synthesis on the *CM-5 Thinking Machines* generated an infinite number of genetic variants. A snapshot of *Schloss Birlinghoven*, where GMD, the German National Research Center for Information Technology housed our Media Arts ReSearch laboratory (MARS), was transformed into a series of *Genetic Modification* (1992). This visual coding process involved interpolating the RGB values of pixels from two source images. This generative process is comparable to the transformation methods of nature and *Gregor Mendel's* crossing of plants.

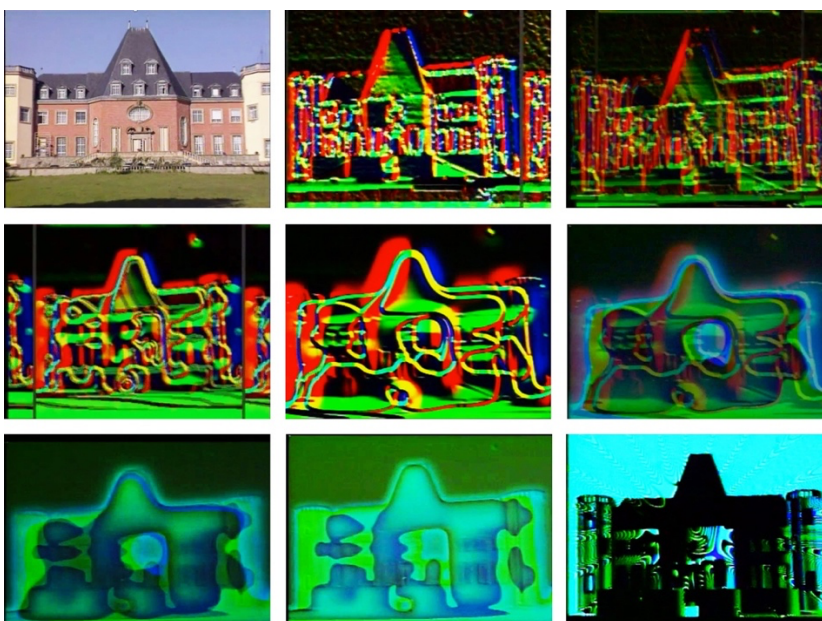


Figure 2. Genetic Modification - Thinking Machines' CM-5 Image Synthesis: (1992) © Fleischmann & Strauss

In classical *Generative Art*, the system must be fully specified to function autonomously. In *Between 0/1* (1988), as in *Genetic Modification* (1992), the generative aspect emphasized the flexibility of the digital.

HOME OF THE BRAIN – PHILOSOPHERS' HOUSES (1990)

The *Virtual Reality* installation *Home of the Brain* (1990) explores bodily movement in virtual space with head and hand, using a head-mounted display and a data glove. Gestures represent the connection between mind, body, and machine. Visitors navigate through virtual buildings of thought. They are guided by the voices of four philosophers who express their contrasting views on the digital future: *Vilém Flusser*, *Marvin Minsky*, *Paul Virilio*, and *Joseph Weizenbaum*. *Virtual Reality* is used to transport the viewer into the minds of these philosophers. In his *Thinking House*, *Flusser* addresses the rise of the Internet. He notes that instead of participating in politics, young people use their terminals to connect to digital networks. *Virilio* observes that in this new digital world, speed replaces time. In his view, this leads to a "frantic standstill."

The media discourse typically found in books converges here in digital media itself. Like the ancient *Greek Stoa*, a new public space emerges within the global digital network. Decades before *Second Life* and the *Metaverse*, *Home of the Brain* was a generative collage of thoughts created by visitor interaction. As part of the generative process, the underlying radiosity algorithm created an atmosphere of light and shadow reminiscent of *Giorgio de Chirico*. This very first VR art installation not only provoked audiences to reflect on virtual reality as a new medium, but also to engage in a philosophical debate about technology itself - made visible as an interactive, real-time 3D landscape of combative statements, sentences, and words.

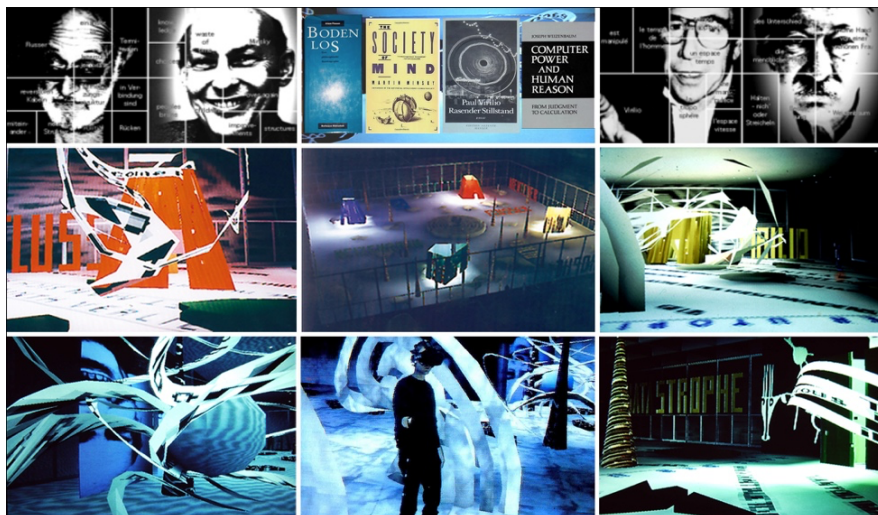


Figure 3: Home of the Brain (1990) Virtual Reality installation © Fleischmann & Strauss

The work is an early example of rethinking the virtual as a symbolic space—one that invites the meeting of architecture, contradicting thoughts, philosophical positions, and radical viewpoints. *Home of the Brain* serves as a metaphor for a completely new kind of public space for cultural and philosophical reflection on emerging technology.

LIQUID VIEWS – NARCISSUS MIRROR (1992)

Liquid Views (1992) is a generative artwork that invites viewers to interact with their reflection on a screen of algorithmically simulated water. The viewer's image is captured by a video camera and integrated into the real-time water simulation, creating a transforming mirror. As in *Caravaggio's* painting of *Narcissus*, viewers are drawn to touch their reflection, but unlike *Narcissus*, this installation transforms the inward gaze into a public experience as the viewer's distorted image becomes visible to others.

The line between observer and observed is blurred in this encounter with self and other. This process challenges familiar notions of identity and reveals how we come to see ourselves not only through our own eyes, but through the eyes of those around us.

Anticipating today's selfie culture, *Liquid Views* highlighted the societal shift toward self-representation shaped by the gaze of others and the digital mediation of personal images. The installation was revolutionary for its time, allowing viewers to become both subjects and objects within a generative framework that encouraged introspection while making the self publicly visible.

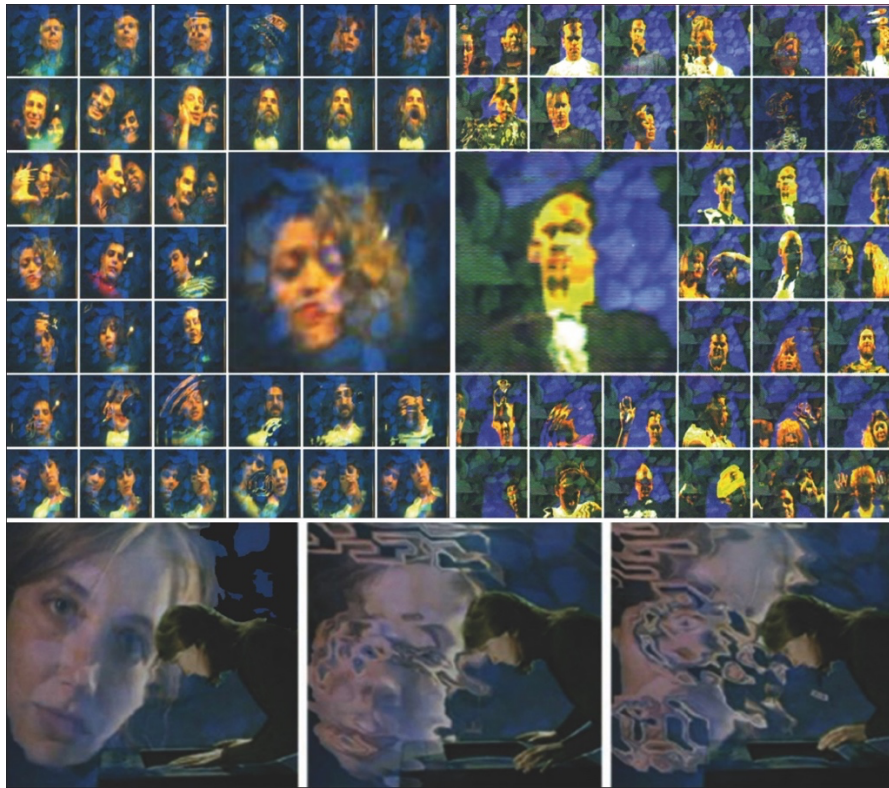


Figure 4. *Liquid Views* (1992) Mixed Reality Installation © Fleischmann & Strauss

Technologically, *Liquid Views* is a milestone in interactive art. It was one of the first works to use a homemade high-resolution multi-touch interface. It integrated the camera, touchscreen, and real-time water simulation into a seamless experience that merged physical and virtual realities. This imperceptible interface, reminiscent of the later development of smartphone technology, is both highly immersive and intuitive. The swiping gestures that were a key component of the interaction foreshadowed the touch-based interfaces that would become commonplace more than a decade later.

The installation's impact lies not only in its technical achievements but also in its ability to merge art and interactivity. As one of the earliest examples of performative, generative art, *Liquid Views* invited viewers into a process of discovery, where their own actions shaped the artwork. This shift from passive observation to active participation marked a significant evolution in the relationship between art and audience.

Liquid Views was widely acclaimed and exhibited in nearly 100 venues, from its debut in *Visions of Virtuality* at GMD's *Castle Day* in 1992, to SIGGRAPH's iconic *Machine Culture* show in 1993, to *Electric Dreams* at Tate Modern in 2024. The interactive nature of the work revealed fascinating cultural differences in audience response.

In Los Angeles, playful comments such as "*This touch is like sex with my computer*" reflected light-hearted engagement, while in Paris, men were reluctant to see themselves in public. In Mexico, visitors hesitated, treating the work like a religious icon. Each location brought its own history and culture to the artwork, creating unique narratives shaped by the viewers themselves. *Liquid Views* continues to influence the discourse on interactive art and remains a pivotal work in the exploration of self-awareness in the digital age.

RIGID WAVES – NARCISSUS ECHO (1993)

Rigid Waves (1993) presents a generative artwork in which typical mirror reflections are replaced by algorithmically controlled self-images, allowing viewers to experience themselves from unconventional and distorted perspectives. The artwork responds to the viewer's movement and distance, fragmenting and altering the self-image in real time. This dynamic interaction evokes a sense of dissonance between self-perception and external appearance, akin to the myth of *Narcissus and Echo* from Ovid's *Metamorphoses*.



Figure 5. *Rigid Waves* (1993) Mixed Reality Installation © Fleischmann & Strauss

In *Rigid Waves*, the digital mirror no longer unites the self; instead, it fractures and rearranges the image into autonomous, fluid representations. The result is a reflection, where the viewer's movements create a distortion that underlines the gap between the self and its representation. As the viewer moves, the mirror responds by distorting their image, creating an asynchronous experience of real-time movement and digital reflection.

This disconnection between the viewer and their reflection introduces an opportunity to encounter oneself in new, unexpected ways—fragmented, delayed, distorted, or frozen in motion. The digital mirror exposes hidden facets of the self, challenging how we perceive our identity and offering alternative realities through these virtual doubles. The echoed distortion of the self invites reflection on how technology mediates our perception of identity.

Through this performative interface, viewers are encouraged to see themselves from unusual vantage points: from behind, from the side, or even through distorted proportions. The body is reborn in these fractured reflections, separating self-perception from the self-image. In this disorienting digital encounter, the viewer is freed from the usual expectations of identity, offering a conversation about disruption, dislocation, and the possibilities of alternative realities. The fragmented reflection, much like a dance with one's digital double, offers a searching exploration of self-perception and how we are seen by ourselves and others.

NETZSPANNUNG.ORG – NETWORKED KNOWLEDGE SPACE (2001)

In response to the emerging Internet as a new public space, the *netzspannung.org* project was launched in 2001. The project functions as an online repository and platform for *Media Art*, featuring curated channels such as *Digital Sparks* (2001-2008), a student competition, and *Telelectures* (2002-2006), which showcased eminent artists and scientists. These lectures, which were streamed live on the Internet and directly to partner universities, preceded the advent of platforms such as YouTube or Zoom. The *Media Art Learning* channel, operated by our MARS Lab and by 25 German universities, provided examples of media art teaching. This cross-border mixture of content worked as a virtual art encyclopedia, resulting in an unconventional digital archive for the interdisciplinary field of media art, where no cross-subject system existed. The *netzspannung.org* archive has been in operation for almost ten years. *Netzspannung.org* was archived at the ZKM Center for Art and Media in Karlsruhe in 2010, preserving thousands of media art documents.

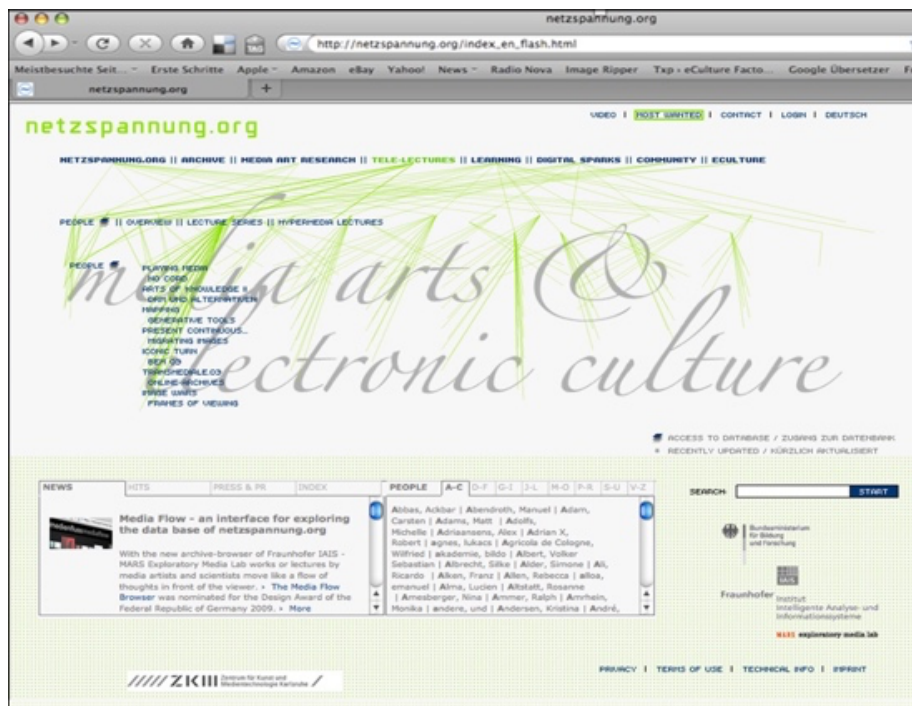


Figure 6. Netzspannung.org – Archive & Platform for Media Arts (1999-2000) © Fleischmann & Strauss

NETZSPANNUNG.ORG'S KNOWLEDGE DISCOVERY TOOLS (2002-06)

Online repositories are often inaccessible to the average reader. Typically, only experienced researchers can access their treasures. They are accessible only to experts who know exactly what they are looking for. Our goal was to turn the archive into a networked knowledge base. We developed tools like the *Semantic Map* (2002), a zoomable landscape that presents content in a self-organizing map organized by neural networks, the jukebox-like *Matrix* (2005) or *Media Flow* (2006), which visualizes the flow of ideas through images, authors, and keywords. By enabling performative, intuitive archive exploration, these interfaces transform information retrieval into a meaningful act of discovery. They are meant to be used as walk-in installations as well as screen-based installations in both real and virtual environments.

SEMANTIC MAP (2002)

The *Semantic Map* displays archive information as a zoomable landscape. The system is based on *Kohonen's self-organizing map* (SOM), which is trained to recognize patterns in text and group similar entries based on their semantic content. The self-organizing map uses a neural network to discover content connections between texts, identify similarities, generate keywords, and organize documents into thematic clusters. In this way, the *Semantic Map* transforms the digital archive from a static repository of information into a dynamic, intelligent, navigable knowledge network where the semantic connections between database entries are visually represented.

One of the most important contributions of the map is its ability to function as a thinking tool. It encourages the viewer to discover new knowledge structures based on his or her own interpretations. Browsing the map becomes a performative act. It leads to a co-creative process of finding meaning and provides the viewer with new insights. The documents of individual works and artists appear as nodes in a network of ideas. They connect thoughts, issues and practices. The "reader" of the map learns by finding differences. In this way, they contribute to the creation of meaning. This is the performative act of the viewer and the interface. The Semantic Map shows how comparative reading affects our thinking. It is a first attempt at Marvin Minsky's 1990 statement: "Imagine if the books in a library could talk to each other."

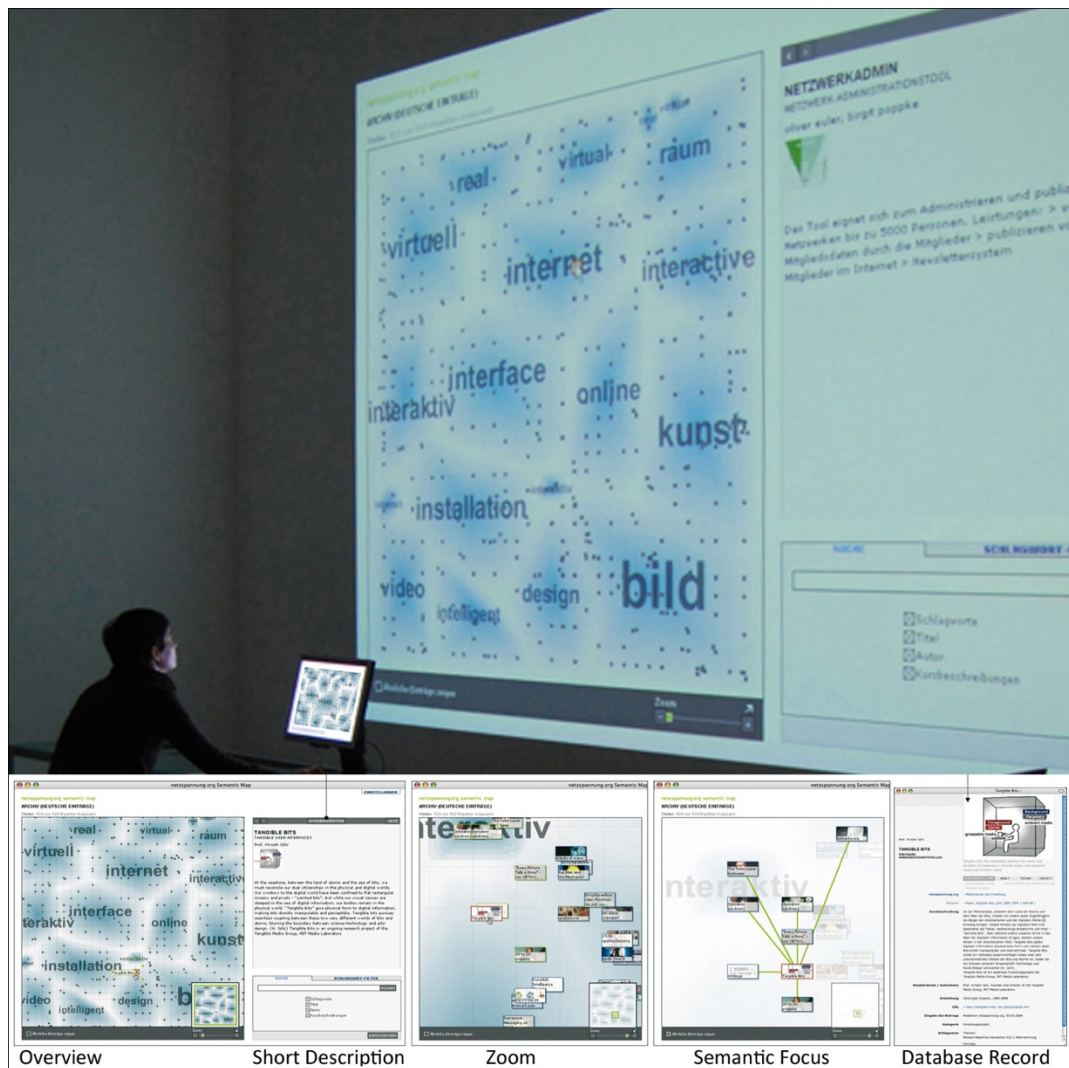


Figure 7. Semantic Map (2002) © Fleischmann & Strauss

MEDIA FLOW (2006) AND MATRIX (2005)

The *Media Flow* (2006) view of the *netzspannung.org* database represents the flow of ideas. We see authors, images, titles and keywords floating before our eyes. The *Matrix* interface is like a jukebox for selecting videos. It uses color codes to indicate categories such as science, art and design. Simply waving their hands in front of our touchless *PointScreen* (2002) allows visitors to choose one of the 456 videos. All three of these new interfaces to the archive allow for quick browsing of the entire archive and an at-a-glance understanding of what the archive has to offer. "*Netzspannung.org and its groundbreaking interfaces create knowledge and data structures. What has emerged here is a model for an international educational infrastructure that deserves to be emulated,*" said the brilliant late director *Peter Weibel* at the opening of the *Fleischmann and Strauss* solo exhibition *Interfacing the Archive* at ZKM in 2012.



Figure 8. Media Flow (2006) and Matrix (2005) © Fleischmann & Strauss

ENERGY PASSAGES – A PUBLIC THINKING SPACE (2004)

In November 2004, words came to life as part of the site-specific installation *Energy Passages* in front of the *Haus der Literatur*, a prominent cultural institution in Munich, Germany. This interactive work allowed participants to engage with a poetic, audio-visual stream of words running across the square. Initially, viewers interacted casually, but soon realized they were playing with the daily news. The installation, which lasted for four weeks, used an AI algorithm to distill the content of the daily newspaper into 500 essential keywords each day. This system evaluated the newspaper and participants' chosen words, blending fact-based reporting with the visitors' preferences. The result was a dynamic demonstration of the power of murmuring floating words as poetry.



Figure 9. Energy Passages (2004) © Fleischmann & Strauss

Visitors could select the words they wished to engage with through touchscreens or by speaking into microphones. These interactions created a layered soundscape, fostering reading, conversation, and even performance. Each selected word was associated with five similar terms using a nearest-neighbor algorithm. The most frequently selected words, such as "price," "parents," "sacrifice," "love," "food," and "girl," contrasted sharply with the more factual, impersonal terms from the newspaper like "percent," "years," "Germany," and "millions." This interaction highlighted the difference between individual

concerns and the abstract framing of news stories, creating a public dialogue space where the participants could explore, and debate shared values. Throughout the installation's duration, more than 4,000 visitors engaged with *Energy Passages*, selecting words to express their interests or simply walking through the swirling stream of text. The interaction became a living conversation as visitors sang, danced, and physically navigated through the words, drawing energy from the immersive, poetic environment.

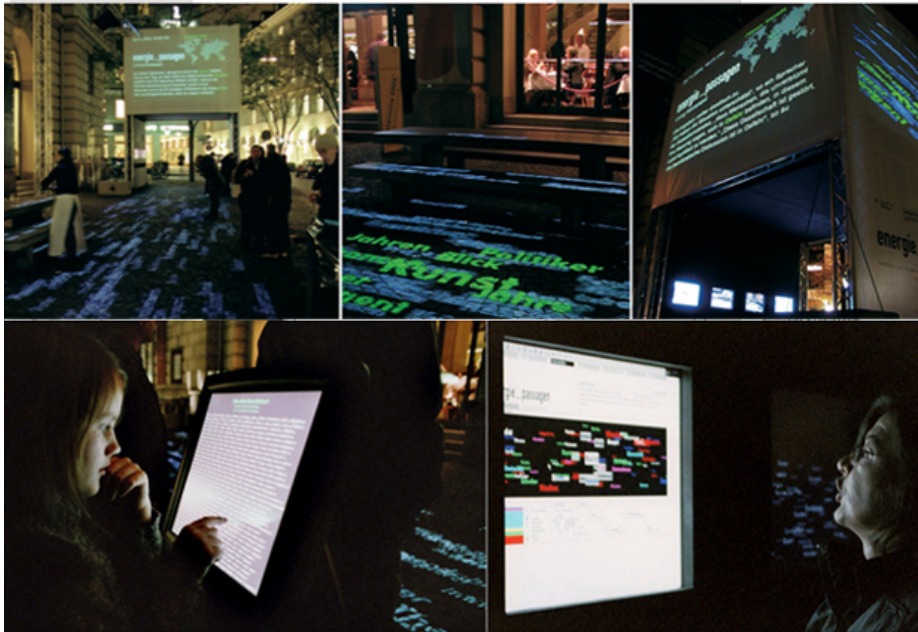


Figure 10. Energy Passages: Interfaces (2004) © Fleischmann & Strauss

Energy Passages effectively demonstrated how media art can not only evoke aesthetic feelings, but also stimulate public discussion and civic engagement, motivating people to participate in democratic processes related to current events and societal issues. The installation introduced the concept of a *Thinking Space* - an aesthetic and intellectual intervention in the global media landscape, creating a third space where personal expression, collective thought, and mass media converge.

EVOLVING INTERFACES: FROM OBSERVATION TO ACTIVE REFLECTION

Generative interactivity has redefined the relationship between art and audience, turning passive observation into active participation. Projects like *Berlin-Cyber City* or *Home of the Brain* demonstrate how interaction generates not only visual diversity and experiential variation but also stimulates public dialog and personal reflection. Works like *Liquid Views* and *Rigid Waves* explore self-perception through digital mirrors, predicting today's culture of self-representation, while *Energy Passages* encourages collective thinking and democratic engagement.

These projects demonstrate the impact of generative interactivity as a transformative force in digital art. By empowering audiences to co-create, these works open space for discovery and meaning-finding. This evolving interaction reflects the essence of generative interactivity—creating *Thinking Spaces* where art, technology, and human experience converge to inspire ongoing engagement and reflection.

At its core, this interactivity allows knowledge to emerge through the act of participation, triggering insights that lie outside the system itself. By reversing the conventional interface from "*what you see is what you get*" to "*what you get is what you didn't see before*," these projects invite the audience into a dynamic process of discovery and engagement. This is the essence of generative interactivity - a performative interface that evolves over time, creating an open space for artistic exploration and reflective thinking. You might say: This art is regenerative.

Related Links:

- MEDIA ART AS THINKING SPACE - Fleischmann & Strauss <https://www.fleischmann-strauss.de/>
- ADA FEATURE: Fleischmann & Strauss, Let's talk about archiving, Interview by Alejandro Quiñones and Carla Zamora. Text by Alejandro Quiñones. Dez. 2023
<https://digitalartarchive.at/magazine/fleischmann-strauss/>
- (COLLECTIVE) FLEISCHMANN / STRAUSS *1950, *1951 currently based: Berlin, Germany | Gargnano, Italy. <https://digitalartarchive.at/database/artist/19/>
- ZKM | Center for Art and Media, affiliated institution, fleischmann-strauss.de / artnetwork@fleischmann-strauss.de