

Architecture, Art and the Neurosciences

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Summary: New trends in the field of architecture increasingly emphasise dialogue with the fine arts, something that is evident in the Land Art movement, the use of light installations, and the placement of art on buildings in Kunst am Bau (‘Percent for Art’) projects, for example. Other efforts address the application of neuroscientific findings in the fields of perception, spatial orientation, action control and artificial intelligence as a means of furthering our understanding of the manner in which built spaces are experienced and integrating this into planning and design.

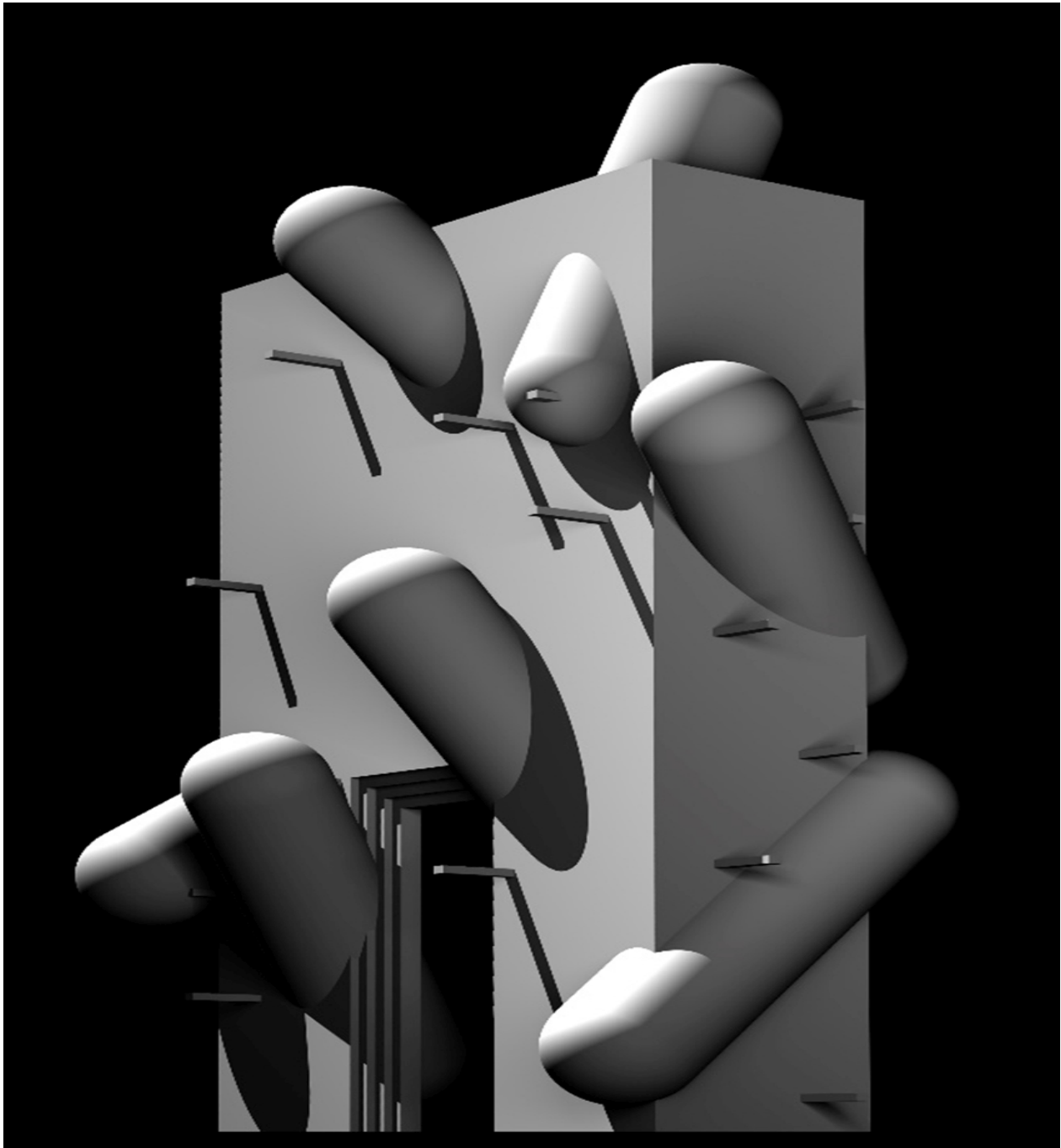
The entire world a Bauhaus: a call to action that reduces architectural design to functional architecture and its cities to autistic spaces. A self-satisfied cubism is pervading the land. In this thoroughly structured world, pragmatic proximity is prized, while such common terms as fusion, ambiguity and impurity have become foreign to us. Ambassadors of the International Modern take realities that have grown organically over time and dissect these into more manageable components – it is a mental world in which only black and white exist.

The one-dimensional view of modernity allowed the holistic interplay of the arts to dissipate. Structural fusion, emotional discourse and the mixing of colours were taboo, and interfaces were configured as joints. Separation was strictly maintained, almost as if contact of any kind would have been a sacrilege. The generalists with whom we are familiar from the Renaissance – such master builders as Michelangelo and Leonardo da Vinci – disappeared from the scene as all-rounders were replaced by specialised engineers.

Today, in contrast, people no longer expect detailed perfection in our prevailing culture of remembrance. People value the memories embodied by old masonry, authenticity – the property that imbibes the course of life and objects and creates atmosphere and aura.^{[1] [2]} It is not without reason that polyvalent images have come to dominate in the fields of music, film, theatre, art and architecture. In opera, expansive settings are created using music, poetry, dance, architecture and painting with the goal of capturing the mood of a brittle world in all its complexity. In clear contrast to the purist aesthetic of modernity and of the Bauhaus school, the world is depicted as a multifaceted melting pot. It is an aesthetic programme that is evident throughout the history of culture.



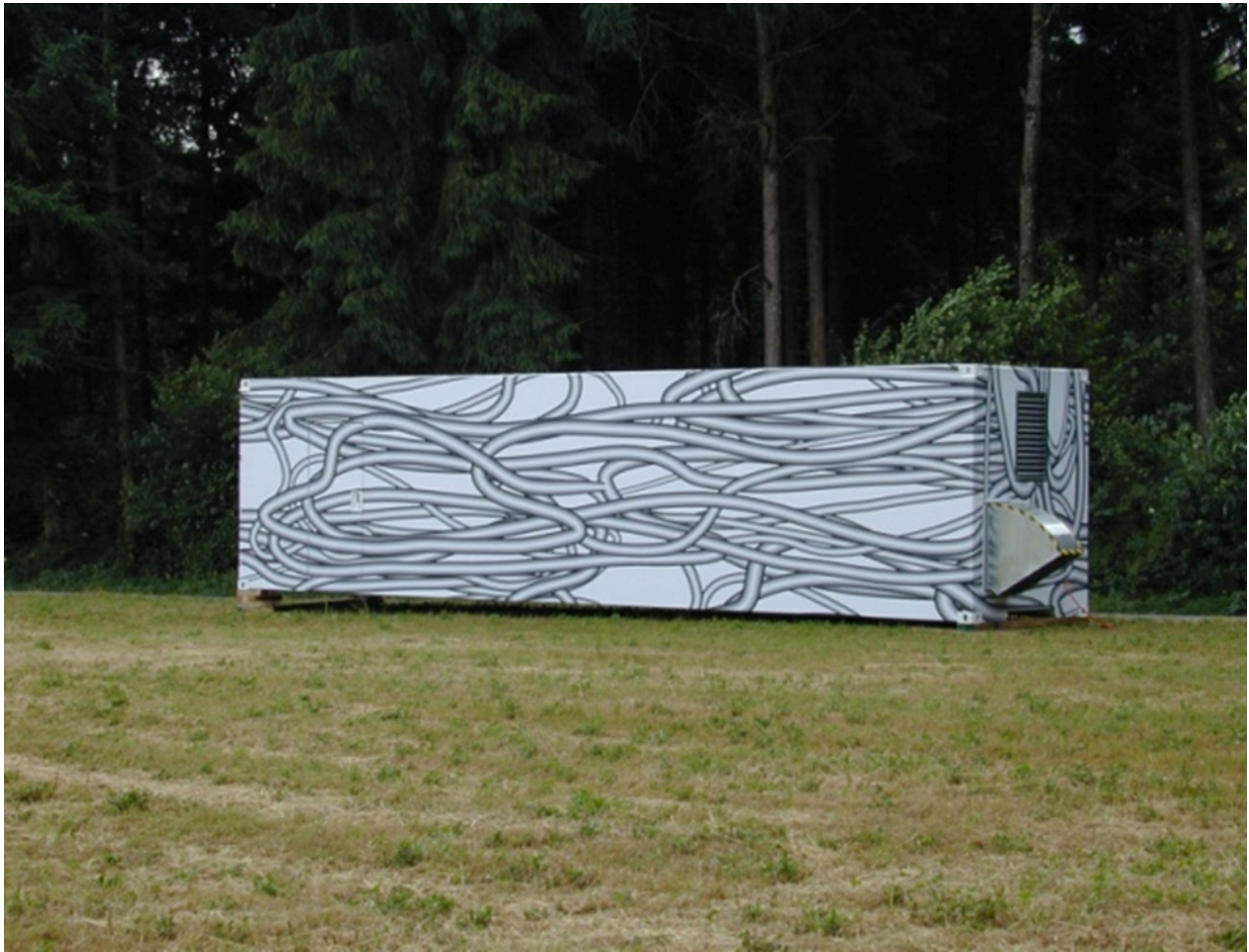
O & O Baukunst: NRW State Archive in Duisburg (2020). Photo: Christian Heuchel.



bureau Heuchel Klag: *Sleeping Freedom* (2012). Photo: bHK.

Even in the baroque period, architecture engaged in dialogue with the genres of painting and sculpture, with a greater emphasis on lighting and colour, to deepen the perception of emotions in paintings by Caravaggio and sculptures by Bernini. It is a trend that continued in Art Nouveau, in the Wiener Moderne, in the Belle Époque, in Kurt Schwitters' Merzbau and in Antoni Gaudí's Basílica de la Sagrada Família. The term *Gesamtkunstwerk*, an 'all-embracing art form', has unfortunately come to be seen, incorrectly, as an indistinct mixture of various artistic forms. In contrast to modern works, which strive for academic autonomy and are predicated upon an overarching knowledge of aesthetic interpretation, a *Gesamtkunstwerk* occludes the boundaries between various artistic genres through interplay and relies upon interdisciplinarity. Here, discourse and an active discussion of art comprise key components.

In keeping with the *Aesthetic Theory* by Theodor W. Adorno, the goal is to make autonomous works of art possible, and to give art the freedom it needs to escape a uniformity of interpretation and accept diversity as reality.



rheinflügel Baukunst: *Kunsthaut Zug mobil* (2014). Photo: Christian Heuchel.

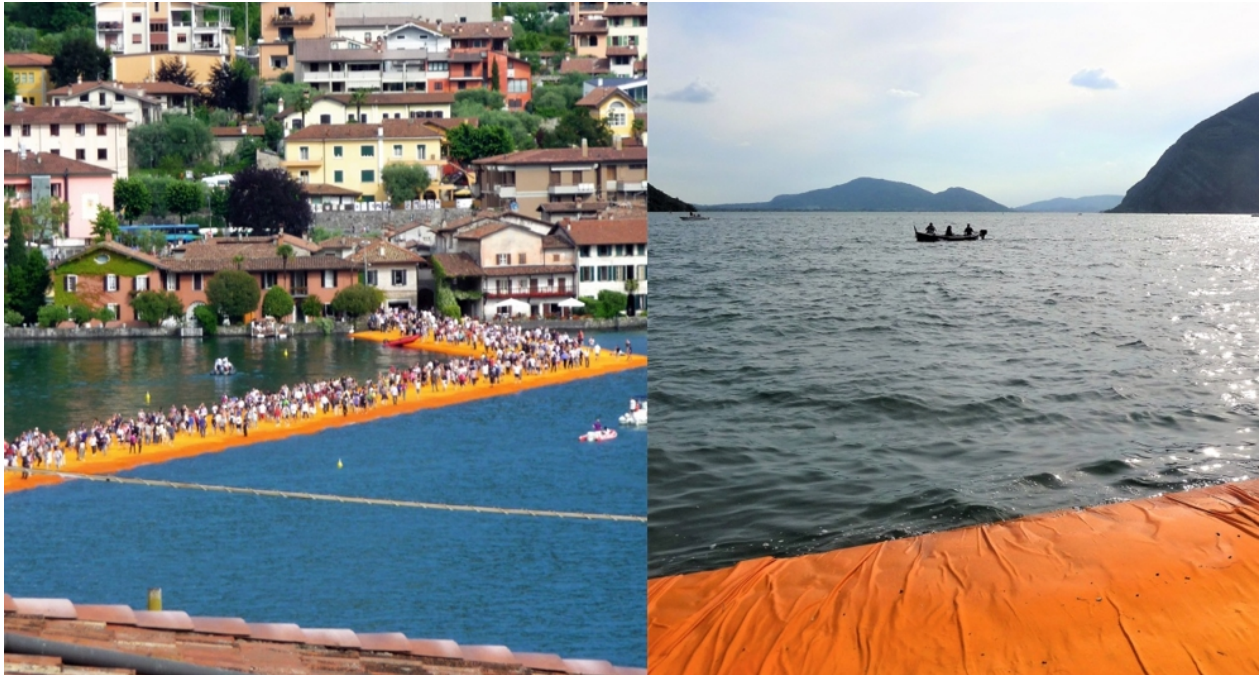


rheinflügel Baukunst: *Kunsthause Zug mobil* (2014). Photo: Christian Heuchel.

The link between the fine arts and architecture is evident when viewing a building as a *Gesamtkunstwerk*. A symbiosis of texture, ornamentation, forms and colours imparts everyday architecture with artistic content. The result is a shared form that unites its individual components and makes them tangible for others. A building is a tactile and timeless counter-model to a digitalised world. On a smaller scale, a handcrafted book satisfies this desire for contextual orientation and a compact summary of the world. The books, produced using traditional printing methods, have been kept rugged and small, their letters rendered with lead type on precious laid paper. Along with their visual impact, the books' texture appeals to the sense of touch, and their aroma of printer's ink activates the olfactory senses to create a multifaceted sensory experience.

The Land Art movement, in whose context natural and urban landscapes inspire works of art and spatial experience, provides yet another example of the ongoing dialogue. The location is part of the artwork, and artistic endeavour is combined with the manifested appearances of nature. It is nature that supplies the substance, such as iron, cement, limestone and clay, and its so-called aggregate, sand, gravel and water: concrete and steel. Familiar works include Richard Serra's *East-West/West-East*, monoliths in the deserts of Qatar that draw the observer's gaze to the landscape, as well as the works of Christo and Jeanne-Claude, which reflect the close relationships between organic structures and their artistic interpretation. A recent example is provided by the *Floating Piers*, floating walkways covered in yellow fabric that were set up in Lake Iseo in northern Italy. A site-specific approach is also the basis for *The Sky Over Nine Columns*, an installation by Heinz Mack featuring columns covered in shimmering golden mosaic tiles that was exhibited at the Venice Architecture Biennale 2014 in front of the Church of

San Giorgio Maggiore designed by Andrea Palladio. The work represents the connections between the Occident and the Orient.



Christo and Jeanne-Claude: *Floating Piers* (2016). Photos: Irene Daum.

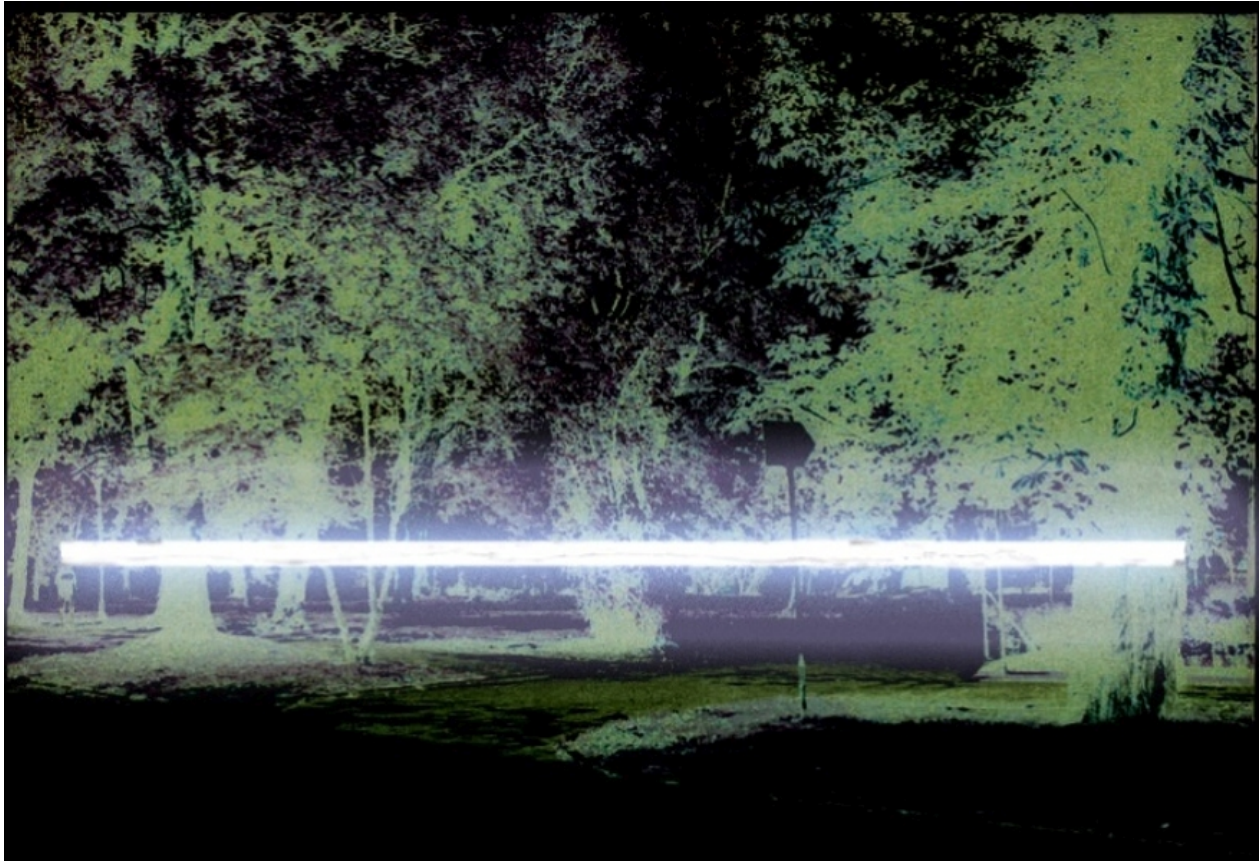


Heinz Mack: *The Sky Over Nine Columns* (2014). Photo: Irene Daum.



Heinz Mack: *The Sky Over Nine Columns* (2014). Photo: Irene Daum.

The use of artificial light on façades and building complexes within the context of light art installations is also based on the interplay of art and architecture. Examples include the Colour Festival at the Bauhaus Dessau and the installations of Dan Flavin, which are inspired by psychological insights into spatial perception. Nor should one neglect the use made by studios and exhibition rooms of the unique atmosphere offered by historical factories in areas shaped by industrial culture, such as the world-famous Leipzig Cotton Mill.



bureau Heuchel Klag: *LUX Warsaw* (2011). Photo: bHK.

The placement of *art on buildings* (the literal meaning of *Kunst am Bau*, as ‘Percent for Art’ projects are known in German) focuses attention on the dialogue between these two disciplines. There is no other métier in which the relationship between art and architecture can be better or more radically emphasised. It is only here that the direct link is fostered and given lasting representation. The interface between these disciplines is the greatest point of friction. It calls for conscious appraisal, and the resulting dialogue serves to sharpen and radicalise the respective architectural and artistic positions.

It is the artist who defines the rules, while the artwork’s scope acts as a mediator between the building and the observer. Thanks to their specialised approach, the artist is always in search of a personalised access to the situation. They have the opportunity to reflect on the environment in greater detail and – with the wealth of means at their disposal – more directly translate their ideas into reality. The artist builds the bridge between the building and the observer. Art on buildings is inescapable, public, directly accessible and foreign to any museum explanations. The designation *art on buildings* ascribes the artwork’s location: it is not a museum, a street or a public square – it is the place within and on the architecture. Even the smallest artistic interventions can maximise a building’s profile. Art on buildings is ultimately an unbeatable instrument of sophisticated building culture.



bureau Heuchel Klag: *Monument to Freedom and Unity in Berlin* (2009). Photo: bHK.

Recent developments have witnessed the opening of an intensive dialogue engendered by the collaboration between architecture and the fine arts with empirical research in the fields of psychology and the neurosciences (cf. *Academy of Neuroscience for Architecture* (ANFA)). In the following, the implications of the latest findings in the fields of cognitive and affective neurosciences pertaining to the understanding of how built spaces are experienced and to the optimisation of future planning in the field of architecture will be explored on the basis of the work of ANFA. The concepts discussed by ANFA[3], including the term ‘affordance’, which refers to the actions suggested by functionally relevant properties of an environment, and ‘body schema’, which represents the sensation of the position of one’s own body within space, contribute to achieving an improved understanding of how people respond to their built environment, the sensations it evokes, and the manner in which these inspire actions. These findings can be drawn upon to design spaces that are best able to satisfy the requirements of their users. According to Aldo Cibic, head of the eponymous architectural firm in Milan[4] and Director of the 10th Architecture Biennale, it is people’s activities and the complex network of relationships between persons, objects and locations that give spaces their identity. In keeping with this insight, when Cibic creates multi-storey buildings he designs the verticals such that interactive living spaces featuring new forms of community come into being while allowing for the integration of private and public spaces.

The cognitive and creative processes that are so important to the planning and configuration of spaces are the subject of interdisciplinary research projects (cf. ANFA[3]). Working from a set of functional and technical specifications, subsequent development leads to a dynamic interaction of form and function and the genesis of a significant whole from many individual components. According to Peter Zumthor, a prominent Swiss architect, during the design process vague fragments and images emerge from memory as elements fusing into one another, growing into an end product that is something new.

Memory research has shown that remembering involves an error-prone process of reconstruction that cannot be compared with playing back a recording; instead, it is dependent upon numerous factors, such as the subjective significance of individual elements within one's memory. The networks in the brain that deal with cognitive processes of remembering the past overlap anatomically with those networks that are connected with imagining the future. The process of imagining a new building is a targeted simulation and construction. Starting out with a vague idea and inspired by personal memories, an increasingly precise image gradually arises as technical aspects of feasibility, adaptation to the surroundings and other similar criteria are addressed. During planning and design, implied knowledge and conscious reflection, along with cultural context, personal experiences and an architect's individual cognitive style, are all drawn into the process. The artist conceives an experience of a built environment – not only its structure, but also its affordance and its atmosphere. Design is the bridge between the concept and the construction.

When it comes to the understanding of how built spaces are experienced, visual perception is of particular importance, yet attention is increasingly also being given to studying its close links to the management of the content of such spaces. The neuronal systems that are responsible for analysing the properties pertaining to the recognition of an environment and identification of specific objects therein are different to the systems that are employed in analysing the visual proprieties that are relevant to action, such as for controlling grasping motions. On additional processing levels, all information pertaining to the visual world is integrated and analysed with regard to how it fits in with stored schemata detailing the typical appearance of particular objects. An individual sees what they recognise and the purpose for which an environment is being studied. The neuronal networks of the visual system are extremely plastic, and they are continuously modified on account of visual experiences.

Spatial perception and orientation within space demand that data on the conditions within the surroundings and of one's own position therein be updated continuously and without interruption.^[5] They are based on the interplay of all the senses (seeing, hearing, smelling) and on feedback concerning the motions of the eyes and body that, taken together, make it possible to generate an inner picture of spatial relationships. In contrast to there being a subjective impression of a uniform spatial experience, there are in fact multiple spatial reference systems active within the brain. In the egocentric system, objects within a space are represented as they relate to the position of one's own person, whereby a distinction is made between the space that is in close proximity to the body and spaces that are further removed. In the allocentric, i.e. object-specific, system, objects within a space are represented as they pertain to the spatial positions of other objects, i.e. their distances from one another, their relative sizes and the presence of any striking characteristics (landmarks), regardless of the position or viewpoint of the observer. Observer-based and object-based reference systems are mediated by different regions of the brain. Another system contains knowledge of spatial relationships within a larger context, spatial scenes in their geometry, mental maps of locations such as that of the city in which one lives.

The processes of learning topographical relationships, navigation and the creation of cognitive maps take place via a system within the temporal lobe, the hippocampus and neighbouring regions of the brain that processes spatial information and mediates long-term storage. This complex network comprises the coordinated activity of various neuronal systems whose function is extremely plastic, i.e.

dependent on its utilisation. The knowledge that has been gained regarding orientation within space can be beneficial for the dialogue with architecture within the context of planning the layouts of larger buildings or places devoted to encounters (e.g. where information signs or lifts are planned) while facilitating the orientation within, and navigation of, spaces.

The processes that control the movements and activities of people within spaces also play an important role in spatial perception. The term 'body schema' represents the image of one's own body with regard to the space that it occupies and its position within space, as well as the awareness of one's own body and its distinctness from its surroundings. Body schema is involved in the planning of actions, and it changes as the actions offered by the environment change. Neuropsychological findings have demonstrated that the brain temporarily treats external objects such as tools as parts of the body and integrates these into the body schema; as a result, a hammer or toothbrush, for example, is perceived as part of the arm. Expansions of this concept, including to the driving of vehicles or the use of a room, are currently under discussion, e.g. by the neuroscientist Michael Arbib. This could allow elements within a space to be designed such that they could be integrated into the body schema and action control in the same manner as with tools that are being used.[\[6\]](#)

In a steady stream of images, particular visual stimulations will automatically draw our attention and trigger specific actions. J. J. Gibson, a visual perception psychologist, coined the term affordance to describe the ways in which elements within a space offer themselves for productive use – an armchair's affordance calls on someone to sit on it, while an elongated object invites its use as a tool. These are joined by generalised scripts, i.e. the knowledge of what someone is able to do in a particular setting, like a restaurant. The manner of construction and character of items and materials offer us various possible actions that tell us what we can do with them. Affordance involves directing attention to the individual components of built spaces and links these to planned actions. An ongoing dialogue between architecture and academia is exploring ways in which affordance character can be taken into account when planning built spaces in order to optimally stimulate perception and particular actions, such as by promoting environmentally aware behaviour.

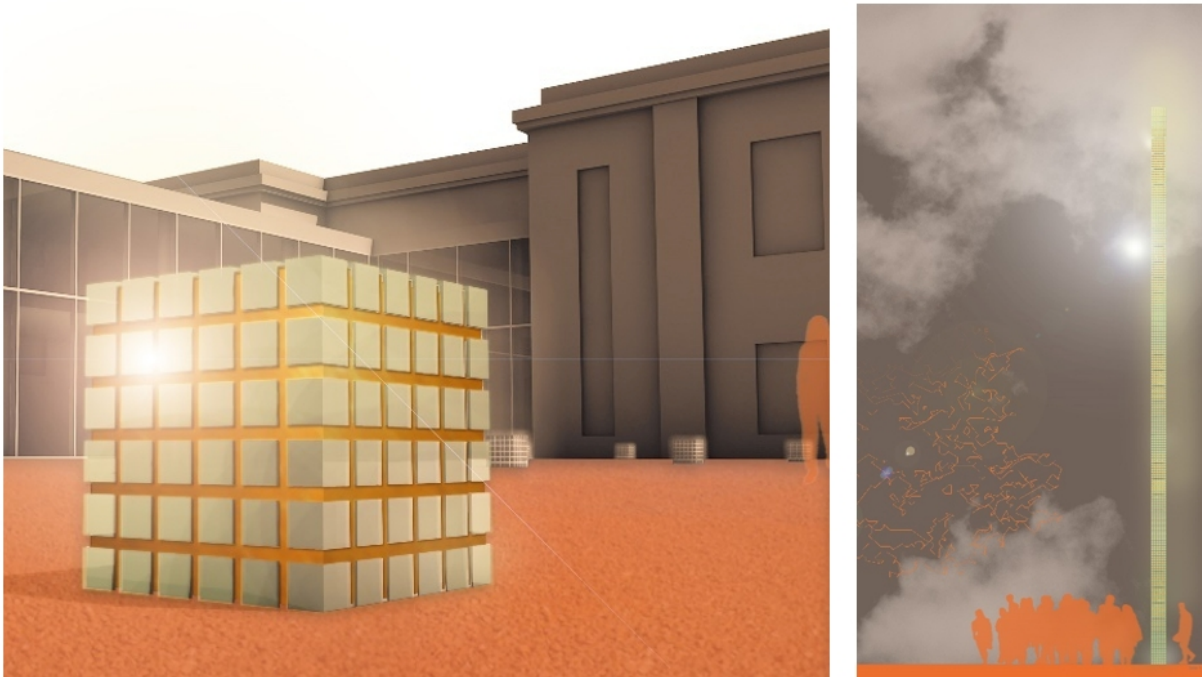
It is not only the structure and function of built environments that represent significant aspects of their quality, but also their emotional impact. The atmosphere is a form of affordance that permeates a room and extends beyond its purely spatial properties. Along with the configuration of factors such as space and light, atmosphere is shaped by sensory perceptions, by materials, forms, sounds and the options for action. Knowledge of how the brain works can help here to create the desired atmosphere. An architect should see a room through the eyes of its future users; they should empathise with them and account for ways in which an overarching mood – perhaps relaxation, or something evocative of corporate identity – might be called into being.

From a neuroscientific standpoint, the system of mirror neurons, of brain regions that place an individual in the position of another as involved in empathy, plays an important role. Mirror neurons are activated not only when a movement is carried out, but also when observing a similar movement carried out by others, just as they are when someone observes emotions such as fear or pain in others, allowing the observer to suffer the same sensation. It is a system that makes possible the intuitive understanding of the emotions and actions of others through internal simulation. It is possible that similar mechanisms are also involved when someone gains a sense of a location's atmosphere – as an

intuitive experience based on the automatic activation of the mirror neuron system, similar to what happens when observing a sculpture and imagining how the artist wielded their hand.

A number of approaches employing artificial intelligence have recently given rise to interactive buildings that use sensors to analyse various aspects of their environment, such as temperature, and react to these via effectors, such that they can adapt to changing circumstances. Here, conceptualisation and development are able to draw on findings from computational neuroscience dealing with the mathematical modelling of information processing at the level of the nervous system. Neuronal networks are computer-based simulation models that mimic the structure and function of neuronal systems. They are based on the modelling of complex sensory systems and their links to motoric systems. Solutions to a wide range of application-specific problems have been created on the basis of neuronal networks. A good example of their application in the field of architecture is the ADA project – the intelligent space^[7] that was presented as part of the Swiss national exhibition Expo.02 in Zurich. With the help of cameras or acoustic sensors, it was possible to determine the locations of individual visitors in the exhibition pavilion, allowing the system to react, e.g. by changing the colour of the floor to direct visitors to a particular location. The current situation was continuously evaluated and feedback provided via visual or sound effects. The ADA network is able to learn from new data, allowing it to adapt to different situations and communicate with visitors.

Numerous buildings boast sensors that regulate the volume of light or effectors that react to changing internal and external conditions (such as weather or temperature). Social interaction with residents or visitors based on neuroscientific findings on spatial orientation or navigation could also be integrated into a network model and utilised for further planning. Interactive buildings are an excellent example of the opportunities available for dialogue between architecture and neuroscience that open up new perspectives for interaction between people and environments.



bureau Heuchel Klag: Kunst am Bau: *Art on the German Federal Archives* in Berlin (2008).

Photo: bHK.

Featured image above the text: bureau Heuchel Klag: *Weißes Rauschen* (White Noise) in Berlin (2009).
Photo: bHK.

Literature

[1] www.ortner-ortner.com

[2] www.bureau-heuchel-klag.de

[3] www.anfarch.org

[4] www.cibicworkshop.com

[5] Daum, I. (2014): *Landmarken, Panoramen und Navigation im Raum*. [Landmarks, Panoramas and Navigation in Space.] In: Herbert, B. & Samssuli, J. (publisher): *Urban Traces – Wahrnehmung im öffentlichen Raum*. [Urban Traces – Perception in the Public Sphere.] Athena Verlag, Oberhausen.

[6] Robinson, S. & Pallasmaa, J. (2015): *Mind in Architecture. Neuroscience, Embodiment and the Future of Design*. MIT Press, Cambridge.

[7] www.ada.ini.uzh.ch

Tags

1. Architecture
2. Christian Heuchel
3. Irene Daum
4. Neuroscience