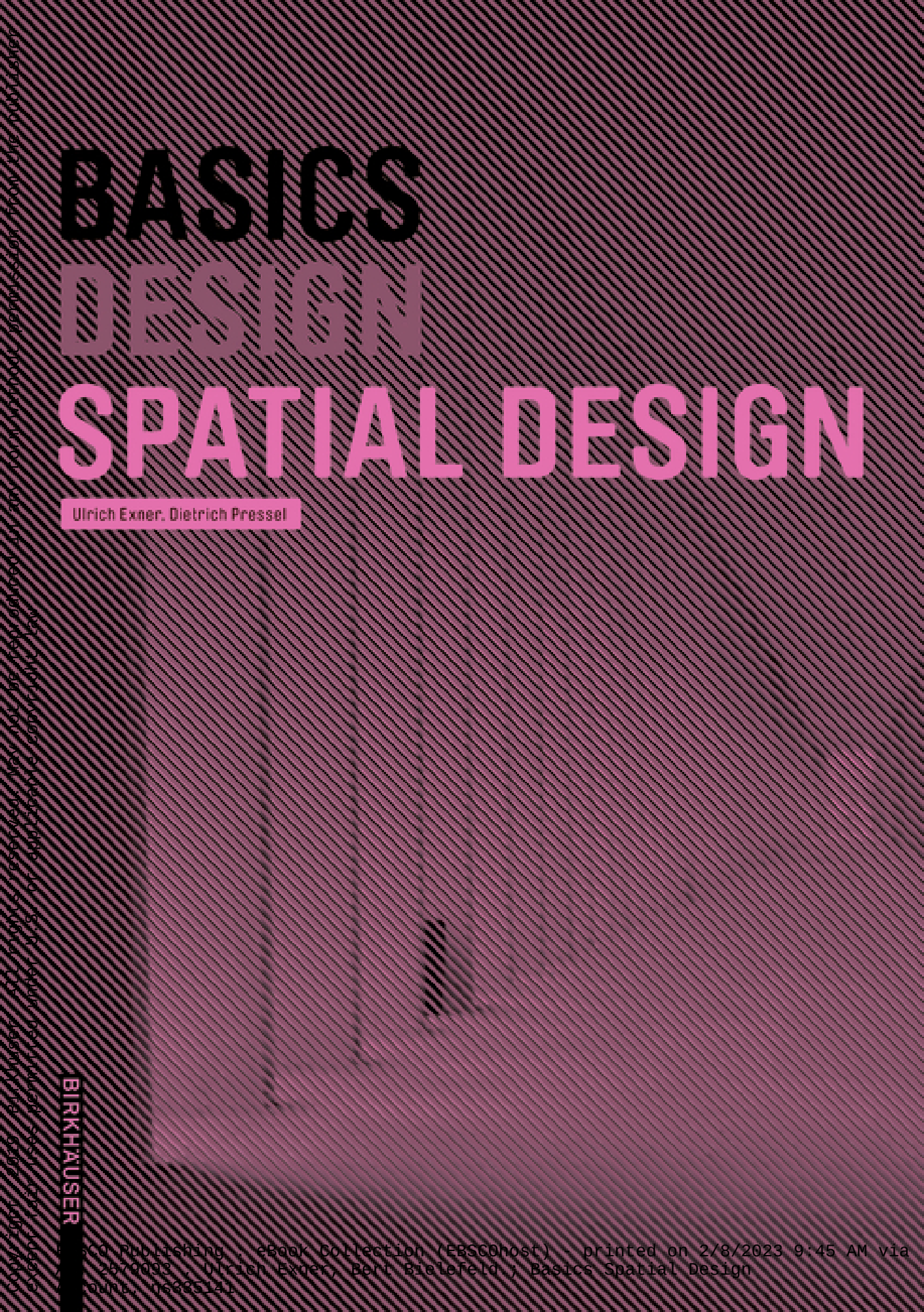
BASICS DESIGN

SPATIAL DESIGN

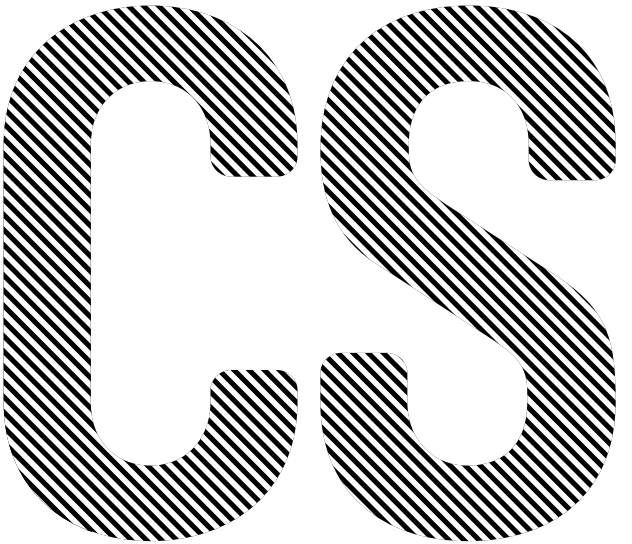
Ulrich Exner, Dietrich Pressel



BIRKHÄUSER

Ulrich Exner – Dietrich Pressel

Spatial Design



Ulrich Exner – Dietrich Pressel

Spatial Design

BIRKHÄUSER
BASEL

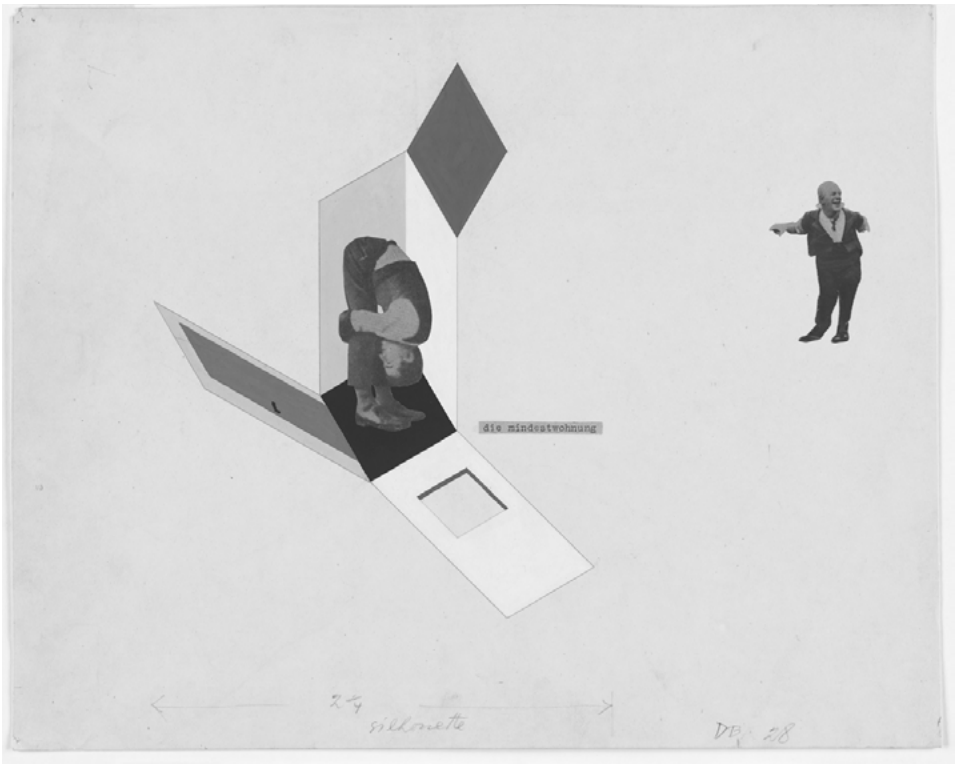
Contents

Foreword

Planning and designing spaces is an essential aspect of architectural design. Comparable principles and parameters can be identified, irrespective of landscapes, urban spaces, or spaces inside buildings, and applied to design and perceive space. Space can be designed consciously by architects, urban planners, or other individuals, yet use and the passing of time have an equally important effect on its shape and transformation. Moreover, there is no objective perception or evaluation of space; it is always conditional upon the viewer or user's individual senses and socio-cultural background. This allows a wide spectrum of possible approaches and a wealth of design options.

Basics Spatial Design is a continuation of our thematic series on design. It focuses on one of the practice's key components by examining the phenomenon of space, independently of specific functions and professional disciplines. As an important introduction, the book also discusses the different senses humans employ to perceive their environment, how people process these sensory stimuli, and how we base our evaluations on personal experience. To explain the range of different spaces, the book goes on to describe and contextualize the different spatial typologies and their respective characteristics. Basic principles that are essential to designing all types of spaces are discussed in the chapter "The parameters of spatial design" and then substantiated in the chapter "Elements and Means of Spatial Design," using individual design methods and actual examples. The authors hope to convey a deeper understanding of the specific attributes of spaces, and the ways in which designers can consciously influence their subsequent effect.

Bert Bielefeld, Editor



Introduction

Space is fundamental to human existence, and much of the spatial environment is designed by people. Day-to-day life always takes place within a space, whether it is a landscape, a city, a house, or a room. People naturally trust that their built or natural environment is permanent, despite the fact that earthquakes or war can suddenly destroy that very environment. People perceive space with their senses directly, individually, and always in a new and fresh way. There are spaces in which we enjoy or do not enjoy walking, relaxing, dreaming, or working. A forest or a street might seem inviting during the day but threatening at night. Within seconds, a spatial situation can feel too close or too large, safe or threatening, inviting or repulsive, which are all impressions that influence our behavior accordingly. Hikers always deliberately choose a resting place according to particular criteria: the sun is shining, the wind is not too strong, it is sufficiently cool, has a pleasant view, and sounds from the environment are absorbed well enough so as not to disturb the sought-after tranquility. The atmosphere of a place such as this is difficult to describe in detail, because various aspects come together simultaneously to make an impression; they are not perceived and analyzed individually.

People design their spatial environment according to their needs for protection against the forces of nature, their various behavioral patterns, work and life style, and their desires and philosophies. Yet a large part of the spatial environment is determined by others or is pre-given, often by the private interests of others, according to natural factors, or the will of the political majority. Constructed spaces can stimulate the senses and the mind through form, materiality, and light or color. Their dimensions can provide either shelter or security, and their design can generate feelings of surprise, astonishment, joy, or wellbeing. Inventing a spatial container is at the same time the invention of a way to enliven it. Spatial design, as a built implementation, can also be described as the cultural-ideological, site-specific, economical, political, social or use-determining parameters that define human existence. These parameters are subject to constant change and always influence constructed spaces. In spatial design, requirements and concepts should be recognized that will be applicable to an individual or relevant to a group, for a millennium, or perhaps only for a few hours.

Spatial design can be generally defined as any type of active spatial appropriation, whether it is a room or a landscape. At the center of this group is space as a relationship, perceived sensorially and cognitively,

Fig. 1: Cans provide the greatest amount of volume in relation to the most amount of external material, plus a choice of surface design.

between things, bodies, or elements of the activated nature. Below, we discuss human perception of the built and natural environment, the characteristic phenomena of space, and the means and elements available for designing it.

Spatial perception

The prerequisite for any spatial design and its effect is the human sensory and cognitive perception of the surrounding environment. All of the sensory stimuli conveyed by the space are processed by the brain, which influences how an individual feels, behaves, and moves. ○

Humans are believed to possess up to thirteen senses, including the five main senses of sight, hearing, touch, smell, and taste, as well as balance. Some people do not have access to all of the senses, or are not able to perceive or fully perceive certain sensory stimuli such as light or sound. The sense of equilibrioception is responsible for perceiving gravity, and therefore spatial verticality, as the constant orientation in space.

Spatial perception serves our individual, day-to-day basic orientation, without our needing to absorb all of the spatial characteristics completely. We are constantly using new spaces in our daily lives. Much of a space's information is processed so quickly by the senses and the cognitive system that it automatically influences our behavior without the need to first activate our thinking process. The human processing of perception and information quickly allows a space to appear cozy or uncomfortable, claustrophobic or protective, without perceiving the spatial characteristics individually. We know the moment we enter a café whether we like the atmosphere or not. ○

Spatial perception is individual. After a long period of time, adults see the place where they spent their childhood as small, although they remember it as being large. At the same time, there are many spatial characteristics that several people perceive in a similar way. Orientation systems, for one, would not function otherwise. Perceiving the spatial environment mostly occurs while we are in motion, which can be encouraged by a space's particular attributes.

○ **Note:** The cognitive system is the term used for the human function associated with perception, learning, remembering, and thinking; in other words, human thoughts and mental processes.

○ **Note:** Sensory perception is aesthesis in Greek. In philosophy, the term "aesthetics" is used to describe the theory of sensory perception. In everyday speech however, aesthetic is now used as a synonym for beautiful.

Fig. 2: The specific attributes of material are perceived with the close senses.

Fig. 3: Directed view, restricted to the human field of vision

Fig. 4: Estimating the distance to the Himmelstreppe (Sky Stairs) in the Moroccan desert

Fig. 5: Arriving at the Himmelstreppe after walking for two hours

CLOSE AND DISTANCE SENSES

Perception is mainly a product of the five human senses of sight, hearing, touch, taste, and smell. The intensity of these senses varies from person to person. > Tab. 1 They can only produce a complete sensory impression by working together – for example when a picture of the rough surface of a wooden board evokes the impression of how the depth of its grain might feel and how it would smell.

Close senses

Direct contact with the perceivable object is created by the close senses of smell, touch, and taste. None of these three requires light, and they are for the most part constantly available. The sense of touch is essential to a feeling of wellbeing in a space, because contact with the spatial shell is made through the skin.

Tab. 1: Intake capacity of the five main senses in bits per second

Sight	Touch	Hearing	Smell	Taste
10,000,000	1,000,000	100,000	100,000	1,000

Tab. 2: Visibility range in different atmospheric conditions

Very clear visibility	Clear visibility	Slightly cloudy visibility	Cloudy visibility	Very cloudy, light fog	Snow flurries, thick fog
50–80 km	20–50 km	10–20 km	4–5 km	2 km	0.01 km

Distance senses

Acoustic and visual signals also work reciprocally while we are in the process of perceiving. Neural connections structure these signals and provide information about orientation in the direct human environment. Hence, visual perception is more selective when accompanied by specific acoustic signals than in an acoustically diffuse space. Through the eye's lens, visual signals project a two-dimensional image of the environment onto the retina. With the help of the neuronal structure of the brain and one's own personal experience, this image can be perceived as a spatially complex composite. Interpreting visual signals is conditional upon individual experience.

As is evident in the mountain range in the background of Figs. 4 and 5, contours are difficult to perceive at a distance and have a flat appearance. This makes it hard to estimate distance. By contrast, the atmospheric and visibility conditions > Tab. 2 that are familiar in Central Europe allow a relatively reliable estimation of distance in a typical landscape.

● **Example:** The qualities of a material are touched, smelt, and seen. They will be evaluated as pleasant if all three individual factors are experienced as being in balance (see Fig. 2).

THE COGNITIVE SYSTEM

As described above, sensory impressions of space are more or less consciously interpreted by the intellect or the cognitive system, and influence our behavior, thoughts, and emotions. A spatial element can generate an instinctive behavior, be perceived as a signifier, or trigger memories.

Spatial elements as signs

This type of spatial perception is similar to reading a text. Analogously to the theories and methods of linguistics, sensorially perceived stimuli are "read" from spatial elements as signs, and their meaning is processed and interpreted by the human intellect. The elements of a space are hence seen as data transmitters that relay more about the elements than merely conveying their direct presence.

PHENOMENOLOGY OF SPACE

The philosophy of phenomenology represents the theory that spatial experience is directly influenced by human perception, which means that human behavior in the world is defined by sensory perception. Sensation and awareness were already assigned to the body before the thinking process was added to them. In the course of human development, physical experience has molded people's ideas about things, space, and time. Since human existence and the body are inseparably related to space, spatial design is significant in terms of learning as well as the general acquisition of knowledge.

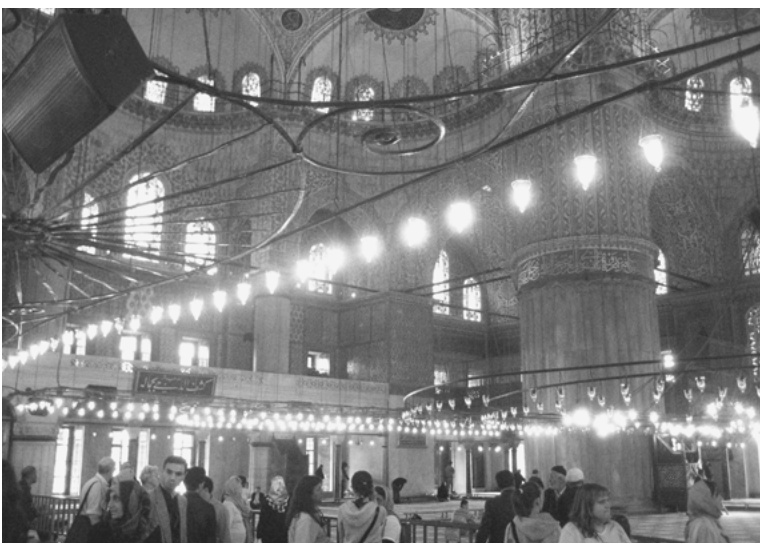


Fig. 6: Impressive spatial atmosphere in a mosque in Istanbul

The atmospheric effect of a space is essential to human wellbeing – yet it is difficult to precisely define or to gauge, and can only be partially justified using analytical methods. Its diffuse qualities make it difficult to plan, present, or understand. A room lit by candles is generally considered "cozy." Yet the flickering flame of the candle, the colorful glow, and the diffuse darkness of the spatial borders' surfaces are not the only reasons behind this atmospheric spatial impression. In addition to these visual aspects, other sensory stimuli such as the scent of wax, the warmth of the flame, and its occasional, quiet sizzling sound all account for the inviting atmosphere. > Fig. 6

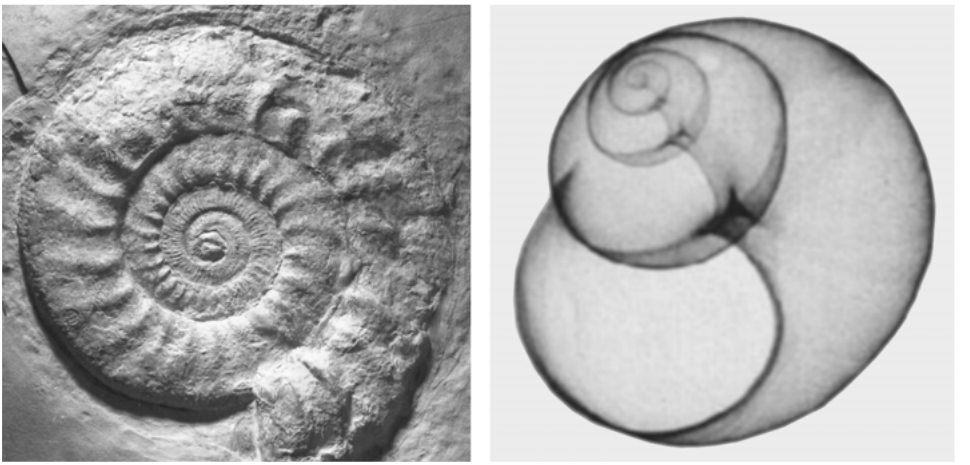


Fig. 7: This snail shell illustrates the life form within.

Types of spaces

Many different spatial forms are influenced by the same uses, human ideas, behavioral patterns and needs, or comparable site-specific conditions. They form spatial archetypes that can be found in different cultures depending on climate, region, and point in time. Therefore, uses such as residential, production, or the practice of religion can often be read in architectural form, meaning that the spatial shell and structural design clearly indicate the actions that take place within. > Fig. 7

The next section will introduce some common types of spaces, the uses of which can easily be read in the spatial design. But use alone does not determine form; other relevant parameters of spatial design will be explained in the section below.

Although people are constantly altering and adapting spaces to suit their changing needs, many of the structural features of a space remain consistent.

FUNCTIONAL SPACES

Spatial forms are always influenced by their functions. Every constructed building and space is a site for human interaction, dealings, rituals, games, and spectacles. These actions determine the spatial design

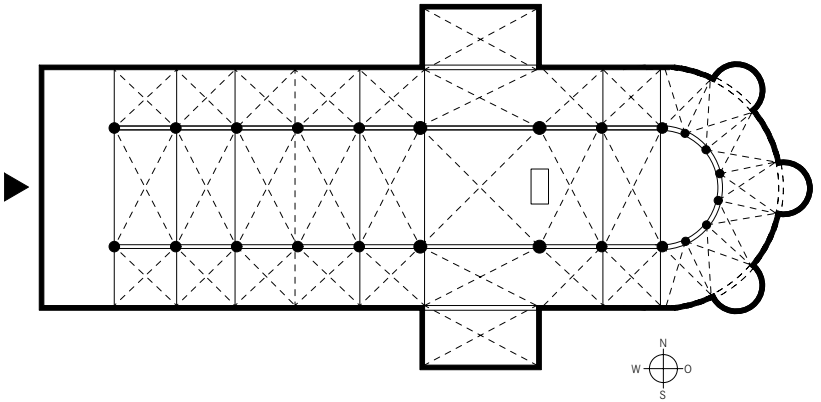


Fig. 8: Ground plan of a basilica

to a great extent and, in turn, the spatial features influence the user and the functions. A space may be the necessary container for a certain action or may not have a specific function assigned to it at all. Spatial types can be identified and distinguished by whether or how clearly a specific function can be recognized in their structural design. Specific architectural requirements can strongly influence a spatial design and, if this composite has been built several times, create an architectural category. Infrastructure and engineering buildings are often very directly based on a specific use, making other, subsequent uses almost impossible. > Fig. 9

The opposite of this example is a spatial type that is open to several uses, a functional ability that also influences its spatial design. Hence, a public city square has only a few distinct assigned uses. Its size alone allows different activities that include individuals casually spending time, demonstrations, summer festivals, and weekly markets.

● **Example:** A basilica is a precise spatial form that has been built throughout history in many different variations (it was originally a secular construction). The elongated hall is entered from the west. It is aligned with the apse, which mostly faces east in the direction of Jerusalem. The altar for performing religious rituals was situated here in clear public view (see Fig. 8).

Fig. 9: Technical requirements create spatial categories, such as the historic wind towers that have been traditionally used for centuries in Arab countries for ventilation, or the equally familiar cooling towers of power stations in industrial countries.

GENIUS LOCI

Site-specific spatial type

The attributes of a specific site create the spatial type because they have a fundamental influence on the spatial structure and form. An overhanging precipice requires a different house and supporting frame than a flat piece of ground.

In addition to these factors, local wind, temperature, and lighting conditions also influence the choice of spatial alignment, the type and number of openings, or the specific attributes of the spatial shell. > Fig. 10

Fig. 10: A spatial type determined by local conditions (cave dwellings)

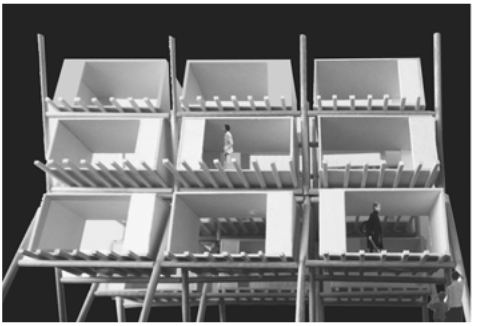


Fig. 11: Residential or office containers are largely not site-specific and can be used almost anywhere.

In comparison to this, there are many non-site specific spatial forms such as an airport terminal, which are universally applicable and form different contextual or functional references. Even industrially manufactured residential or office containers are relatively non-site-specific and are designed accordingly. > Fig. 11

Dimension

The specific scale of a landscape, a city, a street, or a room makes them spatial types that determines the activities they can accommodate as well as the significance attributed to them. A room can hold only a certain number of objects, people, and activities, and is perceived as a space with a private or semi-public character for a small number of people. A city square, on the other hand, is a suitably large space that can accommodate many people's day-to-day activities, such as work, shopping, eating, living, and communicating. Nest, territory, and universe represent three of the spatial dimensions that define human existence: private space, familiar environment, and public area.

Material

Material is an essential factor of a site-specific architectural type. A construction material that is available in large amounts locally creates typical spatial structures that can be found again and again, and their forms can be traced to the particular attributes and availability of the material. > Fig. 12

● **Example:** If the development site is on a street above an incline, the access level can be placed at the upper floor, and the ground plan and spatial form can be adjusted accordingly.

Fig. 12: Brickearth houses in Southeast Asia made from local materials and a timber frame building in a densely wooded area

PRIVATE AND PUBLIC

Spaces are characterized by their level of public accessibility. Depending on their assigned uses, dimensions, and qualities, spaces can have either a private or public nature, which is quickly recognized and will directly influence our behavior while in the space. The borders between private and public are often blurred because private and public uses often intermix or change. The private or public character of a space is defined by dimensions, the degree of social control, and permeability, meaning the number and types of openings in its spatial shell.

Public spaces

A public space includes all accessible, open spaces within the built structure or community, and always exists where the general public uses space in different ways. It is simultaneously a space for movement, activities, information, and lingering. This is where groups and individuals from different social classes, nationalities, and cultures can meet and communicate. They can conduct business, express their opinions, and gather ideas directly without having to experience them through the media. Public space is shaped by its dimensions. It generally has to provide enough space for people to comfortably move about, yet cars, streets, and trains also determine its dimensions because public space is also a primary public traffic and transportation circuit. Sequences of movement and activities can be directed and controlled by designing this type of space, and it consequently also has political significance. Its design is often reshaped and transformed over the course of time and is witness to a multitude of uses and meanings.

Social control

Public space offers greater freedom of movement than the comparably small, private space. Social control and surveillance by others restricts and protects activities in public space, because it helps to maintain socially accepted standards of behavior. > Fig. 13

Fig. 13: Urban public space

Fig. 14: Public square in Valencia

Squares

A lack of social control can quickly turn a space into something inhospitable; public activities no longer take place and there are no attractive amenities that encourage a visitor to linger.

Public squares and buildings are frequently assigned symbolic or prestigious functions that influence the development of urban structures in regards context. Political, scientific, economic, or religious developments, as well as new means of transportation and communication, are constantly changing the design, significance, and use of public space. Public space is often a spatial type that has been influenced by the site in question. Special smells, a certain sound absorption, climatic conditions, or people's site-specific clothing, movements, and activities form the overall impression and determine the use of the space. Because of differences in culture and climate, public spaces and the way in which they are designed or animated differ fundamentally between southern and northern countries. > Fig. 14

○ **Note:** People in a busy and hence socially controlled public space would normally intervene or assist if a violent attack takes place. In a public landscape space, this level of control is missing, which produces a feeling of almost unlimited freedom that can also turn into fear.

Fig. 15: A line of houses with billboards and three-dimensional objects

Wherever people can be found, public spaces will also be defined by private interests or the will of the political majority. Control over the use
○ and design of public space is an expression of power.

Public space is often shaped by the need for good orientation and
○ the great number of signs and elements it requires.

Private space

Private space is a spatial type that is meant to protect the privacy of the individual. This is a place for activities that are not observed by the general public.

○ **Note:** Private economic interests have turned facades in public spaces into advertising and information surfaces. The degree of freedom of thought and movement will determine whether, and if so to what extent, a particular and individual appropriation of public space is possible (see Fig. 15).

Fig. 16: A public space surrounded by uniform, stereotypical, and monofunctional buildings

Fig. 17: A street situation consisting of diverse and multifunctional forms

A private room and an apartment are typical private spaces. Their design is largely based on human scale and is defined by activities and objects that are either partially or not at all shared with the general public. This spatial type frequently possesses a solid spatial shell that clearly separates the interior from the exterior and provides a retreat, safety and security, familiarity, and intimacy. It is constructed to include closable openings, which allows the resident to control who may enter and to what degree.

○ **Note:** The ever-increasing demand for order in the urban configuration results in uniform structures that are frequently assigned only one function. These spaces are being appropriated less and less by different users (see Figs. 16 and 17).

Fig. 18: Personally defined residential space

RESIDENTIAL AND WORK SPACES

A particular characteristic of residential space is that it can be designed primarily according to personal requirements – yet a distinction should be made between shared and individual needs. Needs that are shared by the majority of people are primary needs, which include security, a roof over one's head, and a place to wash. Individual needs go beyond these general needs and are aimed at a type of self-discovery and frequently a self-expression within one's own four walls. > Fig. 18

Individuality and intimacy

Residential space reflects the personality of the resident; after clothing, it is the spatial shell closest to the body. For this reason many elements and materials in the residential space are chosen because they are pleasant to touch. Like a nest, it offers intimacy, warmth, and protection. The residential space is subdivided into zones according to function. Visual associations, spatial divisions, and openings are some means of dividing the space into closed and open areas. The rooms allocated for personal physical needs, such as the bedroom or bathroom, are primarily closed to visitors or the public. They have only a few openings that are small, or difficult to see from the outside, and are usually placed further away from the entrance than the living rooms. Other rooms, however, should be open to both friends and strangers and can serve as a way of expressing or presenting one's own personality. If living and working take place under one roof, it is possible to make the public space a part of the living space, or conversely the living space a part of the public space.

Special residential spaces

In addition to private spaces, there are places such as hospitals, care facilities, retirement homes, orphanages, and hotels that fulfill the spe-

cial needs of specific social groups. Illness, for example, needs to be controlled and isolated by spatial borders in order to safeguard the physical wellbeing of the majority. On the other hand, these facilities also spatially isolate physical decline and death. Hotels offer temporary shelter to travelers and can be used as residences or spaces for private or professional events.

Work spaces

Workshops, production halls, and offices are spaces that are designed according to specific work processes and procedures, the products to be manufactured, and the machinery required. ●

There needs to be sufficient light, air, and room for movement for the workers or employees, especially because this can help maintain a good level of work performance. There are different spatial types according to the number of employees.

Production lines require spatial shells that are large enough to accommodate their needs. They are designed according to function and the size of the machines, and are not built to encourage people to spend time in them. On the other hand, workshops in the craft trades usually refer functionally to the activities and needs of their skilled employees, because workers here play a greater role in the production of goods. Work places that are publicly accessible, such as a department store, are primarily based on the needs and requirements of the customer.

Office work places are designed primarily for intellectual activities, and the need for movement is minimal. Since the spatial requirements of this work are fairly similar, the typology of office spaces does not vary greatly.

The aim and function of a commercial enterprise is to make money, which means that the design of workplaces is a matter of efficiency in cost and function. To avoid adverse effects on the wellbeing of employees, many countries now have laws to regulate the design of work and social spaces, taking into consideration occupational health aspects that are essential to health and safety. Since offices and factories are designed for a changing staff, there are not many possibilities for the users to give their office or workspace a personal touch.

● **Example:** The supporting structures for printing works have to be able to support the weight of the machinery. They need to be strong enough to prevent the building from vibrating while printing is in progress.

CULTURAL AND LEISURE SPACES

Cultural and leisure spaces are for games, spectacles, ceremonies, shopping, exhibitions, and other events that are not a part of daily life and work. They are designed for a large number of users, are usually tall structures that indicate their function and which can be seen clearly. Spatially, they reflect the desire of the public to temporarily abandon the familiar everyday world. They are publicly accessible, provide many spatial attributes, and allow social activities to take place that would normally not be possible in a private or work space. A city park, swimming pool, or landscape outside of the city are typical leisure spaces. > Fig. 19

Religious ceremonies and visiting churches, mosques, or temples provide spiritual inspiration, which is enhanced by the appropriate spatial type. Museums, theaters, and libraries are places of education, yet also fulfill a communicative and social function. Even commercial adventure parks or shopping centers, as semi-public spaces (restricted opening hours, only a paying public), provide a diversion from the everyday. However, they are primarily dominated by private business interests.

Contemplative spaces

Some leisure and cultural spaces are meant for contemplation. They are usually designed for concentrated, long-term use, for example schools or universities. The contemplative space thrives on special proportions, materials, light, and color. Its unique ambiance can be experienced by everyone. > Fig. 20

Sacred spaces

Sacred spaces are also contemplative spaces with a sublime atmosphere that virtually everyone finds mesmerizing. It is immediately perceived as pleasant and people's behavior adapts to the spatial impression, for example by lowering their voices. Emotional reactions should be deliberately evoked in sacred spaces, in order to make it easier to convey and to concentrate on the religious substance.

● **Example:** Reading rooms are spaces for quietude and meditation. Here, too, everything is subject to one single function: concentrated reading and study. These spaces provide private areas for temporary use, yet they are also public spaces that exercise strict control over social activities.

○ **Note:** A sacred space's rituals, its special acoustics, unusual spatial dimensions, and often its smells can trigger memories in the visitor of similar spaces he or she has previously experienced. These parameters can be adapted to serve different functions and purposes.

Fig. 19: Different leisure spaces and different approaches to their design

Fig. 20: A contemplative space for concentrated reading

Fig. 21: Archaic structure and interior space inspire contemplation

Fig. 22: Annual religious pilgrimage to the Kaaba in Mecca

Using spatial effect to influence emotions is also a strategy applied when designing spaces that do not have a religious function, such as government facilities, prestigious reception halls, or corporate seminar rooms.

MOVEMENT AND CONNECTIONS

Many spaces are defined by horizontal and vertical travel and traffic routes. Hallways, corridors, stairwells, streets, underpasses, tunnels, and bridges form the traffic zone spatial type. There are different forms of traffic zones for people and their means of transportation, according to the type of use, destination, and speed. In most cases, their directional course is clear. Their function as traffic zones defines a large percentage of the spaces between the architectural structures in a town or city. Stairwells, ramps, or elevators handle vertical movement.

Some traffic zones are entirely dedicated to establishing efficient connections between places, and others also provide certain amenity values. Public streets commonly provide both. The wider they are, the more pleasant they are to spend time in. Squares and intersections are non-directional traffic zones because they have the capacity for diverse routes and pathways and can also accommodate other public functions. Functionally defined traffic zones often create resting areas for additional, temporary uses. > Fig. 23

Fig. 23: Traffic zones / junctions

Mobile spaces

In addition to containers, which can be placed on different sites for temporary living or working, cars, airplanes, cable cars, ships, and trains all fall into the category of mobile spaces. Their design is not primarily site-specific and it centered on function, the type of forward motion, and safety requirements. The period spent in these spaces is limited to the time it takes to travel between two places. The interior of a car, for example, can also be a place where longer periods of time are spent, such as on a long journey or in a traffic jam. For this reason they are designed with soft upholstery, textiles, leather, and entertainment electronics to give them a homey and comfortable atmosphere. At the same time, and more than with fixed spaces, the need for status is very important because these mobile spaces are seen more often than fixed spaces by others and at different locations, or are used by several people at a time. There are several fixed-location spatial types for mobile spaces, including stations for parking, service facilities, and pick-up or drop-off zones at train stations, gas stations, tram stops, parking garages, bus stations, airports, and so on. Their design is centered on the particular means of transportation, but also take into consideration the departure and arrival aspects of these spaces.

Fig. 24: The formal language of representation from different centuries

REPRESENTATION

Both public buildings and apartments represent attitudes that the owner or resident displays and uses to communicate with, repel, or otherwise influence the user or visitor. Theaters, churches, town halls, and political party headquarters are spaces that reflect their symbolic substance largely by means of architectural or interior architectural means. Select materials in town halls are meant to represent a community's sense of dignity; political party headquarters with glass facades metaphorically communicate to citizens the essence of transparence; courthouses symbolize, in addition to their functional ground plan arrangement, the state's claim to power; and theaters contribute atmospherically to the imaginary world of the stage. > Fig. 24

Often, power is symbolized by the effect of a large building, or by having small, neighboring structures at a distance.

In everyday architecture, indications of standing or prestige are not as obvious as in public buildings. Many spaces are created that follow ideas conceived by planners for a certain target group and are not directly tailored to the needs of the individual user. Moreover, economic factors or budgets do not often allow housing environments to be personalized,

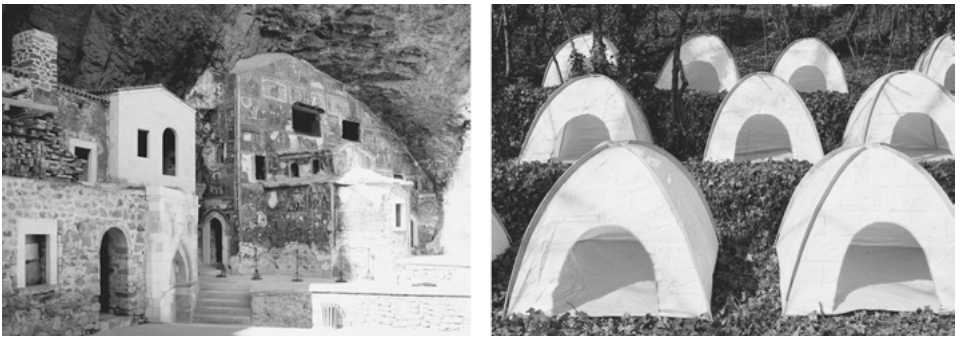


Fig. 25: Sumela Monastery, a structure of permanent, centuries-long use; and a tent as an example of temporary use

which often results in homogenous residential types. The user is an abstract dimension in the mind of the planner. The lifestyles of the various residents are secondary to the planners' decisions. The planner represents and imposes his or her vision onto a third party. By contrast, residents try to fulfill their needs for self-representation in their homes by means of individualized spatial appropriation. Selected furniture, interior design that is as individual as possible, such as special curtains, or a particularly distinctive entrance doorway, are all ways of expressing individuality. > Chapter Elements and means of spatial design

Spaces represent various philosophies of order, violence, control, and power. Prisons, closed psychiatric facilities, and sometimes entire countries are some places that limit or control the freedom of movement of their occupants.

PERMANENT AND TEMPORARY USE

Spaces can be classified according to their duration of use, because they influence a spatial type as early as the construction phase. A sturdy form, durable material, and a solid construction are used to design permanent structures such as monuments, bunkers, and mausoleums. Wear and tear of the material or various subsequent design additions, which change the original form almost beyond recognition, mean that long use can greatly influence the spatial design. > Fig. 25

In contrast, production halls are constructed only for the presumed duration of the product distribution, and tents are erected for a matter

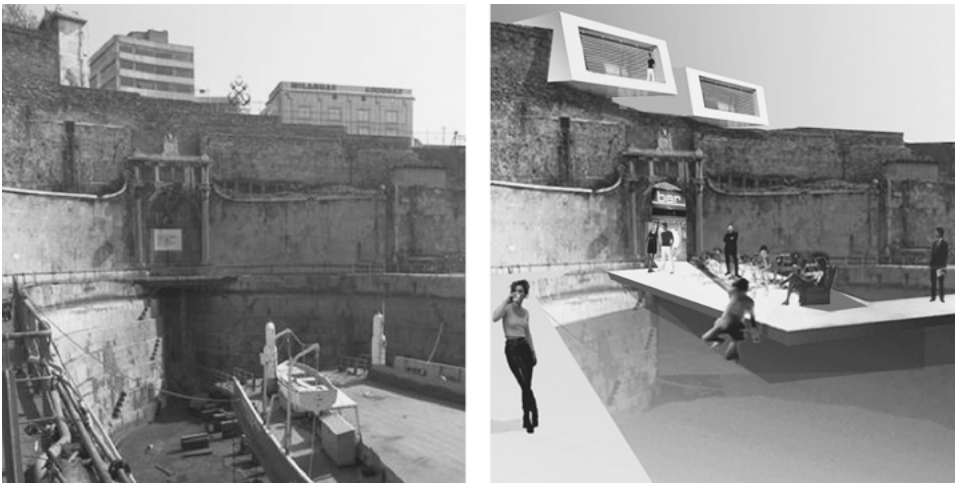


Fig. 26: Shipping dock assigned a new temporary uses: before and after

Fig. 27: Kokerei Zollverein, Essen: an industrial wasteland used temporarily as an open swimming pool

Fig. 28: Public viewing during the 2006 Football World Cup in Frankfurt

○ **Note:** When a large corporation closes down or relocates, it usually has an adverse effect on an entire area of the city. Interim uses for the resulting empty grounds can generate a temporary redesign of the existing spaces (see Fig. 27).

Fig. 29: A ceiling suspension creates a hollow space of 30 cm.

Fig. 30: Adding figures to the ceiling suspension space creates a theatrical space. Perception is based on familiar, human scale.

of hours or days. Spaces are decorated or used temporarily for parties, and streets are transformed for the duration of a procession or parade. Empty lots in cities or towns are used provisionally and rebuilt to adapt to these new uses. > Fig. 26

Sometimes temporary spatial "implants" for new uses can trigger other architectural developments and processes, and create a snowball effect for their respective context. > Fig. 28 If the new uses prove successful, then the structures that were originally conceived as temporary can become permanent buildings.

STAGED AND IMAGINARY SPACES

Similarly to the spatial types for cultural and leisure functions, stage spaces or set designs also create day-to-day, temporary functional relationships. Imaginary spaces are largely a temporary change of a spatial type. Analogously to dealing with a theater piece, several images are created for the stage and installed and taken down. The audience should be carried away with the help of the constructed scene to an imaginary world for the duration of the performance. The spatial means or lighting effects extend beyond the space and are meant to inspire the imagination. > Figs. 29 and 30

Spatial ideas can be presented and tested using scenographic means. Structures designed for trade fairs or exhibitions are scenographic constructions that allow a company's products or exhibits to be presented or staged in the most appropriate and visually advantageous manner.

Trompe l'œil

The "trompe l'œil" effect is a scenographic element used to dissolve the spatial borders of a real spatial type. > Fig. 31

Fig. 31: The “trompe l’œil” effect: real and imaginary space

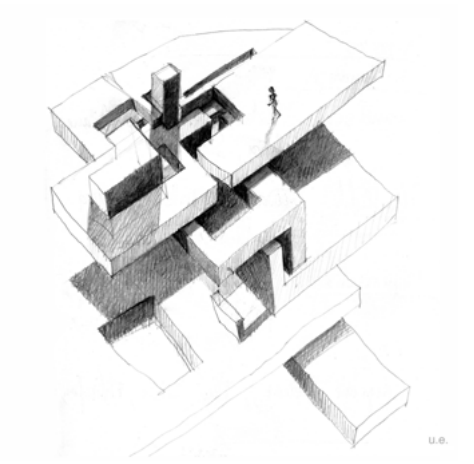


Fig. 32: An imaginary space drawn from fantasy

Imaginary spaces

Architectural ideas outlined on paper, or built three-dimensionally as a model, are imaginary plans for a spatial design that first exists as an idea but has not yet been realized. Many architects use the freedom of imagination to find ideas by temporarily ignoring certain laws such as gravity or outdoor climate. Sometimes this process produces unreal or dysfunctional spaces that seem more like a fantasy than an actual functional structure. > Fig. 32

The parameters of spatial design

In addition to function and use, a space possesses other distinctive features that are significant to spatial design and can be emphasized as specific spatial qualities. One fundamental design element in architecture and city planning is the empty space between structures, which can be designed by arranging and positioning individual architectural elements, things, and objects. Space is perceived physically by all the senses and cognitively with our mind; its different dimensions are defined by spatial phenomena. They determine the type, application, and effect of diverse spatial design means that will be introduced at the end of this section.

BUILDINGS IN CONTEXT

Every site has its own specific, spatial environment. The design of a building changes the form of its surrounding space, and conversely, the surrounding space determines a structure's possible design options. A site is influenced by many complex and diverse factors. In addition to the built or natural environment, there are also numerous historical, cultural, and social references that can all serve as contexts. The type, manner, amount, and intensity of the references characterize a spatial design as either contextual or autonomous, if there is no connection or only a weak connection to the features of the environment.

Village, city, and landscape are different architectural contexts, and each determines the type of building design. Neighboring buildings, for example, often set the height of a building's floors, or a ground plan is laid out often according to the available natural light.

SCALE AND SPATIAL DIMENSIONS

Spatial and architectural scale, especially the most standard occurring sizes, is determined primarily by how the structure will be used, and is always perceived in relation to human scale and the adjacent spaces. Proportion is what makes us read a space as large or small. A small building that is based on human scale looks even smaller when placed next to a very large building, because of the great contrast. This also works the other way around. The viewer's individual experience, and the particular spatial dimensions with which one is familiar and uses as a reference, also plays a great role in the perception of scale. > Fig. 33

A person who grew up in a village with single-story buildings will perceive scale differently to someone who was raised in a city of skyscrapers. ○

Fig. 33: Proportional relationships in a quarry

People are affected by the relative perception of spatial scale effects. It can influence, for example, the way and manner in which we move about a space, or whether or not the space generates a sense of safety and security. A room that exceeds a certain size no longer seems contained, but indifferent; even the effect of scale is lost.

Architects and planners have developed several systems over the course of the architectural history, all which refer to human scale. One of the most recent is Le Corbusier's "Modulor." > Chapter Elements and means of spatial design

INTERIOR AND EXTERIOR

Every spatial border defines a here and now. The impression of interior and exterior is created when additional spatial borders frame a structure in a way that allows a particular spatial depth to be perceived. The spatial shell serves as a communicative channel between the interior and the exterior, and the type and number of openings determine the relationship between the two. > Fig. 34

The interior of a building can either be clearly visible from the outside or not. A glazed facade creates an almost seamless transition between interior and exterior. The spatial border between interior and ex-

○ **Note:** Scale is relative, which means that errors of judgment are possible. For example, a piece of furniture seen in a large furniture store might at first appear small and delicate, but later in a smaller apartment, it can suddenly look disproportionately large.

● **Example:** A large hall with no window to the outside can have a tiring effect on people during a long lecture. A window to the street reduces the degree of spatial closure, and offers a pleasant diversion to the audience and some freedom of movement to the eye and mind.

Fig. 34: A glazed facade as a transition between interior and exterior

terior can be very thin, as in a glass surface for example, or thick, like the outer walls of medieval fortresses that even had small rooms integrated into them.

Open and closed

The type and number of openings or the overall permeability of a space's borders determine whether the space is perceived as open or closed. The openings can allow views of neighboring rooms or passageways, both of which also establish an impression of open and closed space.

ORDER AND CHANCE

The given landscape can be viewed as space that has been ordered according to natural influences and conditions, but is often perceived as disordered and chaotic. People organize existing spaces by dividing up sections and delineating areas. Since the topography and vegetation of the landscape are formed according to their own natural laws, any architectural or urban planning project is a mixture or a layering of natural and artificial order.

Chance

In addition to the planned or target-oriented design of rooms, a large part of spatial design will always be left to chance or be subject to the users' organization, due to the many extremely varied and complex relationships between the different elements that shape a room. > Fig. 35 It is therefore recommended to integrate areas where users can influence the use and design into rooms that have been designed according to preset rules of composition.

When building in an urban context, there are usually structures and examples of architecture that were built at various periods throughout

Fig. 35: Building without a planned principle of order

history and represent earlier principles of order. Constructed order can often still be recognized within the urban fabric centuries later. Old and new order plus chance buildings merge and interweave in many cities, to such an extent that they are difficult to distinguish from one another and create an impression of labyrinth-like disorder.

Imposed or self-determined order

People have to deal with very different systems of spatial order during the course of their daily lives. Many of these have been designed by the city authorities, or by architects, urban planners, and engineers, and not by the users themselves.

One's own apartment is one of the only places that can be at least partially designed according to one's own ideas of order. Private residences convey information about how a person might design his or her private space if free from imposed principles of order. This is where we see the personalized organizing principles of "hoarding." Residents superimpose their own objects and artifacts onto existing spaces and adapt the spaces to suit their private needs. Changes quickly make a difference within this self-determined system of order, so that even the slightest deviation can create a feeling of disorder.

● **Example:** In some cities new buildings were built on top of abandoned Roman amphitheaters and adapted over the course of history to serve other functions, such residences. The ancient spatial order can only be seen in the city plan, over which a new architectural order has been superimposed.

Fig. 36: Spatial depth with the horizon as border

Direction and orientation

Another, typical spatial principle is the spatial alignments in a room that are necessary for orientation. A vertical distinction is made between up and down for reasons of gravity, and the horizontal axis is defined by the horizon as a constant visible line with a left and right side in our field of vision. All the elements in a room, together with the available lighting conditions, determine the degree to which we visually perceive depth extension. However, movement is what defines depth as a third, spatial dimension, which is what makes space a tangible experience. > Chapter The parameters of spatial design, Time and space

Depth is fundamental to people's perception of space, because physical movement would be impossible without it. The horizon is the constant horizontal spatial border in depth. It is perceived as infinite because it can never be reached or touched. > Fig. 36

Aligned spaces motivate visitors to move along their main directional axis in order to experience the room's dimensions. The alignment is perceived by the senses and the cognitive system in relation to the body, which can move the farthest along this axis. Spaces that are not aligned, for example an inner courtyard or a city square, do not impose a particular direction on the visitor. Rather, they invite him or her to linger, as long as they are large enough and sufficiently lit. Spatial orientation requires a space's borders to be effective; therefore, the more openings a space has, the less effective the directional effect.

DENSITY – EMPTINESS

A space can be filled with things in such a way as to make it seem welcoming and open, or claustrophobic. The feeling of not being able to move within a space is frightening. And conversely, an empty large room

Fig. 37: Urban density is created by diverse, rich design and a myriad of human activities.

where one can move freely can also seem threatening and empty. In such a situation it is difficult to position one's own body, because things that the eye would otherwise use to measure and assess distance are missing. Hence, the size of the room is not clear in relation to the body or objects, which is the standard criteria. There are few ways in which the senses, the body, or the head can make a connection or enter a relationship. A certain amount of spatial density is necessary for people to feel
- a sense of wellbeing.

Perceiving a space as being full or empty is always individual and in relation to one's own body size, experience, mood, and freedom of move-

● **Example:** The first guests to arrive at a private party often linger in the kitchen: a small room, full of different objects, in which a variety of activities take place, including entertaining guests. This room is often more appealing than the spacious living room, the room originally intended for receiving guests.

○ **Note:** Signs of use such as scratches, chips in corners, or yellow wallpaper in a room are an indication of the duration of use and the residents. They give a feeling of authenticity to a space.

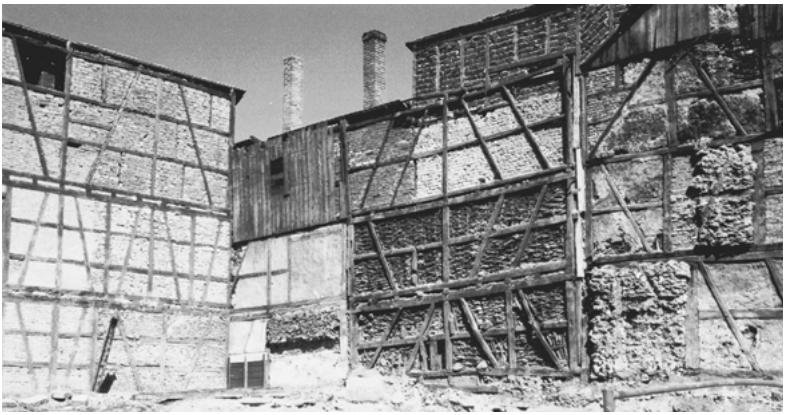


Fig. 38: The signs of time caused by age and deterioration of material

ment. The feeling of fullness or emptiness can also be triggered if a space has many memories for the viewer. The degree of spatial density is very quickly and directly conveyed as either pleasant or unpleasant, and cannot be measured. It is evaluated by personal experience, cultural influences, and physical and mental freedom of movement. > Fig. 37

TIME AND SPACE

Space is always experienced in connection with time. Moreover, visiting a different place always occurs at a different point in time. And at the next moment even this place has changed because of a change in lighting, perhaps the visitor's attention has shifted, or things in a room have been moved to a different position. Walking through a spatial structure allows one to experience time and space, because the spatial sequence might be conditional upon speed, or might have to be completed within a certain amount of time. Since time and space are the defining factors of human existence, our memories are often supported by remembering a certain space or room, and vice versa.

The physical-material nature of rooms is defined by time, because all material ages and its consistency changes over the course of time, which can be a result of sunlight, mechanical abrasion, or simple wear and tear. > Fig. 38

Spaces are witness to past eras and often consist of many elements that originated at very different periods in time. Hence, the condition of the space is a visible sign of the passing of time. > Chapter Types of spaces, Permanent and temporary use

SPATIAL CONDITIONS

The particular spatial effect is determined by several physical and chemical conditions, including temperature, humidity, room acoustics, light, and smell. All of these conditions are typical spatial attributes that work together, change with time, and, most importantly, are all perceived by the close senses. The effect the spatial conditions have on the visitor is determined by the spatial shell's qualities. This is a more or less permeable membrane between the interior and the exterior, through which, for example, differences in temperature are regulated. In turn, the human skin also functions as a membrane between the body and its environment, and is able to sense even the slightest change in temperature or humidity.

Room temperature has a direct effect on users and is both planned and perceived according to human body temperature and activities. For example, office work would be extremely impaired in temperatures under 18° C, yet physical work at this temperature is much more pleasant. High temperatures even make certain forms of physical work impossible. Even clothing, as an additional skin, influences the effect spatial conditions have on the body.

The humidity of a room is directly related to the room's temperature; warm air can absorb more humidity than cold air. After reaching a certain temperature called dew point, water vapor condenses into liquid that settles on surfaces in the room with temperatures lower than dew point.

The surface of the spatial borders also significantly influences a space's acoustics. They reflect sound waves or absorb them, depending on their particular surface properties. Sound-absorbing walls do not reflect the waves; the sound waves penetrate the material and are absorbed.

○ **Note:** A surface creates a sense of discomfort when it is clearly colder than the air temperature and the human body. It draws heat from the body, leaving a sensation of cold, because the temperatures of the room's surfaces are in constant exchange, and compensate for their differences in temperature.

○ **Note:** Hard, impermeable surfaces will strongly reflect sound waves, making it difficult or even impossible to hear correctly when inside the space, because of the long reverberation time. The waves are reflected several times and hardly absorbed. If the volume is too high, it can exceed the human ear's pain threshold, making it impossible to remain in the room unless soundproofing measures are taken.

Fig. 39: A spatial opening determined by material

Light

Natural or artificial light is an essential element of spatial design and a fundamental source of information about the dimensions and quality of the space. If there is not enough light reflecting from the space's surfaces, its borders, and hence the space itself, are unclear; and conversely, light can be perceived only when it has a surface from which to reflect. The spatial borders' surfaces reflect incoming light at various levels of intensity and provide information on the dimensions of the space. Spatial depth is enhanced by colors from the blue end of the light spectrum, and by keeping contrasts to a minimum.

MATERIAL

Material dictates spatial construction options and therefore influences spatial form. Materials also determine how one approaches certain details of workmanship, span width lengths, and the type and quality of the space's borders. Therefore the dimensions of the openings in a space and the length of a column-free ceiling are conditional upon whether the structure is a solid or a frame construction of timber, steel, or concrete. > Fig. 39

As mentioned above, a particular material's texture and composition, or color and smell affect the impression and appearance of a space. At the same time, the available dimensions of the structural elements, their construction and hence the spatial form itself are always conditional upon the chosen material and the particular options the material allows for workmanship and production.

ATMOSPHERE

Comfort, coziness, and wellbeing are spatial effects that cannot be truly gauged, but are perceived immediately. Atmosphere is a typical and tangible spatial phenomenon. A room's atmosphere addresses the entire range of human senses in a very direct and complex manner, and eludes rational comprehension. The effect often referred to as "wellbeing" is very difficult to define, partly because sensing it is so subjective. In addition to functional and intellectual needs, atmosphere exists as the focal point wherever people are found. It is defined by human activity as well as by all of the spatial parameters and qualities that the senses and the mind can perceive.

Elements and means of spatial design

The section below introduces the means and elements that are available for spatial design, the manner in which they may be implemented, and their respective effect. As mentioned in the previous section, atmosphere is created by fulfilling the functional, aesthetic, or technical requirements. It is the sum of diverse spatial phenomena and activities along with their lasting and complex interrelationship, which we perceive cognitively and sensorially. An atmosphere can be inviting or repelling; it can inspire certain activities, trigger memories, or make a visitor want to linger. Its basic nature is essential to our sense of wellbeing, the type of spatial design, and how we behave in the space.

IDEAS AND CONCEPTS

The idea for a design begins with employing all of the means and elements that shape a space. It can be developed experimentally, determined by the results of analyzing the given parameters, or discovered intuitively. In general however, all three approaches collaborate when creating an idea. > Fig. 41

The design idea is a spatial concept that outlines an arrangement of the users' spatial requirements and how they can be realized architecturally. It serves as the basis for implementing design and its elements.

Concept

Use-related and aesthetic ideas influence the architectural or urban concept. It is the chosen principle of order, which is fundamental to

Fig. 40: Mass housing is largely designed without concern for the spatial design repertoire available (detail).

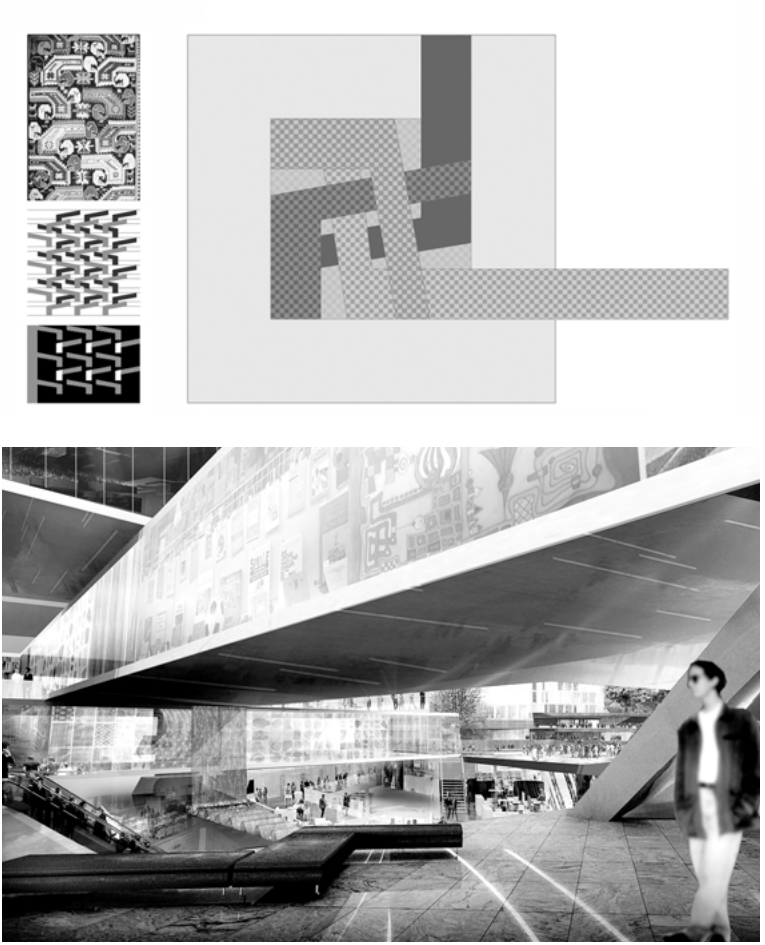


Fig. 41: Pictorial representations can also be used to develop ground plans or buildings. Here, ornament serves as the visual design concept for a ground plan.

spatial design, and can be characterized by an unusual plan, a special supporting structure, axial references to the environment, a typical sequence of users' of movements, or a special arrangement of spaces and uses. > Fig. 42

After the idea has been conceived at first often intuitively or experimentally, drawings and models are developed to test whether all of the factors have been satisfied and issues suitably resolved. This can lead to a series of further attempts until the correct solution has been found.

Fig. 42: An existing house is rebuilt using a second house: the concept of a house within a house.

Fig. 43: Spatial concept: a city square is characterized by a three-dimensional structure consisting of lines, flat planes, and volumes. Its spatial volume also supports the building, which consists of small sections, and enhances its formal concept.

Since many of the means and elements that shape a space are variable, such as color, light, sound, texture, it is wise to have an overarching spatial concept that forms the design and allows the spatial idea to be clearly recognizable. The concept is a lasting means of spatial design that is typical for a spatial structure and will still be recognizable even if the space is assigned a different use at a later point in time. > Fig. 43

Use

As mentioned above, different uses such as residential, office work, or industrial production shape the spatial type and concept. In the case

Fig. 44: The temporary use changes an existing environment. Five years ago a small market was built here as a lightweight construction in an empty lot.

Fig. 45: This new spatial structure refers to a container docks situation; the design focuses thematically on the principle of stacking.

of existing structures, a specific spatial use is usually prescribed, but it may be newly defined or invented and can as such be used as a means of spatial design. If a new and unusual spatial program is realized in a space that was originally conceived for one specific use, the user group and their activities will also change the spatial design. > Fig. 44

The spatial effect is also altered when an existing site is inhabited by new or different people who are not clothed the same way as the previous users, are present at different times, or move differently. The things

❍ **Note:** Additional information and inspiration for developing concepts can be found in: Bert Bielefeld and Sebastian El khouli, *Basics Design Idea;* and Kari Jormakka: *Basics Design Methods,* both Birkhäuser, Basel 2007 and 2008.

they bring with them also affect the space, and temporarily redesign and adapt the environment to their particular needs. A new or different use can also serve to raise critical questions concerning traditional or no longer contemporary functional references.

Context

The environment or an existing building's given attributes form the context. An architectural structure can use these site-specific atmospheric qualities or features as the design's points of reference. > Fig. 45

Urban, historical, or social situations can serve as contextual references. The existing uses and situations of a particular environment, such as shopping opportunities or a busy street as a source of disturbing noise, all influence planning a spatial program, and thus, the design of a new construction.

Whether and/or how a building can produce individual contexts from spatial relationships is also a means of design. The context can be obscured by a closed, solid wall, or strategically included by making openings in the structure. In this way, a window with a view to the sea creates a reference to a landscape. If this is missing, part of the environment is obscured, thereby denying a reference to this aspect of the context.

The contextual reference can be read in the form of a building, in its material qualities, or in its spatial program. Using local building material is also a reference to the environment. The color and texture of a building constructed in this material resembles neighboring structures and is well assimilated. In addition, the dimensions or building form determine whether the structure will be well assimilated by or form a contrast to the given context.

SPATIAL NOTATION

Every spatial design first requires knowledge of the site or existing spatial situation that is to be designed. The attributes of the terrain or existing building are investigated and recorded when inspecting the site. The term used for this procedure is spatial notation. It comprises the quantitative and qualitative data taken from every spatial quality, which are sketched, noted down or recorded in written form, photographed, documented on film, and measured. The spatial extension and attributes of the given site are calculated and documented as objectively as possible by means of measuring equipment. These data are then used to develop a strategic approach using the available spatial design means. In addition to traditional measuring tools such as tape measurers, folding rules, and barometric levels, digital laser measuring equipment allows a precise reading of the spatial extension in all three dimensions. ○ ■

■ **Tip:** Because a folding rule or other appropriate measuring devices might not always be available, it is good to know the length of your stride or the width of your hand in order to roughly calculate distances without the need for measuring equipment.

○ **Note:** Precise calculations and measurements are usually modified to suit the design task. Building furniture requires a different dimensional accuracy than designing a street junction. These dimensions are accepted as objective and veritable for the planning, but are often approximations.

Spatial notations and documented technical data convey the site's spatial attributes as well as the different spatial design concepts to users, workers, and all those involved in the construction. Since the space can usually only be viewed individually and directly on site, this method allows the designer to present the space and thus convey information about its qualities off-site, so that others will be able to structurally realize the spatial design idea.

Full-scale illustration

As a work basis for the spatial design, spaces are presented in a scaled-down form. The scale is chosen so that the presentation format (for example a printed piece of paper) is easy to handle but also large enough to show and process the necessary detailed information. > Tab. 3

All lines in the drawing are abstractions of the real space's attributes because they only represent actual surfaces and materials that overlap or are adjacent to one another. Spaces are usually visualized in two-dimensional drawings such as ground plans, sectional views, and elevations. These orthogonal projections of spatial bordering surfaces are the fundamental notation elements for visualizing, defining, and communicating space. > Fig. 46

Orthogonal visualizations provide details about the geometric and dimensional details of the space. At the same time, they abstract and simplify its complexity, because they can never provide the complete information. Other analyses and notations of spatial attributes such as sound absorption, the material qualities of the spatial surfaces (texture,

Tab. 3: Common formats used in presenting different spatial scales: 1 cm in plan = × cm in reality.

Landscape	City	Building	Blueprint for executing construction work	Furniture	Construction detail
1:100,000–1:2,000	1:10,000–1:500	1:500–1:100	1:50–1:20	1:20–1:1	1:10–1:1

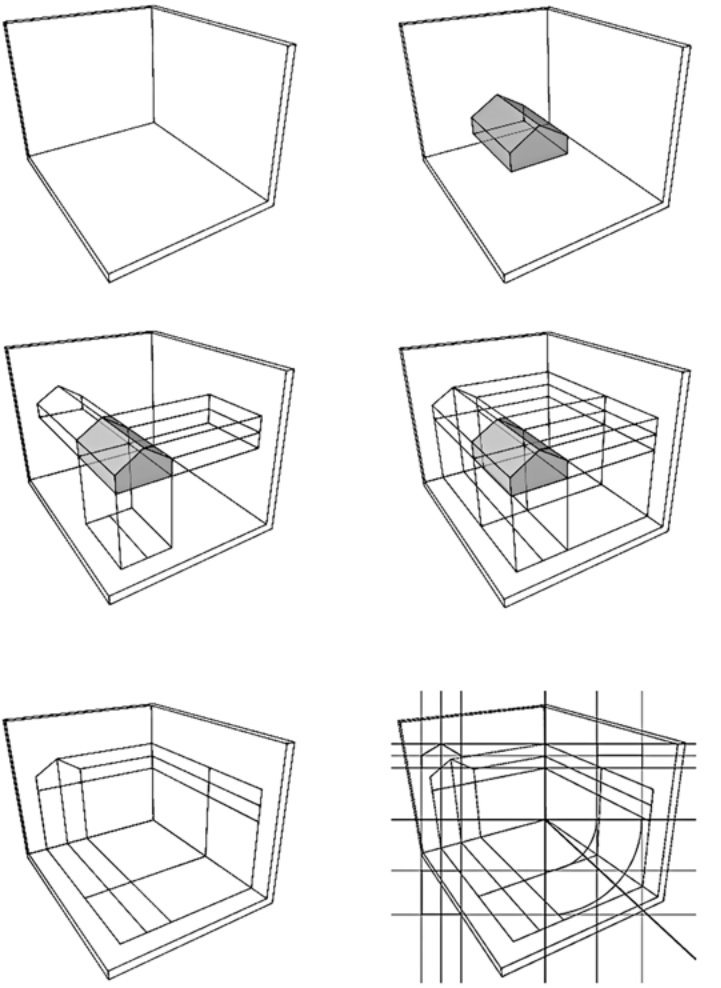


Fig. 46: Diagrammatic plan of an orthogonal spatial visualization

color, material), site inspections at different times of day, or the knowledge of the site's history are all useful for realizing a spatial design concept. For spatial aspects such as these, there are usually only a few appropriate means of notation available, such as instruments that measure light intensity and noise level. Discussions with users and neighbors can also often provide valuable and unexpected information about the site-specific conditions.

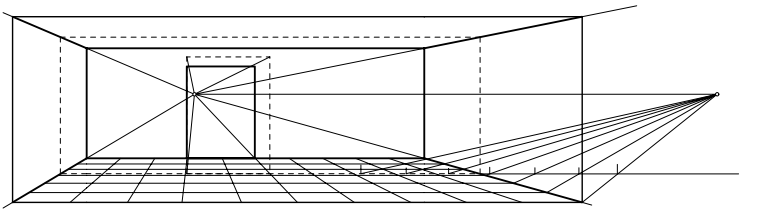


Fig. 47: Perceived depth from a simple linear perspective

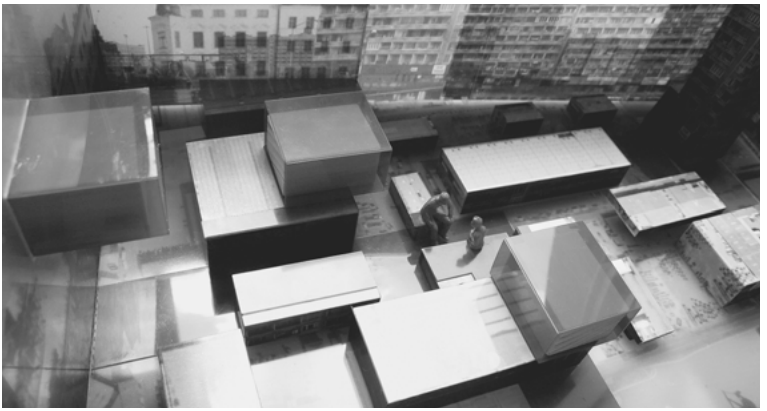


Fig. 48: Spatial presentation using projections of structural images onto the model to check and assess the spatial intervention.

Spatial situation

In order to check or convey a spatial design idea, the space is presented on film as a set visual image, either in perspective or three-dimensionally as a model. A layperson may often not understand orthogonal projections. They are more familiar with perspective images and the scaled-down model as forms of spatial visualizations, which are therefore more helpful in conveying spatial design ideas.

A perspective drawing can illustrate a real three-dimensional space precisely, photo-realistically, or abstractly using only a linear framework. The three-dimensional space is projected onto a screen; all of the depth contours run diagonally to one or more points in the horizon. > Fig. 47

Since viewers have an individual ability to abstract, a too-precise photo-realistic presentation might give clients or users the impression that the design idea is already complete and that they can no longer contribute to or influence the concept. A hand drawing can also convey an idea well and provisionally enough so that changes can still be made.

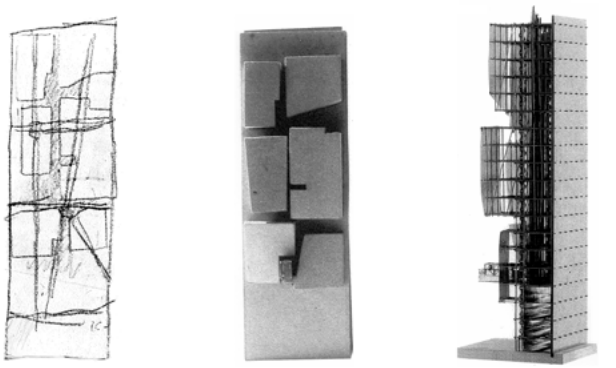


Fig. 49: From sketch to presentation model

Space can now be simulated using powerful computers and given the impression of movement within a three-dimensional space. The viewer's position and eye level can be adjusted, thereby reproducing his or her everyday experience of space.

Spatial models

In addition to perspective visualizations, models are also very common tools that can simulate and present space on a smaller scale. Models are also very helpful in understanding spatial relationships, dimensions, as well as in planning and conveying spatial ideas. Models allow a better comprehension of space and a direct communication of ideas, because they are the most similar to day-to-day spatial experience. The viewer's position and eye level move freely in relationship to the model. In addition to the visual aspect, models can also communicate the haptic impression of individual materials or make it possible to test various light qualities. > Fig. 48

Models of spaces or spatial components, such as a facade element, are built on a scale of 1:1 in order to test and discuss a planned construction. > Fig. 49 ○

○ **Note:** Further information and inspiration regarding spatial visualizations and communicating spatial concepts can be found in: Bert Bielefeld and Isabella Skiba, *Basics Technical Drawing;* Jan Krebs, *Basics CAD;* Alexander Schilling, *Basics Modelbuilding;* and Michael Heinrich, *Basics Architectural Photography,* all Birkhäuser.

COMPOSITION, PROPORTION, DIMENSION

All means and elements of spatial design are put together in a spatial composition. A composition is the product of a designer's strategically compiled and arranged spatial elements. Similarly to the way in which music is composed, structural elements and spaces are planned and arranged so that they relate to one another. Individual spaces or sequences of spaces are composed according to requirements of use, and aesthetic concepts and ideas. The functional necessity of creating a connection between two points is just as influential to a spatial composition as the construction site or the floor space required for a certain machine. The architectural, spatial composition can be based on geometric laws, proportional systems, instinct, a two-dimensional image, axial relationships to points in the environment, or even derived from specific topographic aspects of a landscape.

Order and chance

Most spatial designs and compositions are produced on a daily basis by users' movements and the objects they reposition within a space. Even the scent or voice of a person can greatly affect the spatial impression, and moving elements around in an existing space will constantly change its previous order and composition. Moreover, the specific positions of structural elements can never be completely planned or foreseen, particularly in structures for long-term use. Part of the composition has to remain subject to chance since not every aspect can be controlled 100% by the design. For this reason, many spatial compositions integrate areas that were not designed to be use-specific.

Experimental design

Exciting spaces can be created using experimental approaches in addition to rational-analytical methods. Simple geometric bodies can be quickly turned into spatially complex figures by using a few specific procedures. Two-dimensional, rectangular figures or three-dimensional, highly regular geometric forms – such as a cube – can be divided, doubled, folded, or transformed by other geometric laws to become diverse spatial forms. > Figs. 50–52

● **Example:** A building's future users are mostly unknown to those in the housing construction trade. Open spaces have to be planned for cupboards, beds, chairs, and other furniture. The future design of spaces such as these is far removed from the influence of "spatial composers."

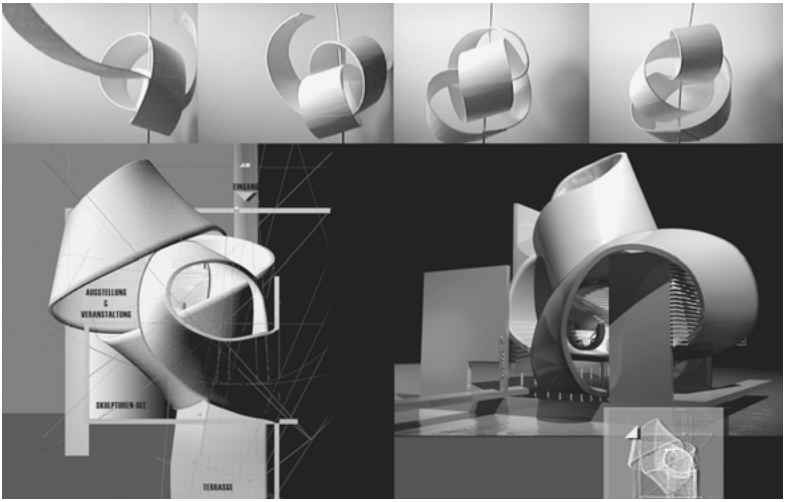


Fig. 50: Compositional experiment using strips of paper

Fig. 51: Compositional experiment using found natural forms

Two-dimensional materials like paper, wood, metal, and so on can be developed to form three-dimensional figures by shaping them into different forms, using methods that suit their particular material attributes (stiff or flexible, for example). These objects, with forms derived from the quality of their material, can be tuned more finely according to

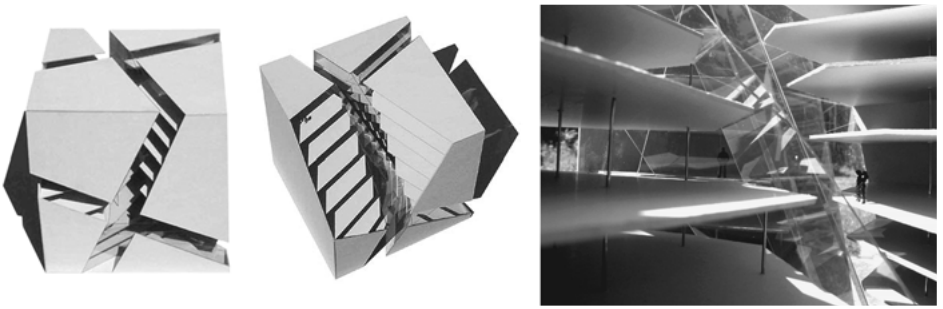


Fig. 52: Compositional experiment in dividing and arranging basic geometric forms

qualitative focal points, which include dynamics of tension, play of light on the surfaces, the randomness resulting from how they were formed spatially, and so on.

Adapting a different manner of presentation and different scale will result, after a further phase of development (for example 3D animation), in a tangible visualization of the spatial object. This process can be taken as far as the pragmatic level of an actual building design. An apparently coincidental spatial configuration becomes a built structure and can still be comprehended throughout this type of process.

Looking at different objects or empty shells produces various personal associations that trigger an idea and set a design process in motion. A model can be a direct means of realizing an idea. Working with a design model makes it possible to immediately control an idea and get feedback from it. The interaction between working with one's hands and conceptual intellectual work builds confidence in assessing one's own work. This exercise can also help develop one's repertoire of realization strategies.

Proportion

Spatial proportions describe the relationship between the width, height, and length of a space or spaces. Certain spatial proportions with fixed geometric laws and dimensions were obligatory in design for centuries. One proportional relationship that was considered well balanced, such as the golden section, defined the dimensions of all spatial elements in the ground plan, sectional view, and details. A space based on the golden section has a tranquil and balanced effect. > Fig. 53

There have been repeated attempts throughout architectural history to develop and apply standard proportional tenets and systems. Le Corbusier's Modulor was an attempt to regulate the scale all spatial elements

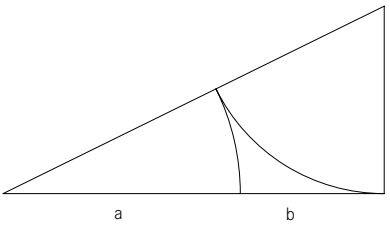


Fig. 53: A golden section is created by geometrically dividing the sides of a triangle.

to fit the standard proportions of the human body. His proportional tenet was based on the Golden Section and a mathematical series of numbers (Fibonacci Series).

Structural elements can also prescribe proportions. Using bricks as the smallest building component creates a modular grid that can determine spatial dimensions. Spatial proportions in Japan are traditionally calculated and defined by the number of *tatami* mats, which measure 1:2 (85 × 170 cm). The length is based on the average height of a Japanese person. A traditional Japanese room is the size of 6 mats.

The metric system of measurement, which is most prevalent today, is based on the circumference of the Earth and no longer refers to the human body. However, the "Imperial" measures used in England and the USA (feet, inches, etc.), and some other historical systems of measurement, are still based on the human body. ○

○ **Note:** There are two lengths in relation to one another in the Golden Section, if the ratio between the sum of those quantities and the longer one is the same as the ratio between the longer one and the shorter: a is related to b as a+b to a. This ratio can be seen in nature as well as on the human body. The golden section is used in the same manner in architecture, art, and music and considered a balanced and harmonious proportion. In figures the ratio is 1.618:1.

○ **Note:** Some spatial proportions are influenced by industrial mass production and the dimensions of their means of transportation, such as shipping containers or euro-pallets. The dimensions of objects and appliances that have been adapted for optimal utilization, for example the floor area needed by kitchen appliances, in turn influences the design and measurements of kitchens.

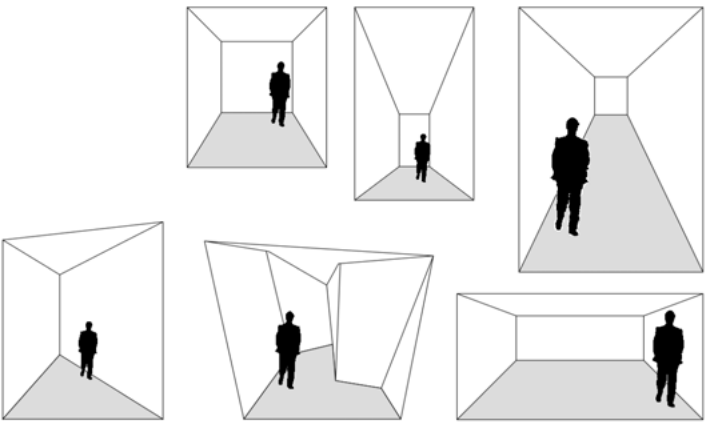


Fig. 54: The spatial effect of different spatial forms

A space with a square floor area and an equal height will have a very tranquil effect, because all of the space's edges are equal in length. Each individual spatial dimension is always perceived in relation to one another and in relation to the human body. Doubling the room's height increases the vertical effect. If the floor area is made longer, the room will receive a directional thrust that motivates people to move in one direction. If a ceiling is low, and the room is almost too low to stand in, it is perceived as claustrophobic because it becomes difficult or impossible to shift the body's position. The same is true for a narrow corridor that is wide enough to accommodate only one person. Since this does not provide enough room to linger, people will move quickly through this space looking for an exit. > Fig. 54

Dimension

The massive difference in spatial types and the familiarity with certain common proportions can be used as a design means to create spatial contrasts. The proportions of spaces are always based on one another and on human scale. A building of standard dimensions suddenly looks much smaller than it really is when placed next to a very large structure. And the reverse is also true: a building looks higher when standing alone. If elements that are small, familiar, and based on human scale are integrated into very large rooms, the impressive overall spatial effect is increased. > Fig. 55

Fig. 55: The lighting fixture hung at normal ceiling level in the Blue Mosque in Istanbul increases the spatial atmosphere by emphasizing the height of the religious space in relation to human scale.

Emptiness and density

Emptiness and density are essential aspects of spatial composition. Spatial density has little to do with how much a space is filled with people, objects, associative possibilities, or activities. The experience of the body in space, or in other words the distance between the body and spatial borders or objects, together with our cognitive spatial awareness, determine whether we read space as empty or dense. A person might not be free to choose his or her position in space if a space is experienced as too full, which could result in a spatial impression that invokes fear (a possible reason for mass panic). A certain relationship between spatial density and emptiness determines the individual wellbeing of the viewer, without this being definable or quantifiable. > Fig. 56

Nonetheless, designing the degree of spatial density is used as a means of spatial design, because it has a similar effect on many people. Expanding the distance between objects or buildings will lessen the density of the space and increase the sensation of emptiness. In this case, there are not enough spatial coordinates that, with the aid of measurements and distances, would otherwise help us determine our position in space. Space is created by the interaction of elements and perceivable intermediary spaces. In the desert, in complete darkness, or at sea, spatial borders may be only partially discernible or completely invisible, which makes the space appear empty enough to seem threatening.

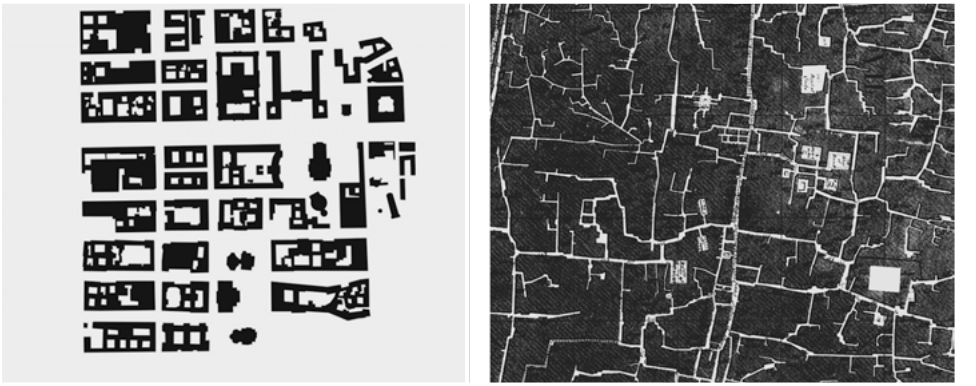


Fig. 56: As-built plans of Berlin and Cairo demonstrate different urban densities with the aid of abstract renderings of the city structures' building masses and empty spaces.

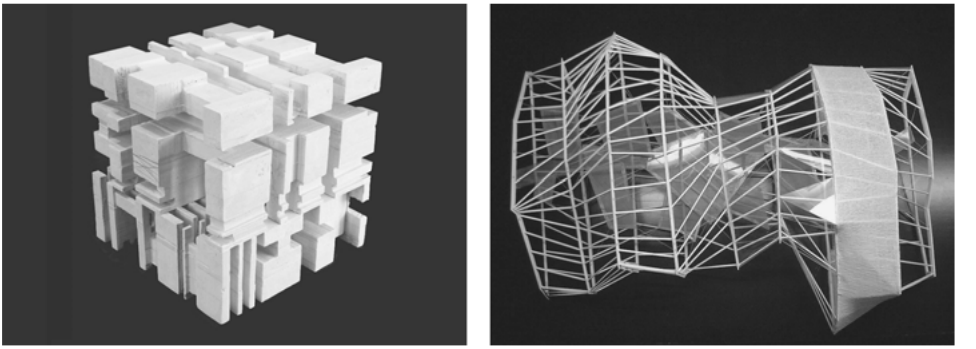


Fig. 57: Subtractive, orthogonal cuts into a cube, and a figure revealed within the structure

SPACE, DESIGN, STRUCTURE

Although various construction or formal aspects are able to determine spatial shape, the tectonic structure that is determined by gravity absolutely does.

Consequently, the support structure of a building can be designed as flat and solid without visible constructive structure, or as delicate and open using supports. > Fig. 57

Spaces with smooth, flowing transitions, or spaces that are clearly separated, as well as integrated empty spaces, smaller cells in a large space, and orthogonal or freely formed spatial borders are all spatial structures that give the built structure its unique form.

SPATIAL BORDERS AND CONNECTIONS

Spatial shell

Creating spatial borders is a basic means of spatial design. Spatial borders divide and zone off the infinite amount of space above the Earth's surface. A spatial shell is created when several spatial borders exists to define a width, depth, and height. An interior and an exterior are created by the two sides of a single linear spatial border. The spatial shell protects against cold and heat, humidity and moisture, noise, and unpleasant or unwanted views. The degree of permeability between interior and exterior is what makes a spatial shell appear open or closed.

This impression of open and closed is determined by the attributes of the spatial borders and the way in which they have been divided, as well as the lighting conditions, and the proportional relationships in the space. Structural elements can provide a three-dimensional quality to floors, walls, and ceilings, and the shadows they create will emphasize the spatial borders.

Spatial connections

Connections between spaces and the interior and exterior are created when openings are made or integrated into the spatial border's surfaces or separate rooms. They provide access or a view to the adjacent spaces and link them horizontally and vertically. The spatial shell is similar to a membrane that is perforated by doors and windows. The number and form of the spatial connections or the permeability of the membrane are important design means and determine the spatial impression.

> Figs. 58–62

The effect of the openings in a space relies greatly upon whether the openings offer an exit or only a view outside, or, in other words, whether there is a way to cross the spatial borders and if so, how. Openings in the surfaces of the spatial borders also provide daylight, fresh air, or a change in temperature to the interior. Windows allow a view through the spatial border in both directions. While garages are measured to fit a car, the doors to a space should correspond to human scale, be inviting to guests, and provide security for private spaces by denying access to uninvited visitors. For this reason, spatial openings are often designed so as to slightly vary the degree of openness via doors, curtains, Venetian blinds, and window shutters.

❍ **Note:** Gravity and the flow of load forces can either be made visible and emphasized, or made less noticeable than other design features.

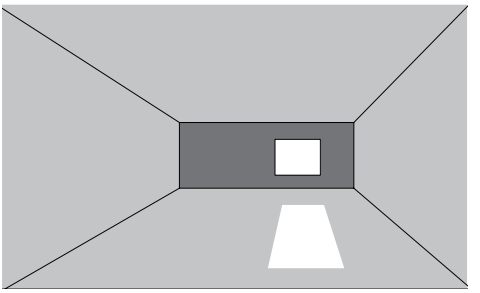


Fig. 58: Light source from one side frontally: high contrast on the walls and floor. The light will have a glaring effect.

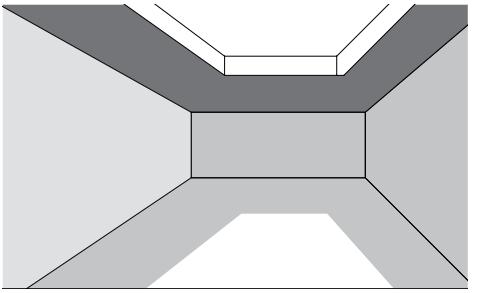


Fig. 59: Overhead light source: diffuse lighting from above absorbs some of the spaces depth.

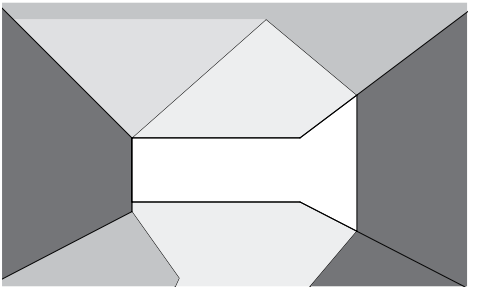


Fig. 60: A generous light source creates light and dark zones in the space.

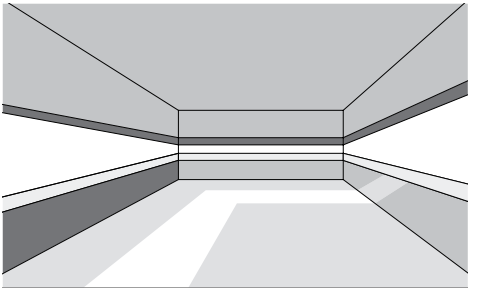


Fig. 61: Surrounding light source: the light band provides a good all-round view. A low parapet widens the space and makes it seem larger. There is a lively play of light and shadow on the floor.

A space will seem closed and separated from an adjacent space if the wall opening is only 70 × 200 cm in size and has a lintel; in turn, the space's borders will seem to dissolve if the opening is twice as wide and is floor-to-ceiling high – this creates a feeling of two spaces flowing in and out of one another. A seamless transition between the floor surface and ceiling will enhance this effect. A wall opening that extends to the floor will create a more spacious and open impression than a window with a parapet. Ceiling-high ribbon glazing emphasizes the horizontal axis. On the other hand, a ceiling-high glass wall almost completely dissolves the borders between the interior and exterior, which suspends one's impression of being inside and makes the space appear to stretch far beyond its borders. Dissolving one spatial edge to create a view or passage will make the space seem very open and emphasizes the diagonal axis.

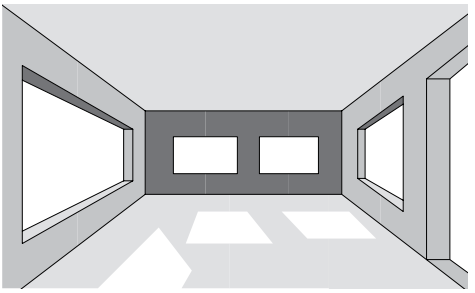


Fig. 62: Several light sources and openings without a recognizable pattern of order can make the space seem perforated and busy.

The dissolved edge undermines the impression of a surrounding shell, makes the construction seem less stable, and creates a feeling of unease.

The position and direction of the openings will structure the walls and ceilings into horizontal or vertical sections. Openings made in the walls and ceilings turn the visible areas of the adjacent spaces into pictures and elements of the space, and the window or doorframes become picture frames. ○

Vertical connections

Spaces are connected vertically via stairs, ramps, elevators, and ladders, or through openings in floors or ceilings. Vertical connections are the diagonal elements that are necessary in order to move through spaces; they can either stimulate motion or create a sense of unease. The tilted surface of a ramp or the horizontal steps on a stairway are

○ **Note:** Door thresholds mark the transition between inside and outside. Throughout architectural history, different cultures have designed thresholds to stress the shift between interior and exterior and make the attributes of the spatial border a tangible experience. A high threshold or a painted threshold emphasizes the spatial zone in the wall thickness between the inside and outside. There are increasing requirements today for building without thresholds – barrier-free architecture – that need to be considered.

Fig. 63: Vertical connection – stairwell of an office building

positioned for aesthetic reasons either open in a space or in specifically allocated areas, which helps to control sound transmission or impede the possible spread of fire (staircases, stairways, and elevator shafts). > Fig. 63 The design of stairwells emphasizes and enhances the vertical and diagonal connections used for communication and light.

Very high spaces can accommodate two stories in some areas. If they are open on one side facing the high space (gallery), the entire area will flow together and be restricted to one space with spatial zones of different heights. Another potential connection option would be to restrict the levels by using differences in height, as is done for example with mezzanines placed at mid-floor height.

LAYERING

Wherever the surface of one material or three-dimensional body ends, the surfaces adjacent to, in front of, or behind it are all visible. The type of layering affects a space and determines its depth effect. It can also emphasize changes as well as different points in time.

Elements that are arranged sequentially in the space can be designed and positioned so as to influence the spatial depth effect. This occurs with layered building components that are arranged as stacked or layered one after the other, which divide the spatial depth into individual zones or sections and enhances the spatial extension. > Fig. 64

Vertical layering

Due to gravity, layering is also an essential spatial design principle regarding the vertical axis. Buildings are made by vertically layering components on top of one another – furthermore, stacking elements accen-

Fig. 64: Layering of building components that is either complex or simple and quickly read can enhance a space's effect of depth.

tuates and highlights gravity and the vertical axis. The construction will seem transparent if the interior structure of the stacked or layered elements is visible. Consequently, the facades of high-rise buildings are usually structured vertically using openings, cornices, or parapets, in order to increase the vertical effect.

Layering and transparency

The history and origins of a space can be read in the spatial layers that have been added at different points in time. It can also be seen on different surfaces and construction elements that vary in age as well. Certain elements of the space provide details about the past and stimulate the cognitive system to make associations and to imagine the age of the space, its historical past, or former inhabitants. The passing of time becomes tangible because these traces of the past are still visible in an existing building after it has been redesigned. Even cities, urban areas, and landscapes are very frequently a result of layer upon layer of various spatial arrangements and chance designs, giving them a more labyrinth-like than transparent impression.

● **Example:** A series of columns divides a long facade into several segments that are closer to human scale than the entire length of the building. The true length of the structure would have an unpleasant effect on the visitor. The columns create a rhythm that invites and guides one's movement through the space along the facade.

Fig. 65: Reflections on a pane of glass can lessen the impression of transparency and create unique images according to the lighting conditions.

TRANSPARENCY

Perforations in the form of openings, and the degree of their light permeability can reveal what a space's border surfaces are actually meant to conceal. Transparency and concealment are also used as design means in order to control the degree of public access or intimacy and privacy. While a pane of window glass is transparent (curtains at most reveal contours when lit from behind), a wall conceals everything that is behind it.

The impression of transparency is created when the depth, attributes, and arrangement of spaces or sequence of spaces are clearly perceivable. Spaces also seem transparent if the viewer or user is able to easily identify their own position in space, to orient him or herself, and to find the entrance or the exit. The effect of transparency is also created when a viewer can look inside a building to see what use or function it conceals, or to see the layout of its ground plan. > Fig. 65

CHOREOGRAPHING SPACE

Spatial choreography is the term used for the spatial design of a sequence of spaces. It governs the movement and behavior of the user in the space. Space is generally perceived while the user or viewer is moving through it. Their line of movement is free and but also determined by the attributes of the space or sequences of spaces. > Fig. 66

One example of spatial choreography that is rich in contrast would be a round space located at the end of a long and narrow hallway, has no

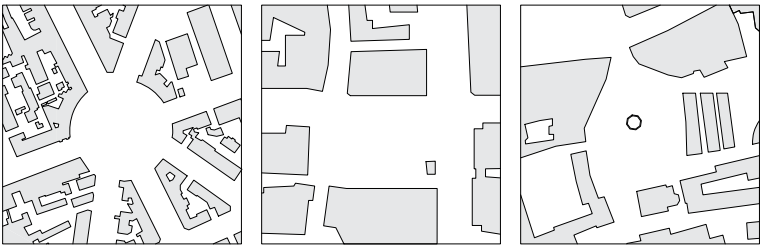


Fig. 66: Different layouts of town squares and connections to the city result in different patterns of motion through the space.

dominating spatial direction, but a tall stairwell passing through several stories of the building. This example of spatial choreography might produce an uneasy impression, but it could also be surprising and stimulate the user to explore the levels above. The antechamber of a church, which is narrow and has a low ceiling, serves as a transition from the exterior to the interior. It is strategically intended to engulf the visitor and emphasize the spatial effect of the high ceiling in the main hall. How the spatial proportions and attributes of spatial sequences are designed can influence a visitor's behavior, as well as the direction in which he or she moves through the space. Spaces can be staged in such a way as to motivate the user to behave in a manner that corresponds with the designed scene, similar to an actor or actress in a stage play. This can be compared with decorating a space for a celebration in a way that will transport the guests temporarily from an everyday situation into a special atmosphere.

A sequence of spaces can be designed so excitingly that they challenge all of the visitor's senses. The lines of movement through a space on both the level and the vertical axes can be designed as straight, bent, or curved, or so as to encourage one to move quickly or slowly.

Medieval cities frequently seem like labyrinths because they have a rich array of spatial impressions, engage all of the senses at the same time, and challenge our motor abilities. The line of movement here has

● **Example:** A recognizable sequence of spaces can heighten curiosity and motivate the user to move through them. In a single room with two openings, the user will walk from the door to the window in the direction of the light. A line of movement is also created when there are two door openings in an otherwise empty room.

Fig. 67: A varied and a monotonous traffic zone (subway station)

only a few long linear segments. It is characterized far more by diverse changes in direction, varying spatial proportions, and a sequence of short and long pathways. A medieval square encourages a visitor to linger rather than to move – as long as there are no potentially dangerous cars. Cities today are mostly tailored to a motor vehicle's radius of movement. Urban planning such as this often hampers pedestrians' or cyclists' movement and can be monotonous and tiring. > Fig. 67

Vertical movement is more difficult than horizontal movement because of the force of gravity, which pulls towards the Earth's core. Consequently, comfort, rhythm, and the duration of the specific vertical movement are essential factors when designing stairs or ramps. Platforms placed at intermediate levels provide a place to rest, a place to change direction, and also divide the climb up into manageable segments.

The pattern of movement expected in a space also determines its form. The most important recurring movements are documented in diagrams as form-defining parameters that will serve as the most direct possible basis for the design of the spatial shell – consequently, the direction, amount, intensity, and speed of these parameters define the spatial shape. The building's design is developed as a function of the anticipated movements at different times of day. Sequences of movements are calculated empirically even for furniture, objects, or machine construction in order to establish a form that best suits the movement.

LIGHT AND SHADOW

For people, light is the visible part of electromagnetic radiation. Yet in the context of physics, "light" represents the entire electromagnetic spectrum of waves. Daylight from the sun and artificial light from various electric sources are all reflected off spatial surfaces. Space can only be

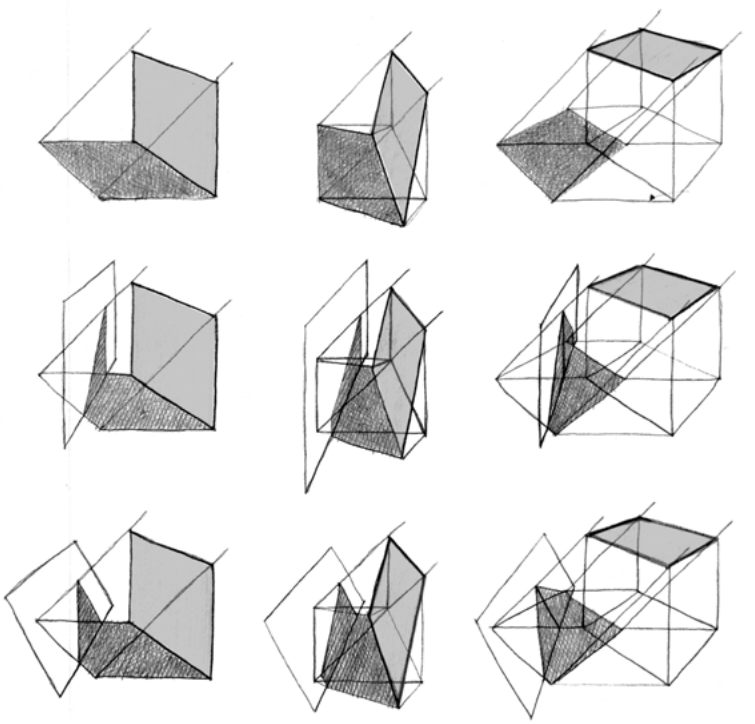


Fig. 68: Spatial shadows from various surfaces create a strong three-dimensional effect even in the simplest spatial configurations.

perceived if the spatial borders and dimensions are sufficiently visible, hence spatial design is always also lighting design. The surfaces that form a space's borders reflect incoming light with more or less intensity; they reveal the extent of the space and enable a person to locate their point of orientation within the space. ○

○ **Note:** The area of light visible to humans has a wavelength of approx. 380–780 nanometers (nm), which corresponds to a frequency spectrum of approx. 789–385 THz. A precise limit cannot be established because the sensitivity of the human eye to the limits of the light spectrum diminishes gradually and not abruptly.

Tab. 4: Wavelengths of the prismatic color of light (in nanometers)

Violet	Blue	Green	Yellow	Orange	Red
380–420	420–490	490–575	575–585	585–650	650–750

Tab. 5: Typical luminous intensity measured in lux (Central Europe)

Bright daylight sun	100,000 lx
Cloudy summer day	20,000 lx
Cloudy winter day	3,500 lx
Television studio	1,000 lx
Room and office lighting	750 lx
Hallway lighting	100 lx
Street lighting	10 lx
Candles one meter away	1 lx
Full moon at night	0.25 lx

Light would not exist without space, objects, particulate matter, or the humidity in the air, because it would have nothing to reflect off. Light can penetrate textile and opaque surfaces partially or not at all. Shadows are created according to position, intensity, and direction of the light source. > Fig. 68

Light color

Light splits into several spectral colors within the area of the spectrum visible to humans. The associated spectral color is determined by the wavelength of the maximum of the continuous spectrum and given a corresponding color temperature (TCP), measured in Kelvin (K). > Tab. 4

○ **Note:** The filaments in a light bulb have a relatively constant wavelength and consequently produce a continuous spectrum similar to sunlight.

○ **Note:** Light is an environmental factor, like sound or exhaust fumes. Light emissions from lighting facilities can harm people and animals or even impair technical processes.

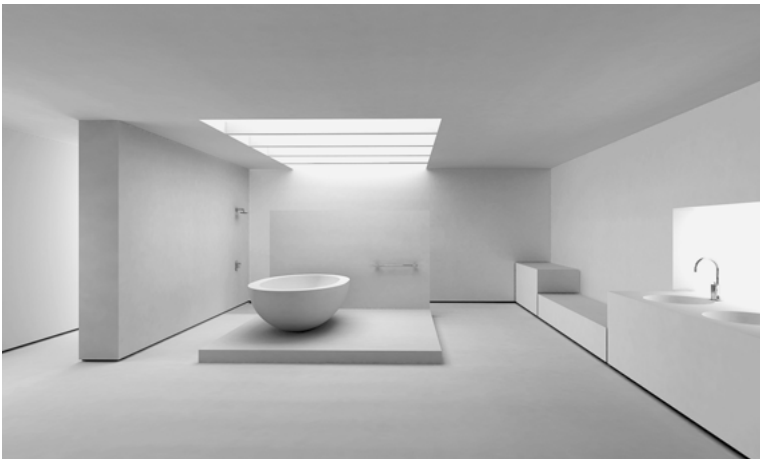


Fig. 69: Overhead and sidelighting sources enhance the three-dimensional quality of the space.

Light is measured in a similar manner to color; perceiving light is very individual and it is difficult to agree. > Tab. 5 ○

Lightness and darkness are essential elements of spatial design and are influenced by the choice of light source and the space's structural surfaces. Light changes according to the time of day or year and is therefore one of the labile design elements. As a means of spatial design, light needs to be planned so that it is able to adapt to different uses and times of day. Spaces can be open or closed to light depending upon what is required by the use or individual need. They will have different effects according to the type and position of the light openings.

○ **Note:** Candela (Latin: taper, candle is the unit of measure for light is the): the luminous intensity, photometric base unit for lumen (cd).

Lumen (Latin: light, lamp), the luminous flux, photometric unit of the luminous flux (lm).

Lux: luminous intensity and specific brightness (luminous emittance), measured with a Luxmeter, it can be converted into luminous flux and und luminous intensity (lx).

WARMTH, HUMIDITY, SOUND, SMELL

The space's physical conditions are also a means of spatial design, yet they require a more dynamic approach because they are constantly changing. Spatial conditions are defined by the material qualities chosen for the spatial shell, or the membrane between the interior and the exterior.

Warmth

A material's thermal conductivity determines how quickly heat will be transferred from a warm body or the space's air, and the way in which the exterior and interior temperature difference is balanced. Is the thermal conductivity of the material very different from its surface temperature? Is there an unpleasant movement of air that will make a room feel subjectively cool although it is sufficiently heated? The thermal conductivity of building components that are in regular contact with the user (floors, door handles, seating, and so on) also needs to be considered, in order to create a desire to spend time and feel comfortable in the space (for example, to walk barefoot in a private living room). ●

Room temperature is regulated according to the particular use of the space. Physical work, for example, requires a lower room temperature than office work. Older people often require warmer temperatures than younger people; and the perception of heat or cold varies from one individual to another. Heating systems for interior spaces are categorized either as direct heat (such as the sun or a tubular radiator) that travels directly to the skin, or convection heat that is transferred by air. Room temperature also establishes the room's humidity.

Humidity

Water vapor is absorbed by the spatial shell and room temperature. Humidity is the term used for the percentage of water vapor in a space or in the Earth's mix of atmospheric gases. The percentage of humidity measures the degree of water vapor saturation in the air. ○

● **Example:** The level of body warmth in a hand is more quickly transferred to a stone than to a piece of wood. Because the stone cools a hand much more rapidly, the stone feels colder than the wood even if its surface temperature is the same.

○ **Note:** 50% relative humidity means that the air contains only half the maximum amount of water vapor it can hold at any certain temperature. At 100% relative humidity, the air is completely saturated with water vapor; if this amount is exceeded the surplus moisture turns into condensation that gathers on the space's surfaces or develops into mist.

Tab. 6: Reverberation times according to use (frequency range 100–5000 Hz)

Recording and sound studios	Classroom, lecture hall	Combi-office	Concerts (depending on the type of music)
< 0.3 sec.	0.6–0.8 sec.	0.35 sec.	1.5–3.0 sec.

Skin is able to sense the level of humidity almost immediately upon entering a room. The relative humidity of a room affects one's sense of wellbeing and consequently one's health. For example, dust bonds together in conditions of high humidity, while low humidity can dry out the sinuses and ultimately cause illness. Moist surfaces in a space often result in mold that can also be detrimental to health.

Sound

Disruptive noise can be controlled by acoustic spatial design. Noise affects the acoustics of a space and is perceived almost immediately. The spatial shell's attributes can function well as sound protection against noise from outside traveling inward or vice versa. The acoustic effect of materials is defined by the degree of sound absorption, which lies between 0 (no absorption) and 1 (complete absorption). The degree of absorption is conditional upon impinging frequencies. There is also a distinction made between two different types of effects: porous soundproofing absorbs sound into the material. Inside the pores, friction transforms the sound energy into heat and thus diminishes the sound reflected by the material. Soundproofing that relies on vibration vibrates with impinging sound waves; this resonance reduces the level of sound reflection.

The most important factor in spatial acoustics is reverberation time. This is the time it takes for a sound to decay in a space, and should be tailored to the space's use. > Tab. 6 For a concert hall, this aspect has to be designed as precisely as possible, yet other spaces such as large offices also need specific sound attributes. Large sacred spaces often have long reverberation times and strong sound reflection; in comparison, very close spaces often seem small and claustrophobic.

Smell

Even the evaporation from material or other people's perspiration can have an impact on the atmosphere one perceives while spending time in a space (library, church, school, locker room, and so on). A strong smell can overpower all the other spatial aspects and make it unpleasant to remain somewhere. Fragrances can produce a pleasant spatial impression if they create positive associations. They are used in certain areas in shopping malls and department stores to create a pleasant experience.

MATERIAL, TEXTURE, ORNAMENT, AND COLOR

The effects that the surfaces comprising a space have on the viewer are defined by all of the materials used. Other, fundamental material qualities also have an impact on spatial impression in addition to the specific material qualities or the texture of surfaces and materials. > Tab. 7

The texture of the material is first determined by the way in which the material has been handcrafted or industrially processed, but it is also a result of use, deterioration, or erosion. Most materials can be produced with coarse, fine, smooth, matt, polished, or rough surface textures.

The surface texture quality also influences the lighting conditions, as well as spatial acoustics, temperature, and indoor humidity.

A room can seem as inviting and pleasant as comfortable clothing if the vibrations of the surfaces of a space are adjusted to the users' movements.

New material

New materials such as nanomaterials and composites are being developed constantly and are used in spatial design. Nanotechnology has made new material surfaces, coatings and textures available that fulfill specific functions. The changes in surface structure are so minute that they cannot be discerned with the human eye.

"Composite" is the term used for the influx of newly developed material combinations that have improved constructive properties. For instance, transparent concrete was invented while experimenting with new mineral aggregates. They are reinforcement with synthetic material instead of steel, which makes it possible to construct much thinner plates.

Fabric and paper

Fabric and paper are temporary spatial design elements, because they deteriorate quickly with use. As with furniture, fabric and textiles can be moved and used in different areas. They are pliable, light in weight, have various textures and are available for design concepts in a broad palette of colors. This makes them very popular as a means of spatial design for walls, ceilings, floors, furniture, or opacity. Typical textile elements and materials in spatial design include:

■ **Tip:** The different materials intended for a spatial design can be presented in a materials collage that displays the interrelationship between the materials that have been found or planned for the project.

○ **Note:** The manner in which one walks along a wooden beam floor with floorboards, on screed in a reinforced concrete building, or on sheet steel is very different due to attributes such as elasticity, sound, and sometime heat absorption.

Tab. 7: Materials for spatial design (selection)

Natural stone	Artificial stone	Wood	Glass	Natural fibers and fabrics	Metal	Synthetic materials and composites	Other
Plutonic and effusive rock – gabbro – granite – diorite – basalt – diabase – pumice stone – basalt lava – porphyry – tufa sedimentary rock – slate – limestone – (lime sand brick – rimstone) – conglo-merate – dolomite – greywacke – sandstone – quartzite metamor-phous rock – gneiss – marble – quartzite – slate	bricks lime sand brick clinker earthenware slabs (cotto) adobe cast stone/ concrete (cement, water, sand/ gravel) – in-situ concrete – terrazzo – ready-mix concrete – concrete block – screed – agglo marble – transparent concrete – cement lime stone ceramics quartz material	soft wood hard wood (including fruit wood, burl wood) tropical wood bamboo straw reeds all wood material wood fiber cork coconut shells	industrial glass laminated safety glass (LSG) window glass glass tubes wired glass fiberglass glass stone glass fiber glass mosaic glass pearls	– felt and fleece – textiles – cane animal fiber (spun/ drilled) wool (sheep, alpaca, llama, angora, cashmere, camelhair, mohair) hair (goat, cow/yak, horse hair) silk (mulberry, tussah, conch) horn fur leather plant fibers – linen – ramie – flax – coconut – cotton – kapok – stinging nettle – hemp – jute – sisal – bamboo – grass – (grass wallpaper)	cast metal, rolled metal alloy iron (steel, stainless steel) copper lead nickel aluminum zinc tin titan silver gold solid (tubes, rods) plates wire textiles film sheeting alloy foam	straw adobe linoleum asphalt epoxy resin Plexiglas acrylic glass foam rubber mineral rock wool film sheeting resin (coatings) thermo-plastics – poly-ethylene – nylon – PET – polystyrene – polyamide – polyester – polypropy-lene thermosets – polyester – bakelite – nylon – polyure-thane – synthetic resin – epoxy resin – melamine elastomeres – caoutchouc (rubber) – poly-urethane	mineral binders plaster lime plaster cement plaster gypsum plaster new materials nano materials (1–100 nm) painted coatings (acrylic, synthetic resin) fiber materials microfibers mineral fibers asbestos fibers from natural polymers – viscose – poly-amide (nylon) – modal – card-board – paper – wallpaper – paper mache chemical and ceramic fibers

- Carpets (floor and wall): wool, synthetic material, cotton, silk, jute, sisal
- Wallpaper/tapestries (wall and ceiling): wool, cotton, silk, linen, metal
- Curtains (interior and exterior wall): cotton, wool, synthetic material, silk, linen, metal yarn
- Blankets and pillows: (furniture): wool, cotton, silk, linen, synthetic material

The material qualities of textiles and paper resemble clothing more than stone or metal and, consequently, people consider them pleasant and familiar. People like to touch them because they are mostly soft, flexible, and do not absorb body heat.

In spatial design, textiles and fabric also serve to absorb sound because they are porous and have a large surface area. They show the movement of air and provide shading or protection from rain.

Ornament is the term used for a repetition of abstract or figurative forms or objects (Latin: ornare = to decorate). The pattern this creates can be used to design and structure spatial elements and surfaces. Ornaments can also represent a certain symbolic meaning and have the effect of lettering. Wallpaper is often decorated with an ornamental pattern, but natural stone can also have a striking grain pattern and look decorative. In the ground plan of a city, the arrangements of buildings that appear repetitively can create a pattern. The joints between the surfaces of a sidewalk can also be designed and perceived as ornamentation. > Fig. 70

Ornament

Many abstract ornamental patterns are based on natural forms or images. An ornament can be painted onto a surface or used as a three-dimensional element to structure a room. In Gothic churches, there are many ornamental structural elements and decorations on the columns and walls that enhance the building's three-dimensionality by reflecting light and shadow.

○ **Note:** Islam forbids the use of images, so very fine, complex, and diverse ornaments based on script were developed over time and used in textile and spatial design.

Fig. 70: Ornament in a public space

Ornaments are often used to structure large surfaces or spaces that would otherwise seem too large, empty, or even threatening. Large surfaces and spaces are divided into areas and sections that correspond to human scale so that users can more easily position themselves in the space. Ornaments fill a space with visual and tactile sensory stimulation and thus lessen or eliminate the impression of emptiness. However, too many differently structured or overly elaborate, three-dimensional looking ornaments can overpower the spatial impression.

Color

Every structural surface in a space reflects natural or artificial light and is perceived as color. The color effect is determined here by the material, its texture, and its surface qualities. The overall color effect of a space varies in intensity, and is conditional upon light, the degree and angle of reflection, as well as the color attributes of the material's surface.

Color can be used to divide spaces into areas and zones, and can emphasize or underplay the focal point of a room. The ceiling in a white room with a black floor will seem higher than if the colors were applied in reverse. Colors also have an influence on how we perceive spatial boundaries: pale, low-contrast colors give spaces the impression of being wider and larger than dark, contrasting colors, because the distance between the viewer and the structural surfaces and dimensions cannot be as clearly read.

Color can enhance the spatial effect of depth if cool-temperature, low-contrast colors are used for the background.

Note: Since the color effect of the reflected light is only possible if perceived by an individual viewer, it is difficult to express and present this aspect of spatial design in words. Hence, color guides and samples are used to choose and present colors.

Note: Color can even influence the amount of time a visitor spends in a room. Experience has shown that an intense, orange-yellow-red color scheme reduces this amount of time more than white-green. Fast-food restaurants use this tactic and choose an orange-red-yellow scheme to ensure customers only remain for a short period of time after they have finished eating, and make room for the next guests.

FURNITURE – FIXED AND MOVEABLE ELEMENTS

Generally speaking, the elements of spatial design are all the things that create spaces between their surfaces. There are fixed and moveable elements of a space. Columns are permanently installed elements of the support structure, but the position of furniture is flexible. Spaces are always influenced by the interaction of all of the elements that form the spatial volume. Even if one element has a stronger effect than the others, the spatial quality is still the sum of all elements together. They form the space between their surfaces and are hence always interrelated. > Fig. 71

Furniture

Furniture is a spatial design element that is either permanently integrated in a spatial shell or can be repositioned. It forms a flexible secondary structure within the primary structure of the spatial shell. Furniture is a means for the user to personalize the space. > Fig. 72

They form independent relationships; a table is given different chairs, and a certain grouping of furniture creates an area within a room. Furniture can make a spatial impression suddenly seem very unfamiliar. Yet on the other hand, furniture can support or even enhance the existing spatial statement and the effect of the space's primary structure.

The size of furniture makes it appealing to use and to touch. It is a very popular design element, because it is well suited to and based on human scale and also creates subsections of space within the day-to-day spatial experience. Furniture often serves as a variable spatial element

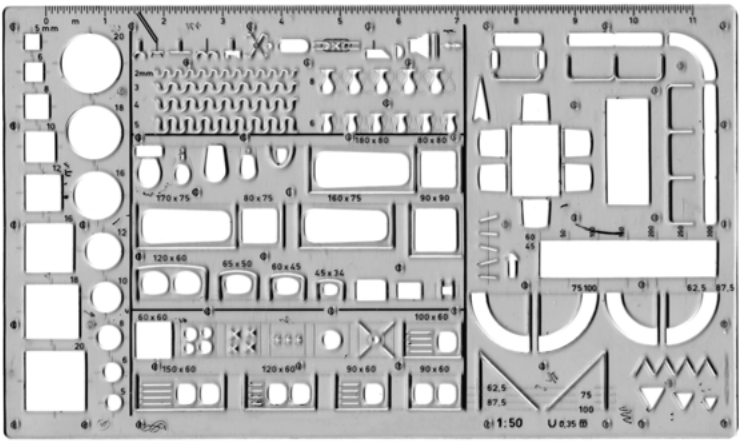


Fig. 71: Furniture template

Fig. 72: A variable furniture element can adapt to the given spatial form, whereas here a functional piece of furniture was developed specifically for the smaller space.

in public city spaces, apartments, or offices, as it can structure the spatial design and can be adapted to different uses. Furniture can also be a tool to diminish or quickly and effectively increase a space's density. Furniture helps people to create a physical connection to the space. A chair in a room has a very inviting effect, simply because it asks the visitor to take a seat.

There is often a piece of furniture in a private room that is associated with memories of family or particular events. This makes its form and attributes less important. The piece of furniture becomes a medium for personal emotions and memories.

● **Example:** The dimensional aspect of furniture differs greatly: a typically small bed can grow to be as large as the room if it is a four-poster, and hence become a comfortable space within a space.

In conclusion

The objective of spatial design is to give a built space or site a presence that can be perceived with the senses and the cognitive system. It is achieved by implementing functional, technical, intellectual, and aesthetic requirements. Human existence takes place within space and time, and in the process, diverse spatial qualities are constantly being perceived sensorially or with the cognitive system in an intense or casual manner. At the same time, people are always changing their spatial environment, more or less actively and in many different ways. People and spaces are therefore in a constant, dynamic interrelationship. Spaces can be designed so that many aspects of human existence are considered and addressed, and so as to provide users with appealing amenities and various possibilities for interaction.

Spatial design serves to form the built environment with a certain atmosphere that is able to provide and ultimately positively influence the sense of individual wellbeing, social interaction, the way one behaves and acts in a space, and finally, even to facilitate a relationship to the spatial environment in the first place. The mood or spatial atmosphere is the sum of many different sensorially and cognitively perceived spatial phenomena.

Whether a spatial design is accepted by users, visited and further developed throughout time, will depend on whether the complex interrelationship between people and space has been successfully addressed. A space's atmosphere can be designed to be lasting or temporary, and most change over time. Even the simple use of a pre-existing space, without redesigning the raw form with construction or material elements, can change the atmosphere because it is redefined by the presence of new users. Consequently, a space's atmosphere cannot be completely planned in advance. Even the spatial impression of a new building cannot be easily conserved for the duration of its use.

Yet spatial atmosphere can still be designed, which is why this book has introduced a diverse repertoire of spatial design elements and means. The type of spatial atmosphere and the way it is perceived are influenced by the lasting and complex interaction between ideas and a spatial concept, activities, the presence of people, light, spatial form, the choreography of spatial sequences, texture, the materiality of the space's structural elements, and acoustics. All of these factors can be strategically employed to create an insightful spatial design.

One of spatial design's most exciting tasks is influencing the future effect of a space, as well as the consideration and decision about whether or how users can be prescribed either a clear spatial structure, or given the opportunity to personalize their own space.

Appendix

ACKNOWLEDGEMENTS

Bert Bielefeld, Dortmund, for his patience and critical editing
Tina Jacke, Siegen, for image processing and diagrams
Petra Klein, Siegen, for her organizational support
Sigrun Musa for image processing and diagrams
Judith Raum, Berlin, for critical editing

LITERATURE

Rudolf Arnheim: *The Dynamics of Architectural Form,* University of California Press, Berkeley and Los Angeles 1977
Gaston Bachelard: *The Poetics of Space,* Orion, New York 1964
Franz Xaver Baier: *Der Raum,* Walther König, Cologne 1996
Gernot Böhme: *Atmosphäre,* 7th, extended edition, Suhrkamp, Frankfurt am Main 2013
Otto Friedrich Bollnow: *Human Space,* Hyphen Press, London 2011
Michel de Certeau: *The Practice of Everyday Life,* University of California Press, Berkeley 1988
Fred Fischer: *Der animale Weg,* Artemis, Zurich 1972
Kenneth Frampton, Harry Francis Mallgrave: *Studies in Tectonic Culture*, MIT Press, Cambridge 2001
Walter Gölz, *Dasein und Raum,* Max Niemeyer, Tübingen 1970
Max Jammer: *Concepts of Space. The History of Theories of Space in Physics,* Dover Publications, New York 1993
Hugo Kükelhaus: *Unmenschliche Architektur,* 6th edition, Gaia, Cologne 1988
Wolfgang Meisenheimer: *Choreography of the Architectural Space. The Disappearance of Space in Time,* Dongnyok/Walther König, Paju/Cologne 2007
László Moholoy-Nagy: *The New Vision. Fundamentals of Design, Painting, Sculpture, Architecture,* Faber, London 1939
Paul von Naredi-Rainer: *Architektur und Harmonie. Zahl, Maß und Proportion in der abendländischen Baukunst,* 7th, revised edition DuMont, Cologne 2007
Christian Norberg-Schulz: *Genius Loci. Towards a Phenomenology of Architecture,* Rizzoli, New York 1980
Colin Rowe, Robert Slutzky: *Transparency,* Birkhäuser, Basel 1997
Bernard Rudofsky: *Architecture Without Architects. A Short Introduction to Non-Pedigreed Architecture,* University of New Mexico Press, Albuquerque 1987

PICTURE CREDITS

Figure page 162: Albrecht Heubner: Mindestwohnung 1927, © 2008. Digital Image, The Museum of Modern Art, New York/Scala, Florence
Figure 1: Christoph Ahlers
Figures 4 and 5: Hannsjörg Voth: Himmelstreppe, photo: Maike Niederprüm
Figure 7 left: Ammonit, photo: Detlef Menzel
Figure 7 right: X-ray photograph of a snail house, photo: ForumS9
Figure 9 right: Nuclear poser plant, photo: Sabine Wolf
Figure 10: Cave dwellings in Cappadocia, Turkey, photo: Işık Aydemir
Figure 11 right: Dietrich Pressel: container studio, photo: Thomas Rodemeier
Figure 12 left: Brickearth houses in south-east Anatolia, photo: Ebru Erdönmez
Figure 12 right: INDEX Architekten: office building, photo: Christoph Lison
Figure 13: Ebru Erdönmez
Figure 19 right: Public space in Seoul, photo: Stefany Kim
Figure 20: Library in Graz, photo: Sigrun Musa
Figure 22: Eralp Erdönmez
Figure 23: site specific_SHANGHAI 04 © Olivo Barbieri
Figure 24 left: Sigrun Musa
Figure 25 left: Sumela Monastery, Turkey, Photo: Burak Haznedar
Figure 25 right: osa_office for subversive architecture – Campinski-Osa-Workshop at the TU Darmstadt, photo: Floris Besserer
Figure 27: Dirk Paschke and Daniel Milohnic: swimming pool, Kokerei Zollverein – Stiftung Industriedenkmalpflege und Geschichtskultur, Essen 2001, photo: Roman Mensing
Figure 31: Tim Haas and Linda Cassels-Hofmann of Art Effects
Figure 34: INDEX Architekten: office building, photo: Christoph Lison
Figure 40: Apartment buildings in Seoul, Photo: Stefany Kim
Figure 42: Meixner Schlüter Wendt: Wohlfart-Laymann residence, photo: Christoph Kraneburg
Figure 43: Santiago Cirugeda, Recetas Urbanas: Prothese Institution, Castellón, photo: Ulrich Exner
Figure 44: Verburg Hoogendijk Architekten: temporary supermarket, photo: Ulrich Exner
Figure 50: Thomas Börm: spatial design study research, University of Siegen
Figure 51: Kerstin Kaiser: spatial design study research, University of Siegen
Figure 52: Mathias Both: spatial design study research, University of Siegen

Figure 57 left: Marko Hassel: study research, University of Siegen
Figure 57 right: Maike Niederprüm: study research, University of Siegen
Figure 63: Oberfinanzdirektion Frankfurt am Main, photo: Sigrun Musa
Figure 64 left: Aldo Rossi: San Cataldo cemetery, photo: Bert Bielefeld
Figure 64 right: Enric Miralles and Carme Pinós: Center for Rhythmic Gymnastics, Alicante, photo: Ulrich Exner
Figure 67 right: Subway station, Seoul, photo: Stefany Kim
Figure 69: Christoph Ahlers
Figure 70: Stefan Schilling: Zeil Projekt, Frankfurt
Figure 72 left: bfa, büro für architektur: apartment building, photo: Valentin Wormbs
Figure 72 right: INDEX Architekten: Die Bank – adaptable furniture, photo: Stefan Schilling

Images on the following pages are credited to the authors:
2, 3, 6, 8, 9 left, 11 left, 14–18, 21 left and right, 24 right, 26 left and right, 28–30, 32, 33, 35–39, 41, 43, 44 left and right, 45 left and right, 46–49, 53–55, 56 left and right, 58–62, 64 right, 65, 66, 67 left, 68.

AUTHORS

Ulrich Exner, architect, Professor for spatial design and planning at the University of Siegen, partner of the INDEX Architekten planning office in Frankfurt am Main

Dietrich Pressel, architect, until 2013 research assistant for spatial design and planning at the University of Siegen, pressel & müller architekten in Frankfurt am Main

Series editor: Bert Bielefeld
Concept: Bert Bielefeld, Annette Gref
Translation from German into English:
Laura Bruce
English copy editing: Monica Buckland
Project management: Annette Gref
Production and typesetting: Amelie Solbrig
Layout, cover design, and
typography: Andreas Hidber

Papier: MultiOffset, 120 g/m²
Druck: Beltz Grafische Betriebe GmbH

Library of Congress Control Number:
2019937155

Bibliographic information published by the
German National Library
The German National Library lists this publication in the Deutsche Nationalbibliografie;
detailed bibliographic data are available on the
Internet at http://dnb.dnb.de.

ISBN 978-3-0356-2019-1
e-ISBN (PDF) 978-3-0356-2284-3
e-ISBN (EPUB) 978-3-0356-2286-7

German Print-ISBN 978-3-0356-1001-7

P.O. Box 44, 4009 Basel, Switzerland
Part of Walter de Gruyter GmbH, Berlin/Boston

9 8 7 6 5 4 3 2 1

www.birkhauser.com