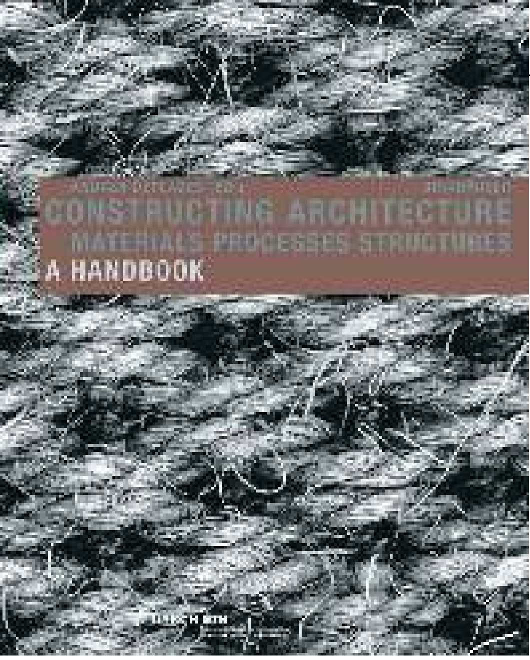
CONSTRUCTING ARCHITECTURE
MATERIALS PROCESSES STRUCTURES
A HANDBOOK

CONSTRUCTING ARCHITECTU

ANDREA DEPLAZES (ED.)

BIRKHÄ

CONSTRUCTING ARCHITECTU

MATERIALS PROCESSES STRUCTU

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Preface

Andrea Deplazes

"Constructing Architecture" describes that architectural position of architects which makes it possible for them to forge links between the planning of a project and its realisation, the competence to create coherence regarding content and subject. During the planning of a project this is reflected in the clarification and development of a design objective, and in the physical implementation becoming increasingly more clearly defined. When, for example, a literary work is translated into another language the use of the correct grammar or syntax is merely a technical prerequisite – a *conditio sine qua non.* The important thing is to reflect coherently the sense and the atmosphere of the original text, which in certain circumstances may itself have a specific influence on grammar and syntax. Architecture is similar: although it is not a language consisting of sounds, words or texts, it has a material vocabulary (modules), a constructive grammar (elements) and a structural syntax (structures). They are the fundamental prerequisites, a kind of "mechanics of architecture". This also includes the technical and structural basics which establish a set of rules and regulations of construction principles and know-how that can be learned and which are wholly independent of any particular design or construction project. Although these tools are logical in themselves they remain fragmentary, unrelated and therefore "senseless" until they are incorporated into a project.

Only in conjunction with a concept does
design process ensue in which the initially iso
cal and structural fragments are at once arra
consummate, architectural body. The fragme
whole complement and influence each othe
step from construction to architecture, from
tectonics.

Tectonics always incorporates all three
the conceptual connection of the physical a
the metaphysical, architectural space, and all
interacting, transforming and influencing as
in the end, are specific and also exemplary.

The best that a university can achieve is
students to teach themselves. This includes:
establishment of basic premises, critical ana
tensive research, advancing hypotheses and
syntheses. Many topics in the basic course
that do not have to be true just because th
this book in black and white. Nor does this
the subject material taught in the lectures.
book should be seen as a provisional co
known and current architectural and technol
as a foundation that allows us to think about
métier of architecture.

Zurich, April 2005

How to use this book

Christoph Elsener

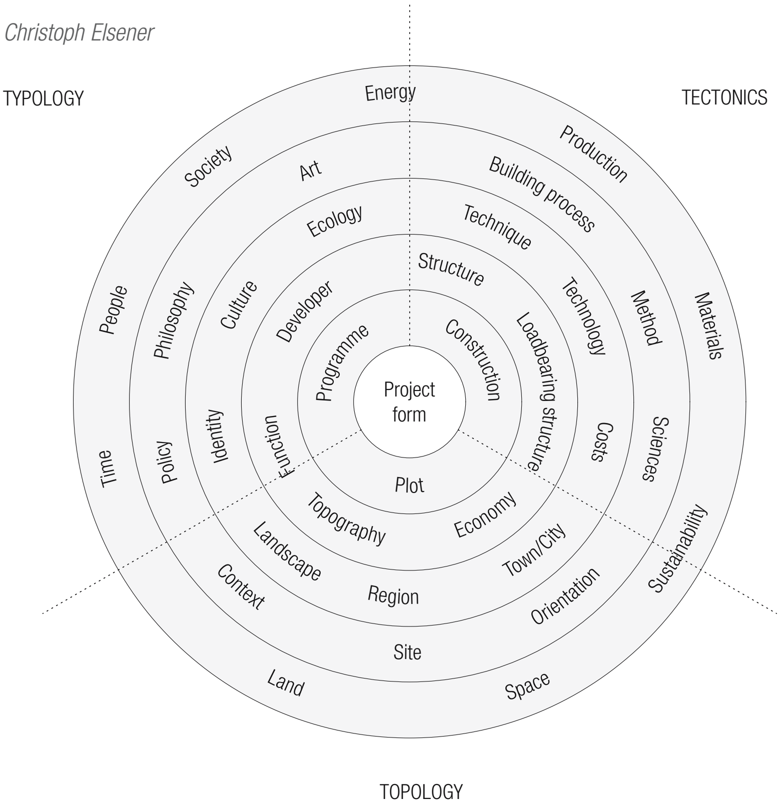

Fig. 1: Form-finding or form-developing processes

All material has a shape, regardless of the existence of a forming will. An artefact raises the question: how did it gain its shape? We may distinguish between two approaches to answer this question. First, which external influences affect the development of a shape? This question suggests a number of factors, e.g. geographical and cultural aspects, as well as factors that are connected to the mentality and the history of a certain people, that unintentionally influence the shape. Second, which criteria determine the shape? This question focuses on the intent, on a range of criteria carefully chosen by the designer.

After all, the shape is the result of a complex interaction of different factors. Only this interaction of factors allows a sensible composition. Composition is not an inevitable result. Within the bounds of a logical solution there always exist different options.

Kenneth Frampton describes three important influencing factors: "Thus we may claim that the built invariably comes into existence out of the constantly evolving interplay of three converging vectors, the *topos*, the *typos*, and the *tectonic*." The term "tectonics" alone covers a broad range, encompassing the construction process from the materials up to the finished building. This book concentrates primarily on this range. However, the historico-cultural approach, as represented in some articles in this book, reminds us that the transitions between topos, typos and tectonics are fluid.

The structure of the book, divided into the chapters "Materials – modules", "Elements" and "Structures", reflects the development process of architecture: starting with a single raw material via the joining of different building parts up to the finished building. This also points to a main objective of the book: it aims to show how much architectural expression depends on its constructional composition. In line with this goal the present work pays special attention to constructional aspects which create "sense", and in this aspect it differs from the albeit relevant but exclusively technology-focused literature. Technical requirements of raw materials and components are constantly checked with regard to their architectural effect. This approach leads to a chapter structure in which the reader will find sober detail drawings next to essay-like reflections, basic construction concepts next to specific descriptions of construction processes, theoretical considerations next to practical ones. For reasons of clarity, however, the "holistic" view of the design processes advocated here has been arranged in a way that allows easy referencing. Besides the introductory essay thematic focal points occur repeatedly in the chapters, which help the reader to find his way around the book and make it possible to compare building materials and construction elements.

The term "properties of materials" covers descriptions of manufacturing methods, assembly and product ranges of the most important modern building materials: clay bricks, concrete, timber, steel, glass and insulating materials. The distinction between "concepts", "processes" and "system" points to the interaction of intellectual conception, construction process and building structure, which considerably influences the development of a constructional solution. "Concepts" describes analysis and interpretation procedures which have proved especially helpful during the development of construction systems. Under the heading "Processes" the reader will find descriptions of preparatory measures prior to starting work on site plus specific site assembly processes. "Systems" describes possible methods for joining modules and components to form coherent, structurally viable assemblies. The construction systems shown here are linked more closely to problems of architectural expression in the section titled "Systems in architecture". Reflections on particular buildings or special types of construction are united under the heading "Examples" and offer additional visual aids describing how construction-oriented thinking finally manifests itself in architecture.

The section entitled “Building performance issues” presents insights into the relationships between the construction and the performance of the building envelope.

The appendix contains a series of drawings, scale 1:20, which illustrate the complex build-up of layers in contemporary building envelopes. Plinths, wall and floor junctions, openings (doors and windows), as well as the roof, are still core areas in the realm of architectural construction. The construction forms presented are bound by a certain architectural concept and may not be generalised without prior examination.

Subjects vary here as to the amount of material each is afforded. This is not due to any particular value being implied but reflects a working method focuse ing. This publication does not claim to be ex though its form as a printed book might sugg rather a collection of diverse basic principles worked out at the Professorial Chair of Arch Construction at the ETH Zurich. Some of the c have been kindly made available to us by outs only a few stem from standard works.

Finally, we have to point out that liability c other types of claim are entirely excluded. Th use of the content of this book is the respons user and not the authors of this publication.

The sequence of architectural construction as an additive chain from small to large

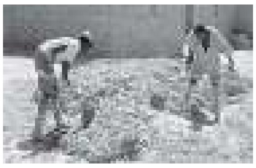

Fig. 2: Earth
Mixing with cob and sand

Fig. 3: Clay bricks
Production, natural drying (in the air), Pakistan

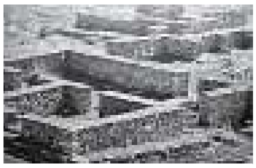

Fig. 4: Wall
Rediscovered remains of a house, Lebanon

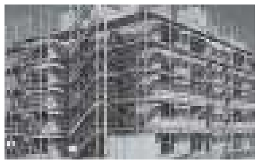

Fig. 5: Structural shell
Masonry building, under construction

Fig. 6: Structure
Hans Kollhoff, KNSM-Eila development, Amsterdam

1. Raw materials
According to Gottfried Semper the raw materials available as potential building materials prior to the first stage of processing can be classified into the following four categories according to their properties:

1. Flexible, tough, resistant to fracture, high absolute strength
2. Soft, plastic, capable of hardening, easy to join and retaining their given form in the hardened state
3. Linear forms, elastic, primarily *relatively* high resistance, i.e., to forces acting perpendicular to their length
4. Solid, dense, resistant to crushing and buckling, suitable for processing and for assembling to form solid systems

Owing to their properties, each of these four materials categories belongs, according to Semper, to a certain technical skill or category: textile art, ceramic art, tectonics (carpentry) or stereotomy (masonry).

This is based on the idea of “every technique has, so to speak, its own certain principal material which offers the most convenient means of producing the forms belonging to its original domains”.

The raw material, however, remains “meaningless” in the architectural sense as long as it is “unreflected”, i.e. its potential for cognition remains concealed.

The “selection” process itself (e.g. from undressed stones) in the form of a collection of modules, but also the preparatory work prior to building already form a planned stage of the work and consequently part of the first stage of production (“preparation”).

2. Modules
The “building blocks” or “workpieces” form the smallest basic components intended for the construction. They are the result of a finishing process – a more or less complex and time-consuming production process:

– Dressed masonry units (blocks, slabs, squared and rough-hewn stones) are produced from irregular stones.
– Moulded and “cast” earths (clay bricks, ceramic tiles, air-dried, fired) or processed earths (cement, concrete) are produced from earths, sands and gravels (e.g. cob, clay).
– Prepared timber members (debarked logs, squared members, joists, boards, battens) are produced from linear, form-stable or elastic modules consisting of organic fibres (e.g. tree trunks, rods, branches).

All these modules exhibit their own inherent “tectonics”, their own inherent jointing principles which are present in the second production stage: layering, interlocking, weaving, plastic formation (“modelling”), moulding, etc.

3. Elements
“Components” consisting of modules represent in a certain way the semi-finished goods of the second production stage (masonry walls and plates; walls; vaults and shells; floors and roofs).

Stability problems become evident during production and also during the ongoing assembly of the elements; these problems can be solved with the following measures:
– horizontal developments such as folds, corrugations, ribs
– vertical gradations with increasing height/depth
– formation of frames through the provision of stiffeners (diagonal stiffeners, supports as auxiliary constructions, corner stiffeners)

4. Structures
The third stage of production forms a “component fabric” whose subcomponents can be described as follows:

A. Loadbearing structure:
Precondition for the building structure. Only the elements necessary for the loadbearing functions (supporting, stabilising) are considered.
B. Building structure:
This is the interaction of all the elements required for the structure (supporting, separating for the purpose of creating spaces), sometimes also called “structural shell”.
C. Interior layout structure:
This contains the realisation of a more or less complex sequence of internal spaces. The relationship between loadbearing structure, building structure and interior layout structure allows us to derive a “tectonics model”. Tectonics in this sense is the physically visible part of this “higher bonding”, the fabric of the architectural concept for the purpose of creating internal spaces.
D. Infrastructure:
All the permanently installed supply and disposal facilities necessary in a building. The relationship between the infrastructure and the building structure frequently results in conflicts.
E. Access structure:
Horizontal and vertical circulation routes and spaces. These include stairs and ramps plus the entrances to a building.

5. The structure
The structure is generate
Structure and process

Building – spaces – load
– tectonics
– “material fabric”
– loadbearing structure
– finishings and fittings
– infrastructure

Plan
– conception (“idea”)
– draft design
– interpretation (signific
– building documentati
– exchange of informat
– chronology of actions

and

Production
– chronology of product
– logistics
– operative sequence
– jointing principles

Further reading

- Kenneth Frampton: *Stu Culture*, Cambridge (M
- Fritz Neumeyer: *Nachd über Architektur, Quelle Architekturtheorie*, Mun
- Gottfried Semper: *Der nischen und tektonisch praktische Ästhetik*, vol 1863 / Munich, 1860 – *Style: Style in the Techn Arts; Practical Aesthetic Mallgrave (ed.), Los An*

Solid and filigree construction

Christoph Wieser, Andrea Deplazes

On the occasion of a lecture on the "morphology of the architectural" at the ETH Zurich architecture theorist Kenneth Frampton drew on the works of Eugène Viollet-le-Duc and Gottfried Semper, who together pioneered the theory of architecture, to distinguish between the development of architectural forms from their origins as "earthworks" and "roofworks", or with the terms stereotomy (solid construction) and tectonics (filigree construction) that are used in architecture theory. While the term "earthwork" includes all the building techniques of solid wall construction (cob, pisé and adobe, clay-and-stone masonry, etc. and their stereotomic forms such as walls, arches, vaults and domes), the open "roofwork" encompasses all structures with linear and rodlike members – textile-like woven structures which span open spaces as "covers", forming the "roof", the overhead boundary to the space below. Timber engineering, with its layered, interwoven assembly, belongs to this category, as does industrialised steelwork from about 1800 onwards.

The principles of the structural formation in filigree construction were not new. They were known to us through anonymous and traditional timber buildings: conical and spherical domes made from straight and curved individual linear members, vertical solid timber construction, two- and three-dimensional frameworks (timber frames, timber studding), horizontal joist floors and roofs, and roof constructions (purlin and couple roofs, trussed frames) were the carpenter's daily bread. They were used principally wherever wood was readily available and a lightweight building material for medium spans was required. It was accepted that wood, in contrast to solid construction, was organic and hence not everlasting (fungal attack, rot, fire). For these reasons timber engineering has never seriously rivalled stereotomic solid construction nor superseded it.

Only after industrialised steel building technology was well established were questions raised about the hitherto undisputed tectonic principles of Western architecture. While in the case of solid construction the massiveness of the earth material finds its architectural expression in the archaic, and occasionally monumental character of stereotomy, the almost complete resolving of mass and massiveness (so-called sublimation) into the barely tangible skeleton or lattice framework of an ethereal phantom volume – the abstract Cartesian grid of a filigree construction – is drawn in space.[1]

Construction archetypes

In 1964 Sigfried Giedion was still maintaining that the issue of the origin of architecture was "very complex", as he writes in his book *The Eternal Present. A Contribution to Constancy and Change*. This is why – despite the tempting title – he does not explore this matter in detail.[2] Instead, he confines himself to presenting the principal evolution, the content of which is backed up by later research. This evolution, in essence, extends from the simplest round or oval huts to rectangular shelters. According to Giedion, "this regular rectangular house which has remained even to this day the standard form for a dwelling, had evolved only after centuries of experimentation with innumerable variants." His underlying weighting of this can be plainly heard.[3] The rejection of round buildings in the course of the evolution of civilisation may well have been for primarily practical reasons – rectangular buildings can be more readily, i.e., more economically, subdivided and extended, and are easier to group together into settlements. The triumph of the rectangular building coincides with the onset of the establishment of permanent settlements; compact settlement forms are, at best, of only minor importance to nomadic peoples.

At the dawn of history, whether a building was rounded or angular was not only a question of practical needs but also an expression of spiritual ideals. According to Norberg-Schulz in the earliest cultures it is impossible "to distinguish between the practical and the religious (magical)".[4] The architectural forms and elements at this stage have both practical and symbolic significance – an interpretation that lives on in the tepees of the North American Indians and the yurts of nomadic Asian tribes. For their occupants these portable one-room homes symbolise the entire cosmos and their interior layout follows ancient rules that prescribe a certain place for every object and every occupant.

At this point, however, it is not the evolution of human shelters that we wish to place in the foreground but rather the characterisation of the two archetypal forms of construction – filigree construction[5] and solid construction. But here, too, the transition from a nomadic to a sedentary lifestyle played a crucial role. If we assume that the early, ephemeral shelters were filigree constructions, i.e., lightweight, framelike constructions, then the Mesopotamian courtyard house of c. 2500 BC is the first pioneering example of a shelter in solid construction. The historical development is reflected in the terminology: only with the development of permanent settlements do we first speak of architecture.[6] The Greek word *tekton* (carpenter) – whom we shall take as representing filigree construction – later led to the word *architekton*, our master builder, the architect.[7] Nevertheless, filigree construction should not be regarded merely as the forerunner of solid construction, as having lost its justification in the meantime. For in the end the construction systems depend on which natural resources are available locally and what importance is granted to the durability of a structure. Accordingly, the two archetypal construction systems are embodied differently yet equally in filigree construction and solid construction.

The first filigree constructions were variations on lightweight, initially wall-less shelters. In terms of their construction these consisted of a framework of branches, rods or bones covered with a protective roof of leaves, animal skins or woven mats. According to Hans Soeder we can distinguish between three different types of house: "Round domed structures (like those of Euro-African hunter cultures), the round tepee-type houses or conical tents of the Arctic and Antarctic regions, and – in regions with a hot or temperate climate – rectangular, inclined windbreaks".[8] Besides the climatic conditions, the first shelters were characterised by the local availability of organic or animal-based materials. This is an assumption because, naturally, no corresponding remains have been found. Gradually, inorganic materials started to be employed for housebuilding as well – in a sense the first optimisation attempts. They were more durable, could withstand the weather better and presupposed a high level of cultural development. One such optimisation is, for example, the covering of a framework of rods with cob.

The term "filigree construction" refers directly to the way in which these forms of construction are put together. Since the 17th century the noun "filigree" (alternative spelling "filagree") has denoted an ornamental work of fine (usually gold or silver) wire, twisted, plaited and soldered into a delicate openwork design. This word is a variation on "filigreen", itself a variation of "filigrane", derived from the Latin words *filum* (thread) and *granum* (seed),[9] from which we can infer the roughness of the metal surfaces. A filigree construction is thus a structure of slender members, a weave of straight or rodlike elements assembled to form a planar or spatial lattice in which the loadbearing and separating functions are fulfilled by different elements. But this static framework contains many "voids", and to create an architecturally defined space we need to carry out one further step – to close this open framework or – according to Semper – to "clothe" it. The relationship between the interior and exterior of a building is thus achieved via secondary elements and not by the loadbearing structure itself. Openings appropriate to the system are consequently structural openings, the size of which is matched to the divisibility of the framework. The reference to Semper is therefore also interesting because in his book *Der Stil,* he designates textile art as an "original art", the earliest of the four "original techniques" from which he derives his four elements of architecture. He therefore describes the tectonic principle of filigree construction – weaving, knotting and braiding – as the earliest of mankind's skills.[10]

Prime features of solid construction are, as the term suggests, heaviness and compactness, in contrast to filigree construction. Its primary element is a massive, three-dimensional wall made up of layers of stones or modular prefabricated materials, or by casting in a mould

a material that solidifies upon drying. The join
of solid construction could be described the
of the techniques of casting and layering. Th
results from the importance of the architec
equivalent of solid construction – stereotom
cutting stone into measured forms such tha
case the simple layering of dressed stones
of gravity are sufficient for the stability of
without the use of any additional media suc
etc. It becomes clear from this that solid c
can only accommodate compressive forces
filigree constructions – cannot handle tensile
example of the principle of "dry walling", lo
sively in compression, is provided by the all-
ings of the "Village des Bories" (borie = dr
in the French town of Gordes, with their sel
pyramidal roofs.[11]

In solid construction the erection of walls
terior spaces directly because the loadbear
closing functions are identical. Consequentl
of the structural shell often corresponds to th
construction, with secondary elements being
superfluous. The sizes of openings in the wal
because these weaken the loadbearing beh
wall. This type of construction is founded on t
cell and groups of rooms are created by ad
gether or subdividing individual cells. As in
case all walls have loadbearing and separati
there is no structural hierarchy. All parts te
equal importance.

This pair of concepts – solid construction
and filigree construction (tectonics) – de
two archetypal construction systems. All the
forms of construction can be derived from the
though their origins are still considerably bl
the array of architectural design forms is les
fined than ever before. Everything is feasible,
available. From a technical viewpoint at leas
to be no boundaries anymore. The often new
ing utilisation of high-tech materials and c
tem components leads to an ever greater bl
original boundaries between construction sy
and filigree construction in their true charact
since been unable to do justice to new dema
options; composite forms prevail.

The distinction between solid and filigre
tion as pure constructions is interesting ins
illustrate the "how" and "why" of building. Th
means of analysis which permits comparis
contemporary systems and also renders th
evolution legible. This whets our appetite for
and simultaneously creates their boundaries.

Notes

1 For example, the structures of the World Expositions of the 19th century, like the Crystal Palace in London or the Eiffel Tower in Paris. For details of the latter, see Roland Barthes, *The Eiffel Tower, and Other Mythologies,* transl. Richard Howard, New York, c 1979.

2 Sigfried Giedion: *The Eternal Present. A Contribution to Constancy and Change.* The National Gallery of Art, Washington, 1964, p. 177.

3 ibid, p. 177.

4 Christian Norberg-Schulz: *Logik der Baukunst (Bauwelt Fundamente 15)*, Gütersloh, Berlin, Munich, 1968, p. 109.

5 Of all the known terms, filigree construction appears to be the most precise and most comprehensive in order to study the essence of the construction tectonics principle. In contrast to this, the term skeleton (or frame) construction, frequently regarded as a synonym, seems to draw unavoidable parallels with plant or animal structures and hence a reference to an "organic" architectural interpretation, which as such has nothing to do with the form of construction. The term lightweight construction is similarly restrictive because not only does it – unreasonably – tend to reduce filigree construction to a form of building "light in weight" but also – indirectly – tends to favour certain materials at the expense of others.

6 Markus Dröge, Raimund Holubek: "Der rechte Winkel. Das Einsetzen des rektangulären Bauprinzips"; in: Andreas Brandt: *Elementare Bauten. Zur Theorie des Archetypus, Urformen weltweiten, elementaren Bauens in einer Zusammenschau*, Darmstadt, 1997, pp. 499–508, p. 501.

7 Kenneth Frampton: *Studies in Tectonic Culture*, Cambridge, 1995, p. 3.

8 Hans Soeder: *Urformen der abendländischen Baukunst in Italien und dem Alpenraum* (Du-Mont Documents), Cologne, 1964, p. 19.

9 Oxford English Dictionary.

10 cf. Gottfried Semper: *Der Stil in den technischen und tektonischen Künsten oder praktische Ästhetik*; vol. 1: *Die textile Kunst*, Frankfurt a. M., 1860, p. 13.

11 Werner Blaser: *Elementare Bauformen*, Düsseldorf, 1982, pp. 31–43.

Comparing the relationship between structure and space
solid construction – filigree construction

Solid construction	Filigree construction
Body made from *walls* (vertical) - solid, homogeneous	**Lattice** made from *linear members* (horizontal and vertical) - open framework (2D, 3D) reduced to the essentials
↓	↓
- plastic, solid bodies **Primacy of the space** - directly enclosed *interior space* - *distinct separation* between interior and exterior	**Primacy of the structure** - no direct architectural interior space creation - no separation between interior and exterior
↓	↓
- *plan layout concept* **Principle of forming enclosed spaces** a) *Cells* - additive, starting from the smallest room unit - divisive, by subdividing a large initial volume (internal subdivision) b) *Walls* - hierarchical, parallel loadbearing walls, clear directional structure (open-end facades) - resolution of the walls: parallel rows of columns (a form of filigree construction, cf. colonnade mosque)	- the construction of the framework dominates: linear members as lattice elements, infill panels **Principle of forming enclosed spaces** Gradual *sequence of spaces*, from “very open” to “very enclosed”, depending on the degree of closure of the infill panels c) *Skeleton construction* - partial closure of horizontal and vertical panels between lattice elements: floor/roof or wall as infill structure d) *Column-and-slab construction* - solid slab as floor/roof construction in reinforced concrete
↓	↓
Loadbearing principle - horizontal: arches; shells (vault, dome); form-active loadbearing structures (stressed skins) - for long spans: additional strengthening with ribs (e.g. Gothic) and downstand beams (T-beams) - directional systems (truss designs) or non-directional systems (waffle designs)	- walls as infill between columns or user-defined wall developments (non-loadbearing) **Loadbearing principle** - horizontal beams (primary), possibly more closely spaced transverse members (secondary) - eccentric nodes; directional hierarchy; layered; primarily timber engineering - axial nodes; directional and non-directional; primarily structural steelwork
↓	↓
Openings as wall perforations - the structural disruption in the wall - mediation between interior and exterior - the hole: dependent on the wall–opening proportions	- for long spans: increased structural depth of primary elements - trusses, plane frames (2D), space frames (3D) **Panel as structurally inherent opening principle** - the structural opening as a variation of the panel between lattice elements - infill panels: solid; horizontal; vertical - non-loadbearing curtain wall, horizontal ribbon windows

MATERIALS –

The importance of the material

Andrea Deplazes

For me, designing and constructing is the same thing. I like the idea that form is the result of construction; and material, well, that's something finite. Nevertheless, confining myself to this formula would be a mechanistic reduction because the shape of the form, deliberate or not, bears – beyond its material or constructional component – information, an intent. Yes, even the absence of intent is information (which has been sufficiently well demonstrated by functionalism). Consequently, the separation between designing and constructing made by the teachers is a didactic strategy to create thematic focal points, which can be explained beautifully by the metaphor of the potter and his wheel. The potter models a vessel with both hands by applying force from outside with one hand and from inside with the other hand (in opposite directions) in order to reshape the mass of clay into a hollow space. A "vessel that holds space" is produced. At best these forces complement each other, or at least affect each other, as a result of which the didactics sometimes becomes the methodology of the work and, moreover, becomes the design process as such. This process advances from both directions: from outside in the classical way from the urbane to the architectural project, and from inside by means of the spatial and constructional fabric, the tectonics – and both lead from the abstract to the concrete.

Between them lies the architectural matter. It stands as the boundary and transition zone between the inside and the outside and unites in itself all architectural, cultural and atmospheric factors, which are broadcast into the space. This is the paradox of architecture: although "space" is its first and highest objective, architecture occupies itself with "non-space", with the material limiting the space, which influences the space outwards as well as inwards. Architecture obtains its *memoria*, its spatial power and its character from this material. As Martin Heidegger expresses it, "The boundary is not the point where something ends but, as the Greeks recognised, the point at which something begins its existence." From this point of view architects are metaphysicists who would not exist without the physicists (technicians, engineers, designers), or even more like Janus with his two faces on one head: the presence of space (antimatter) and the presence of matter are mutually interlinked and influence each other unceasingly.

Conceiving and designing space or space complexes in advance or reconstructing it/them subsequently are only possible when I know the conditions of realisation and can master them as well.

Consequently, the architect is a "professional dilettante", a kind of alchemist who tries to generate a complex whole, a synthesis from most diverse conditions and requirements of dissimilar priority which have to be appraised specifically every single time.

The character of the architectural space therefore depends on *how* things are done and for that reason it is determined by the technical realisation and by the structural composition of the substances and building materials used. In this respect a remark by Manfred Sack is very instructive: "Again and again there is the sensuality of the material – how it feels, what it looks like: does it look dull, does it shimmer or sparkle? Its smell. Is it hard or soft, flexible, cold or warm, smooth or rough? What colour is it and which structures does it reveal on its surface?"

Sack observes that architectural space is perceptible first and foremost in a physical-sensual way. By striding through it and hearing the echo of my steps I estimate and sound out its dimensions in advance. Later, these dimensions are confirmed by the duration of my striding and the tone of the echo gives me a feeling of the haptic properties of the boundaries to the space, which can be decoded by touching the surfaces of the walls and, perhaps, by the smell of the room too, originating from different things. So only by means of these sensual experiences do I realise what I later believe I can comprehend with one single glance. Vision is obviously something like a pictorial memory of earlier physical-sensual experiences which responds to surface stimuli. I also like the idea of "which structures does it reveal on its surface?" Under the surface lies a hidden secret, which means the surface depends on a concealed structure which existed before the surface, which created the surface, and in a certain way the surface is a plane imprint of this structure. In architecture the line and the two-dimensional area do not exist – they are mathematical abstractions. Architecture is always three-dimensional – even in a micro-thin layer of paint – and thus plastic and material. As an example we can consider the distinction between colour as colouring material and colour as a certain shade of colour, keeping in mind that the latter may be used to generate the impression of two-dimensional areas. This notion makes it easy for me to understand construction not only as a question of technique or technology, but as *tekhne* (Greek: art, craft), as the urge to create, which needs the presence of an artistic or creative, human expression of will or intent, which is the starting point for the creation of every artefact. "Understanding" construction means to grasp it intellectually after grasping it materially, with all our senses.

Extract from introductory lecture, ETH Zurich, 15 January 1999

The perception of architectural space

Tectonics — Form — Space

Physics of the space

Material
Mass
Massiveness
Heaviness
Lightness
Hardness
Softness
Filigreeness
Compactness
Transparency

Boundaries
Opaque
Transparent
Translucent
Surface
– flat
– sculpted

Structure
Tectonic, divided
Non-tectonic, homogeneous
– amorphous, "without form"
– monolithic – layered
– hierarchical – chaotic
– non-directional – directional

Figuration
Euclidian
Mathematical – rational
Geometrical
– abstract
– concrete
Organic
– biomorphic
– intuitive

Dimension
Scale
– broadness
– narrowness
– tallness
– depth

Physiology of the perception

Sight
Light
Colour
Materiality
– abstract
– concrete

Touch
Texture
– rough
– fine, smooth
– fibrous

Feeling
Moist
Dry
Hot
Cold

Odorous
Smell
Agreeable
"neutral"

Sense of time
Movement
Permanence
Scale effect (feeling)
– "broadness"
– "narrowness"
– "depth"

Hearing
Noise
Resonance, reverberati
Echo
Muffled
Harsh

↓

Thinking
Interpreting
Synthesising

The longevity of materials

Usage	Years
1. Floor coverings	
1.1 Textile floor coverings (needle felt + carpeting)	
Price category 1, medium quality, laid, SFr 30–65/m^2	10
Price category 2, hard-wearing quality, laid, SFr 66–140/m^2	12
Natural fibre carpet (sisal-coconut), laid, SFr 80–110/m^2	12
1.2 Ceramic floor coverings	
Plain clay tiles	25
Ceramic tiles	40
Hard-fired bricks, unglazed	50
Reconstituted stone flags	50
Slate flags	30
Granite flags	50
1.3 Other floor coverings	
Seamless cushioned vinyl	20
Plastic floor coverings (inlaid, PVC)	25
Linoleum	25
Cork	25
Parquet flooring	40
2. Plastering, painting and wallpapering	
Plastic grit, Chloster-style plaster	10
Dispersion paint, matt paint	10
Blanc fixe, whitened	10
Woodwork (windows, doors) painted with oil-based or synthetic paint	20
Radiators, painted with synthetic paint	20
Wallpaper, hard-wearing, very good quality	15
3. Wood and plastic materials	
Wood panelling, glazed	20
Wood panelling, untreated	40
Skirting boards, plastic	20
Skirting boards, beech or oak	40
4. Ceramic and stone tiles	
Ceramic tiles in wet areas	40
Stone tiles in wet areas	40
5. Kitchen fittings	
Electric hob, conventional	12
Ceramic hob	15
Cooker, stove and oven, incl. baking sheet	20
Microwave	15
Refrigerator	12
Freezer (upright or chest)	15
Dishwasher	15
Extractor, fan	15

Usage	Years
6. Sanitary fittings	
Bath, shower tray, cast, steel	50
Bath, shower tray, enamel	20
Bath, shower tray, acrylic	40
Shower tray, ceramic	50
Lavatory, pan without cistern, bidet	50
"Closomat" (shower-toilet)	20
Mirror cabinet, plastic	15
Mirror cabinet, aluminium	25
Fittings for kitchen, bath, shower or WC	20
Washing machine and tumble drier in tenant's flat	15
Hot-water boiler in tenant's flat	15
7. Heating, flue, heat recovery system	
Thermostat radiator valves	15
Standard radiator valves	20
Electronic heat and flow counter	15
Mechanical evaporimeter	15
Electronic evaporimeter	30
Plant for hot-air flue/heat recovery	20
Fan for smoke extraction	20
Log-burning stove (with flue)	25
8. Sunshading	
Sunblind, synthetic fabric	12
Louvres, plastic	15
Louvres, metal	25
Plastic roller shutter	20
Wooden roller shutter	25
Metal roller shutter	30
Operating cords for sunblinds and roller shutters	7
9. Locks	
Automatic door locking system	20
Lock to apartment door	20
Lock to internal door	40
10. Reduction in longevity for commercial use	
Manufacturing	25%
Retail	25%
Restaurants	50%
Offices	20%

Source
Schweizerische Vereinigung kantonaler Grundstückbewertungsexperten (Swiss Association of Cantonal Real Estate Valuation Experts) SVKG+SEK/SVIT: "*Schätzerhandbuch, Bewertung von Immobilien*", 2000.

Plastic

Roland Barthes

Although the names of some plastics (polystyrene, polyvinyl, polyethylene) might remind us more of a one-eyed Greek shepherd, plastic is essentially an alchemistic substance. Recently, there was an exhibition dedicated to the whole gamut of plastic products. At the entrance the visitors waited patiently in a long queue to view the magic process *par excellence*, the remodelling of matter. An ultimate machine, an elongated arrangement with a large number of tubes (an ideal form to bear witness to the mysteriousness of a long journey), easily turned out glossy, fluted bowls from a pile of greenish crystals. On one side the tellurium material – on the other side the perfect artefact. And between the two extremes: nothing. Nothing but a journey, supervised by an employee wearing a peaked cap – half god, half robot.

Plastic is not so much a substance as the notion of infinite remodelling. It is, like its ordinary name indicates, the omnipresence that has been rendered visible. And that is exactly why it is a truly miraculous substance – the miracle being a sudden conversion of nature every time. And plastic is infused with this astonishment: it is not so much an item as the trace of a movement.

Since this movement here is almost infinite and converts the original crystals into a quantity of ever more surprising objects, plastic is basically a spectacle that has to be deciphered: the spectacle of its final products. Looking at all the different final shapes (a suitcase, a brush, a car body, a toy, fabrics, tubes, bowls or plastic film), the matter presents itself unceasingly as a picture puzzle in the mind of the observer. This is due to the total versatility of plastic: we can use it to form buckets as well as pieces of jewellery. That's why we are constantly astonished by and are constantly dreaming of the proliferation of the material, in view of the connections we are amazed to discover between the single source and the multiplicity of its effects. It is a happy astonishment since mankind measures its power by the range of possible conversions, and plastic bestows on us the euphoria of an enchanting glide through nature.

But there is a price to be paid for this, and that is that plastic, sublimated as a movement, hardly exists as a substance. Its constitution is negative: it is neither hard nor deep. In spite of its usefulness it has to be content with a neutral quality of substance: resistance – a condition that demands infallibility. It is not fully accepted within the order of the "big" substances: lost between the elasticity of rubber and the hardness of metal it does not attain one of the true products of the mineral order: foam, fibre, plates. It is a congealed substance. Regardless of its particular state it keeps its flaky appearance, something vague, creamy and solidified – an inability to attain the triumphant smoothness of nature. But above all it gives itself away by the noise it makes, that hollow, weak tone. Its sound destroys it; just like its colours, for it seems only to be able to retain the markedly chemical c
red, green, and it keeps only the aggressive s
It uses them just like a name which is only in
to show shades of colours.

The popularity of plastic bears witness t
ment regarding the myth of imitation. As is
imitations are – from the historical point
middle-class tradition (the first clothing imi
from the early years of capitalism). Up to no
imitation was always pretentious, was part of
simulation, not application. Imitation aims t
cheaply the most precious substances: prec
silk, feathers, fur, silver – all the world's lux
Plastic does without this, it is a household su
the first magic matter that is ready for ordin
it is ready because it is precisely this ordinar
its triumphant reason for existence. For the f
artificial aims at the ordinary, not the extraord
same time the ancient function of nature has
fied: nature is no longer the idea, the pure su
has to be rediscovered or has to be imitated
substance, more abundant than all the world'
raw materials, plastic replaces them all, even
the invention of shapes. A luxury item is alway
the earth and always reminds us in an especi
way of its mineral or animal origin, of the na
of which it is only a topical image. Plastic exi
used. Only in very rare cases are items inve
the pleasure of using plastic. The hierarchy o
has been destroyed – a single one replaces t
whole world could be plasticised and even
itself – for it seems that plastic aortas are a
produced.

"Plastic" (1957)
Excerpt from: Roland Barthes, transl. after: Mythologies, Paris, 195

The pathos of masonry

Ákos Moravánszky

Fig. 1: The intermeshing of nature and the built environment in the image of ruined masonry
Mario Ricci: "Capriccio" style with ancient ruins, pyramid and decoration

Layers

Pathos is "in" – despite its bad reputation for being "hollow", a reputation that, shadowlike, accompanies every emotional expression. Region, identity, space – terms that formerly were used with care – now take on an excessive force, probably in order to become points of reference in a rather uninteresting situation, or just to cause a sensation. And in architecture what could be more emotional than masonry? Where masonry is concerned we think of a figure with characteristics that tie the masonry to a certain place; characteristics like material, colour, weight, permanence. It is the artistic characteristic of masonry that provides the ethical and aesthetic resonance that legitimises many things. A wall with a coat of plaster or render is not necessarily masonry, regardless of how well it is built and coated. Masonry is "a structure that remains visible in its surface and works through it"[1] – regardless of the material used: natural stone or man-made bricks or blocks.

The relationship between nature and the built environment, as it was represented in the ruined masonry of the late Renaissance "Capriccio" genre, was intended to demonstrate the vanity of building and the corrupting power of death. In the end nature is waiting to take revenge for its violation "as if the artistic shaping was only an act of violence of the spirit".[2]

But the connection between masonry and nature can also be looked at from a less melancholy standpoint. Rudolf Schwarz described in his book *Von der Bebauung der Erde* (Of the Development of the Earth), published in 1949, the material structure of the Earth as masonry built layer by layer, starting with the seam "made from wafer-thin membranes of the universal material", from precipitation and sedimentation.[3]

Viewed by an unprejudiced onlooker the masonry *itself* should appear as a rather commonplace product when compared with the complex structures of high-tech industry. However, we sense the pathos quite clearly when masonry becomes the symbol for the building of the Earth, for the creation – or for homeliness as a contrast to modernisation. Brick-effect wallpaper, which decorates many basement night-clubs and discotheques, shows the sentimental meaning that attaches to masonry.

There are at least two debates about masonry: one about its surface as a medium for meaning and a boundary, the other about its mass as a product of manual work. Although both debates overlap constantly, I shall deal with them separately here.

The lightness: the wall, the art

No other theoretical study has formulated more new ideas regarding the double identity of masonry (and inspired a lot more) than the two volumes of Gottfried Semper's *Style in the Technical and Tectonic Arts: or, Practical Aesthetics*. The basis of Semper's system is the typology of human production methods: weaving, pottery, tectonics (construction in timber) and stereotomy (construction in stone). These four types of production correspond to the four original elements of architecture: wall, stove, roof and substructure (earth fill, terrace). What is important here is the ontological dimension of this breakdown: those four elements are not formally defined, but rather are aspects of human existence. It is remarkable to witness the flexibility that the seemingly rigid breakdown of architectural techniques allows with regard to the determination of its components. Even a mere sketch would be beyond the scope of this article. At this point it is important to establish that masonry artefacts could be products of the two "original techniques" – weaving and stereotomy. Tectonics, "the art of joining rigid, linear parts"[4] (an example of this is the roof framework), is alien to masonry.

Semper's observations were influenced by the remains of walls discovered during excavations in the Assyrian capital Nineveh, which he saw in 1849 when he visited the Louvre. In his opinion these masonry fragments confirmed his clothing theory: the wall as boundary is the primary element, the wall as a load-carrying element in the construction is of secondary importance. The stones forming the surface of the Assyrian masonry (the remains at least) were assembled horizontally on the ground, painted, enamelled, baked and only then erected. In his manuscript *Vergleichende Baulehre* (Comparative Building Method) Semper wrote: "It is obvious that clay brick building, although already well established in Assyrian times, was not focused on construction. Its ornamentation was not a product of its construction but was borrowed from other materials."[5] This theory still provokes – and inspires – us today because of its apparent reversal of

Fig. 2: The wall as a boundary element is the primary function, the masonry as loadbearing element the secondary function.
Nineveh, excavations of town walls between 1899 and 1917

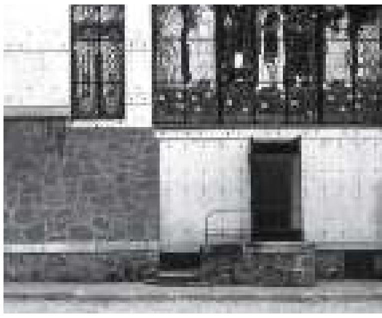

Fig. 4: Stereotomy and marble-clad masonry
Otto Wagner: Steinhof Church, Vienna (A), 1907

Fig. 3: Lightweight rendered facade over heavyweight masonry
Jože Plečnik: Sacred Heart of Jesus Church, Prague (CZ), 1939

cause and effect. It is the appearance of the masonry, its wickerwork-like surface, that determined the technique, and not vice versa. Semper states that the knot is “the oldest technical symbol and … the expression of the earliest cosmogonic ideas”,[6] i.e. the prime motif of human *tekhne*, because a structural necessity (the connection of two elements) becomes an aesthetic, meaningful image. The effect of an oriental carpet is based on the rhythmic repetition of its knots; the whole surface is processed uniformly. Art is always a kind of wickerwork: a painter – no matter if he or she is a landscape painter of the 19th century or an “action painter” like Jackson Pollock working in the 1950s – works uniformly over the whole of the canvas, instead of placing coloured details onto a white surface. Only this calligraphy allows us to experience masonry. “The mesh of joints that covers everything, lends … the surface not only colour and life in a general way but stamps a sharply defined scale onto it and thereby connects it directly with the imagination of human beings”, wrote Fritz Schumacher in 1920.[7]

Although Semper’s theory regarding the textile origin of the wall has it roots in historicism and has been misunderstood and criticised by many representatives of the modern theory of material authenticity, it still influenced the aesthetics of masonry in the 20th century. Naturally, this fact cannot always be attributed to the direct influence of Semper’s theory. But in the architecture of Vienna the acceptance of Semper’s ideas is unmistakable and even today architects like Boris Podrecca still feel bound by this tradition. Above all, it was the group led by Otto Wagner who interpreted Semper’s theses early on in an innovative way. The facades of the Steinhof Church (1905–07) and the Post Office Savings Bank (1904–06) in Vienna are structured according to Semper’s distinction between lower, stereotomic and upper, textile bays.

A pupil of Wagner, the Slovene Jože Plečnik interpreted these themes in a new way, as can be seen in his works in Vienna, Prague, and Ljubljana. “New” here means that he integrated his knowledge about ancient forms with virtuoso competence: distortions, alienations, borrowed and invented elements balance each other. T
the Sacred Heart of Jesus Church in Prague,
39) according to Plečnik’s plans, is clearly
lower, brick-faced and upper, white-rendere
granite blocks projecting from the dark bric
facade of the library of the university of Ljub
41) is also a membrane of stone and brick. In
combination probably symbolises Slovenia’s
with Germanic and Mediterranean building c

Louis Henry Sullivan compared the effe
built with bricks made from coarse-graine
soft sheen of old Anatolian carpets: “a te
innumerable highlights and shadows, and
appearance”.[8]

Fig. 5: A weave of natural stone and clay bricks
Jože Plečnik: University Library, Ljubljana (SLO), 1941

As its name alone indicates, Frank Lloyd Wright's invention, "textile block" construction, tries to achieve the fabric-like effect of precast blocks made of lightweight concrete. In 1932 he wrote an article in which – distancing himself from the sculptor-architects – he called himself a "weaver" when describing the facades of his buildings in California, e.g. La Miniatura or Storer Residence (1923): "The blocks began to reach the sunlight and to crawl up between the eucalyptus trees. The 'weaver' dreamed of their impression. They became visions of a new architecture for a new life… The standardisation indeed was the soul of the machine and here the architect used it as a principle and 'knitted' with it. Yes, he crocheted a free wall fabric that bore a great variety of architectural beauty…

Fig. 6: Decorated brickwork
Louis Henry Sullivan: National Farmers' Bank, Owatonna (USA), 1908

Palladio! Bramante! Sansovino! Sculptors, all of them! But there was I – the 'weaver'."[9]

Ancient and Byzantine masonry and the religious architecture of the Balkans show in many different examples how the surface of the masonry becomes a robe when decorations are used instead of a structural configuration with pilaster or column orders, e.g. by inserting glazed ceramic pins or small stones into the mortar joints. These buildings manage without a facade formulated with the aid of openings and sculptural em-

Fig. 7: Wright's second "textile block" house in Los Angeles
Frank Lloyd Wright: Storer Residence, Hollywood (USA), 1923

bellishments and instead favour the homogeneous impression of the masonry fabric. In the late 1950s the Greek architect Dimitris Pikionis designed the external works to a small Byzantine church on Philopappos hill, near the Acropolis in Athens. His plans included a footpath, an entrance gate and other small structures. Here, Dimitris worked, even more than Wright, as a "weaver", knitting together landscape, existing and new elements to form a colourful story.

Carlo Scarpa created a similar work with historic wall fragments and new layers at the Castelvecchio in Verona. Dominikus Böhm, Rudolf Schwarz and Heinz Bienefeld also used decorative masonry "clothing", often with inclined courses, brick-on-edge courses and lintels in order to illustrate that the shell is independent of the foundation. The facades to the Markus Church in Björkhagen (1956–60) designed by Sigurd Lewerentz demonstrate yet another strategy: the horizontal bed joints are as high as the masonry courses themselves. For this reason the brick wall exudes a "calm" expression, as if it was made of a completely different material to that used for the construction of, for example, the Monadnock Building in Chicago – an ancient skyscraper which, in the era of frame construction, was built in brickwork at the request of the building owner. In this building the enormous compressive load could be visually expressed.

The textile skin corresponds to the idea of the "decorated shed" propagated by the American architect Robert Venturi. The Venturi practice, an imaginative workshop of

Fig. 8: The interweaving of the structure and its surroundings
Dimitris Pikionis: Landscaping and refurbishment of St Dimitris Lumbardiaris Church, Philopappos hill, Athens (GR), 1957

post-Modernism, strives for a rational (according to American billboard culture) separation between the building and the medium conveying the meaning. The facades of many buildings designed by this practice employee large-format panels covered with a floral pattern that leave a naive, ironical impression. The decorative brick facades of the Texan architectural practice of Cesar Pelli also underline that the outer skin is a shell – like almost all masonry, at least since the oil crisis, when the new thermal insulation regulations made solid masonry quite uneconomic.

In the works of SITE, the architecture and environmental arts organisation led by James Wines, masonry as a kind of shell becomes a symbol for the consumer society; its character as a false, glued-on decorative layer

Fig. 9: Historical wall fragments, new layers
Carlo Scarpa: Reconstruction of the Castelvecchio, Verona (I), 1958–74

Fig. 11: The world's tallest self-supporting brick facade
Burnham & Root: Monadnock Building, Chicago (USA), 1884–91, e
and Roche, 1893

Fig. 10: Bed joint widths approaching the height of an individual brick
Sigurd Lewerentz: Markus Church, Björkhagen near Stockholm (S), 1960

peeling away from the substrate was feature
department store projects. Such preparator
obviously necessary in order to pave the way
all moralising about clothing as an illusion, ab
as a mask. In today's architecture the materi
ity of masonry is often perceived as a myth
ing with SITE ideals, just a bit less pithy. Th
headquarters in Winterthur (1999) by Urs B
Adrian Meyer asks whether a facade system
of industrial technology and consisting of p
masonry panels, still needs the pathos of m
or – perhaps on closer inspection and th
unusual precision and the joints between t
whether it comes closer to the modern ideal
material that has freed itself from manufactur
to Ernst Neufert). The loadbearing structure
ment block in Baden designed by Urs Burkar
Meyer (2000) consists of the masonry of the
concrete service tower and the in situ concret
distinctive floor edges allow for the stacking
vidual storeys, which is done by displacing th
sonry panels and large window openings in
storeys.