Towards a Phenomenology of Responsive Architecture: Intelligent Technologies and Their Influence on the Experience of Space

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Abstract

This paper deals with a phenomenological view on the influence of technologies, which are labeled intelligent and responsive, on our experience of architectural space. The origin of these technologies is to be found in cybernetic science and the following evolution of cybernetic machines and computers in an attempt to create artificial intelligence. An explicit architecture-oriented application of computers and AI was proposed by Nicholas Negroponte and the Architecture Machine Group in the 1960´s and 1970´s. Negroponte endorsed the integration of "intelligent minicomputers" in architectural spaces in order to intensify our relation with these environments. He was, however, confronted with the same critical questions that were formulated at the same time by Hubert Dreyfus in his phenomenological investigation of AI. Phenomenology is an instrument to reveal our relationship with technology despite the fact that it also has a tradition in opposing technology. Although phenomenology has a tradition in opposing technology, it is rather an instrument to reveal our relationship with technology. Therefore, the inquiry presented here takes on Don Ihde's phenomenological approach towards various structural features of human-technology relations which he laid out as `embodiment´-, `hermeneutic´-, `alterity´-, and `background´-relations. In his work, Ihde is anxious to present a demythologized account of technologically mediated experiences in relation to an environment. The paper contemplates the work of Nicholas Negroponte, Tristan d'Estrée Sterk and Gordon Pask. Pask was a scientific pioneer in the field of cybernetics with artistic interest in the development of responsive environments. The actual work of Sterk is influenced by Negroponte's architectural concepts. But Sterk takes into account recent developments in computing power, controlling systems and mechanics. His work encompasses shape shifting architectural envelopes and environments which respond to the actions of dwellers and to environmental conditions. The phenomenological approach proposed here investigates forms of `user – architectonical space – relations´ in connection with intelligent technologies, deployed in architectural environments. The paper focuses on the active and discerning subject which stands in relation with the space it inhabits.

Author biography

Born on August 19th, 1978 in Villach, Austria. From 1998: studies of architecture at the University of Applied Arts in Vienna and at the Aarhus School of Architecture, Denmark. 2005: Diploma at the University of Applied Arts in Vienna, Studio 1, Zaha Hadid. From 2005 to 2007: employed as architect and project developer in Denmark and Austria. Since 2007: PhD research project at the University of Applied Arts in Vienna, fellow employee in architectural offices.

Introduction

There is a tendency in phenomenology to be sceptical and critical towards technology. Certain phenomenologists such as Martin Heidegger opposed modern developments of technology by blaming technology for the hastening of every day life in the service of yield. On another level, Hubert Dreyfus was able to contribute new impulses to the research field of artificial intelligence over the last decades by criticising the development of AI based on the mechanization of human abilities. He realised that the rule-based research of AI developers and computer designers often led to dead-ends because they had no knowledge about the essence of human being. Dreyfus pointed out that one achievement of phenomenology after Edmund Husserl persists in realising that cognition can not be explained by the notion of rules. Based on Maurice Merleau-Ponty's phenomenology, Dreyfus underlines that perception and comprehension are based on the human ability to learn flexible patterns of behaviour.[1] Human intelligence is widely defined by abilities concerning cognition, problem solving, the recognition of contexts and context switching. Some of these abilities can partly be simulated by computers with high efficiency but at this moment there is no claim for a complete model of human intelligence in a holistic sense. This diagnosis should prevent a direct and maybe negative comparison of human intelligence and aspects of artificial machine intelligence as it is presented in the context of the paper.

In my understanding, phenomenology does not exclusively serve as an instrument to criticise technology, but rather to describe our relationship with it through the concept of intentionality. In doing so, our entire presence including our cognitive characteristics is of importance. Technology has an impact on this presence and, as a medium of material culture, influences the sensory and bodily experience of a person in reference to an environment. The deployment of responsive technologies to architectural spaces leads to a re-evaluation of

person-environment-relationships and to discussions about topics like `personalisation of architecture´. These technologies establish new aspects of lived-space within and in comparison to the geometric appearance of architectural space. Thereby, technological components in architecture give up their status as background related and nearly undetectable technologies and enable a shift in the experience of inhabited space.

Background relations

The concept of architectural responses arose from the work of Nicholas Negroponte and the *Architecture Machine Group* at the MIT from the late 1960´s to the mid 1970´s. Negroponte proposed the application of computers in architectural design and endorsed their integration in built structures and spaces. The initiation of the research program was a consequence of the crisis of architectural rationalism and the endless repetition of industrialized architectural forms. The goals of the program were to make buildings context responsive and to create an intelligent environment that responses to the requirements and desires of users.

The common introduction to responsive architecture is usually made by using the example of the thermostat. It is a basic example of a cybernetic feedback loop placed in a building environment in which the actual output is affected in response to an input. A sensor distributed in the environment is monitoring its change (as for example a decline of temperature). A controlling device, which may also enables a user to enter his/her preferences (a change in space temperature), is reading the sensory output and compares it to a predefined instruction (hold a certain space temperature). If there is a change in the input criteria (temperature dial) the controlling device is triggering actuators (the heating system) which are able to change the environment. The thermostat is an example for what Don Ihde calls in his classification background phenomena. That is, as the term reveals, when a “specifically functioning technology” occupies a “background or field position” or becomes “a kind of near-technological environment itself.”[2] Once set, these technologies, controlling for example lighting, heating, and cooling systems, are operating more or less automatically. They do not require our focal attention. These technologies in the background would be a source of conflict for a phenomenology as operated by Heidegger, because they disconnect us from activities that bring change to an environment we live in. In this view, which might be called romantic, the way to heat a home is that one has to go out to cut down a tree using an axe as a technology for this purpose. Furthermore, someone has to chop the wood, dry it, store it, and at last set it ablaze to generate heat energy. In contrast, to operate

a thermostat is a “fire and forget” activity. But also a conventional wood fired oven becomes an example for background relations in the intervals between the maintenance of the fire. The oven does not need our undivided attention to cause environmental change. This examination should demonstrate the sometimes tense relationship between phenomenology and technology. It is shown in a missing acceptance for the nature of technology and its development as a fact of human endeavour. Ever since technologies have been deployed and accepted, they, on one hand, intended to change our ways of doing and on the other hand they also have changed the production of environments and social fields where we place our doing. In the philosophy of technology, these two points were often strictly divided by the discussion over the neutrality or non-neutrality of technology; divided by the instrumental theory of technological-determinist position on one side and by the substantive theory of social determinists on the other side for which Heidegger took position.

Naturally, technologies are compassed by human experience. Therefore they are matter of the *lifeworld* and thus part of the phenomenological concept. Husserl brought the notion of *Lebenswelt*, respectively lifeworld, into phenomenological philosophy to be understood as most basic layer of World. In his view, “any secondary or specialized world”[3], such as science and technology, has to have an immediate connection to the basis or otherwise has to be critically questioned. It is pointed out that “the issue of the lifeworld” arose with the “advent of modern science”.[4] Science took over great authority in the attempt for objective investigation and explanation of World. Phenomenology, in its characteristic as scientific philosophy based on the subjective, coped with that fact through argumentations that sciences were widely and originally embedded in the lived world. The notion of lifeworld is interpreted as a basis for the human experience of daily life which is no matter of reflective attention. This basis will be received unquestioned and as self-evident. “[T]he lifeworld in which the experience happens is normally out of sight” as “human beings do not make their experience in the lifeworld an object of conscious awareness.”[5] That means, this oblivion is not just an absence but an absence of something that can be brought to mind through the consciousness itself.[6] It can be assumed that the experience of architectural space through human-technology relations is emanating likewise from the same basis that is called lifeworld as the experience of all other matters of daily life. The impact of technologies should not have a disconnecting effect towards the lifeworld. But technologies take influence on the preconditions which humans come across in their daily life. Technology is grounded in the World-stratum but daily life is changing in the face of technologies. In phenomenology, the

“grantedness of the everyday world” is identified by the term “natural attitude” which emphasises the phenomenological fact “that people are immersed in a world that normally unfolds automatically.”[7]

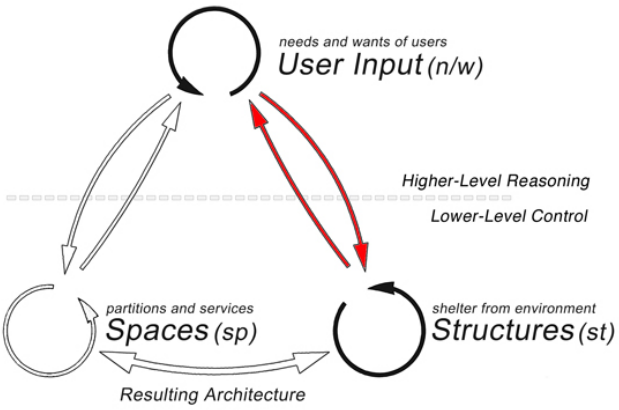
In fact, the perception of technologies in background position shows similarities to how we commonly perceive our inhabited spaces. We recognise the boundaries of our inhabited spaces but we usually do not pay focal attention to the physical presence of their geometric dimensions. Except the space is unusually big or small, the ceiling is very low, or the geometrical and material appearance of the architectural space is sensational so we become fascinated with it. At the same time we have proof of the existence of technologies in the background because of their impact on the building environment, but we do not pay focal attention to them. In their operational manner they are barely detectable. We notice them occasionally. For example when we hear a noise in the moment a system has been activated. Building management systems come to our mind when they fail to work properly. If a room is still cold when we want it warm or the automatic sunblind will not open or close according to the solar radiation. It seems not coincidental that background related technology is mostly attached to – or is placed under surfaces that define an architectural space. That is, not to hide it merely physically. Technology is located at the edge of an architectural environment as it is located at the periphery of our perception. Building envelope and technology are, as they were, “to the side.”[8] They build up a usually penetrable sheet between a proximate environment of interior space and the broad or external environment.

Responsive architecture

The disadvantage of the thermostat principle as mentioned above and of similar cybernetic devices is shown in the static and predetermined input and output criteria. The demands upon an intelligent environment take more than the simple work of monitoring and controlling under predefined settings but require a constant and context related response of the build structure to the user. Therefore, Negroponte and others were following a concept in which an environment had a functional image of itself upon which it was able to map actual occupant activity in addition to sensors and actuators: “[…] it would not only be able to monitor and regulate environmental conditions but also to mediate the activity patterns through the allocation of functional spaces.”[9] A precondition for these abilities is, besides basic and predefined settings, that the building starts to “know” the inhabitant and is able to respond to contextual variations. Negroponte followed the idea of a responsive architecture, but refused

an all-too hackneyed interpretation of so-called intelligent structures through the interplay of sensors, computers and programs that produce predefined effects, triggered by a user or dweller and potentially impacting their actions.

The actual work of Tristan d'Estrée Sterk, head of the *Office for Robotic Architectural Media & Bureau for Responsive Architecture*, takes on the conceptions of responsive architecture as developed by Negroponte but takes into account more recent developments within the fields of robotics and machine intelligence. Having the possibilities of 21st century computing power, he developed a discrete model of architecture consisting of a multitude of sensors, processors and actuators, conducted by hybrid control networks and embodied in an alterable structure of tensegrity elements. In his explanation, the hybridized model of control has three major parts: 1) the user input, which gives the users the possibility of controlling or manipulating responses that extend throughout the building; 2) a building structure with responsive capability to respond directly to environmental loads; and 3) spatial responses that are used to control the partitioning and servicing of internal space. Sterk points out that in responsive architecture the next architectural state of a building is determined by the concept to "treat the needs and wants of users as a set of ever changing conditions." [10] As the architectural state is to be in flux, space transforms from a former static modular order into a topological field which responses to bodily activity. The setting of responses is dependent on satisfying very substantial questions about person-environment relationships, sustainability and the life style of users.[11] Thinking in scenarios reveals the different levels of a possible engagement of responsive architecture. Further, it leads to an analysis of relations that can be established with such a techno-environment.



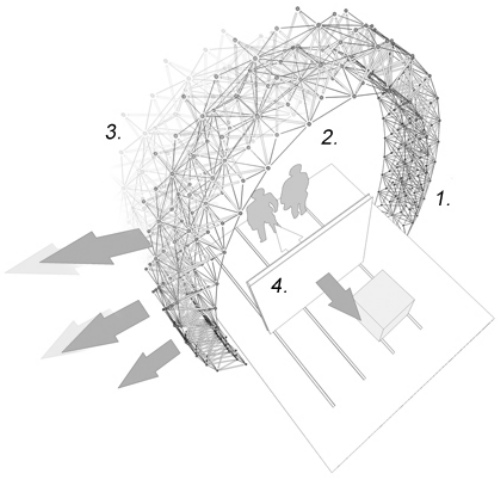
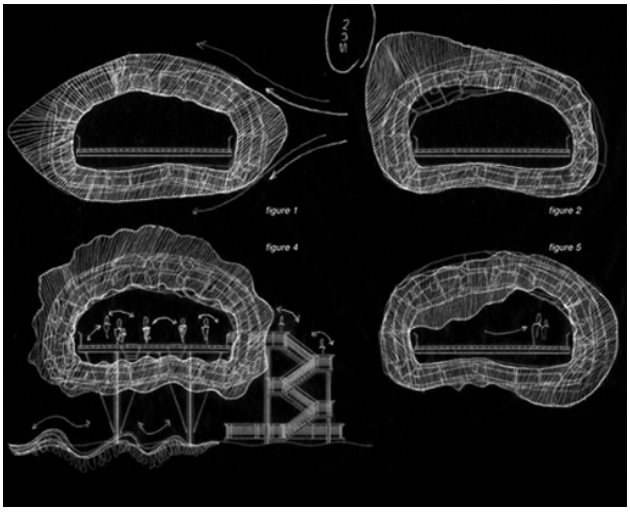


Figure 1. Proposed hybridized control model for use within a functional responsive architecture (Courtesy of Tristan d'Estrée Sterk). **Figure 2.** Structure and internal partition working cooperatively in response to changing patterns of use (Courtesy of Tristan d'Estrée Sterk)

A basic quality of architectural space is to preserve a comfortable climatic environment opposite outside conditions as cold, heat, wind, and rain. If the temperature is dropping due to outside environmental conditions the heating kicks in, controlled by background related technologies. But it is assumed, that I do not just desire a warm space but to run the heating on low costs. One possibility is to monitor all spaces for human activities and heat up only the spaces which are actually occupied. Another thing is the monitoring of the active body itself. Sitting at a working table for a longer period makes us more sensitive to a temperature decline because we have not moved for a while in contrast to kids who get warm by playing around. Bodily activities have an effect on the perception of space climate and thus on the amount of energy which is spent to change it. Moreover the system could recognise me working at the table, not moving to other areas, and starts a space transformation. The inhabited space would then be physically minimized to preserve energy. This decision could be supported by my online schedule that indicates that I am not expecting any visitors and therefore I do not need my working space in full representational size. In contrary, a threefold clapping of my hands or any other activity indicates that I disagree with the space minimization and the system has to come up with other responses to my desires. In fact, at this level of responsiveness, it is not just me who has a relation to the techno-environment but its technology also to me, caused by the design of it. This technology-human relation is a hermeneutic one. An interpretation of our world based on the possibilities of machine intelligence. If a user phrases the desire for warm space and low energy costs without static criteria, the responsive architecture has to interpret the user's wants and needs within its technical abilities and compare it to the user's behaviour and appreciation of spatial qualities.

Don Ihde relates the term hermeneutic to more textual interpretation and thus reading, besides the meaning as simple interpretation. While reading, in its bodily perceptual nature, entails a relation with or towards the technology, the readable technology delivers, in form of text, references of a world that lies beyond face-to-face verification. The precondition for that is the understanding of the textual meaning. It is essential "to know how to read the instrumentation and from this reading knowledge get hold of the "world" being referred to."[12] The rev counter of an engine or the thermometer are examples of readable technologies. It is

possible to get a vision of world that is either not visible or that one can not or will not experience with the percipient body. Readable technologies often occupy interface positions whose meaning lies in the extending of hermeneutic capacities into a technological world beyond. A readable technology transports information from one environment into another. In the case of responsive architecture that can be computer screens which indicate monitoring processes, settings, and system status. But also the architectural state of a responsive architecture can be an object of hermeneutic relations in the simple interpretational sense. Normally, by mounting the display of a thermometer in the living space while the sensor is attached to the external environment, I obtain a reference of the environment beyond the building envelope which can be `cold´ or `heat´ by reading the temperature scale. But in responsive architecture, the building or space envelope itself is a conditional indicator. Tristan Sterk points out that a considered feature of responsive architecture is the ability to change its architectural form according to environmental conditions and weather. The deployment of actuated tensigrity structures holds the opportunity to change for example the aerodynamic profile of a building to minimize the wind load. From the physical alteration of the envelope it is possible to give an interpretation of the environmental condition. Even not objectively measured in numbers and kilometres per hour, I am aware that strong winds are coming from a certain direction.



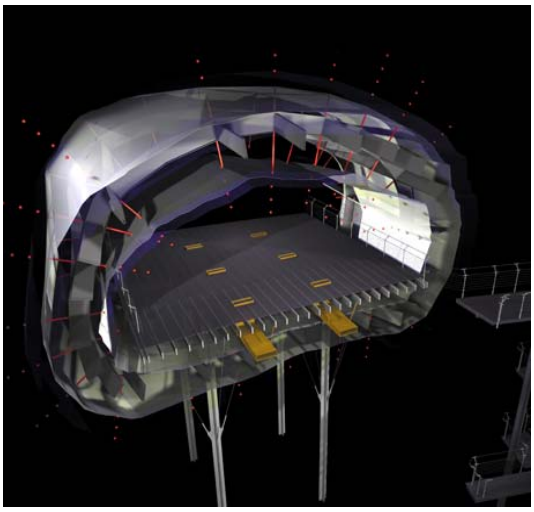


Figure 3. frais: Experimental performance space over Chicago Harbour, four out of six stimuli/response conditions: fig1) wind/aerodynamics; fig2) sun/heliotropism as a gradual change; fig4) many activities simultaneously/de-stability; fig5) motion/temporary instability (Courtesy of Tristan d'Estrée Sterk). **Figure 4.** frais: Experimental performance space over Chicago Harbour, section through the building envelope (Courtesy of Tristan d'Estrée Sterk).

The decisive step made here is a shift from background relations towards focal relations. Shape-shifting envelops can draw focal attention and meaning to the boundary between inner and outer environments compared to static envelopes and their “being to the side.” As mentioned by Don Ihde: “What is read occupies an expanse within the focal center of vision […].”[13] Drawing attention towards an intelligent envelope holds the question how a user perceives it. At one side, it can become the meaning of something that is often representative for clothing: a second skin, and therefore embodied in some sort. This meaning can be implemented to responsive architecture because it adjusts to a certain point to bodily activities. Simultaneously, it allows for the experience of environmental conditions within certain opacity. But to experience embodiment relations the components of a responsive architecture have to work extremely smooth together facing the needs and wants of users immediately and minimizing restrictions for their bodily activities. At the other side, responsive architecture can be perceived as something other than me, with which I have a relation and that is entering a conversation with me about the environmental settings. The latter is depending on the ability of responsive architecture to be not merely reactive but interactive. The notion of interactivity is not automatically and immediately applicable to responsive architecture. Usman Haque, in his occupation as designer and researcher in the field of responsive environments, defines interactivity as something that exceeds pre-programmed call-and-response-cycles between human beings and techno-environments. For Haque, the essential of interaction “concerns transactions of information between two systems.” Thereby, the transactions “should be in some sense circular,” depending upon “openness and continuation.”[14]

The Other

Don Ihde characterised the approach towards the otherness of technology through the notion of `alterity relations´. Entering a conversation leads to interaction with someone or something other than me, in this case a technological opponent with whom I exchange a dialog. That exceeds a level of anthropomorphism of technology as trivial affections for artefacts and leads to the humanisation of a technological environment. The latter is also an outcome of AI research.[15] The before mentioned ability of machines to interpret and to show interactive behaviour can technically be achieved by control circuits and nowadays by software-agents and neuronal networks. Usually combinatory systems lead to efficient results. Scientific pioneer work in the conception of AI and cybernetic machines which are able to get in contact with a subject was certainly carried out by Gordon Pask who began his career in the

1950s. A key element of Pask's work was his *Conversation Theory*, a theory of interaction between human beings and machines among themselves and among each other. Responsive environments as the famous *Colloquy of Mobiles* reflected Pask's ambitions in interaction design, where the impact of actions on the environment led to further modification of actions through interaction loops. For the machine part, the goal in mind was to reduce the determining character in terms of input and output criteria and to approach a situation of "multi-loop interaction" which is dependent on the continuation of cycles of response. Space would then be built up through the conversation of a person with a responsive environment "where the history of interactions builds […] possibilities for sharing goals and sharing outcome."[16] In the interaction I am aware of the existence of "the Other" than me. The Other is someone who is familiar within the association with me, with whom I communicate, and with whom I, in a familiar acquaintance, stand in an actual and exclusive state of being.[17] The Other is also a precondition for the observing of my being and physical existence from a different point of view than mine. This becomes sensible in Pask's intention to establish machine-opponents and technological competitors for humans. In his left orientated ideology, cybernetic techno-environments were instruments to face daily routine and mind-numbing work, which transforms people into passive individuals. In the concept of the "Fun Palace", which Pask was developing with the architect Cederic Price in the 1960's, the cybernetic environment should monitor and grasp the behaviour and interests of visitors in order to generate spatial configurations and activity programs for them.

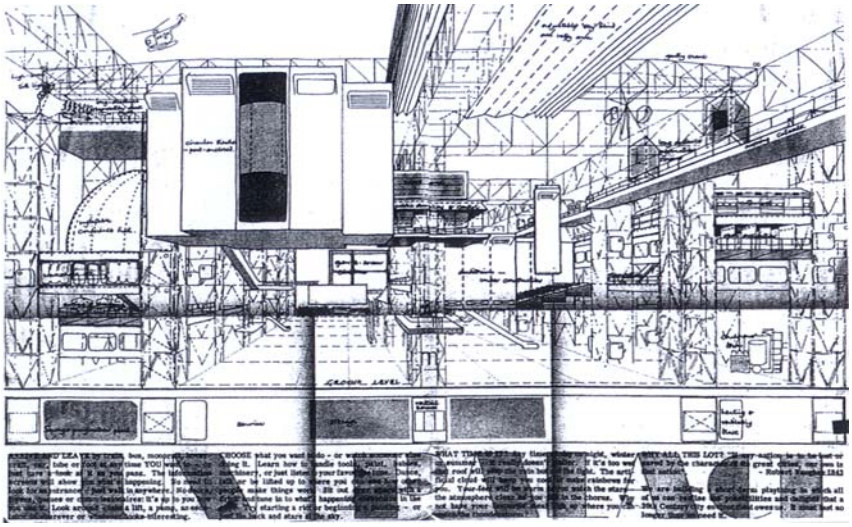


Figure 05. Information brochure for the *Fun Palace Project*, July 1964 (Margit Rosen, "`The control of control´ - Gordon Pasks kybernetische Ästhetik," in *Pask Present*, ed. Ranulph Glanville (Wien: edition echoraum, 2008))

Through the viewpoint of the technological other, the responsive environment should motivate individuals to participate and explore by providing learning experiences. Pask was following the idea of a technological competitor to allow people to develop a critical consciousness for their everyday life. The idea of social participation was connected with the concept of `conversational interaction´ in cybernetic human-machine-systems.[18]

In succession to Pask's work stands for example "Ada", which was an interactive pavilion at the Swiss Expo in 2002. Ada was a product of neuroinformatics and similar to the Fun Palace an artefact for edutainment and creativity development of users. Compared to the Fun Palace and his mechanical changeability, Ada's responsiveness was widely based on optical signals by luminous surfaces and texts on digital screens. Ada was largely hermeneutically perceived.

Figure 6. Ada, lights and projections as elements of communication (http://architettura.supereva.com/interview/20040205/index_en.htm, 01. 2009). **Figure 7.** Ada, colour changing floor elements (http://architettura.supereva.com/interview/20040205/index_en.htm, 01. 2009).

Noticeable is the terminology with which Ada is described and characterized by its developers. The declaration of Ada as living organism, creature, and intelligent space is closing in on AI fundamentalist jargon that was rejected by Dreyfus. More interesting though are statements about architecture being a boundary system and a more or less porous margin between an inside and an outside.[19] Thereby, Paul Verschure from the Institute of

Neuroinformatics at the ETH Zurich, which was responsible for the design of Ada, affirms that this position on the tension between two spaces is of importance as a new layer in build space for perception, learning and thinking. In responsive architecture the space envelope exceeds its meaning as element of enclosure and exclusion.

Summary

Responsive architecture takes over a notable position in the field of architectural research. The discourse is, however, mostly focused on technical feasibility and questions of usability. Typically, technologies in their physical and syntactical appearance take most of the concentration of responsive architecture developers. Other disciplines like phenomenology permit a different point of view on the nature of techno-environments. Technology has an important part within the phenomenological discussion. That is to a certain point because technologies in use are perceived as not neutral but as something that brings change to World which is perceived. The example of Dreyfus' critique towards AI shows on the other side that phenomenology, even rejected before, has the ability to influence the development of technologies, especially that ones which imitate human experience. In the case of responsive architecture it is not merely the aspect of AI that draws attention, but the experience of space through technology. It is shown that there is a change of focus towards space envelopes, which give up their solely meaning as boundary between the dualistic positions of inside and outside. Moreover, they become an interface between environments which lie on both sides. This counts likewise for situations of interior and exterior space, for architectural space and a technological world beyond, and for me as active and discerning subject and the space I inhabit.

Endnotes

[1] Hubert and Stuart Dreyfus, *Künstliche Intelligenz* (Hamburg: Rowohlt, 1987)
[2] Don Ihde, *Technology and the Lifeworld* (Bloomington, Indianapolis: Indiana Univ. Press, 1990)
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[18] Margit Rosen, "`The control of control´ - Gordon Pasks kybernetische Ästhetik," in *Pask Present*, ed. Ranulph Glanville (Wien: edition echoraum, 2008)
[19] Marialuisa Palumbo, *Looking at the first neuromorphic space. A conversation with Paul Verschure* (http://architettura.supereva.com/interview/20040205/index_en.htm, 01. 2009)