SCALE
ENCLOSE | BUILD

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WALLS, FACADE, ROOF

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FOREWORD

Architecture conveys its message via the facade, the building envelope. Houses, urban spaces and landscapes are initially perceived in terms of their overall outward appearance, and only after that in their details. The facade determines the appearance of the building, and hence the street space and even the landscape where the building is located.

The fifth volume of the *SCALE* series deals with the facades of buildings, which provide their envelope and depend for their appearance on the construction details. The title *Enclose | Build* conveys the ambivalence of the subject: the poetry and volatility on the one hand, and the practical necessities of the production process on the other. This volume, together with the volume *Support | Materialise,* describes all of the building components required for construction and puts them into context, from the design drawing through to technical implementation. It thus makes clear how different design processes influence the idea of construction. Owing to the technical developments of recent decades, facade concepts are increasingly being created almost free of technical restrictions. Furthermore, facades are no longer limited to the vertical plane, but rather envelope the entire building. In consequence, the last chapter but one of this volume deals with the classic structure and principles of roofing, including constructional details.

As the public face of a building, its envelope conveys its immediate expression; it bears witness to the historic era of the building and the architect's approach. Some 150 years ago, Gottfried Semper, a proponent of historicism, postulated that buildings should be cloaked by a facade. He understood buildings to be a fixed volume which should be 'clothed', similar to a man with textile garments. Just about fifty years later, the Deutsche Werkbund and the proponents of the International Style that had evolved from the Bauhaus movement turned their back on this attitude; instead they demanded honesty and the proper application of work and materials, with dramatic consequences for the facade. From today's point of view, the emancipation of architectural form, together with its counter-movement, Post-Modernism, provided the basis of today's diversity of building envelopes. These combine aesthetics, technology and functionality. They can independently enclose space, determine the character of a space, or even create it. Advances in building technology with respect to building physics, energy efficiency and sustainability raise new issues and provide new solutions for the design of facades.

Within this dialogue, we consider it important to discuss the elements that make up envelopes in an authentic and technically correct manner – not just as abstract images, but also in a way that assists the implementation of the respective idea in detail. The diversity of design options is reflected in the diversity of contemporary construction methods. The main part of this volume therefore describes different suspended facade systems and their effects, and presents their principles and characteristics. Following an introductory chapter, we deal with the various envelopes under the categories of self-supporting or non-supporting facade, examining their development and discussing their symbolic, aesthetic and technical possibilities. For the self-supporting envelopes in particular, there are overlaps between the construction methods illustrated in the *Support | Materialise* volume and the discus-

sion of the principle differences in the construction of a building with non-self-supporting envelopes (curtain wall facades).
What comes first – the structural system, or the appearance and effect of a building? This ambivalence permeates the entire design process; it has to be faced by all those involved and can only be resolved via an integrative approach to design. Both this and the aforementioned *SCALE* volume demonstrate that design, material and structure not only depend on each other, but benefit from this interaction: they need this combination to create the desired architectural effect. This also depends on the quality of implementation at the different scales – from the outline design stage through to construction detailing. This volume therefore covers the different stages and includes detailed drawings to illustrate the relationship between design principles and construction details.
Enclose | Build completes the core of the current *SCALE* construction series. It would not have been possible without the prolonged and committed involvement of all its authors and contributors, to whom we express our heartfelt gratitude. We would also like to cordially thank the architects and photographers who have provided us with their projects and photographs. Above all, we would like to thank the volume editor, Eva Maria Herrmann, who has pulled the threads together, and Andrea Wiegelmann, who conceived the series and has continuously supported it. We thank Birkhäuser Verlag for its helpful cooperation over a long period of time. We have enjoyed working on these essential architectural issues and their ramifications. We hope you will be inspired by an enthralling read.

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Alexander Reichel, Kerstin Schultz

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INTRODUCTION

Mankind has been building shelters since time immemorial in order to gain protection from the weather, wild animals and enemies. The envelope of these shelters forms the boundary between the outer environment (specific local and climate conditions) and the sheltered interior, which – with as consistent a room temperature and climate as possible – can be used in all of the necessary ways. As demands for people's general well-being have increased, the requirements have become more complex but the essential, protective function of the building envelope has remained the same. Conversely, the building envelope also has an outward role to play. It enables communication and creates relationships with outdoor space. The term 'building envelope' normally refers to the facade, but that is too simplistic. In this book we shall look at the different building elements such as plinth, wall and roof in combination. These can envelope a building like a skin, and are responsible for dealing with all impacts resulting from the environment. Over the course of centuries, many variants have been developed in response to diverse requirements.

A decisive influence on the design of the building envelope has always been exerted by the location, its climatic and cultural conditions, and the locally available material. Historically, the availability of materials at a location played a decisive role – one that is now regaining importance due to today's ecological criteria.

Buildings have an effect upon each other depending on how close together they are, forming rural and urban patterns of settlement. It follows that the location of a building is paramount in importance and has a fundamental influence on the shape and design of the envelope. While nomads developed element-based envelopes in the form of tent-like constructions for flexible, temporary use, settled populations developed solid forms of enclosure which were place-specific and designed for durability.

Likewise, the location of a building involves both cultural and historic influences. For example, depending on the cultural context and the era, the connection or separation of public and private space can become visible and thereby reflect the social structures of the society. To this day the envelope of a building is an expression of the social status and position of its users. In the case of public buildings with a representational function, the facade will always reveal the attitude to society of those who built it; it has always been used to express wealth, influence and power. The function of a building has a significant effect on the construction and design of the facade. The close interplay between facade, internal arrangement and construction determines its composition, transparency and openings.

While up into the twentieth century the building envelope was normally not just a space enclosure but also part of the loadbearing structure, the dematerialisation of the once structural wall to create the suspended facade, which can fulfil structural and symbolic functions, has opened up a range of aesthetic and functional options. Whereas solid structural envelopes impose limits on the design of openings (facade with windows), the continuous development of new building materials is enabling a separation of the envelope from the loadbearing structure, providing greater flexibility and freedom in the facade design. The loadbearing elements of a building can either be concealed by the envelope, be visible in interaction

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1 Tent structure in Arabia
In the arid zones of Persia and Arabia where timber is scarce, tent poles were covered with high-strength fabrics in order to create large, well ventilated envelopes that provided protection from the sun. The height of these structures was determined by the length of poles available, the size and strength of the cloth and the process of putting up the structure, which remained unstable until it was tied down.

2 Borie in the south of France
The corbelled vaulting consists of small, unworked flat stones and has been used in rural areas up to modern times. These stone houses have a pointed roof and are built without cement and mortar. The building technique, with its small components, is typical of a manual process.

with the envelope, or become the main design theme. The enclosing envelope is directly related to the type of use, the loadbearing structure and the building services installations. Constant feedback relating to function, construction and expression is necessary to produce a well-integrated overall design.
A building envelope is not just about the building surface. It fulfils a multitude of functions. The quality of an envelope can only be assessed in the overall context of functional, structural, stylistic, ecological and sociological criteria. Depending on the concept, it will have not only a protective function but also those of structural support, climate control, lighting and communication with the surroundings.
The expression and form of a facade result from the multiple requirements the building envelope has to fulfil. For example, the design of a facade may be determined by use, function, or construction respectively; alternatively, a facade may have a purely sculptural and expressive intent. It may represent the function of a building in a symbolic or iconic way to the outside, or fulfil a specific purpose as a landmark (e.g. a lighthouse). The interplay of these factors determines the appearance and overall impression of the building. One contemporary development is to see the envelope as an active system within a sustainable energy concept. Depending on the approach and possibilities, this may take a variety of forms, ranging from simple folding shutters in front of windows for shade, to glass facades with controlled ventilation openings, daylight control systems or integrated photovoltaic panels for the generation of energy.

Increasingly the ecological assessment of a facade not only focuses on the energy demand or energy gain during its service life, but is extended to include the eco-balance over the complete life cycles of its constituent parts – from the production of the raw material to the disposal of the envelope. This highlights the connection between economic efficiency and ecology. The overall assessment of the life cycle can reveal important information about the cost efficiency of a facade during its service life, apart from the cost of construction. This includes the expenses of cleaning, maintenance, renovation and renewing materials.
It follows that building envelopes should be considered not in isolation, but as complex elements that are integrated into the design process. This increases the demands on the design team and the design and implementation processes.
This book complements the Scale volume Support | Materialise in addressing the subjects of enclosure and building with a focus on the fundamental systems and principles of the loadbearing structure and the facade – from the foundations to the roof. It aims to illustrate the breadth of options in designing envelopes, as well as their limitations, and to develop an understanding of their technical implementation.
This publication is intended to encourage solution-oriented thinking, involving constant reference to context, typology and construction, rather than strict obedience to a given design principle.

3 The Curtain Wall House, Tokyo, 1997, Shigeru Ban
The Curtain Wall House is symbolic of the emancipation of the envelope from the loadbearing structure. Weather protection is afforded by a textile curtain which, when open, eliminates the boundary between the interior and the exterior. The private space becomes public, and the public space becomes part of the private sphere.

4 The Opera House, Oslo, 2008, Snøhetta
The plinth, walls and roof of the building merge seamlessly to create a walk-on roof landscape. The additional public urban space thus created adds to the amenity value.

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CULTURAL CONTEXT – HISTORY

Original architectural space fulfils the simplest functional requirements – those associated with providing protection – with the use of locally available materials.
Gottfried Semper, writing in the middle of the nineteenth century, developed a theory of the facade which he derived from the lightweight but effective construction of nomadic tents – which are still in use today with their system of a separate loadbearing structure and a protective envelope, even in extreme climatic conditions. As in the world of fashion the garment envelopes the space of human existence. Rather than the functional technology of construction, Semper emphasised the symbolic and cultural criteria for the suitability of the architecture. While early buildings were designed along purely functional lines in response to a given situation, over the course of history the concept of buildings as accommodation evolved from one of being purely protective into the discipline of architectural design. The collapsible, enveloping structures of migrating peoples were replaced by buildings designed for permanence. Just as in clothing there are many variations of colour, weaving patterns and textures, so too the positioning of openings, the arrangement of structural elements – such as arches and columns – of friezes, paintings and sculptural, figurative elements developed as independent forms of expression.

The term 'facade' derives from the Latin 'facies' (face), which was used in antiquity to describe the publicly visible side of a building – especially of prestigious buildings (sacral as well as secular). A structure built by the hand of Man symbolises the interaction between the individual, the outside space and society. This encompasses the climate and topographic contexts on one hand, the reflection of societal forms, political intent, religious provenance and ethnic grouping on the other, and even the availability of local resources. A building serves as a store of information, and is at the same time a witness of different epochs.

Since time immemorial, people have availed themselves of the power of expression inherent in built forms. The pyramids are the mighty enclosure of a pharaoh who thus manifested his power and his connection with the heavens to his contemporaries and for posterity. While the early democratic structures of the Greeks and Romans resulted in residential buildings having private, introverted inner courtyards, public temples were designed to be all the more ostentatious.
From the Middle Ages onwards, as a society of citizens and tradesmen developed, the facades of secular buildings were also increasingly decorated for representational purposes. Openings acquired special importance. They served as a filter between the exterior and the interior that could be opened to a greater or lesser degree. Even though the size of windows in residential buildings was limited for a long time, the openings themselves were often elaborately designed. Coloured or moulded surrounds emphasised their importance in the facade.
In Gothic architecture, parts of the external wall were relieved of their structural functions for the first time, by elements such as columns, flying buttresses, ribs or piers. In place of the masonry came large windows intersected by tracery. While in the Gothic period the envelope consisted chiefly of the supporting structure, in the Renaissance the facade became separated from the building and was understood as a separate design element.
In the time of industrialisation, from the middle of the nineteenth century, new materials and construction methods (such as the skeleton construction method) and new building types (such as industrial buildings and warehouses) brought about a fundamental change. Large glazed facade openings become possible and heralded the transition to the first all-glass facades. With the onset of the Modern age, the influence of the building structure on the enclosing envelope was reduced and the envelope became an independent component of the design.

The separation of the loadbearing structure from the envelope can go as far as completely dissolving their original connection. In Post-Modernism, an architectural style from the 1960s to 1980s, facades were placed as backdrops or stage sets for the space in front of a building and in this way re-applied the principles of the Renaissance. In later developments, some facades became fully independent of the building and developed into standalone, sculptural forms with their own – sometimes iconographic – meaning. The discrepancy between preservation and creative development is considerable. Freezing a supposedly ideal state of affairs can lead to 'pattern book' architecture and regression, just as disregard for the cultural context gives birth to 'foreign bodies' that strain to create an effect at all costs rather than integrating into an urban context.

Today too, the interface between interior and exterior reflects the cultural context in a reference to the social structures of the society and the place where they have developed, and in the sense – propagated by Modernism – that openness, transparency and design are to be understood as expressions of democratic society.
In the future, the functionality of facades will be extended even further. Technical progress has made it possible for facades and roofs to absorb and process energy, to dispose of dirt, to provide acoustic insulation and to transmit information. At a highly technical level, the envelope performs tasks which are also expressed in its appearance – be it imperceptibly or conspicuously.

1 Traditional housing in Cameroon, consisting of pressed, sun-dried clay in the form of a conical shell.

2 Stralsund Town Hall, 1278: This magnificent facade has a strong representative intent, being higher than the three-storey town hall that it fronts.

3 Togu-do, Kyoto, 15th century: The Togu-do is built in the Shoin architectural style. Built as a private residence and subsequently used as a temple, the Togu-do contains a room for the tea ceremony, which became the archetype of all later tea rooms (chashitsu) in Japan.

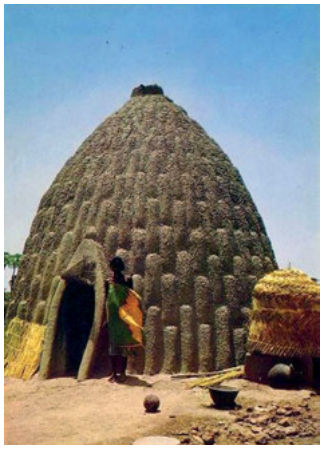
4 Palace on the Grand Canal, Venice, early 15th century: The elegant palace is a typical example of the special style of the Venetian Gothic.

5 Grote Markt, Antwerp, 16th century: The status of the city of Antwerp in the 15th and 16th centuries, as one of Europe's foremost commercial and cultural centres, is demonstrated by the luxuriously designed guild halls and citizens' houses.

6 The Majolica House, Vienna, 1898, Otto Wagner: Inspired by Gottfried Semper's theory of 'dressing', Otto Wagner uses facade cladding with thin, precious materials – here in the form of tiles with floral motifs – in order to give the building an appearance that is independent of the construction.

7 The Fagus factory, Alfeld, 1911–1913, Walter Gropius and Adolf Meyer: In this building, glass is used as enclosing element, independent of the loadbearing structure. The corner is built without a column, thus emphasising the lightweight character of the transparent envelope.

8 The Seagram Building, New York, 1957, Mies van der Rohe: The bronze-coloured tower block is deemed to be the prime example of the 'skin and bones' architecture of Mies van der Rohe and still serves as an ideal prototype for skyscrapers. The facade is subdivided using slender bronze profiles, the spacing of which is reduced towards the building corners in order to emphasise the verticality of the tower block.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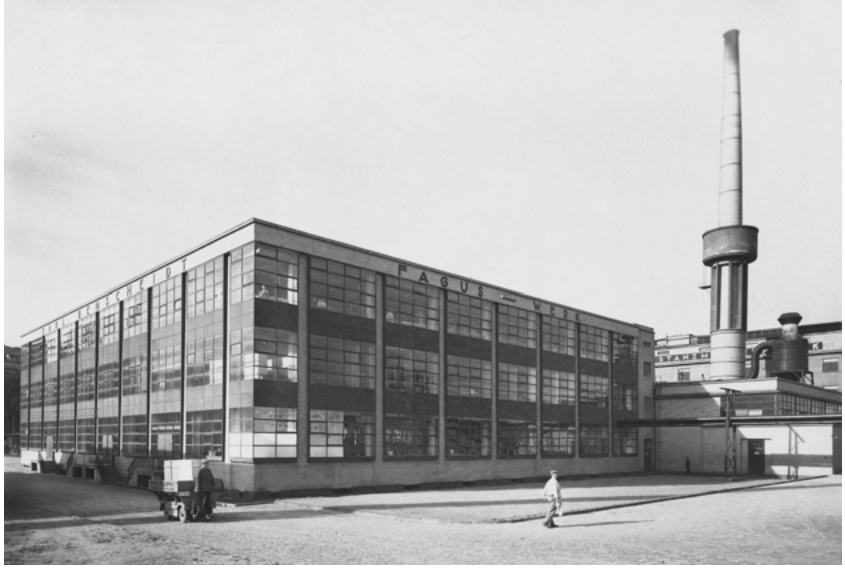

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PLACE AND ENVIRONMENT

The individual connection with the environment, the historic, cultural, climatic and material conditions of a place require careful analysis. Only dialogue with the place itself makes the quality of architecture visible and tangible – conversely, a misunderstood reference to the place will have an effect on the popular acceptance of a building and its sense of belonging. The issues are not only those of urban space, landscape and topography, but also those of climate conditions and local resources – which influence the use of energy and technology – in addition to building control requirements.

For example, glass facades either mirror the surroundings – be they urban or rural – or allow a view into the building, depending on the angle of vision, reflection and time of day. It is possible to emphasise transparency and views into the building in order to let the building meld into the townscape or a country landscape. → 1

Buildings are in a dialogue with their surroundings. They can be designed in keeping with the landscape or surroundings or in deliberate contrast to them. Owing to the material used, the turf roof houses of Iceland blend well with the landscape and replicate the hilly topography of the surroundings. On the other hand, envelopes can be integrated in a cultural context while contrasting completely with their surroundings, either by complementary colouring or an unusual use of a traditional material. → 2

In today's globalised world, identity and tradition are gaining new significance. Available regional resources, know-how relating to materials, old and new processing methods and economic means of transport are becoming increasingly important.

Social acknowledgement is also reflected in the degree of self-confidence that is evident in architecture. Traditional construction methods and modern vocabularies of form complement each other in a meaningful way. → 3

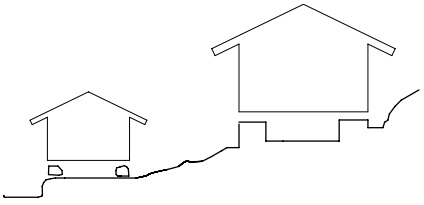
A place is not only defined by the orientation of a building to account for the site boundaries and the cardinal directions, but also by the characteristics of the site itself, be it level, sloping, dipped, or even partly covered by water. The conditions on a given site can be accommodated in the design in a number of different ways. The landscape may be one of rolling hills or ragged rock; rounded or angular elements may dominate; the surroundings may be matte or feature a smooth, shiny surface, while the colours of the landscape may change over the course of the seasons. The building, in turn, may stand out from its surroundings or reflect them; it may continue the terrain or completely merge with it. The existing context can even be exploited to generate the design. In areas where buildings are highly exposed to the weather, a plinth is often used as transition between the ground surface and the building itself. In addition to its protective function, the plinth – with its material, surface finish and colour – can also serve as a formative element in the design. → 4 On the other hand, the volume of a building with a fixed schedule of accommodation can be visually reduced by placing the required space partly or wholly under the natural contours of the terrain. → 5, 6 Where this is required, new buildings can be integrated inconspicuously in landscape areas worth protecting or in established urban areas. Alternatively, they can enhance the surroundings if judiciously placed in a prominent position. In this case, the local topography makes additional demands on the material and construction. The design of a freestanding, exposed building must pay more attention to watertightness, airtightness and durability than a one that is sheltered by landscape features or other buildings.

1 Tower block ensemble, Ulmenstrasse, Frankfurt am Main, 2009, Max Dudler: Two existing tower blocks were revitalised with a contemporary element facade, which is nevertheless in keeping with the Wilhelminian buildings in the neighbourhood, owing to the proportion of openings and the material chosen.

2 The Ecumenical Forum, Hamburg, 2012, Wandel Hoefer Lorch: Typical for the location, brick is used as the face material of the back-ventilated suspended facade, which nevertheless reinterprets the local style with its shape and colour scheme.

3 The Floating House, Ontario, 2008, MOS Architects: The varied properties of timber as a construction material – including the fact that it floats – were used in the construction of a holiday home; the building was assembled on land using prefabricated timber elements which were later installed on a floating pontoon at an island in the lake.

4 Timber houses in the Valais
This specific, local style of building is a direct response to the location (climate and topography) and materials (timber and stone). The natural stone plinth is used to level the terrain; it also protects against snow and moisture and serves as the foundation for the timber structure. The vertical arrangement of functions – plinth, stables, living space – and hence the use of natural ventilation and heat, determines the particular style of houses in the region.



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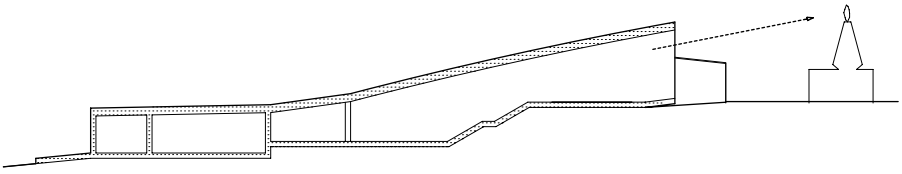
5 Visitor centre at the Hercules monument, Kassel, 2011, Staab Architects: The form is the result of the location (topography, and view of the Hercules monument). The building follows the natural gradient of the terrain and, by cleverly integrating various functions, manages the differences in level without creating excessive volume on the slope.



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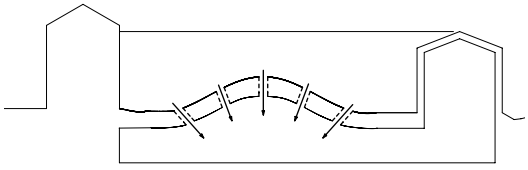
6 Extension to the Städel Museum, Frankfurt am Main, 2012, Schneider + Schumacher: The special feature of this locality (open space in the inner city) is retained by placing the building underground. The underground structure provides the floor space required for the exhibitions, which receive filtered light from above while allowing use of the roof area as a public open space.



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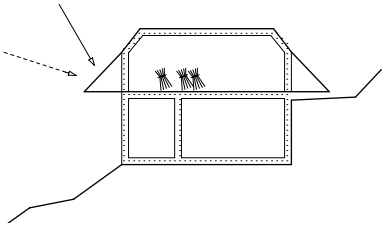
CLIMATE

Traditionally, the design of facades and roofs was and still is primarily determined by the local climate. The construction of walls and roofs developed in tandem with the respective trade skills. Materials and construction methods were used in ways that kept costs low while ensuring the longest possible service life. The shape of the building – its volume, roof pitch and eaves overhang – was a direct response to the respective weather conditions.
From time immemorial the climate has been the dominating factor in the design of buildings that evolved from inherited experience. Also referred to as autochthonous building, this approach employs the naturally available local resources in a way that is appropriate for the climate and the use. In regions exposed to heavy snowfall, shallow-pitched roofs with natural stone covering (additional mass to counteract the risk of the roof lifting off and to stop snow from sliding off the roof so that its insulating properties can be used) and large eaves overhangs are common. Conversely, steeply pitched roofs reaching down close to the ground can better withstand rain and the horizontal forces generated by strong wind. → 1 In hot climate zones with little precipitation, monopitch or flat roofs usually predominate. In these areas, solar irradiation into the building is minimised by large canopies, small atria and the dense juxtaposition of buildings. Thick, solid walls with small window openings provide storage mass with a phase shift, which keeps the building cool during the day and warm during the night. → 2 Large eaves overhangs form intermediate climatic zones and prevent overheating in summer.
Numerous requirements, which can be met with more or less advanced technical and functional input, continue to influence the development and execution of the envelope. Local weather conditions on the outside should not adversely affect the cosiness and comfort of the interior. This applies not only in regions with extreme day-to-night and summer-to-winter fluctuations, or in sub-polar and -tropical zones, but also in temperate zones, as in central Europe, where the climate is subject to pronounced regional differences. Every place has a specific climate which is determined by its topography and situation.
Consideration should be given not only to the differences between mountainous, inland and coastal regions, but also the differences in the microclimate, such as those between urban and rural areas and those within an urban environment. It follows that a detailed analysis of regional climate data, which are summarised in the thermal insulation standards and are obtainable in greater detail from the databases of regional weather stations, is an essential prerequisite for the design of the building envelope.
→ SCALE, vol. 2, Heat | Cool

While it is not possible to change the exterior conditions imposed by the choice of location, the type and functionality of the facade and roof can be influenced by the design. Infrastructure and industrial buildings are naturally subject to different comfort criteria than residential, cultural and sports buildings. → p. 28, Typology and Use
In addition to the general requirements for thermal comfort in the interior, the facade has to fulfil additional functions. Acoustic requirements, such as insulation from the noise of traffic and machinery, have to be taken into account, as have the hygienic requirements for air quality, ventilation and the prevention of air pollution from the outside. The need to reduce glare and contrast while meeting requirements for sufficient daylight influences the type and size of openings and the choice of building components for solar screening and light control. → SCALE, vol. 1, Open | Close Energy-efficient use of the facade, including energy generation and control, introduces greater complexity into the design of the envelope. The better the thermal properties of the materials of the envelope are, the less energy is required in summer for cooling and in winter for heating.
Due to globalisation, the materials and construction methods used in different countries are becoming ever more similar. With the beginning of industrialisation, new technologies and means of transport made construction less dependent on local materials, and design more independent of the local weather conditions. However, current sustainability studies have highlighted the opportunity to conserve energy and resources by using regional materials and building types to protect against heat and cold. → 3
What are the local climate conditions and how should they be dealt with? How much energy input can be expected from sunlight, and how is it possible to integrate solar screening in the design while making use of the potential energy gain? Instead of relying solely on ever more sophisticated technology to meet the increasing demands made of building envelopes, the architectural designs of the future will have to exploit appropriate materials and forms in dealing with the prevailing climate conditions. The design and implementation of building envelopes must be based on a comprehensive assessment of all the parameters and their interaction.
All these factors relating to a locality and its cultural basis indicate why, in architecture, each design task must be fully appraised anew. Similarly, tried and trusted typological, technical, or conceptual solutions should not be transferred from one project to another without close examination. Different places and different times will always give rise to very specific, original solutions.

1 Traditional farmhouse in the Black Forest
The shape and overhang of the roof provide protection from rain and snow as well as plenty of space for the storage of hay, which also insulates the interior in winter, thereby contributing to the occupants' comfort.



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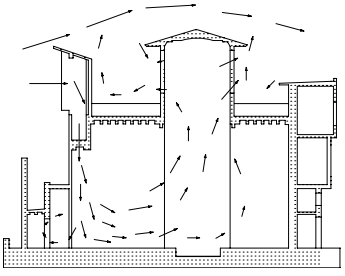
2 Traditional building structure in a desert climate
Clay is an available local resource and is used in solid construction. By zoning the layout, protected areas are created (in the shade or close to the relatively cool ground). The knowledge of physical phenomena (cold air sinks) allows the utilisation of natural cooling resources by creating an air draught, which is caused by the small temperature differences in the shaded parts of a building. This has led to a distinct type of structure known as a 'wind tower'.



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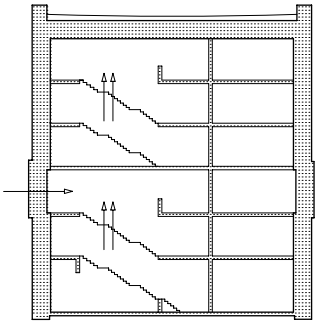
3 Office building 2226, Lustenau, 2013, Baumschlager Eberle: Experimental office building without heating. The building has ventilation and cooling (by air), which is actively controlled and utilised. The material used is brick which, with an external wall thickness of 76 cm and a low proportion of openings to solid wall, is used as storage mass. This makes it possible, using only internal heat sources such as lighting, equipment and users, to retain enough heat in the building to ensure thermal comfort. In this way the traditional construction feature of thick masonry walls has been modified as the basis of an energy-conserving concept using control technology (air).



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PRINCIPLES OF ENCLOSURE

Facades vividly express the interaction between construction and design, functionality and aesthetics. The loadbearing function of an envelope cannot be considered in isolation, but represents an integrated system which takes factors such as environmental context, climate and use into account. The more functions an exterior envelope has to fulfil – such as structural support, protection against the weather – and the more it is intended to express the purpose and aesthetics of the building, the more complex is the design task. Conversely, many more design options are available when the facade does not have to meet structural and functional requirements. In this context, an understanding of the unity of technology and aesthetics is the prerequisite for a good, holistically accomplished design. In the design process, the focus is on the structural system of the secondary structure, as well as on the materials and the desired appearance. Both the surface finish (from smooth to textured) and the design of the form (composition, proportion of elements and joints) have to be taken into account to the same degree as technical feasibility (in the form of production conditions, prefabrication processes and installation). At the design stage, it is necessary to establish how the material relates to the environment ↘ p. 40, Ecology and Life Cycle, and also how cost efficiency, material selection and construction are affected. ↘ p. 38, Economy and Process Quality The requirements for a new building are different to those for a conversion, a rehab (usually strengthening an existing structure) or a refurbishment, which are often linked with the preservation of historic buildings and represent more complex tasks with respect to the unity of aesthetics and technology. The different components of a building envelope – plinth, wall, openings, roof – have to fulfil different functions depending on their respective positions.

The plinth is the interface between the building and the ground, and can either be perceived as an independent element (e.g. in a different material or colour) or be integrated into the envelope. In addition to its functional requirements – transmission and distribution of loads from the loadbearing structure and envelope, protection against water and/or external influences and intruders, compensation for differences in the level of the terrain etc. – a plinth can also make a formal statement. A solid plinth with the height of a full storey may appear forbidding, whereas an open and transparent ground-level area has an inviting feel. On the other hand, the plinth often combines different types of enclosure. In buildings where both commercial and residential uses have to be accommodated, a different style of plinth can help with the orientation between public and private areas.
Topographic and climatic conditions determine the choice of plinth material – either based on and rising out of the ground, or detached in a different plane. Depending on its surroundings, a building can even be designed without a plinth – that is to say, a plinth without any distinct appearance – in favour of a more homogeneous envelope.

When the facade serves only as a thermal enclosure of the interior, the separation of the loadbearing function from the enclosing function ↘ SCALE, vol. 3, Support | Materialise allows much more freedom in the design – be it in the visual expression of structural elements or the application of a more abstract design, be it showing the true nature of the material or mystifying it. With the transformation of the flat wall (solid construction) into a transparent enclosure of space with a system of beams and columns (skeleton construction) and cladding, the classic image of the solid wall and its visually expressed functions changes in favour of a more autonomous envelope. While in solid construction the openings are largely determined by the construction grid for structural reasons, the position of openings in skeleton construction is not determined by any particular order or geometry. ↘ SCALE, vol. 1, Open | Close

The facade and the roof together form the visible envelope of a building. For this reason, the design of the envelope is ruled by universal principles. The composition of envelopes ranges from clearly distinguishable elements – plinth, wall, roof – to seamless, tent-like designs.
The envelope will always follow the shape of the building. Its appearance can be changed to suit the design approach, the context, the topography and the type of construction. For example, we are familiar with the principle of filigree facades in the Venetian Gothic, just as we know it from the Belgian art nouveau style, from historic timber construction and from modern concrete facades.
The basic principles are illustrated by the adjacent drawings and on the following pages.