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Cycle XXIX

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Thesis Title

Wall(les)s, liminal environments between inside and outside

Curriculum: Architecture (ICAR 14)

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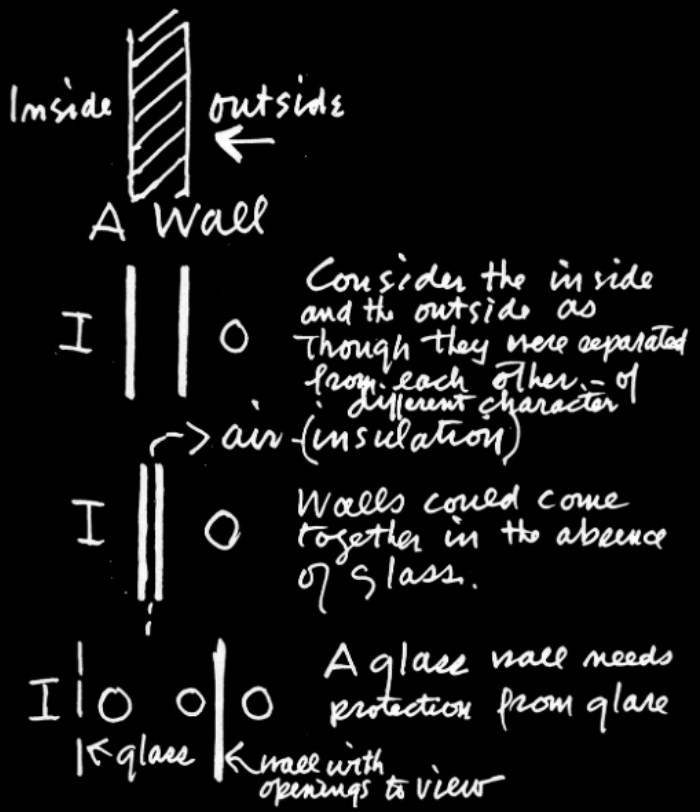

Salk Institute for Biological Studies, La Jolla, Luois Kahn, 1959 - 1965

ABSTRACT

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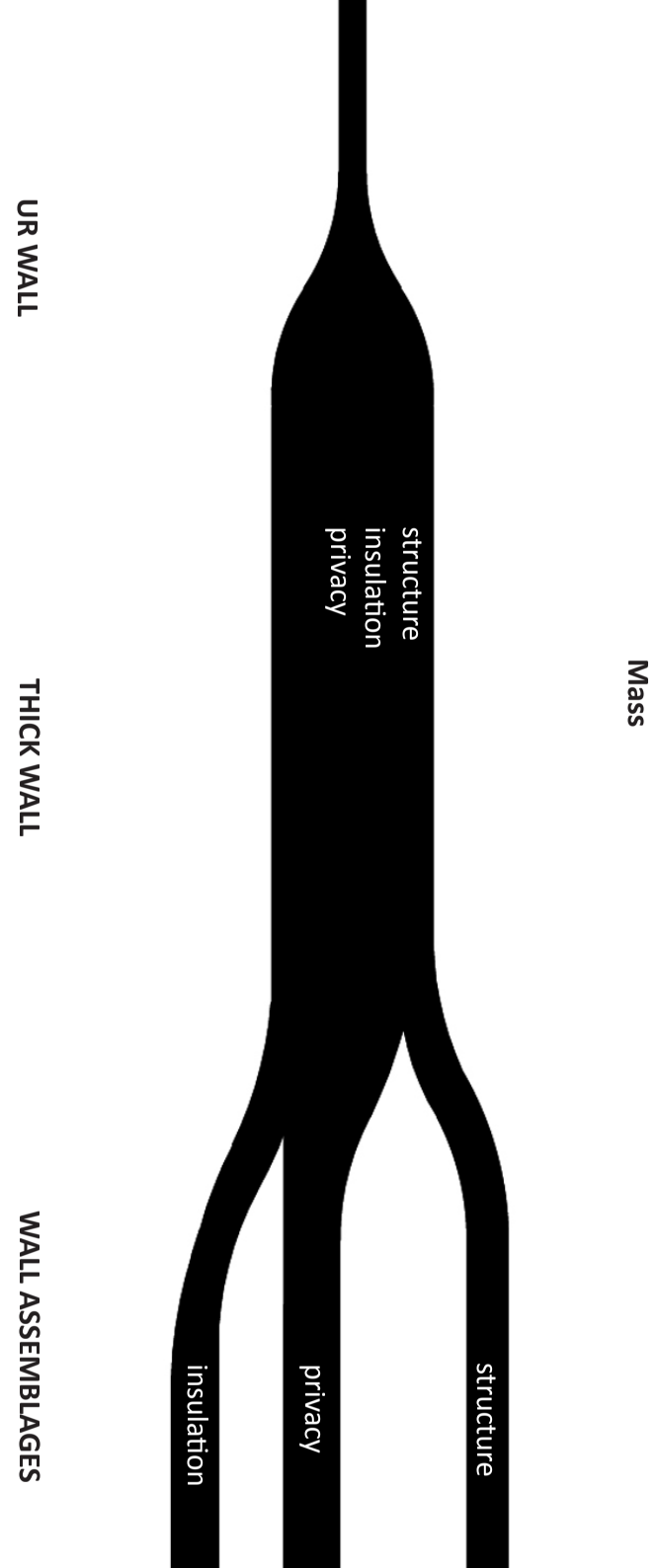
Wall(les)s is a research on architectural unconventional boundaries. Starting from the wall system, the thesis investigates solutions where its thickness becomes a place of relationship between the parts, generating hybrid territories and contents.

The technological development and the obsession for security, comfort and energy performance of buildings, has further extended the contents of the limit, marking a shift from monolithic wall to a more layered and complex configuration. Moreover a huge amount of devices takes part of it and manages the exchange between the inside and the outside: natural and artificial thermal insulation, double and triple air chambers, heat exchangers, controlled mechanical ventilation, biometric and electronic access devices. The evolution and progress behind the constituent components of our buildings did not have the same impact in terms of typology and space organizations.

To rethink the limit as a spatial threshold is to realize that inside and outside are not separable by just one wall or frame, and as such, numerous territorialities, scales, continuity and discontinuity, transparency and opacity in between can be integrated.

An overall reflection on it, as a unifying element can call for a new integration between the parts unveiling unconventional relations between interior and exterior spaces, architecture and technology.



THE UR WALL

The four elements of architecture, Gottfried Semper

Caribbean hut, Gottfried Semper

Straw matting hut, Lacaton & Vassal

THE THICK WALL

The wall as a living place, Francesco Cacciatore

Temple of Horus, Edfu

Pantheon, Rome

Intra Muros, The Chapuisat brothers

Roman Double wall_Nerone

Tempio Malatestiano, Leon Battista Alberti

El Muro_Jesus Aparicio Guisado

Fortified churches in Transilvania_Socks magazine

Morris House, Louis Kahn

Esherick house, Louis Kahn

The Open School, Lateral Office

Salk Institute for Biological Studies, La Jolla, Louis Kahn

Church and School in Rochester, Louis Kahn

Bernabeu stadium, Deconcrete magazine

Très Grande Bibliothèque, OMA

WALL ASSEMBLAGES

Maison Dom-Ino, Le Corbusier

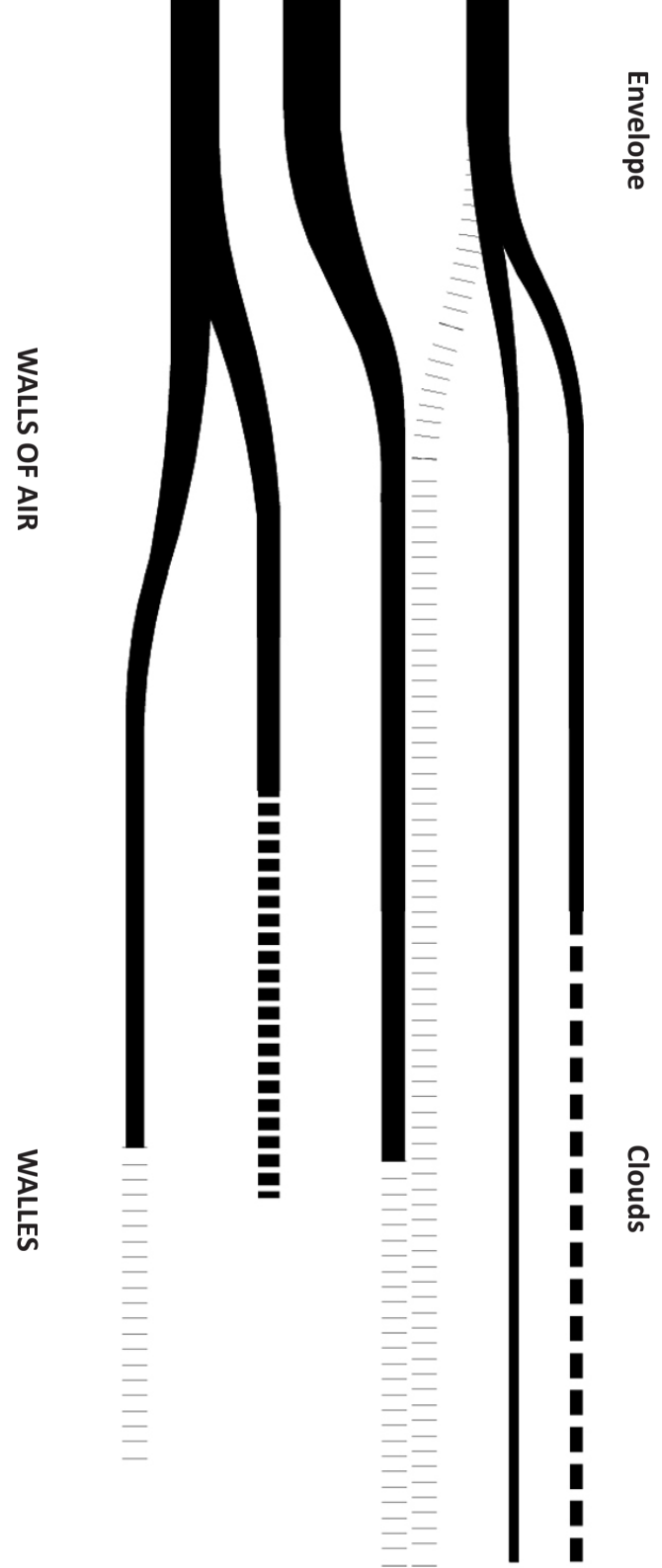
Imperial Villa Katzura, Kyoto

Friedrichstrasse Office Building, Ludwig Mies van der Rohe

Miller House, Richard Neutra

Open the Box, Sylvia Lavin

A wall for alla seassons, Mike Davies and Richard Rogers



Polivalent wall, Mike Davies and Richard Rogers
The Trombe wall, Felix Trombe
Double Envelope Houses, Lee Porter Butler
ReGen Villages, EFFEKT
IVAN Museum, SANAA
Latapie House, Lacaton & Vassal
Nantes school of Architecture, Lacaton & Vassal

WALL OF AIR

Die Hard, John McTiernan
Nakatomi Space, Geoff Manaugh
Octagon House, John Hayward
Larkin Administration Building, Frank Lloyd Wright
Mur neutralisant, Le Corbusier
Mur neutralisant, Le Corbusier
Richards Medical Laboratories, Louis Kahn
Environmental bubble, Reyner Banham
Convective Apartments, Philippe Rahm
Ducth Embassy, OMA
Toledo Glass Pavilion, SANAA

WALL LESS

Nicolas Schoffer_House with Invisible walls
Pepsi Pavilion, (E.A.T.)
Transsolar & Tetsuo Kondo Architects_Cloudscapes
Gulf Stream, Phillipe Rahm
Jade Eco Park, Phillipe Rahm
Carlo Ratti, Personal Cloud
Carlo Ratti, Local heating

“Architecture should be conceived of as a configuration of intermediary places clearly defined. This does not imply continual transition or endless postponement with respect to place and occasion. On the contrary, it implies a break away from the contemporary concept (call it sickness) of spatial continuity and the tendency to erase every articulation between spaces, i.e., between outside and inside, between one space and another (between one reality and another).
Instead the transition must be articulated by means of defined in-between places which induce simultaneous awareness of what is significant on either side. An in- between space in this sense provides the common ground where conflicting polarities can again become twin phenomena.” Aldo van Eyck

INTRODUCTION

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In the phase of extreme cultural dispersion that characterizes the today's state of art in architecture, it becomes essential to question on those elements that represent a reference points in the disciplinary debate; for the architects but also for its dialogue with clients and society. Rediscover one of this points in order to transmit and make available to comparison the work of architecture is one of the ambitions of the present research, which is of course addressed to the general public and professionals, but it seeks to become a didactic reference above all.

The attempt to relate to basic concepts in architecture serves, first of all to the researcher, to confront works also chronologically very distant, that can be compared using stable system of reference, such as the fundamental topic of the architectural limit as the space where various contradictions between inside and outside take place.

No doubt that the concept of limit is one of the basics of the development of architectural thinking. The difference between two places or entities, inside and outside, public and private, architecture and nature **implies an action of delimitation**. **Space, not considering its nature of being physical or metaphysical, material or immaterial depends of the recognition of its limits.**

The richness and multiplicity of meanings of the concept of limit finds its origin in the ambivalence of the simple act of marking a limit. If on the one the concept of limit represents the beginning of every human settlement, it is also – as Carl Schmitt affirmed in his seminal work on the "jus publicum Eeropaeum", the starting point of the formation of any form of jurisdiction. Marking the land, tracing the limit are not only the primordial forms of establishing the settlement form, but their consequences reach the possibility of the coexistence of people, and power formations of every sort which are always "founded on new spatial divisions, new enclosures, and new spatial orders of the earth" (Schmitt, 2003).

At a figurative level the limit symbolizes spiritual and material protection. It identifies the corral, the closed space, and it closes and defends, limits protecting and generating space. A town was identifiable by the existence

of the walls that enclosed and divided it from external space. From its beginning, the construction of the architecture has been fundamentally connected to the idea of limit, **capable to describe and measure the amount of space of which man takes control and lives**, and where representing his or her personality to the space delimited. As Francesco Iodice (2015, p.56) writes in his book “Cavity and Limit”:

“The concept of limit in architecture is defined by the element interposed between the inside and the outside, between nature and the built area, and generally tends to emphasise the independent character of the two parties, the autonomy of the inside and of the outside.” (Iodice, 2015, p.56)

The architecture needs bounding, enclosing elements, without which is not separated from external space; conversely, to go into a space means to pass a threshold, a limit whether physical or only apparent.
The limit as considered until now, may appear like simply something that separates two environments, in fact it characterizes a crucial step, a filter between inside and outside, and as it could be noted during the centuries **has experienced different interpretations and resolutions, specifically in the relation that has intended to develop from time to time between these two entities, inside and outside.** Hence, it does not simply recognizes and signifies exclusion, but as well, frequently inclusion between the two entities. In his essay Building Dwelling Thinking, Martin Heidegger (1993, p.343-364) has pointed out that:

“The limit is not a point where a thing ends, but that from which something begins, its essence.”

In the older times of architecture from the ancient Egyptian culture, throughout the Greek and Roman period regularly coming down to today, the threshold, the limit is and has for all time been the crucial element, albeit in various interpretations and variations. Greek culture, for instance based the idea of limit on the concept of column, prompt elements that

spatially identified a specific place, a void without defining it physically. Moreover, Roman culture made of the wall thickness and the material stability a characteristic feature of its architecture.
Additionally, in the beginning of the last century, with the diffusion of the frame structure, can be noted a division between the distribution of the places and the massive existence of the bearing wall. This phenomenon as described by Carlos Marti Aris (1993) is related to the tendency of division and separation in diverse specialized subsystems.
The envelope with its two-dimensional nature has substituted the mass. The steady decrease of the wall section, made possible from a technical viewpoint with the arrival of new materials, can be read as a direct correspondence with the progressive modification of the contemporary society and the new relationship people developed with it.
The division between the bearing structure, closing and partition, bring to the realization of **layered enclosures, in which each element is created and made to mediate the relationship between interior space and exterior space, in terms of climate, energy, acoustics, aesthetics and communication.** The enclosure of the buildings has for all time played a significant role, but lately the study of the division layer between the outer and inner spaces, it is set as the most sophisticated field of research and experimentation of architecture. There are companies like Permasteelisa group and Focchi that are highly specialized in the detailed design and realization of sophisticated enclosures.

State of art

The contradiction between the inside and the outside generates liminal liminal spaces in the wall thickness deriving from different necessities: symbolic, defensive, structural, mechanical ect. This contrast between the two entities can be a major manifestation of contradiction in architecture. (Venturi, 1966). As he states in his famous book “Complexity and Contradiction in Architecture” (1966, p.70):

“Contradiction between the inside and the outside may manifest itself in an

unattached lining which produces an additional space between the lining and the exterior wall."

The liminal spaces mark a passage, give it thickness, ritualizing it. To cross them in a conscious way means to be able to recognize the traits that characterize them and distinguish them from the surroundings. Liminal spaces are generally places of **great richness in several respects:** biological richness as often biodiversity is greater here than in other places (Clément), spatial richness or areas generally characterized by different uses and functions (Koolhaas); relational richness or places in which antinomies, contradictions, juxtapositions occur (Zanini).
The study of the architectural limit as a space of contradiction between inside and outside is developed in different forms and declination deriving from a detailed investigation on the wall system.
Three main fields of interest are strictly connected in this research: **the liminal condition** with its richness and intrinsic dynamism (Zanini), **the structure and the thickness of the wall** as basic architectural boundary and its transformation over time in relation to the contingent necessities of our society (Semper, Koolhaas), and the technological development related to **climate control machinery that makes the architectural limit a medium of environmental management and a device that creates specific places made by temperature, light and humidity** (Banham).
The investigation tries to update these consolidated theories, focusing on contemporary examples that explore the wall system and its components as a space of relation between the parts. For each field there are specific references in bibliography that the research confronts and intersects in a way to define the specific topic: Wall(les)s

Objectives

The mission is to promote critical and theoretical reflection on the relationship between inside and outside, through the research on the evolution of the wall system as the primary element of bounding architectural space. As the research reveals a progressive loss of mass and decomposition in

various specialized layers, **the idea of the limit between two different entities can be substituted with the sequence of territories with certain depths, a sequence of 'liminis' that provides spaces for human activities.**
The objective is to research examples of liminal spaces that transform the architectural boundary in a multiform element that manages privacy and climatic information while defining intervals of interstial space between the parts. Wall(les)s explore these gradients and transitions where differentiation between spaces is achieved less by rigid walls than by extended thresholds.

Methodology

The survey investigates liminal spaces analyzing their origin, the problematic and their potential. Wall spaces, stratum spaces, duct spaces, air spaces are some declinations. **The structure of the chapters tends to relate a consolidated theoretical aspect with a more contemporary experience.** From Gottfried Semper to Lacaton&Vassal and Koolhaas, from Rayner Banham to Sanaa, Rahm and Ratti.
Conceived as a collection of small monographs that can be read separately, the consecutive development of the arguments gradually point up a tendency of a progressive physical dematerialization of the architectural boundary (mass – envelopes – clouds) until the introduction of local climatic devices that question its overall existence. **This framework derives from the observation of the studied phenomenon and its subdivision and organization recalls analogous modalities of organization of space.**

Index / Structure

The research marks the transition from the wall as solution to the wall as function, and a system of answers to multiple question of management of the relation between inside and outside. It is organized as a selection of key words that describe different conditions of limi-

nal spaces in relation to architectural layouts. Ur-wall, thick wall, wall assemblages, wall of air, wall less describe unconventional boundaries that constitute intermediate spaces between the wall layers.

- the ur-wall is the primitive boundary. Through the rereading of the Four Elements of Architecture by Gottfried Semper, the chapter underlines **the layering of the archaic enclosures**, determined by the symbolic use of the woven partition and its derivations, and the backside presence of the masonry wall necessary for defensive purposes. The project Straw matting hut by Lacaton e Vassal, it's a reinterpretation of these primitive enclosures with the insertion of habitable interstitial spaces between them, that constitute a gradient of transition between inside and outside.

- the thick wall is the profound boundary deriving from the traditional Egyptian and the Roman architecture. In the temple of Edfu, as also in Pantheon are evident the **multiple linings determined by structural necessities that create liminal spaces between layers**. From Alberti to Kahn and Koolhaas the thick inhabited perimeter can become a device for organizing the program in solid and empty, main and service spaces, and excavating the action for generating places and **dealing with the dark bands of the poché.**
The chapter also clarifies a paradigmatic passage from structural poche, to a hybrid poche accommodating both structure and mechanical service.

- wall assemblages is the multi-layered boundary. The conceptual and visual detachment of the support from the supported, and the separation of structure from enclosure, in an era of environmental awareness has produced various form of wall assemblages. From Neutra to Lacaton&Vassal, the chapter explores examples that work with the **insertion of intermediary devices, turning the area between the interior and the exterior into an inhabitable buffer space of intense spatial ambiguity and important programmatic potential. The treatment of a climatic threshold as a space rather than a surface can have a profound spatial implication.**

- wall of air is the air boundary. Modern buildings rely on climate control machinery to maintain reasonable temperatures indoors. The mechanical system as a device of relation between interior and exterior can become an occasion for envisioning air spaces such as people can move through them. The chapter highlight **solutions where mechanical system, structure and program are packed together in hybrid solutions of great innovations.** Airspace, Airduct and Airplenum are declinations that describe three of these examples.

- wall less is the blurred boundary. Through the description of technological devices the chapter **questions the traditional architectural enclosure as unique way of bounding inhabitable spaces.** The quoted examples by Transsolar, Rahm and Ratti create climatic clouds able to construct places with **vague and multiple boundaries, questioning aspects of economy, sustainability and energy consumption.**

The chapters are occasionally interrupted with inserts with black background representing isolated descriptions or quotes on related topics.

“ The ur-wall is not, according to 19th century theorist Gottfired Semper, a mud or stone line of enormous and comforting heft, but an artfull woven partition. Hanging loosely, perhaps flapping, the woven screen generates and, crucially, symbolizes - the division and organization of activities within the dwelling. The woven “wall” is an enabler of civilization, the thick structural wall merely a deffender of it…”

Elements of Architecture, Wall, Rem Koolhaas, p.20

THE UR - WALL

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"The first sign of human settlement and rest after the hunt, the battle and wandering in the desert is today, as when the first man lost paradise, the setting up of the fireplace and the lighting of the reviving, warming and food preparing flame. Around the heart the first groups assembled; around it the first alliances formed; around it the first religious concepts were put into the customs of a cult. Thorough all phases of society the hearth formed that sacred focus around which the hole took order and shape." (Semper, 1851, p.102)

According to Semper the fireplace is the first and the most important, the moral element of architecture. Around it were grouped the three other elements: **the roof, the enclosure and the mound**, the protecting negations or defenders of the heart's flame against the three hostile elements of nature. Correspondingly to how diverse human societies developed under the different influences of climate, natural environments, and social relations, the mixture in which the four elements of architecture were arranged as had to evolve as well, with some elements turning out to be more protagonists while others retreated into the background.

Semper find a very clear example for his theory of the Four Elements of Architecture in the Great Exposition in 1851, in a painting of an Indian hut with the four elements clearly recognizable. In this Caribbean Hut all the elements of the primitive architecture appear in their most original and primitive form: the fireplace in the centre, the surrounding basement with the pillar structure as a terrace, the roof loaded by columns, and the rush mat as a window fixture or a wall enclosing the inner space.

But what primitive technique evolved from the enclosure?

As reported by Semper none other than the art of the wall fitter (Wandbereiter), that is the **weaver of mats and carpets**. The use of wickerwork for setting apart one's property, the use of mats and carpets for floor coverings and protection against heat and cold and for subdividing the spaces within a dwelling in most cases proceeded by far the masonry wall, and particularly in areas favoured by climate.

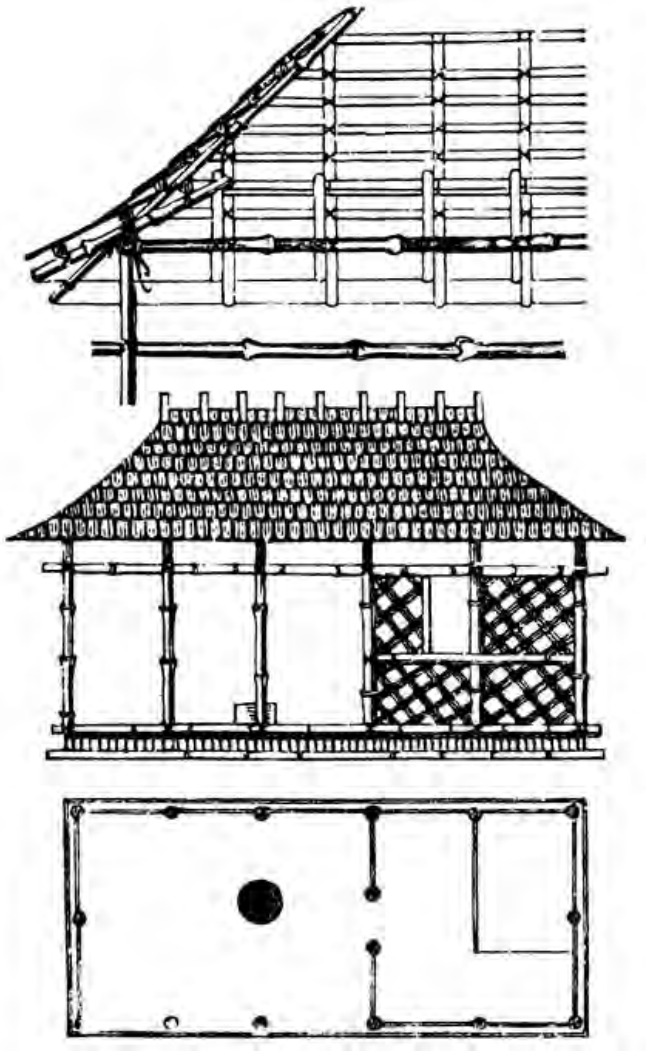


Fig. 1 - Caribbean hut (The Great Exhibition, 1851), Gottfried Semper, The four elements of Architecture, 1851
Semper's Primitive Hut had four fundamental elements: hearth, roof, enclosure and mound. The enclosure finds its origin in the weaving and fabric and relates to comfort and decor.

"The masonry wall was an intrusion in the domain of the wall fitter by the mason's art, which had evolved from building terraces according to very different conditions of style...Wickerwork, the original space divider, retained the full importance of its early meaning, actually or ideally, when later the light mat walls were transformed into clay tile, brick, or stone walls. Wickerwork was the essence of the wall." (Semper, 1851, p.102)

Hanging carpets are the true walls, the observable boundaries of space. The frequently solid walls behind these were indispensable for reasons that had nothing to do the creation of space; they were required for security, for supporting a load, for their permanence and much more. Everywhere the requirement for these less important functions did not occur, **the carpets are the original devices of dividing space. Still where construction solid walls become essential, the latter were simply the internal, invisible structures hidden behind the factual and legitimate representatives of the wall, the colorful woven carpets.**

The wall preserved this significance when materials other than the original were utilized, either for reason of increased durability, better preservation of the inner wall, economy the display or increased brilliance or for any other motive. The imaginative mind of man created many such substitutes and all branches of the technical arts were sequentially enlisted.

Semper has explained that the most broadly utilized and maybe the oldest substitute was offered by the mason's art, the stucco covering or bitumen plaster in different countries. The woodworkers made panels with which to fit the walls, particularly the lower parts. Workers that treat fire supplied glazed terra cotta and metal plates. As the final substitute maybe can be counted the panels of stand stone, granite, alabaster and marble that the authors discover in extensive use in Assyria, Persia, Egypt, and even in Greece.

Extensively the character of the copy followed that of the prototype. The artist who designed the painted and sculptured decorations on wood, stucco, fired clay, metal, or stone conventionally although not intentionally imitated the multicolored embroideries and trellis work of the age old carpet.

In the existence of sculptured stone panels in the inferior parts of the Assyrian palaces can rightly be taken as the first step to later stone building, than the obvious development made in this direction by the famous Persian monuments at Murghab and Istakhr is very educational. Of the original masonry walls that had been built in big parts from crude brick, there stays just the marble corners shaft jointly with the door and window frames. These frames are made of one piece, however are **hollowed out in such a method that the idea of panelling is still clearly evident.** The brick wall was anchored into these cavities and linked to the marble shafts by its dressing, perhaps wood panels or carpets.

With Egyptian monuments, the innovative significance of the wall had by now become more blurred; the hierarchical system (probably primordial, but in any case developed on ruins of very and more nature bound cultural circumstances) gave the carpet motive the fixed significance of a stone hieroglyph. However, the new reason is often rather obvious. Nowhere does the stone wall come into view as such, but is **covered both outside and inside as if with a painted carpet.** Extraordinarily enough, one of the few architectural members that was available to the Egyptian architecture as well revealed the ancient standard of panelling walls.

While in China, as Semper argued, where the four architectural elements most clearly have remained separate from one another, the partition wall which is the most part movable, retains its original meaning independent of the roof and the masonry wall. The inside of the house is separated by such partition walls, which relate as little to the real structure as do the exterior walls, build of brick however hollow and dressed with braided reeds and carpets.

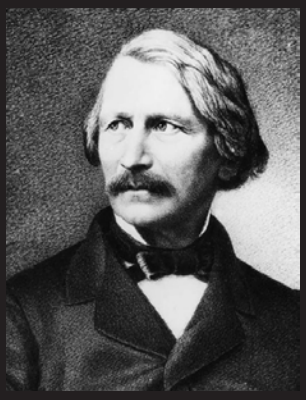
Concluding Semper states that a simple reference to these reports that contain the most complete history of wall fitting, would be sufficient to prove that **dressing walls had been a custom widely practised among all prehistoric peoples.**

In analogous mode, all the exterior surfaces of temples that were intended to show painted sculpture were built for paneling. The pediment, the metopes, the frieze, the balustrades between the columns, and the equivalent lower panels of the cella were therefore arranged. His assertion was

that polycromy arose from that ancient supremacy of the wall fitters's technique over the mason's in home furnishings, and that simply on the massive terrace walls could the mason let his own work emerge autonomous of other works. Even in Greece it is found the same. Therefore, the Parthenon, for instance stands on a terrace of beautiful Eleusinian squared stone; it was the single part uncoloured. Furthermore, barely earlier than the Roman period, did the construction of the wall and the nature of its material develop into treated as a decorative element in the crucial parts of the construction, primarily on the exterior walls. Before this period even the most dignified materials- the granite chambers at Karnak, the Alabaster panels of Nineveh, the ivory panels and paintings, even the golden joints of the temple walls no less than the columns and splendid sculpture of the Parthenon chiselled from snow – white pentelic marble - we given a coat of paint.

Antique polycromy lost its historical basis on one occasion the **wall's material and building obtained their high artistic importance with the Romans. No longer were material and construction subordinate features hidden behind a partition wall, merely serving; they began to create form, or at least to influence it,** a right the roof had previously long enjoyed from the inception of the arts. **Since the wall began to break upon the domain of the roof through the artistic usage of the arch and the vault, even this ancient symbol of sacredness, the roof has been robbed of its supremacy and significance or at least has had it disputed.**

" Yet Gottfried Semper famously thought that the archetype of the wall was the hanging fabric of the tent or the temporary pavilion. The solid walls – of mud, wood, stone, brick that came to supplement these temporary barriers arrived only later, Semper argued, to make permanent the achievement of the temporary wall, which was to define a community via a symbolic membrane. Thus the social and the symbolic is seen as a primary, suggesting a wall that is as dynamic as the humans that it is main to contain…" (Koolhaas, 2014, p.3)



Gottfried Semper, 1803 -1879

"…nevertheless it remains certain that the beginning of building coincides with the beginning of textiles.

The wall is that architectural element that formally represents and makes visible the enclosed space as such, absolutely, as it were, without reference to secondary concepts.

We may recognise the pen, bound together from sticks and branches, and the interwoven fence as the earliest vertical spatial enclosure that man invented, whose construction required a technique that nature, as it were, put into the hand of man. The transition from the plaiting of branches to the plaiting of basts for similar domestic purposes was easy and natural.

That led to the invention of weaving first with blades of grass or natural plant fibers, later with spun threads from vegetable or animal matter. The variations of the natural colors of blades soon made people use them in alternative arrangements, and thus arose the pattern.

Soon man surpassed this natural resources of art though the artificial preparation of materials; the dyeing and knitting of colourful carpets were invented for the wall dressing, floor coverings and canopies.

Whether these inventions gradually developed in this order or another matters little to us here, for it remains certain that the use of the crude weaving that started with the pen – **as a means to make the "home", the inner life separated from the outer life, and as the formal creation of the idea of space – undoubtedly proceeded the wall, even the most primitive one constructed out of stone or any other material.**

The structure that serve to support, to secure, to carry this spatial en-

closure was a requirement that had nothing directly to do with space and the division of space. It was foreign to primitive architectural thinking and was at the beginning not a form – determining element. The same is true for walls constructed out of unburned bricks, stone or any other building materials, all in which in their nature and use has absolutely no relation to spatial concepts. They were used for protection and defence, to secure permanence in the enclosure, or to serve as foundations and supports for the spatial enclosure above, for carrying stocks and other loads, in short for reasons foreign to the original idea of spatial enclosure.

In this connection it is of the greatest importance to note that wherever these secondary motives are not present, woven fabric almost everywhere and especially in the southern and warm countries carry out their ancient, original function as conspicuous spatial dividers; **even where solid walls become necessary they remain only the inner and unseen structure for the true and legitimate representatives of the spatial idea: namely the more or less artificially woven and seamed together textile walls."**

Gottfried Semper, The four elements of Architecture, 1851, p.255

As explained by Jean Philippe Vassal, in the School for the nomads in the middle of Sahara in Niger, there is nothing- no city, no rural community, no tree, jut sand and sky. The temperature is very high during the day, around 50 ‘C and the sky and the sand are white and reverberate in the intense heat. The people that live in this area are nomand and their only routine is the desert.

A straw shelter is the single visible structure says Vassal: it’s a school for nomad children. Its floor area is 70mq, and it’s 1.6m high. **Tree branches are stuck in the sand, other branches connect them to form a roof, and the whole thing is covered in woven millet straw. Oddly, while outside it is extremely warm, one goes indoors under this roof and it is pleasant. The radiation is stopped up, it is dark. Two very diverse atmospheres: the indoors in shadow and the outside full of sun.**

As described by Vassal the difference in temperature creates a slight movement of refreshing air. Thirty kids are seated on the sand, they look and pay attention to a school programme on the television positioned in a table. Under the table, the batteries for it, and on the roof, a solar panel generating the required energy. There was not even an educator. Just a good motive to be in this place.

With only a minimum amount of sheltered, interior space – a tent – the Tuareg nomads perform most of their daily routines outside, moving from one spot to another in search of shade, depending on the course of the sun.

In this way, Vassal explains:*“ the Tuareg ‘live’ their way through a territory along a route that starts at the tent in the morning and ends up there as well in the evening.”*

Due to a shortage of resources, locals regularly construct makeshift shelters out of retrofitted materials. These structures, some of them as basic *‘as stretched t-shirts over twig frames’*, are spontaneously assembled and disassembled once they have outlived their use.

Unaffected by a priori expectations of architectural form and longevity, these minimal and rudimentary structures are as functional as they are poetic in their temporal relationship with the territory.

During their stay in Niamey, Vassal constructed a house for himself on

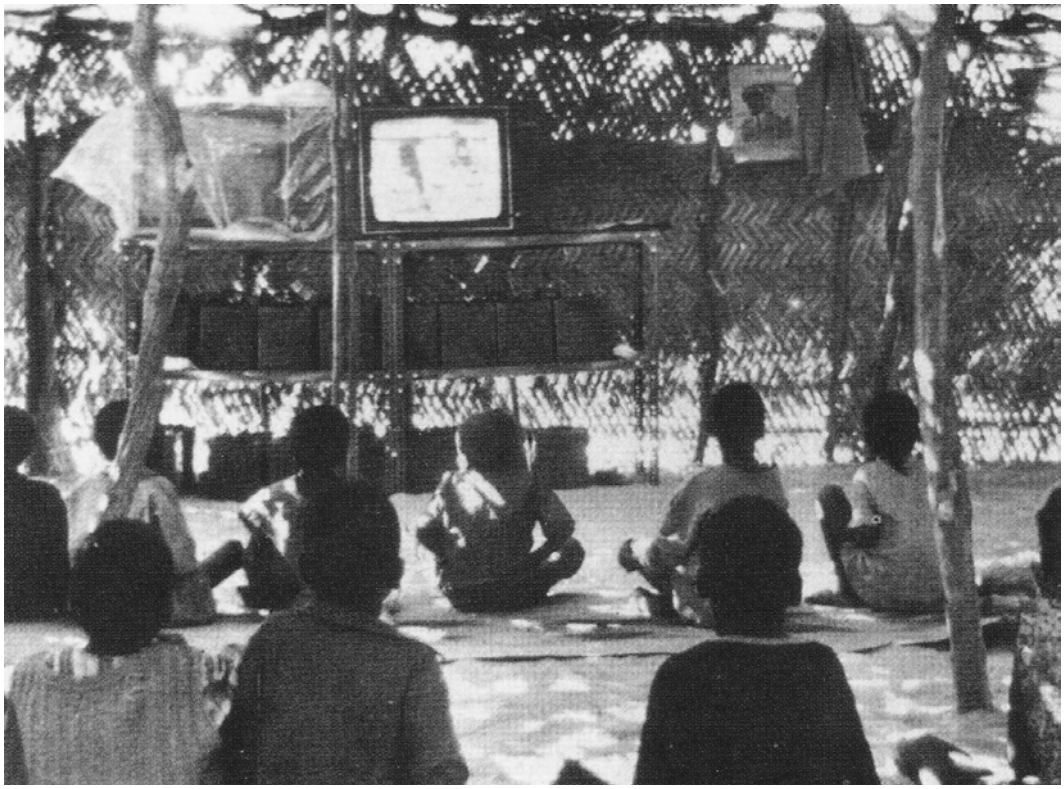


Fig. 2 - Lacaton & Vassal. Children in a school in Niger listening to an educational TV program. The building shelters them from the sun and provides them with a cool interior space.

Fig. 3 - Lacaton & Vassal. Temporary shelters enable human activity: tailor sewing in the shade.

the bank of the River Niger. Even though it merely lasted for two years, its importance as a permanent diagram for the development of Lacaton and Vassal's work cannot be underestimated. Located on an elevated sand dune and comprised of a round volume with a structure made of twigs, straw walls, and a rice matting roof, the house let in fresh air currents from the river and blocked out the blazing sun. The main volume consisted of two concentric circles. The innermost circle, sheltered by both a wall and a roof, furnished the house with just the right amount of interior space, while the outer room acted as neither a fully interior nor exterior space.

Adjacent to this main volume, Vassal constructed a hangar. Sheltered from the sun, this space effectively doubled the project's surface area and functioned as an inhabitable exterior room. **In combination, these three spaces created a gradual threshold from the interior and innermost circle of the house to the exterior landscape, to be occupied according to current weather conditions.** The spatial organization of the straw hut embodied the African principle of living en plein air and provided Lacaton and Vassal with an alternative model to Western architecture, which, caught up with a protectionist attitude, disconnects the building from the outside world. In the straw hut, **the firm boundary of the insulated wall was replaced with the permeability of the straw fence, mediating between the constructed interior conditions and the reality on the ground.**

Fig. 5 - Lacaton & Vassal. Straw metting hut

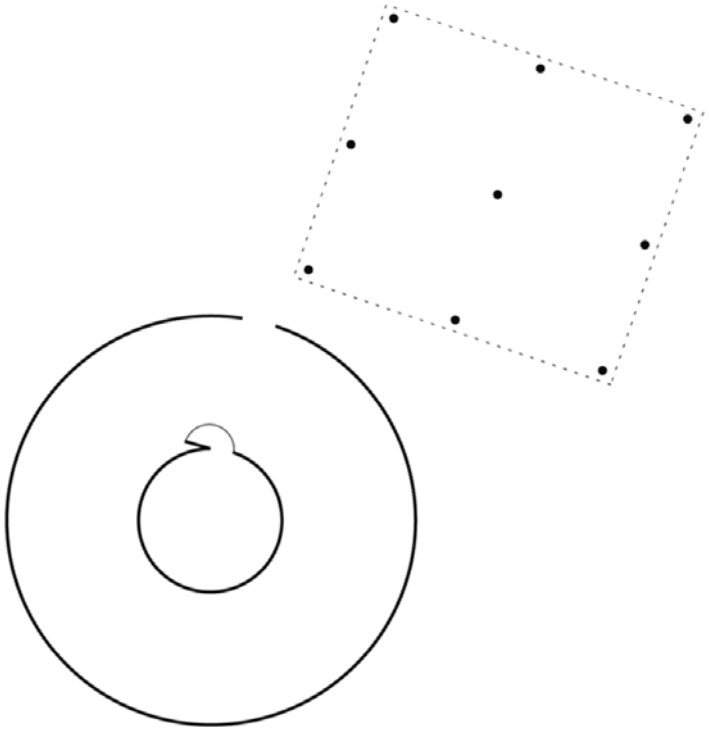


Fig. 4 - Lacaton & Vassal. Straw metting hut, plan

“...football stadiums are like fortresses. Nothing to be seen from the outside; an hermetic, inaccessible private space for public celebrations; When looking onto the constructive elements, the “wall” plays a definitive role, acquiring in both cases a gigantic dimension. The Wall understood as the interface layer with an outer face touching the exterior and an inner one related to the main space. Between these two faces, it is where the highest density of human activity takes place.

A defensive bastion is mostly inhabited in its thickness; the main scene is performed in a rectangular central hall with all its pomp, but the Wall is the actual domestic living space; the real Show, the space for all kinds of transactions.”

from Deconcrete magazine.

http://www.deconcrete.org/2011/02/10/inhabit-a-wall/

THE THICK WALL

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The existing archaeological evidence emerges to remind that mankind can survive, unaided, on almost all those part of the planet that are present occupied, apart from for the most dry and the most cold. The effective word is 'exist': a naked man armed simply with hands, teeth, legs and native cunning emerges to be a practical organism everywhere on earth, apart from snowfields and deserts. However, simply just in order to prosper, rather than just survive, mankind require more simplicity and leisure than a bare fisted, and bare backed, independent struggle to survive could permit. In his famous book "Architecture of well tempered environment" Reyner Banham (1968, p.18) argues:

" A large part of that ease comes from the deployment of technical resources and social organizations, in order to control the immediate environment: to produce dryness in rainstorms, heat in winter, chill in summer, to enjoy acoustic and visual privacy, to have convenient surfaces on which to arrange one's belongings and sociable activities. For all but the last dozen decades or so, mankind has only disposed of one convincing method for achieving these environmental improvements; ***to erect massive and apparent permanent structures.****"*

Partial explanations to these issues have for all time been suggested by alternative techniques; for instance, people wear a coat in the rain, they get in a tent out of the sun, or they get together around the camp-fire in cold evenings. Nevertheless, a coat is not considered to be a sociable solution; tent is short on acoustic privacy albeit it might be satisfactory to keep of prying eyes. In the end, a camp-fire can make available heat and light enough to make a functional area of ground liveable, is short on all sorts of privacy and it does not protect against the rain.
Where settlers were assaulted by individuals they had dislocated, **the blockhouse developed**; where there were feuds among tribal members or where ownership started to turn into the price of the stronger, **the tower took place, the multi-storey house set up on a high and solid sub-**

structure. Around the proprietors of towers weaker occupants inhabited; not believing their own power they required defence, and suzerainty started.
As Semper (1851, p.112) argued, *'a method of building developed as an antithesis to the hut, which for brevity's sake we might call the court building.'*
Still, individual relations could rarely or never develop serenely under these circumstances. Barely was nature defeated by the communal attempts to society when its approvals turn out to be the wanted object of ruder and poorer tribes, against which **defence become necessary.** These methods needed for the defence of the settlement must **have modified their buildings**, yet it did not stop the house from experiencing its own autonomous development, as long as the individuals protected themselves effectively. Nonetheless, in the moment when buildings developed in to the prize of conquerors, things turn out in a different way.
The art of fortification arised and people joined there huts in building forms in which regularity, clarity, convenient planning, and strength were the decisive features

"The primitive houses were huts, simple covers rising directly from the ground. Only later was introduced the protecting wall that introduce the concept of home *as we know it today. So within the experience of the birth of the house, we can distinguish to different ways and forms of understanding the space:* ***the hut, with its subtle elements embedded directly into the soil support the coverage that becomes the predominant element, and the house with its thick walls (the court house).***"
(Guisado, 2006 p.169)

As Jesus Aparicio explains, the Court House is characterized by its perimeter walls and has a horizontal development, while the hut is figured out as a sustained roof with a vertical development.
The prototype of the hut made of light elements under tension, completely open to nature, essentially tectonic, will find accomplishment in the Greek temple. In contrast, the prototype of the house made of walls, closed and

indifferent to the nature, essentially stereotomic, finds its accomplishment in Egyptian architecture and later in the Roman one. [1]

A major place among the architectural traditions that were founded on masonry construction certainly belongs to Egyptian architecture that, in this sense, might almost be considered as the archetype. This is evident not much in the presence and importance of walls in its structure but rather in how the Egyptian wall encapsulates a way of viewing the essence of making architecture and therefore of building.

The cage of the sacred animal signifying the local divinity with the community altar **was enclosed by a plain enclosure** and at first stood on an embankment raised above the Nile. The pilgrims gathered together there, where the processions started and finished. In the moment when the frame of the sanctuary gave rise to a crowding, **a second court was either joined to the first or surrounded it.** Additionally, the demands of the divine service inside rose. The court initially covered simply on particular circumstances with carpets and draperies, later obtained more solid covering and become separated into compartments and treasuries. Furthermore, the entry with its monumental importance, representing as it were the image of the holy cage, strongly indicated the significance of the hidden sanctuary inside and called the pilgrims from far away. The paths the procession had to take were indicated well beyond the borders of the sanctuary.

New courtyards wall were inserted as its significance raised still more; their size and height increase in proportion to the frame of the sanctuary. Moreover, the building developed as well inside; outside the new parts crystallized into a yet richer organization.

Thus, Egyptian architecture arose chiefly from that element we have called enclosure, which was the main field of activity for the guild of wall fitters and their successors, the painters and sculptors.

Gottfried Semper himself, in identifying the four categories of fundamental elements in nature, found a correspondence between **the art of stereotomy and the physical-mechanical characters of stone.**

1 This dichotomy explicitly refers to the opposition between tectonic and stereotomic made by Kenneth Frampton, with reference to the archetypes of the cave and the hut.

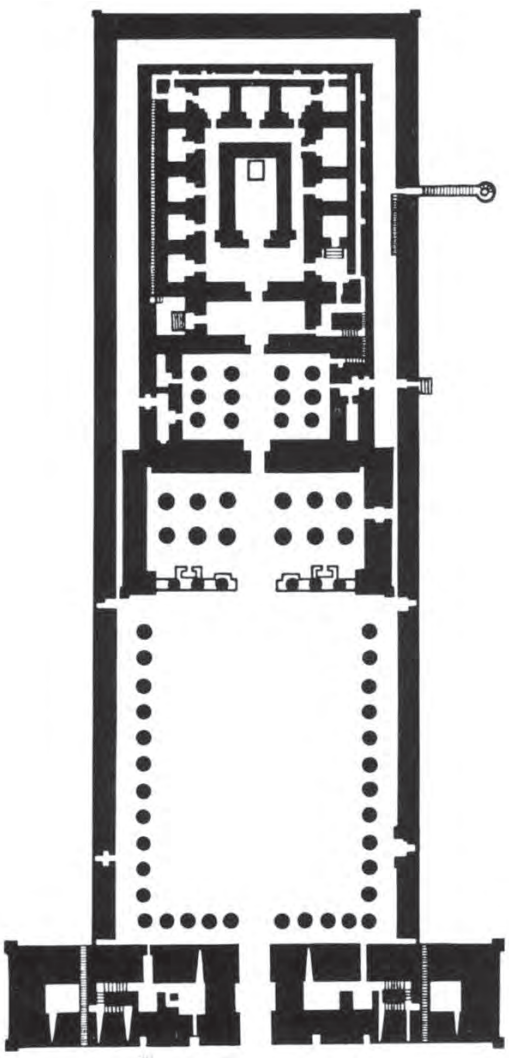


Fig.6 - Temple of Horus, Edfu, Egypt

The series of walls at Edfu are **detached enclosures.** The outer layer enhance the enclosed inner spaces by making them seem protected and mysterious. **Edfu is almost all layers. The residual spaces are closed and dominate the small space at the center.**

The type of work that reveals and emphasizes the fundamental characteristics of stone is in a straight line connected to the activity needed to transform stone itself. This correlates with **the concept of carving**, and, as its comprehensive extension of excavating, a primordial activity that might be carried out on the natural material. **The concept of excavation, in the architecture in Egypt, appears to exceed its literal meaning, to become, by equivalence, the concept of construction itself** as Cacciatore explained in his book "The wall as a living place": ***"We might even say that, paradoxically, what Egyptian architecture tried to build was precisely an excavation".*** (2011, p.22)

Through the perfect reconstruction of the process of transformation of rock into the elements that compose the crucial buildings in Egypt that involve the pyramid or, especially, the temple, it is possible to observe how it is constantly the surface that is expressed firstly, and in the second place, **the wall itself, imagined as a limited mass with a certain thickness set between two parallel surfaces.** It is vital to mention the mode in which, in ancient Egypt, at any time **wall exceeded the thickness that logically permitted for their whole construction in stone, these were constructed by erecting two parallel walls that enclosed a barely dense infill often made of sand**. Moreover, there are cases where, **unusual thickness permitted for the formation of real interstitial spaces resulting between two parallel walls**. Conversely, the concept of permanence of the wall, its resistance to future events, is reflected exactly in the construction in thickness, just like permanence and solidity are expressed on the surface. The final outcomes of such compositional work might be read from a viewpoint that will later appear as crucial in this research.

"If by excavating we may find different architectural elements, corresponding to different levels of organization, this means that ***it is possible to discover a space in the wall's thickness: the space that virtually exists between the layers that make up the wall.*** *But even all those spaces that might have existed before the elimination of the wall's different layers that make up the façade, can and must be contained in the façade itself.* ***The façade requires a complex articulation in order to express***

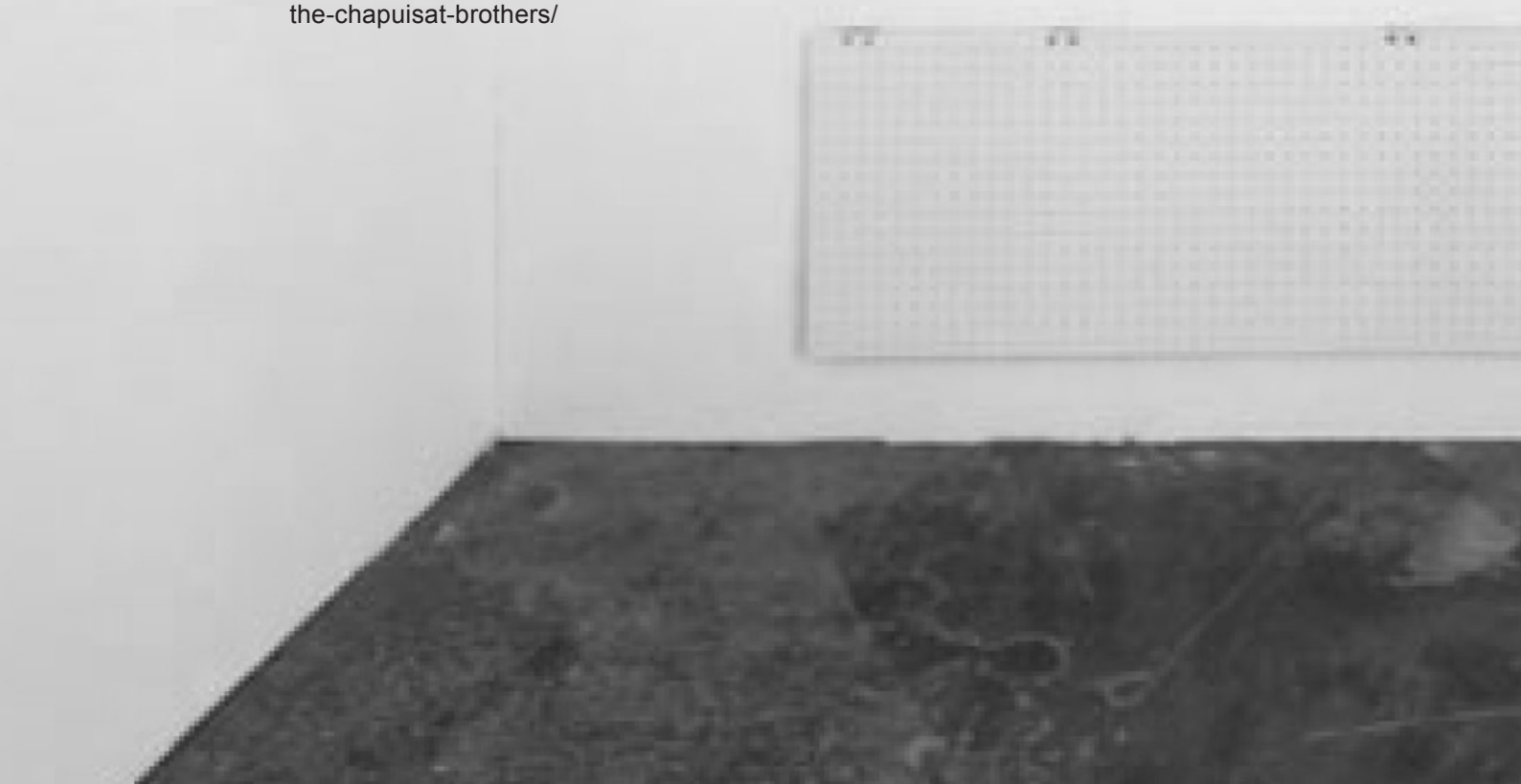
Enter the Space Inside a Wall

The Chapuisat brothers are a Swiss duo of artists who produce constructions able to challenge the current habits in perceiving art installations. Their works are always revealed as visitable environments which the public is invited to explore.

Their series **"Intra Muros"** plays with the nature of art galleries, all become "white cubes", and presents a clean wall, 50-60 cm thick, with the function of supporting other art pieces. At a closer look there's much more: finding a small hatch on the side of the wall, a spectator can enter it and explore the inside like a speleologist. **The wall is organized in a narrow interior pathway and divided in different sub-spaces which synthetize specific living areas like a kitchen, a closet, a restroom, minimal spaces for a paradoxical inhabitation.** The pathway is not comfortable but requires the visitor to rely on his body strenght to be able to complete the exploration.

A similar approach may be found in Chapuisat's 2005 installation, "Hyperespace" in the Kunsthalle Sankt Gallen in Switzerland. **Entering a hole in a wall the viewer will slide for several metres before being immersed in a labyrinthic space made of cardboard but perceived from the inside as a cave.** Once inside, the only way for the visitors to get out is to crawl and wriggle through the complex pathway until he emerges on the other side.

from Socks Magazine
http://socks-studio.com/2014/03/01/enter-the-space-inside-a-wall-two-installations-by-the-chapuisat-brothers/



the building's inner and outer conditions, to reproduce intermediate spaces between the fully urban condition of the outer space and the specifically architectural condition of the interiors"
(Iñiguez, 2001, p.145)

In the citation above, Manuel Iñiguez pointed out that, as an **opportunity implied in the buildings that are based on the significant usage of wall and on the work that can be achieved in its thickness, the opportunity to generate meaningful interstitial spaces.** Albeit this vision is not novel in the history of architecture, it simply in fact appeared when it became a vehicle for meaningful values as well as for simply structural or functional issues. The idea of using the wall's thickness to create interstitial spaces may be found in different examples of diverse ages.
Excluding the examples of Egypt, where the construction of **hollow walls was consequence mechanically determined by the increasing thickening of the wall that beyond a certain limit, had essentially to become a double parallel wall, either filled with sand or left hollow and used for circulation**, the most representative buildings can without a doubt be found from Roman age. As it had by now been indicated, due to the introduction of valued structures, outstandingly thick masonry architecture evidently demonstrated a crucial role in the Roman world. Without a doubt the most representative example of this development and the subsequent spatial, expressive and functional solutions due to the usage and treatment of thickness is undoubtedly the Pantheon, as recognized by Leonardo Benevolo citation below:

"The Romans […] differentiate the consistency of walls and vaults both by using different materials that get increasingly lighter from the bottom to the top, and by framing the masonry fabric with ribs or relieving arches, but do not apply such efforts to the general composition, ***as they view all the solid parts, beyond the wall's edge, as a homogeneous block, as though space had been created like a mould from a shapeless dough.*** *Such compromise generates the structure by concretion, given the habit of filling all the wall thicknesses with horizontal pillared layers of*

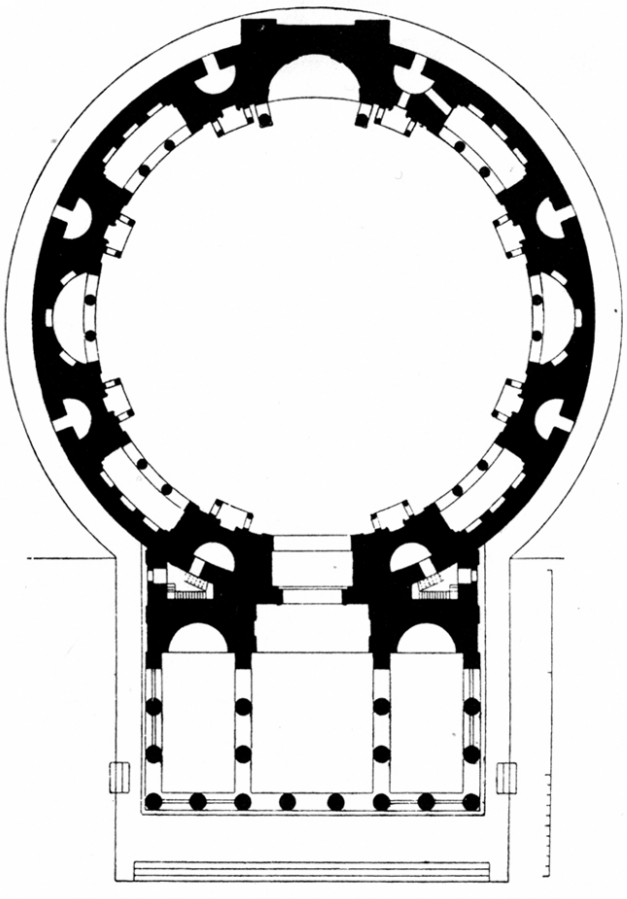


Fig.7 - Pantheon, Rome, 118-128 AD

It is imperative to mention that the Romans were the first to undermine natural stone through the innovation of opus caementicium, hydraulic cement which could be poured into any shape and would set into a stone like material. Their discovery, utilized widely during the late republic for architectural and infrastructural work, was engaged most remarkably in the dome of the Pantheon. This example shows the structural and sculptural potential of the new and marks the start of a curse which the building industry is still attempting to deal.

concrete into which the secondary frame is drowned.
[…] But the need to balance the side thrusts, when the vaults are particularly large, produces a definite break of the continuity of the masonry fabric, with a transversal staggering of the structures of the pier in the direction of the thrusts. The Romans try to avoid such difficulty with a systematic buffering of vaults with vaults so that the thrusts are mutually eliminated. Only from a certain point – from the Pantheon on, we may say – does emerge the solution of a large isolated vaulted building that must support itself with a proper inner articulation. ***Given this kind of problem, it becomes impossible to consider the masonry mass as a mere homogeneous limit, and its articulation necessarily influences the architectural composition****"* (Benevolo, 1960, p.69-74)

In the Roman Temple, a belt of columns typical for the Greek Temple did not protect the sacrum cell, but **the perimeter was extended until the edge** incorporating them. The semi columns lean against the perimeter wall did not have a structural function and this trait was a peculiar aspect of the architectural culture of the Roman Empire. An innovation of this kind would not have been possible without a technical evolution that can support daring construction to the point of determining free lights for over forty meters, as in the case of the Pantheon. We can deduce that **the wall perimeter of the vaulted circular hall represents a fundamental precedent in the history of architecture, a point from which the basic conception of space underwent a significant change.**
The Pantheon's huge masonry mass is indeed articulated, towards the inner space, by a series of niches excavated in the wall's thickness. Given the massive dimension of the central space and of the structures needed for its support, it is possible to talk about actual habitable rooms entirely 'drowned' beyond the wall's perimeter. In addition to the significant and compositional implications, this as well requires an **atypical spatial solution that creates a central, hierarchically existing, space bounded by a collection of minor spaces directly dependent on it and exclusively inward-looking, following a model that it can be defined of central development or of 'centripetal' na-**

ture. It is significant to point out that a brad catalogue of Roman or late Roman spaces may be related to this type of model.
In fact, while Roman architecture persisted to utilize the types of Greek architecture mostly based on the usage of porticoes, simultaneously it tried out many new types of public buildings that include thermae, basilicae, markets, and much more, that were created by functional rather than monumental needs and more and more implied the requirement to include large areas and cover them with vaulted structures. Moreover, other buildings such as theatres and stadia that in the Greek world were usually adjusted to local topographical circumstances now as well needed to be created without such generating standard, as they were erected in urban areas. All these elements helped the appearance of **large structures built by using massive enclosing walls.**
Over time, this process of integration would prevail and lead to the gradual dissolution of the different elements and isolated supports into the thickness of the wall. Hence, the classic column was included in a systematic process of transformation of the severe laws of proportion that had contributed to protect it as a steady form and, isolated within a system with increasingly massive characters, adjusted to the new circumstances by changing size, shape and proportions of its parts.
The person who would reach such process of integration during the period of Renaissance was **Lean Battista Alberti who, by re-establishing the classical combination architrave-column and arch-wall, would provide a ground-breaking and stimulating reading of the Roman system of superposition of architectural system and masonry wall.**
He imagines the Roman architectural system as a whole where **form and building function are integrated by the firmitas of the load-bearing wall.** The attention of Alberti would concentrate on the opportunity of restoring both (form and building function), by using the wall, to a unity that did not exist before. With his work Alberti brought the origin of architecture back to the wall, thus introducing a completely different building concept that would lay the basis for a radically different reading of the Roman architectural system.

Rome and the double wall

One of the first evidenced urban fires was the Great Fire of Rome and it raged for six days in July of 64 AD in the first decade of the sovereignty of Emperor Nero and it placed waste to two third of the city and it modified the plan forever.

Before the conflagration the suburban fabric of Rome was multifaceted: of the structure within Rome, approximately 1.700 were private homes, which represent a minute number taking into consideration the city's labyrinthine warren of apartment houses, or 'insulae', which numbered approximately 47.000. Even though Roman property ownership is completely identified by the land that a building is located on, **the walls around them fall into a grey zone**. **No codification exists for the separation of walls between properties**, and there is little devotion to property ownership laws, a result of the chaotic layout of the insulae that may have speeded up the spread of conflagration.

The state seized the conflagration as a possibility to reassert power over the disordered city. By endorsing regulations of new construction, the emperor was capable to minimize Rome's risks of future catastrophes, but as well to clarify issues of adjacency in Roman property law. **Previous to the code, ambiguously shared walls separate adjacent buildings. Nero's new post-fire code, established clear division between contiguous buildings** *"aedificia…nec communion parietum, sed propriis quaeque muris ambirentur"* (Buildings should not have common walls and a building should be contained by its [own] walls"). Where neighbouring buildings meet, **widespread walls are authorized as two layers parsed by the property line**. **The compartment, defended by a double – plied wall, is born.**

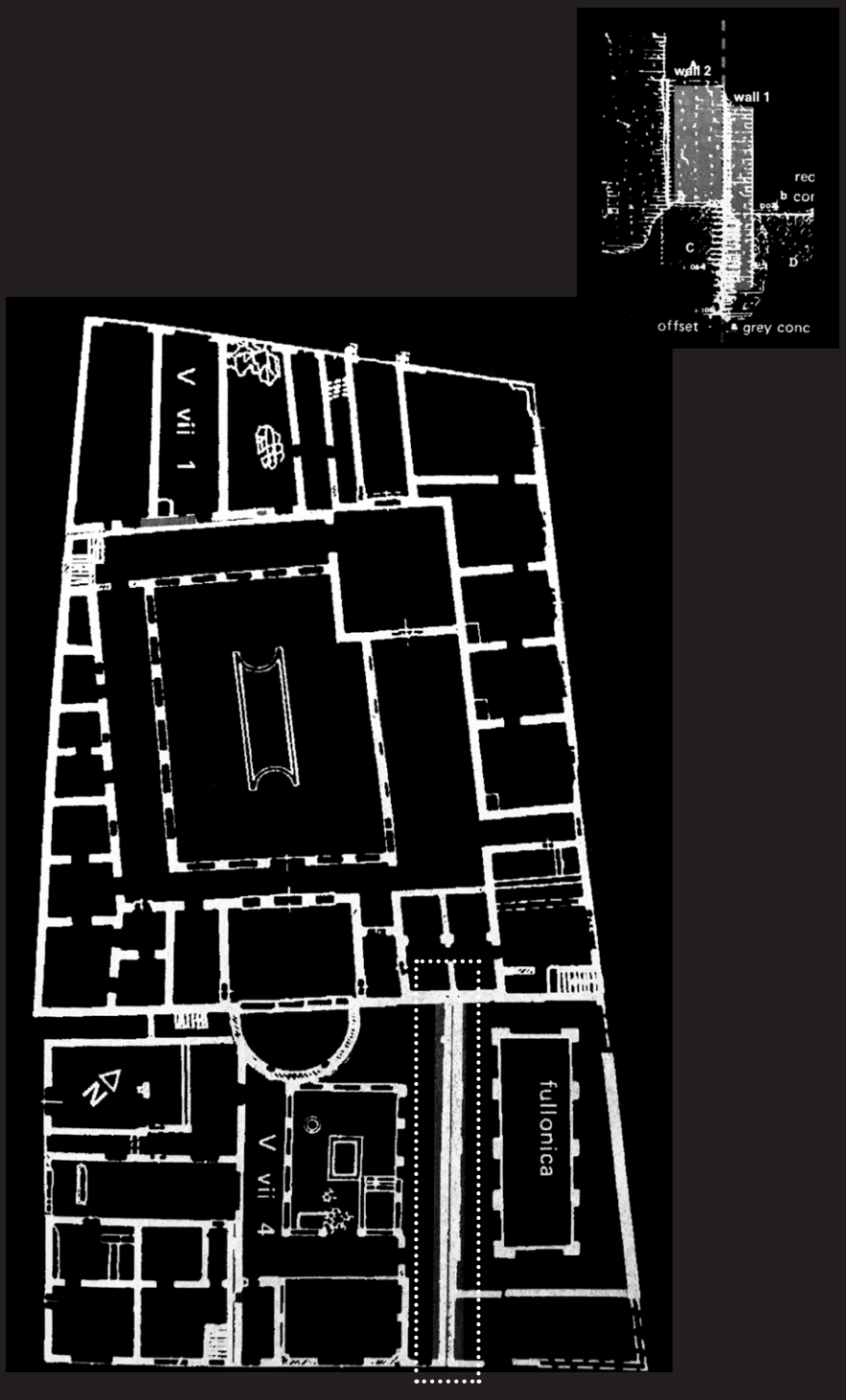


Fig. 8 - 150-165 AD Guild of the Augustales, Ostia
showing double-wall construction between adjacent structures built after the imposition of the Neronian code.

“For Alberti the Roman architectural organism was a whole that combine form and function by means of constructive firmitas of the bearing wall. His interest will focus on the possibility of bringing both (shape and constructive function into the wall, into a unit inexistent in origin.
Romans used the Greek order, whose constructive concept based on the lintel structure with isolated holders, hardly suited to a wall as the Roman one with an opposite constructive character, based on the forces developed by the arc. The primary objective of Alberti’s proposal was the overcoming of this dichotomy of meanings; for this he ***gives the load-bearing wall a predominant role, that is, a role rector within the system and not only in terms of form but much more as a concept.*** *By working this way, Alberti leads the origin of architecture to the wall, thereby introducing a totally different constructive concept that sets the stage for a substantially distinct reading of the Roman architectural system. Alberti gives also a new vitality to the Roman overlapping of orders, giving it a new meaning in a whole that is already defined as a wall”* (Iñiguez, 2001, p.128)

Moreover, the most outstanding asolution considered by Alberti in this direction is that of the façade of the Malatestian Temple in Rimini. Here **the original walls are thickened by means of a heavy masonry enclosure**. The pre-existing medieval construction was therefore changed into a kind of inner cella of a new temple that is not enclosed in the classical peristyle of columns typical of Greek-Roman temples, but **by a continuous wall that encapsulates it**. A row of rooms open onto the sides of this masonry box which express the intermediate piers as though they were a series of square pilasters connected by upper arches. In this case, therefore, t**he theme of arch and wall is correctly restored, as the massive pilasters between the rooms appear to be created almost by removing part of a previously solid wall and are perceived as actual fragments of an interrupted wall**; on the other hand, the pilaster itself clearly becomes a key element, with a both constructive and representational meaning.
Concerning this, after Ablerti, the perimeter would turn out to be the most complex part of the construction, so much so that it can accommodate and correspond to all issues posed by the resolution of the entire construction.

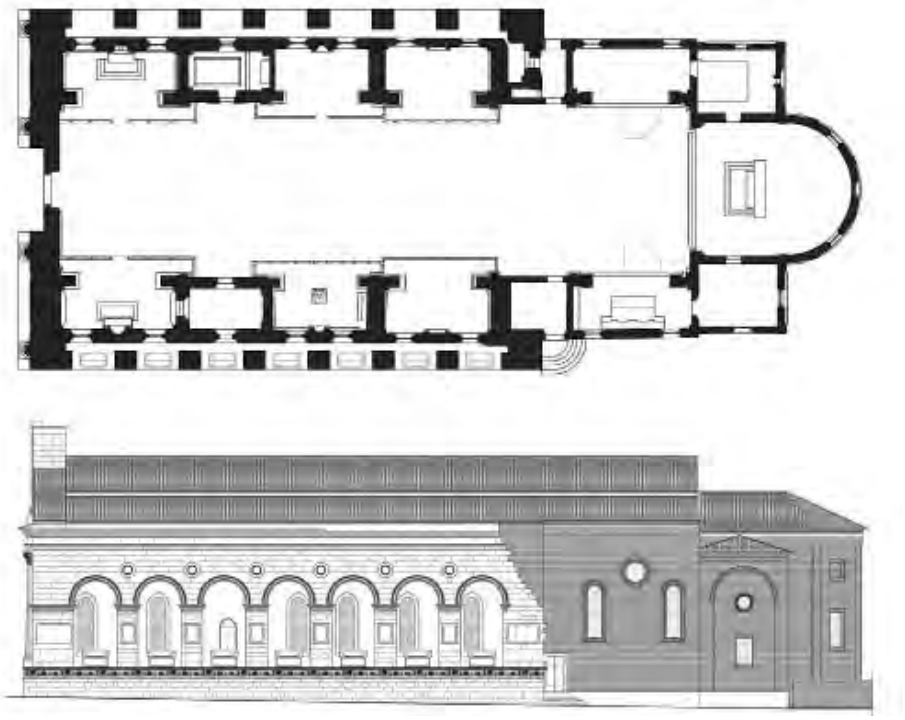


Fig.9 - Tempio Malatestiano, Rimini, Leon Battista Alberti, 1472

The architecture return to identify itself with the solid wall, dug by a series of internal chapels, and pierced by smaller openings on the external facade. Alberti's work bears witness to the return of the importance of the solid wall system, starting from the re-elaboration of one of the most representative elements of Roman architecture: the Arch. It found a vivid expression in the first San Francesco in Rimini, where Alberti realizes an external wall enclosing an existing structure.

So considered, **the perimeter therefore became the outcome of the convergence of a range of contrasting, internal and external, stresses, that are expressed through the wall's physical support.**
The Alberti's theory developed **the concept of excavation into the surface of the wal**l as a means of expressing the elements of the architectural orders as the consequence of a sculptural process. (Cacciatore, 2011, p. 34)
Although Alberti, in order to maintain a formal coherence between the wall and its composition, had stopped at the pilaster strip or the pilaster, his work **actually opened a virtually endless possible process of formal development, so much so that the wall would from now on become the physical focus of an almost exasperated experimentalism.** The architecture theme based on the solid wall element does not end in the work already described, but turn back strongly in the project for Sant'Andrea in Mantua.

"Here Alberti is forced once again" au pied du mur " literally, once again, at the bottom of that enormous, high and extended wall that bounds the nave of St. Andrew and that together with the one present on the other side, represents statically, executively and expressively the principal structure of the great barrel-vaulted space, or better the essence of the fundamental element of the new type of Christian basilica, conceived and designed by Alberti thinking about the ancient examples, precisely the great basilicas facilities, bath structures, etc.
A great big wall, a wall as it is necessary, along with his cross and secondary elements, to express the stability, the static nature, the sense of durability of this great building, a wall with large also visual thickness, like a big mass that through successive lightening becomes almost a lattice, an intersection of walls, which give mutual support, intended to include the major and minor chapels, as well as the different types of openings to light up all those spaces, without losing, however, the ancient memory of the work of the Pantheon, before all its consistency of massive surrounding wall.*"* (Grassi, 2007, p.120-121)

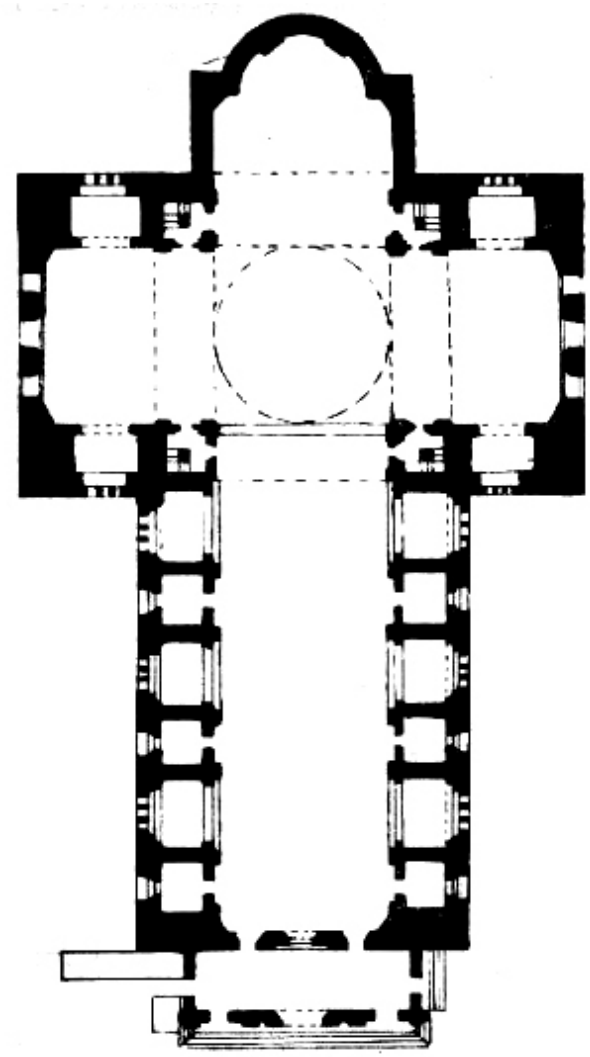
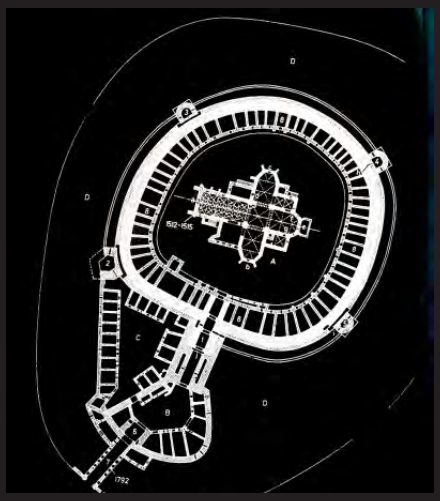


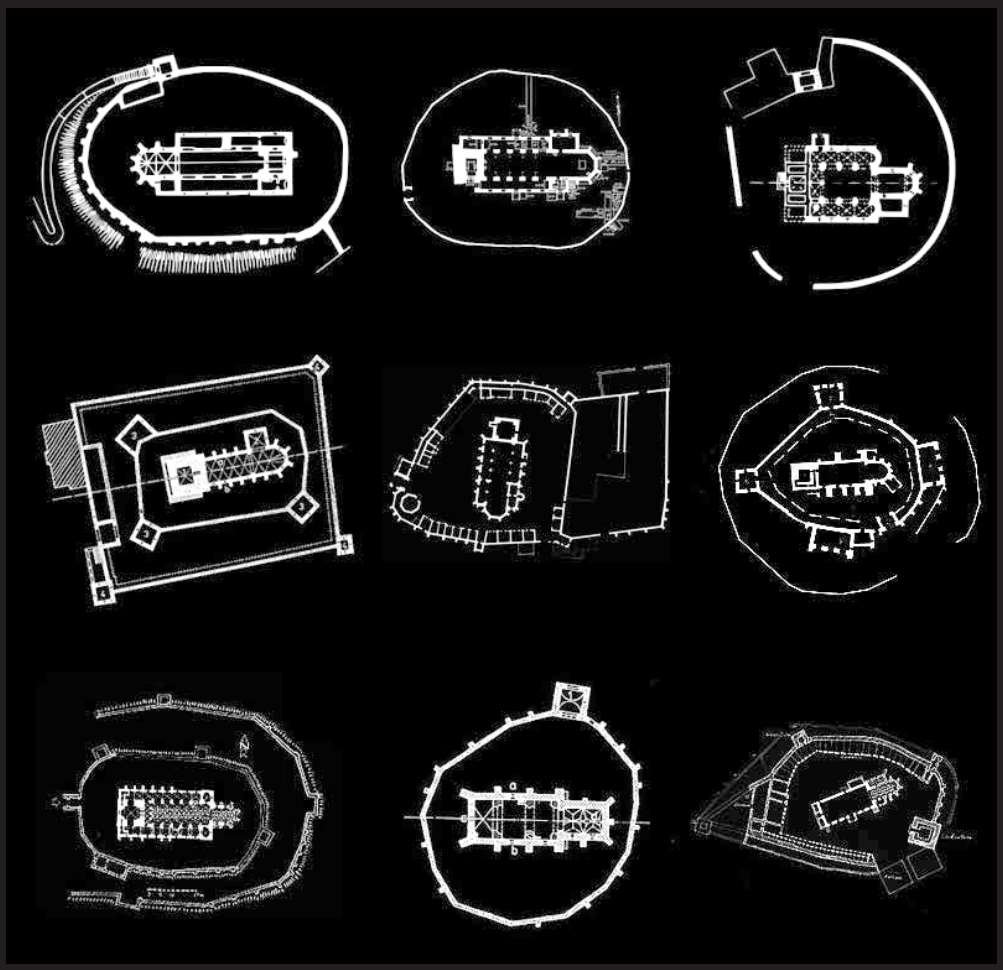
Fig.10 - St.Andrea, Mantova, Leon Battista Alberti, 1472

Fortified Churches in Transylvania

Another interesting case in history related to the usage of **the thickness of a wall as an inhabitable liminal space** may be found in different fortified churches present all over the Transylvanian land.
In the period of 12th century, part of Transylvanian area (today's Romania) was colonized by the Saxons. From the period when this region was under the regular threat of Ottoman or Tartar invasions, most of the communities **begun building fortifications walls around the centre of their social lives: the churches of the villages.**
With the purpose of hosting the villagers during the long sieges, defensive towers and storehouses, and also residential rooms, were increasingly added. Various kinds of fortifications may be found, the central element constantly being the church. In certain situations, **simply a small wall was eriged, from time to time multiple rows of fortification or even a real fortress with bastions and iron gates were constructed.**
The plans show the striking difference between the regular-designed-proportions of the sole churches and the **unplanned form of the simple or inhabited walls which mainly follows the topographical conditions.**

from **Socks Magazine**
http://socks-studio.com/2013/11/21/walls-as-rooms-2-fortified-churches-in-transylvania/





The ultimate consacration by Alberti of the wall enclousure as the basic structural element of the project, turn out to be the reason and result of a combined spatial relation that recolled principles of a past that the Middle Ages had contributed to forget, but that he came into vogue in the effort to state the supreme degree possible the **structural-compositional logics belonging to the continuous wall system.**

Such understanding of the interior space is evidently a prototype of later solutions that would find final expression in the Baroque architecture throughout an idea of the central space defined by the massive wall enclosure.

It is essential to mention that the spatial concept that best described the history of Western architecture from Roman period until the end of the 17th century was in effect steady and connected to **an idea of unified space, internal and independent, in which individual buildings were linked by means of continuous spatial transitions determined by the wall structure**. This situation is described by various factors; among the most important, for the reasons of understanding of such spatial continuity in a quite brad time frame, is the fact that for a long period did not occur technical innovations such as to move constructions towards new forms of expression.

The old tradition of enclosed and contrasted inside space, has been recognized by some Modern masters, even if it has not been much emphasized by the historians. As Robert Venturi writes in his famous book 'Complexity and contradiction in Architecture':

"The essential purpose of the interiors of buildings is to enclose rather than direct space, and to separate the inside from the outside. *Kahn has said: "A building is a harboring thing." The function of the house to protect and provide privacy, psychological as well as physical, is an ancient one."* (Venturi, 1977, p.70)

Louis Kahn is one of the few architects who specifically mentions the use of architectural poché. **Kahn's "servant space," which sometimes harbors mechanical equipment, and the poché in the walls of Roman**

and Baroque architecture are *'alternative means of accommodating an inside different from the outside.'* (Venturi, 1977, p.70)

Kahn acquired this term certainly from the Beaux Arts's educational model and the careful observation of the ancient buildings:

"Some of my ideas in planning came from the poché, from looking at the plans of the old works, not just the Beaux-Arts. ***The sense of structure appeared in the poché. We knew little about the structure; but we knew that the poché was the generating part of the structure – where – there was a wall, or a pier, or a conglomerate kind of pier which was in a sense a very articulated wall. From poché I learned the difference between the hollow wall and the solid wall.*** *I got that directly from Beaux-Arts. And what's I wrong with it?* ***I just peeled away the interior of the wall, ate it up, and used the exterior which is the only effective part of the structure anyway.*** *That came directly from mu training in Beaux-Arts. So did the idea of the service spaces and spaces served"* (Kahn, 1974, p.332)

Louis I. Kahn's work is a sort of trait-d'union that appropriated and reassessed the legacy of ancient "thick" building tradition and made it available as an experimentation ground for the contemporary architectural world. He explained that himself, precisely in relation with the **reversal of structure from solid to hollow:** looking at the medieval building heritage, that he appreciated for its combination of identity and integrity, he said:

"In Gothic times, architects built in solid stones. Now we can build with hollow stones. The spaces defined by the members of a structure are as important as the members. These spaces range in scale from the voids for air, lighting and heat to circulate, to spaces big enough to walk through or live in. *The desire to express voids positively in the design of structure is evidenced by the growing interest and work in the development of space frames […] Structures should be devised which can harbour the mechanical needs of rooms and spaces […]*

It would follow that the pasting over of the construction, of lighting and acoustic material, the burying of tortured, unwanted ducts, conduits, and pipe lines, would become intolerable" (Frampton, 2001, p.215)

During the 20th century, indeed, thanks to ground-breaking technologies in the service of architecture, are generated favorable circumstances for **experimentation on hollow structural elements, for the building of both horizontal and vertical partitions.** This experiment, at least for the first two years, it was fundamentally imposed by technical reasons, that is to make improvement of these **cavities for the passage of equipment and technologies more and more present and voluminouswithin new architectures.**
Furthermore, Kahn would in fact state an increasingly marked **interest for interstitial service elements,** an approach that would permit for a **plain division between secondary 'servant' spaces that include elevators, service cores and mechanical system conduits, toilets and much more and the main 'served' volumes,** therefore giving place to a real and geometrically defined hierarchy of spaces. Hence, it is from this significant concept of hierarchical characterization of space and not from secondary derive Kahn's well-known difference between servant and served spaces. Francesco Cacciatore in his book "The wall as a living place " pointed out this tendency:

*This possibility of an **interstitial space that gradually grows until it substantially increases it accommodating capacity,** would be from now on the defining character of Kahn's work... He would, almost literally, try to achieve the declaration of intent expressed in coincidence with the presentation of the new structural possibilities offered by the City Tower's web systems where the possibility of **generating interstitial spaces increasingly larger to the point of being inhabitable became evident. These spaces would, gradually, range in scale, to quote Kahn's words, "from the voids of an insulation panel, voids for air, lighting and heat to circulating systems", hence service spaces and for system conduits like in these early examples of thickened ceilings, to "spaces***

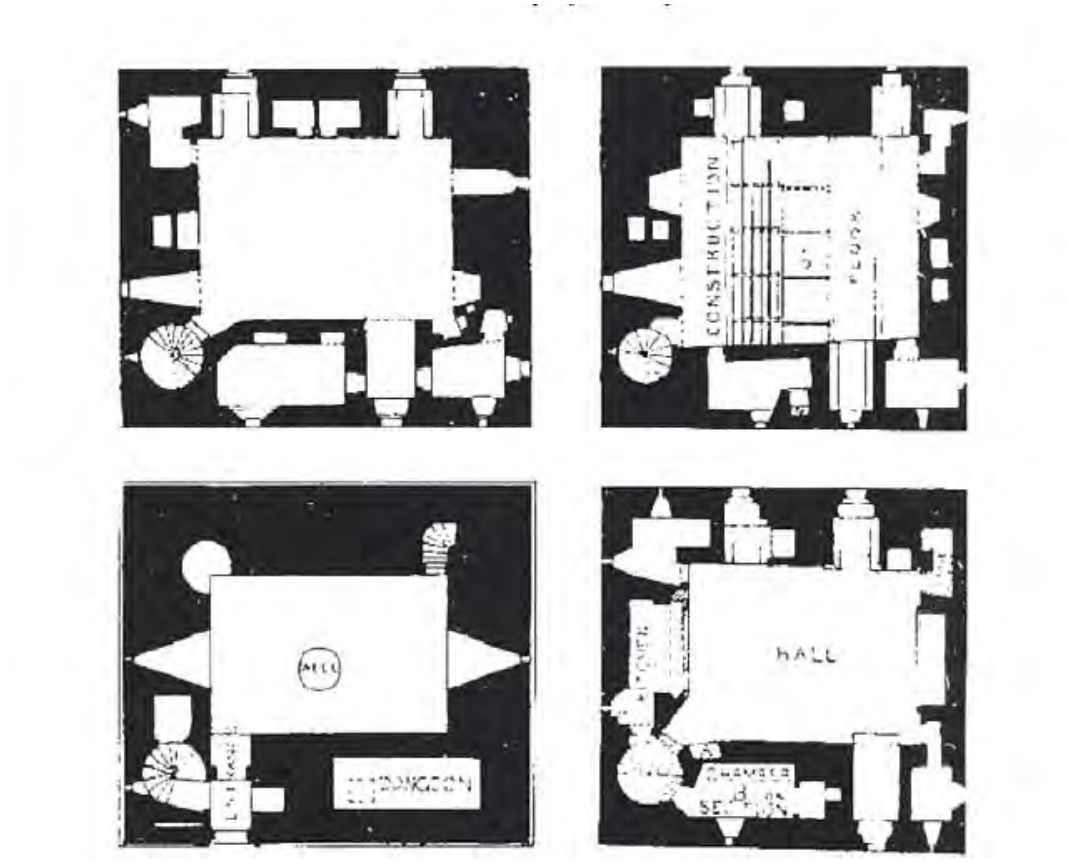


Fig.11 - British Castle Floor Plan Sketches by Kahn. *Source: Brownlee, David B., and David G De Long. Louis I.Kahn: In the Realm of Architecture. Los Angeles: Museum of Contemporary Art, Rizzoli, 1991, 68.*

The floor plan shows subsidiary rooms and a stair contained within the thick walls of a single central room. The main room is so dominant, clearly defined and undisturbed by its surrounding support spaces that the castle retains the sense of a one room building. Louis I. Kahn saw in it a way to provide services without compromising the integrity of primary spaces. He wrote: *"The Scottish Castle. Thick, thick walls. Little openings to the enemy. Splayed inwardly to the occupant. A place to read, a place to sew. . . . Places for the bed, for the stair. . . . Sunlight. Fairy tale."*

big enough to walk through and live in". (Cacciatore, 2011, p.88)

He argued that Kahn seemed to simultaneously promote two different tendencies, that would lead to clearly distinct formal solutions and interstitial spaces with different functions and characters. ***"The first one is originated by a process of 'folding' of the wall, while the second one results from an idea of the wall itself 'duplicating'."*** (Cacciatore, 2011, p.88)
The design for the **Morris house** in New Jersey, demonstrates in this sense certain significant new elements and nearly appears to aim at a reconfiguration of the traditional way of conceiving the building's boundary. As Cacciatore claims (The wall as a living place, 2011, p.110) the **perimeter walls** to the east and south were **achieved by a repetition of small walls transversally laid out that, essentially, establish an extraordinarily deeper thickness in the closing wall**.
Nevertheless, the interstitial space generated by the in-depth work in these fragments of wall is not incorporated as a useful space of the house, as the window frame is placed on the inward and back plane. Hence, depending on whether the portions of wall are translated into a constant or point support, **a conventional porch or normal sun-shading loggias are generated**. Exactly in one of the middle versions of the Morris House, nonetheless, Kahn saw that, by merely moving the window frame on the external plane, this interstitial space could face to the inside and be incorporated as an actual room on the house generated into what is in fact the wall's 'virtual thickness'.
While in the **Esherick house** in Philadelphia, planed between 1959 and 1961, Cacciatore states that one can evidently see how the **perimeter walls are imagined in the sense of 'perceivable thickness' due to the wall folding inwardly** to decide, depending on the folded section's depth, an obvious but remarkable thickness in both symbolic and practical terms. Indeed, observed from outside, the wall gives an obvious idea of excessive mass, while the 60 centimetres of the privately **folded wall create a series of interstitial cavities that may be simply utilized to accommodate furniture,** objects and seating. The construction where Kahn brought this system of folded walls to an intense refinement is without a doubt

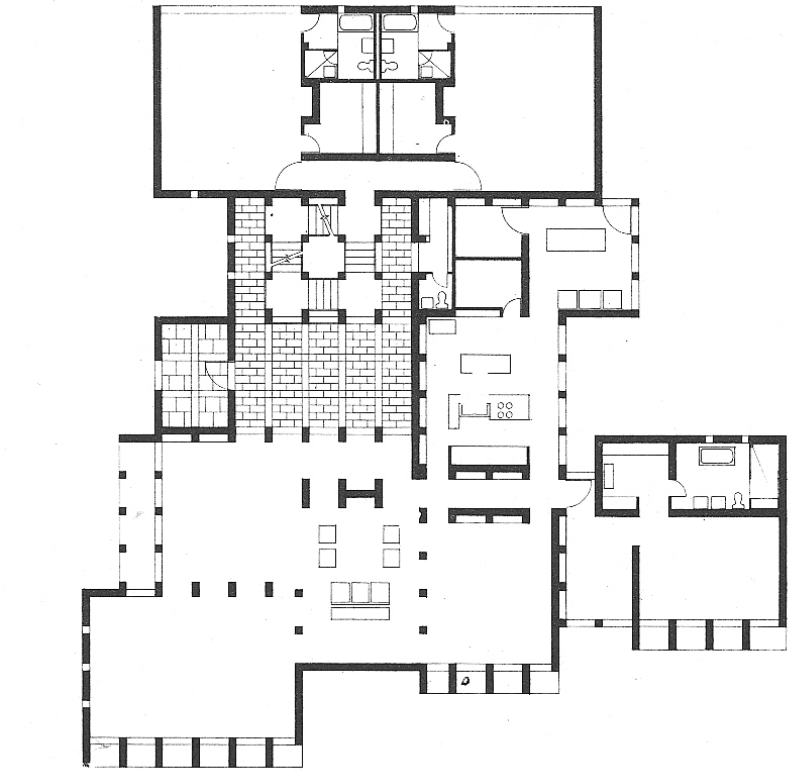


Fig.12 - Morris House, Louis Kahn, 1959

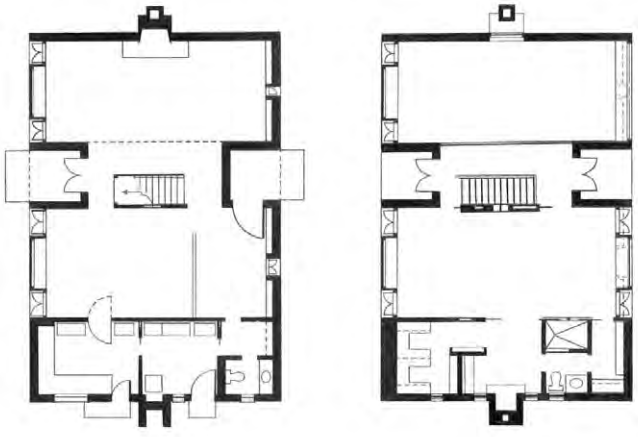
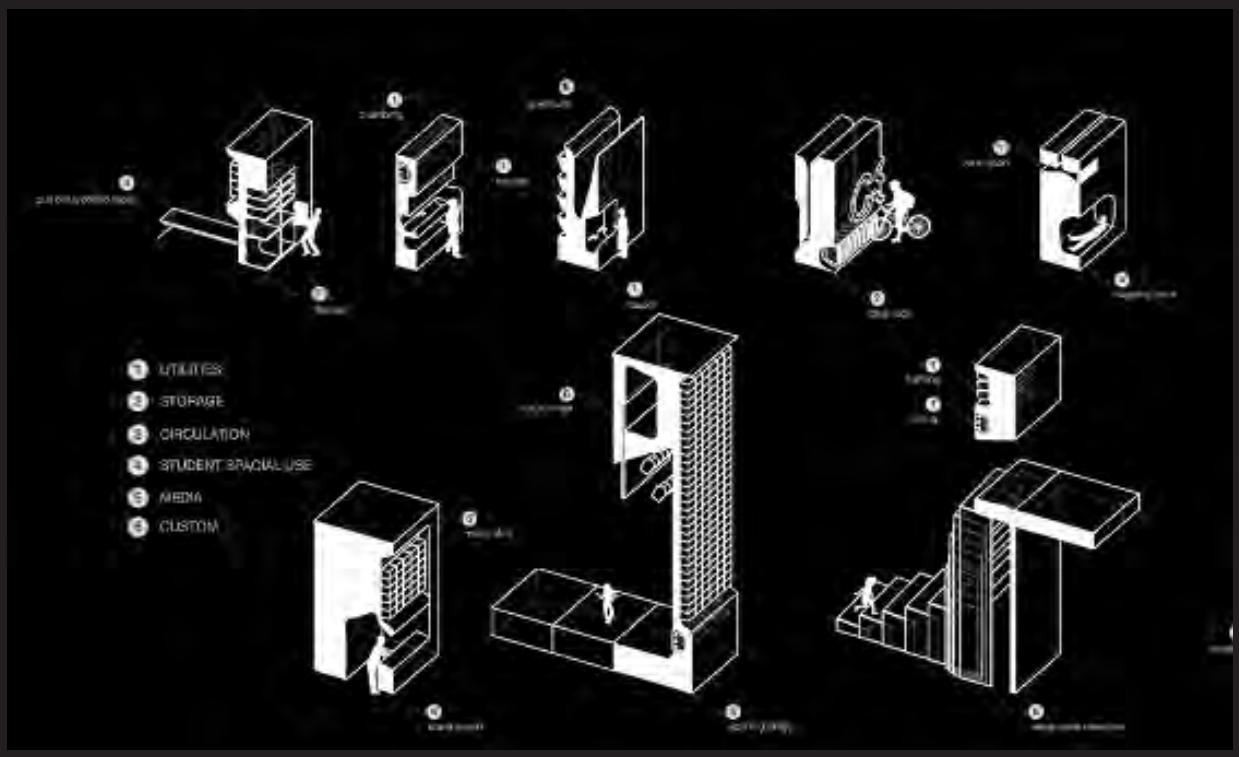


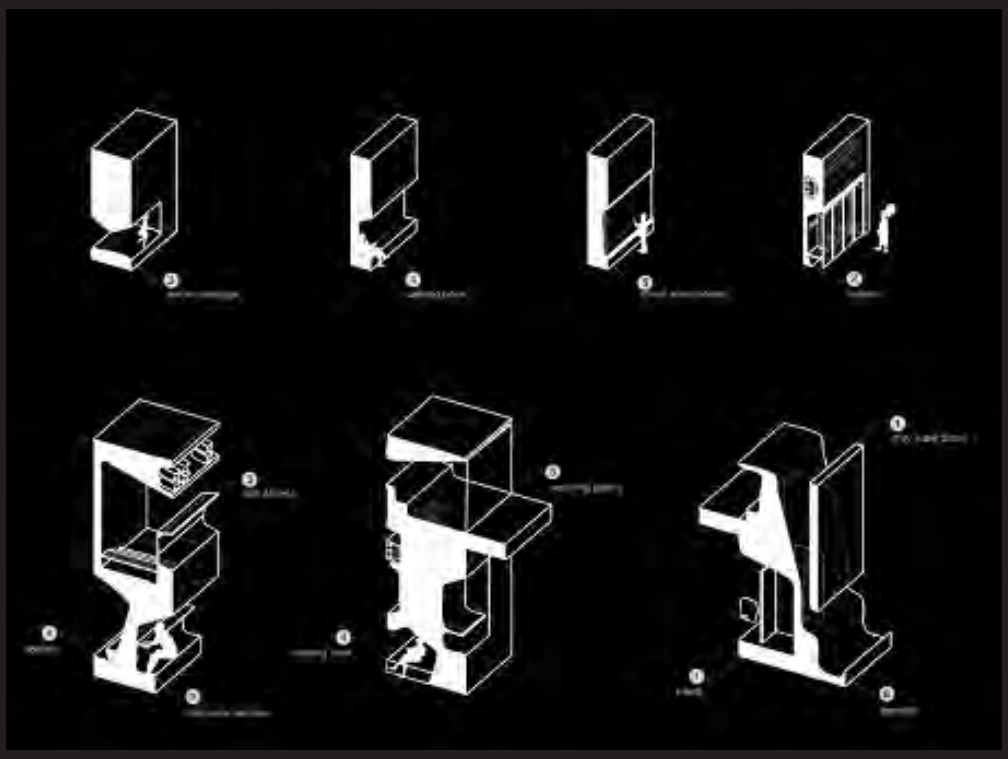
Fig. 13 - Esherick house, Louis Kahn, 1959

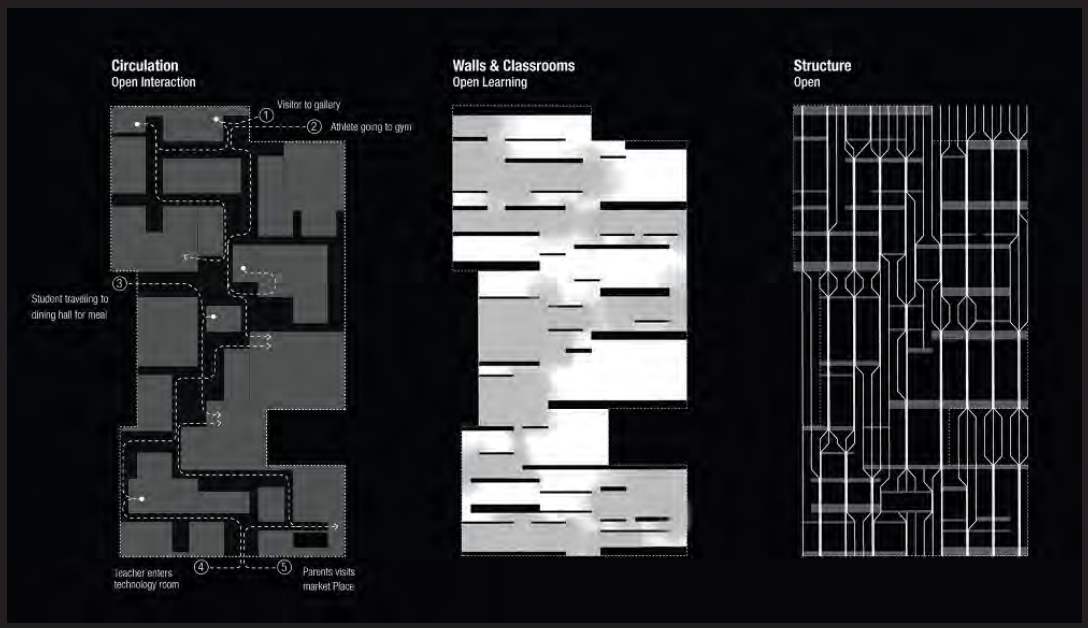


walls as furniture

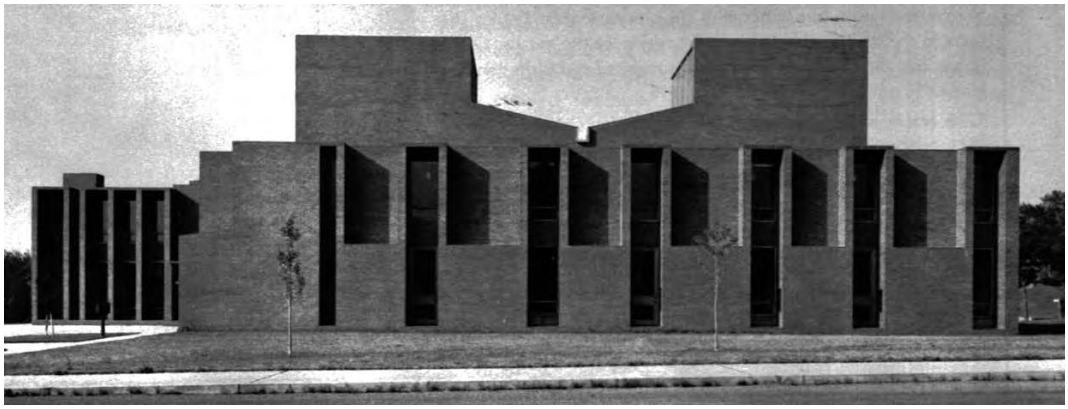
Wall types allow for a full integration of service spaces (washrooms, closets, mechanical), access (stairs, elevators), and room-specific utilities (shelves, sinks, darkrooms) into the walls, thus freeing the space. Each wall is customized and is what generates the identity and range of uses of each room. As the solid wall is subtracted and subtracted, a colour is revealed that tints the hue of the room, giving it its identity within the school.

LATERAL OFFICE, Cleveland Design Competition , the Open School
http://lateraloffice.com/THE-OPEN-SCHOOL-2011




Circulation
Open Interaction
Visitor to gallery
Athlete going to gym
Student travelling to dining hall for meal
Teacher enters technology room
Parents visits market Place
Walls & Classrooms
Open Learning
Structure
Open

the **First Unitarian Church and School in Rochester** where the guiding concern behind the overstated increase in thickness is the control and modulation of light. As the concern of light more and more developed into a foundation in Kahn's work, walls grew thicker, and he worked into their **thickness to generate interstitial spaces that could be planned to become inhabitable.**



A declaration of intent that refers instead to the duplicating wall, is dated 1961, when Kahn wrote:

"Because a wall has an interior which is different from an exterior … we have come to the point where this realization now can separate an exterior wall from an interior wall … and create space between them that you could walk between, that which you couldn't do with a solid stone wall".

The perfected **application of the duplicating wall principle** is presented for the first time by the **Salk Institute for Biological Studies**. This system is mainly applied to the unbuilt design for the meeting house. At this time, Kahn imagined a solution with the dining room and meeting room enclosed by a second system of independent walls, therefore **generating a specific space into the walls,** resultant by their respective intersection and inscription of the circle into the square or the square into the circle.

According to Kahn, inside glare will be counteracted by the juxtaposition of apertures, contrasting in size and shape, in the **double-layered walls.** Kahn has talked of the **modification of light more than the spatial expression of enclosure as his reason for the contrasting layers.** The characters of these transition spaces are completely diverse from those of the interstitial spaces characteristic of the folded wall.

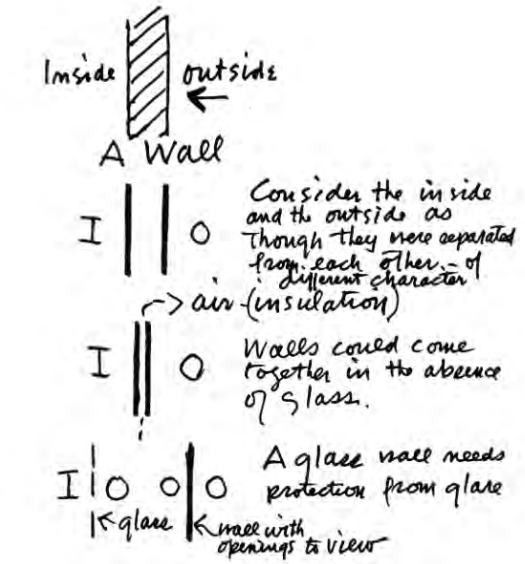


Fig.14 - Salk Institute for Biological Studies, La Jolla, 1959-1965. Sketches

Fig.15 - Louis Kahn_Salt Institute for Biological Studies_Meeting House

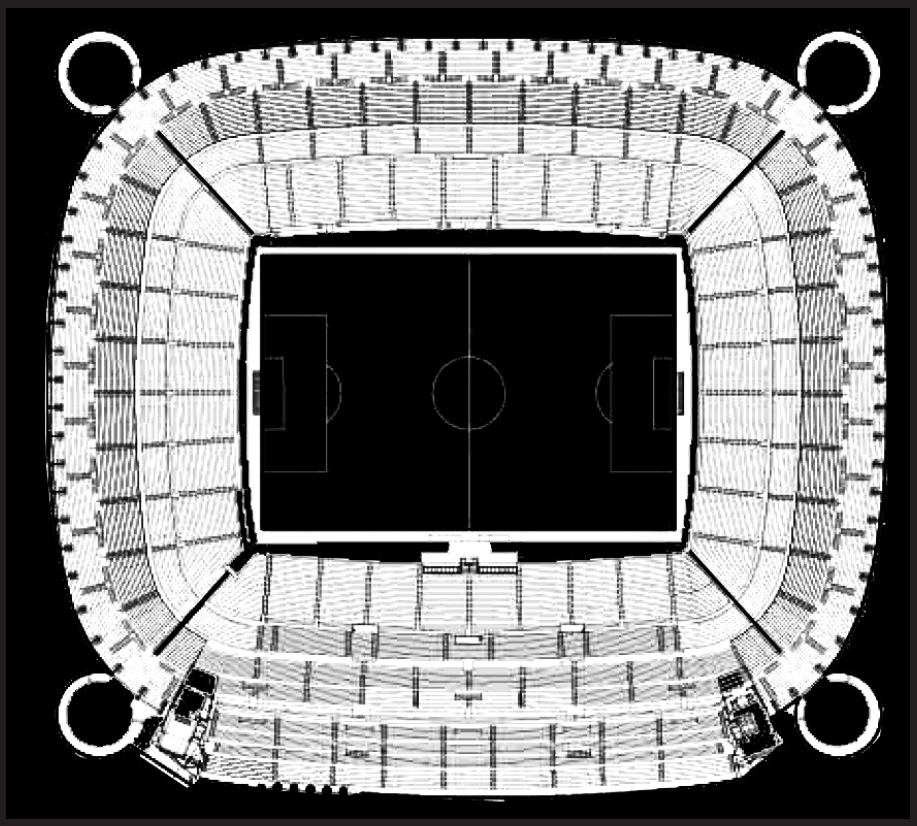
inhabit a wall

Football stadiums are like fortresses. Nothing to be seen from the outside; an hermetic, inaccessible private space for public celebrations; an indicator stating urban power and measuring international recognition...This contemporary way of colonising a territory has a lot of similarities with medieval castles...When looking onto the constructive elements, **the "wall" plays a definitive role, acquiring in both cases a gigantic dimension. The Wall understood as the interface layer with an outer face touching the exterior and an inner one related to the main space. Between these two faces, it is where the highest density of human activity takes place.**

A defensive bastion is mostly inhabited in its thickness; a several metres deep structure supporting the whole building, but also lodging the whole variety of tiny and intricate chambers for everyday life: wardrobes, storage, chimneys, fireplaces, staircases, sleeping chambers, sitting facilities, lord office, chapel, ovens... Bernabéu Stadium also has the evacuation routes located in its perimeter, audience stands, changing rooms, VIP lounge area, eateries, shop, trophy showcases, toilets, lockers... In both situations, the main scene is performed in a rectangular central hall with all its pomp, but the Wall is the actual domestic living space; the real Show, the space for all kinds of transactions.

from Deconcrete magazine.

http://www.deconcrete.org/2011/02/10/inhabit-a-wall/



Real Madrid Bernabeu stadium, flooplan, from Deconcrete magazine

This explanation roughly regularly presents outer loggias or unsheltered spaces with no specific function. Kahn himself contrasted them to the uncertain and functionally indeterminate character of the ancient ruins. The **interstitial space here demonstrated as mere hollow spaces with no character of particular functions** find in the void a more logical dimension as an idea of architecture. Kahn appears to point out such void that can be lived in and walked through, sheltered and full of characters, or even just considered as an opportunity of living, as the ultimate and most significant objective of spatial experience.

In the proposal by OMA for the **Très Grande Bibliothèque**, a competition to build a new national library in France, the hole building is imagined as **huge mass from which voids are carved out to create public spaces.** The program called for the creation of different volumes, including libraries for moving images, recent acquisitions, reference, catalogues and scientific research. One of the sketches for the ZKM (Zentrum fur Kunst und Medientechnologie, 1989) become a source of inspiration for the design, the ideogram of its **two fundamental parts: the stacks (layering of floors) and the reading rooms (voids cut into the layering).**
Koolhaas writes that it seems absurd to imagine the ultimate library at the moment when the electronics revolution seems about to melt all that is solid and to eliminate all necessity for concentration and physical embodiment. But that was exactly what the French government proposed when it organized a competition for the TGB in the summer of 1989: a megalomaniac's dream of 250,000 mq on the east side of Paris on a site near the Periphérique, facing the Seine.
Along with conference centers, restaurants, offices, etc., it would consolidate five totally different libraries for the world's entire post-war production of words and imagines. The Bibliothèque is as much cinema as library - would be contained: a cinemateque, a library of catalogues, and a scientific research library. The immense amount of information to be stored within these spaces (books, films, digital databases) becomes the incentive for the overall concept design.
The building is a residue of process of elimination, adding and subtracting programs. The main distinction is characterized by the differ-

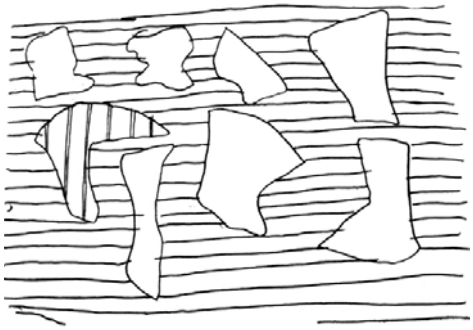


Fig. 16 - “An old sketch for ZKM, suddenly pregnant. Imagine a building consisting of regular and irregular spaces, where the most important parts of the building consists of an absence of building. The regular here is the storage; the irregular, reading rooms, not designed, simply carved out.” *from SMLXL, Rem Koolhaas, p. 616*

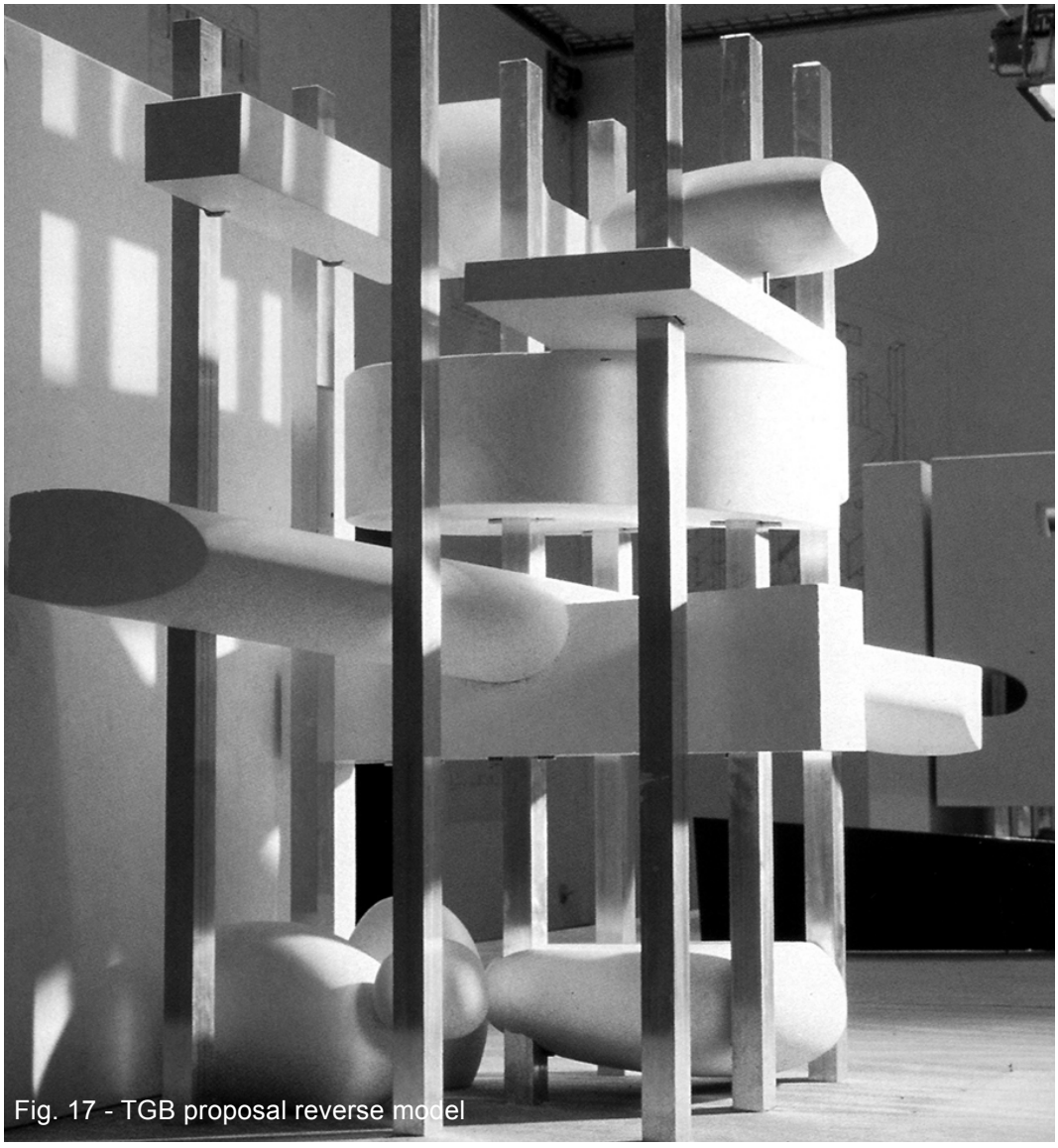


Fig. 17 - TGB proposal reverse model

ence between book storage (solid) and public reading rooms (voids).

“TGB is a cube. It is solid storage with the reading rooms – voids – excavated where efficient. Dark in the centre, day light on the perimeter. Crowds below empty chambers above for reflection.”
(Koolhaas, 1995, p.630)

A reverse model, shows what is solid as melted and what is void floats as object in nothingness. **The interstial becomes the main space.**

“The Very Big Library is interpreted as a solid block of information, a repository of all forms of memory - books, laser disks, microfiche, computers and databases. In this block, the major public spaces are defined as absences of building, voids carved out of the information solid. Floating in memory, they are multiple embryos, each with its own technological placenta.” (Koolhaas, 1995)

Different plans and sections organized by OMA features Venturian poché fields to bring out the vision of reading rooms hollowed out within a sort of boulder. One of the two models indicating only the rooms, the service spaces and the elevators in solid form, while the other shows the complex of the stacks in the form of a mass perforated by the cavities of the rooms. These are similar to sculptural versions of the poché.
In order to acquire this specific relationship among the various spaces of the library, in the end a solution was established: re-joining the beams to achieve a single, continuous vertical structure that could be freely cut to permit insertion of the rooms. Throughout the initial point is the Vierendeel beam, the structural model most alike to this beam-wall is the resistant concrete wall freely cut to adapt to layout needs.
The walls and the floor slabs are hollowed to interlock the reading rooms, which are not crossed by structural elements and are wider than the spaces between the floor slabs. The reading rooms are surrounded in shells and have the form of “pebbles” accidentally organized on the lower levels (auditorium and projection booths), of a “cross” between various volumes

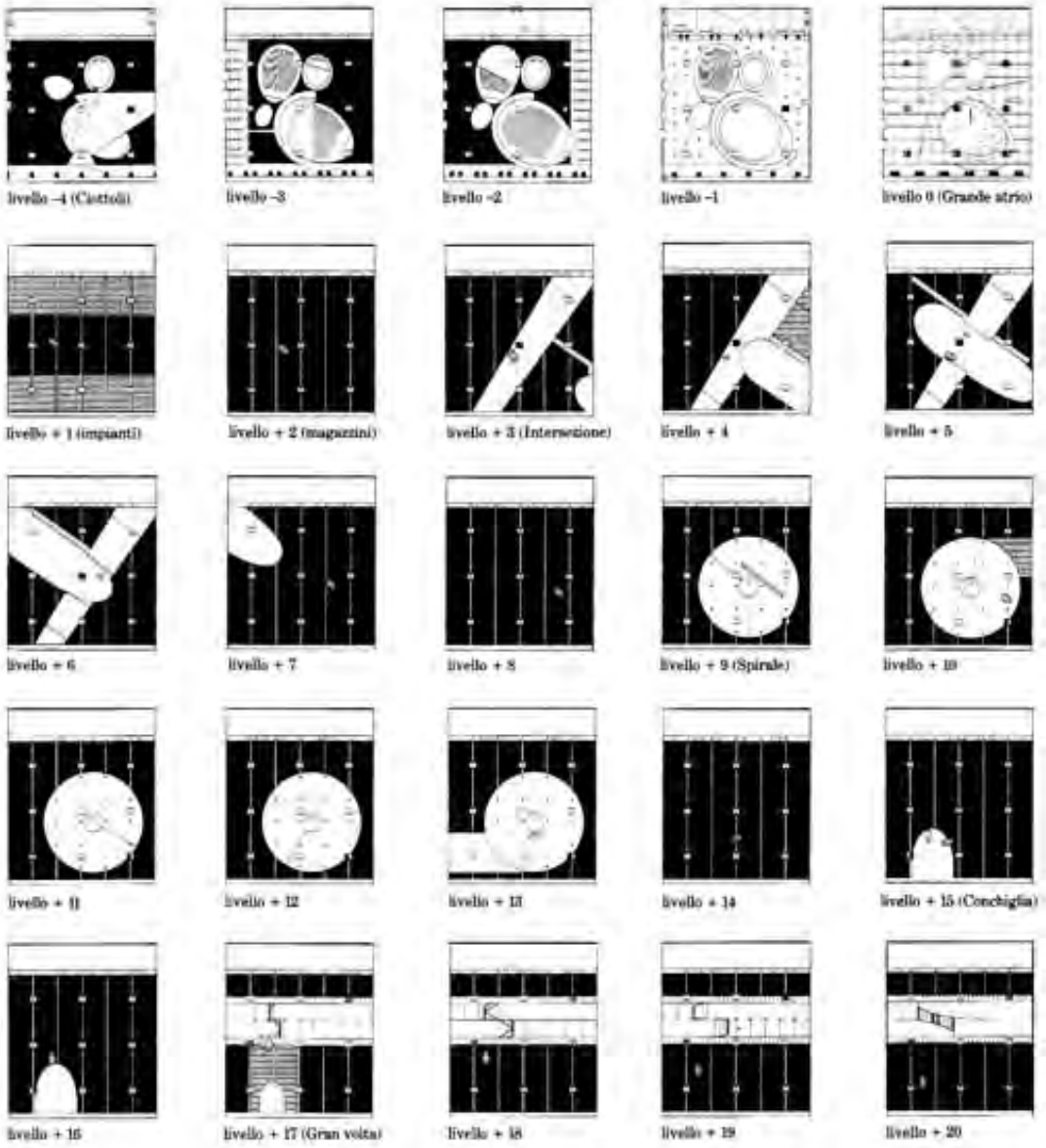


Fig.18 - Très Grande Bibliothèque. Series of plans sliced the cube horizontally

(present events library), of a spiral (study library of three large ramps), of a “shell” (catalogue room) and of a “loop” based on the Moebius strip (research library). With the exclusion of the facade of the offices, perforated by windows, the others are decorated with cloud motifs, translating the vision of a series of cavities generated within a nebulous mass.

“Because the building is colossal, almost a cube and entirely public, its demands for “conditioning” are massive, its artificiality total...If its section expands like a soufflé through the additional demands of structure and services, the cube (now it fits inside the Grande Arche at la Défense) will turn into a tower. ***The building simply could not afford to have ducts If it turns “zebra”, it will never exist...Services must be exiled from the section.“*** (Koolhaas, 1995, p.673)

The upper load bearing structure is composed of five long walls that subdivide the plan into parallel bands for the stacks. **The walls are made of hollow reinforced concrete, about two meters thick, subdivided into vertical shafts – plenums – that supply and extract. They are calculated to prevent fires and equipped with interspace for conduits and technical equipment** – giant deep beams defining a self sufficient structural system. The nine elevator groups, enclosed in glass cages, are inserted in the pattern of the walls.
In Last Apples, Koolhaas describes the role and outcomes of structure and physical plan in the conception of large buildings. This critical assessment is inserted in SMLXL, between the project of the Tres Grande BIbliotheque and that of the ZKM specifically because the development had affected OMA to rethink the impact of the structure in architecture and to make the Technology of the ‘fantastic’ develop.
Last Apples opens with the comparison between the conical profile of the column and a large building, to pose the question of the quantity of resistant material to concentrate in the lower levels of the building, which leads to the “systematic reduction of freedom” in the organization of space. The solution is found in the Vierendeel beam, discussed in Koolhaas’s reflection on the projects for the TGB and the ZKM, and in the handwritten

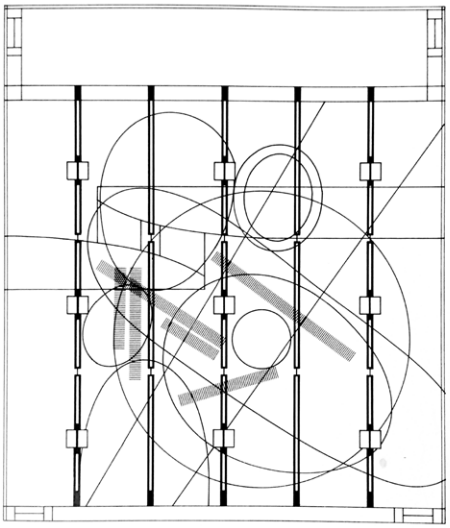


Fig.19 - The resulting superimposition of voids.

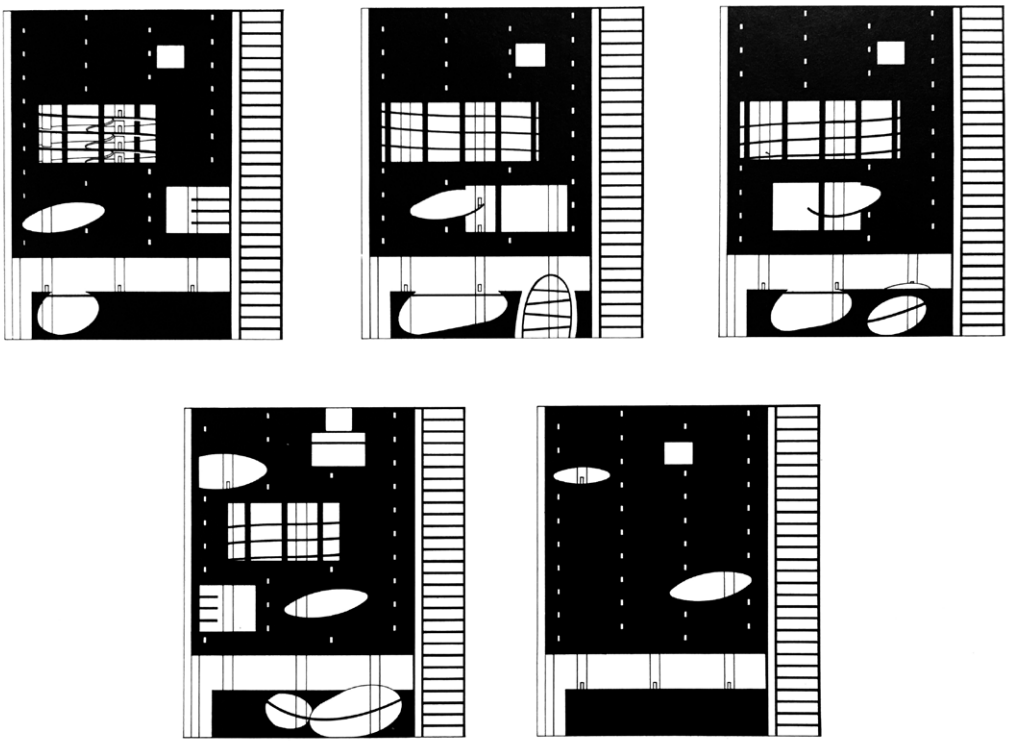


Fig.20 - Très Grande Bibliothèque. Sections

notes by Cicil Balmond.
The fact that this beam is a system to resolve the invasive character of vertical structures and the stratification of floor slabs, physical plant and spaces, also leads to Koolhaas's expression "Vierendeeel concept".
The Vierendeel beam can contain, in its thickness, channels, conduits, and physical plant elements that would usually give rise to a section of alternating bands, or a "conceptual zebra" in which "white and black compete for outright domination", as Koolhaas says.
The question of the invasive quality of physical plant parts, then, makes Koolhaas's theory evolve in the direction indicated by Semper, Wright, Le Corbusier or Kahn, that of hollow structures to house physical plant and service spaces.
Koolhaas's "free zones for human occupancy alternate with inaccessible bands of concrete, wiring, and ducts" and wind up corresponding to Kahn's main and service spaces – and the dark bands of the poché. Though he urges architects "to abolish the single grandiose solution integrating structure and services". (Koolhaas, 1995)

“...the space are designed to be inverted according to season, the function to slide, the new activities to be displaced. There is this border, this interval, this ballast which grants the user the mobility and the possibility to construct new scripts, intertwined with the architects own.
It is likewise to the user to participate in the inter-cutting between situations, and possibly to modify them.
The architects permit these intervention through the insertion of intermediary devices, often placed between the places containing the program and the exterior façade. Elements of transitions that permit the user to pass from one space to another, to experience a change of emotion, to invent new displacements, to link up with off-screen space so that one can even create a terrestrial surface that exists nowhere.”

Karine Dana, El croquies n.177-178 - Interview on Lacaton & Vassal

WALL ASSEMBLAGES

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During the last years of the 18th century different technical innovations created that driving force helpful to the birth of the practical and theoretical foundations essential for renewal of a tectonic architecture concept, after a long period where the masonry art had found superior application. Between the instant when the new materials were utilized for the first time, and that in which they came to be completely used in their technical characteristics, is present, nevertheless, a distance of almost on hundred years.

It is vital to mention that merely as a result of technical innovations that were reinforced in the period of the 19th century, Western architecture was capable to concretely translate innovations and visionary designs of the last years of 18th century, through the direction given to architecture by the significant engineering works born from the usage of the new materials, involving primarily steel and glass. The discovery and the gradual improvement of the structural grid, both in the case of reinforced concrete and steel, permitted the expansion of new spatial forms compared to the conventional building technique, which had characterized Western architecture from Roman period until the Baroque and beyond. The revolution of the new technologies in formal expression completed determined the spatial variation of crystallized customs over time, and it occurred through a new poetic expression.

Le Corbusier developed **Dom-ino**, a housing prototype consisting of horizontal slabs and pilotis that **reduced the building to its minimum**. Architecture has never been exposed so bare. The system was used as an acronym that mixed domus and innovation; it never saw production, but turn out to be an emblematic project of 21th century architecture and an antecedent to one of the most well-known building systems: the concrete structural frame. **The conceptual and visual detachment of the support from the supported, and the separation of structure from enclosure is only resolved through the use of the piloti.**

Concrete piers specified in the patent application plans and perspectives of 1915 were to be absorbed by **enclosing and partition walls. Parti-**

tions and skin detach from any tectonic rationale to no longer be examined in terms of finite forms, but as flexible interchangeable shapes. Seeing that the psychical elements that helped relate the self to the world disappear, a new occupant appears- more free yet destined to enduring instability.

This model suggested an open floor plan, which was composed of concrete slabs sustained by a minimal number of thin, resistant concrete columns around the edges, with a stairway offering admission to each level on one side of the floor plan. The frame was to be totally separated of the floor plans of the house therefore offering freedom to design the interior configuration. The model eliminated load-bearing walls and the supporting beams for the ceiling.

The Modern Movement during the 20's and 30's of the last century, with the introduction of the International Style tends to the unchangeable **reduction of the thickness of the wall, planned as a progressive thinning of the boundary**, until it is decreased to only few millimetres, those **represented by the glass**, and tending to a substantial **cancellation between the interior and the exterior,** in which the natural and the living paces lose their own divergences to melt entirely; indeed, an architecture that discovers its archetype, as pointed out by the same masters of the Modern Movement, in the Imperial Villa Katzura built in Kyoto, Japan, around the middle of the 1600. It is important to underline that, Gropius after visiting the Imperial Villa of Katsura, said to his friend Le Corbusier:

"Dear Corbu, everything we fought for has its parallel in the ancient Japanese culture. The Japanese house is the best and most modern that I know and genuinely prefabricated."

The Western architectural culture of this period saw in the orthogonal and modular spaces, devoid of decoration, clear parallelism with contemporary modernism, coming to admire Katsura as an historical example of modernity.

In exploring in his famous book Complexity and Contradiction in Architecture, Robert Venturi argues that the boldest contribution of orthodox

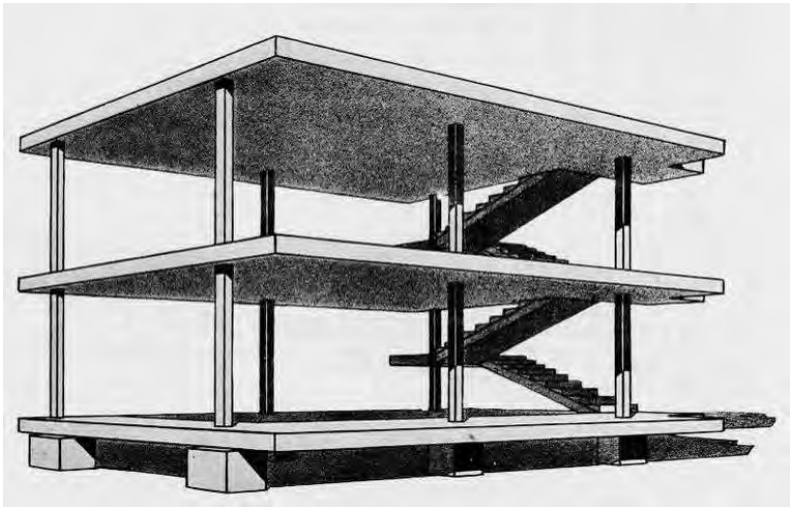


Fig. 21 - Free design of the façade.
By projecting the floor beyond the supporting pillars, like a balcony all round the building, the whole façade is extended beyond the supporting construction. It thereby loses its supportive quality and the windows may be extended to any length at will, without any direct relationship to the interior division. A window may just as well be 10 metres long for a dwelling house as 200 metres for a palace

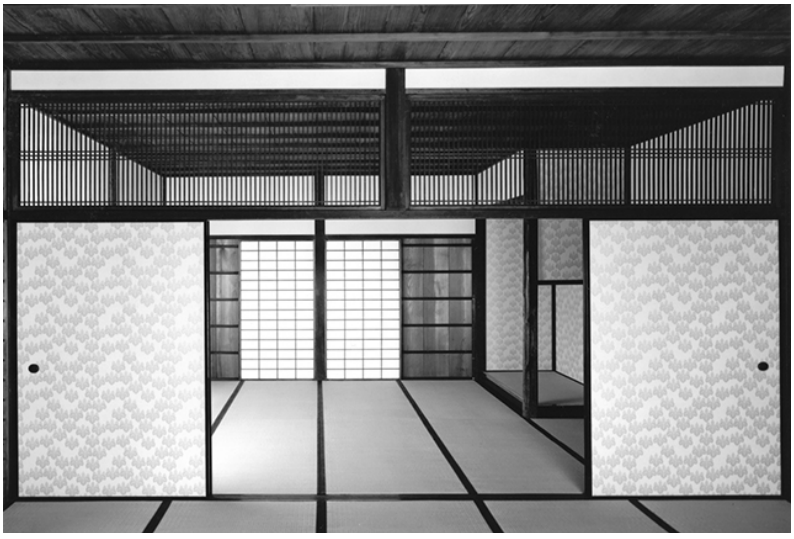


Fig. 22 - Villa of Katsura, Kyoto, Japan

Modern architecture was its so-called **flowing space, which was used to achieve the continuity of inside and outside.**

"Flowing space produced an architecture of related horizontal and vertical planes. The visual independence of these uninterrupted planes was scored by connecting areas of plate glass: ***windows as holes in the wall disappeared and became, instead, interruptions of wall to be discounted by the eye as a positive element of the building. Such cornerless architecture implied an ultimate continuity of space. Its emphasis on the oneness of interior and exterior space was permitted by new mechanical equipment, which for the first time made the inside thermally independent of the outside."*** (Venturi, 1966, p.70)

The progressively raising usage of glass in buildings over the last 1500 years has been translated in sharp acceleration since the industrial revolution. **Buildings have evolved from structures of massive walls, penetrated by small openings to diaphanous skins of minimal material, clothing skeleton, structural frames and cores.** For the period of this steady evolution, glass has experienced technological refinement. Two most important factors are evident-raised size and raised material strength-which have allowed a greater and greater range of uses.
In qualitative terms, nonetheless, glass stays unchanged; its properties of light transmission have not been changed. However, important architectural modifications were built around the raised capacities of **glass as small panels were substituted by elements of a scale of a wall.** The pioneers of modern architecture powered their way forward utilizing glass as crucial tool in the utilization of new spatial dynamics. Mies van der Rohe, in 1921, made known his **Glass sky-scraper project- the precursor of the curtain wall building of today; no clearer nor more fundamental statement of the glass skin concept has subsequently been made.**
"[Concrete, steel and glass] are genuine building elements…or a new building art. They permit a measure of freedom …that we will not relinquish any more. Only now can we articulate space freely, open it up and connected to the landscape." (Mies, 1933)

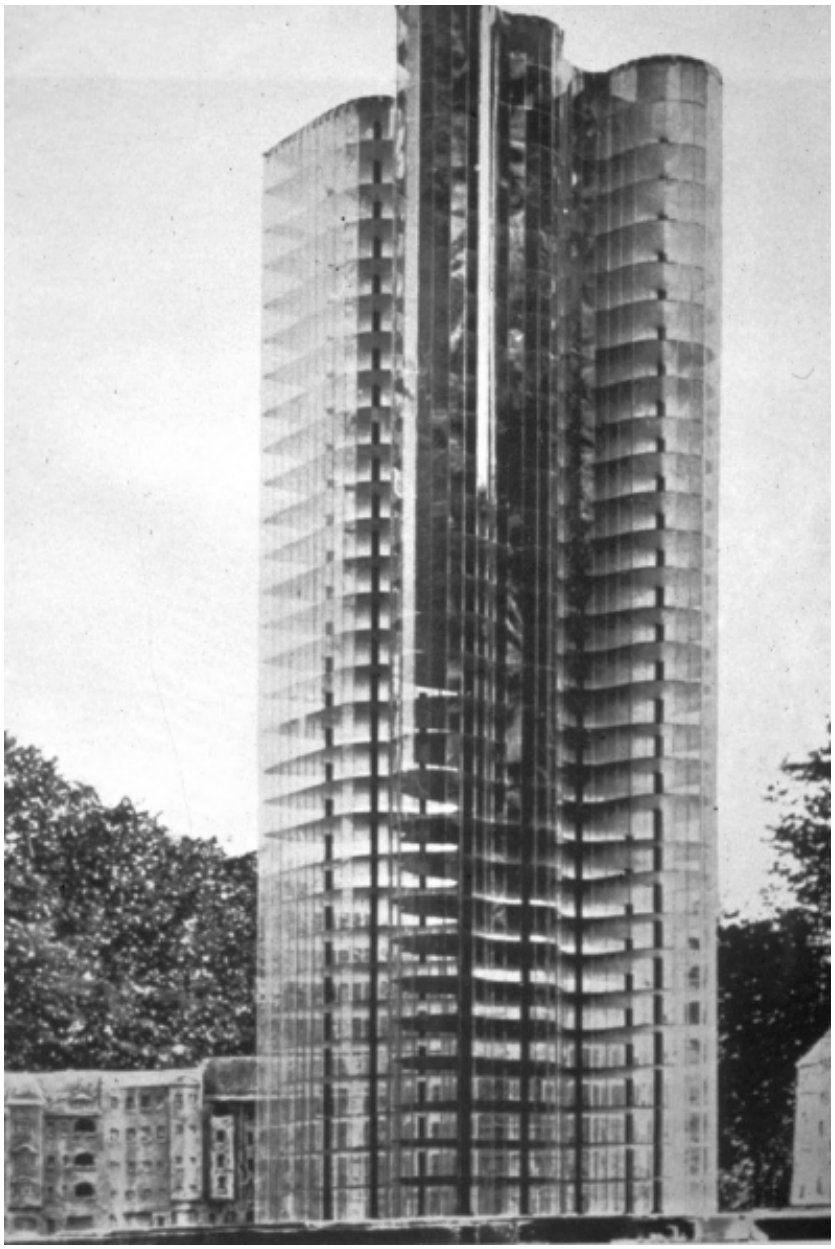


Fig.23 - Ludwig Mies van der Rohe, Friedrichstrasse Office Building, 1922

When transparency was considered to be a concern and light still fundamental, glass block was developed and utilized widely, as a consistently grained translucent walling system in the 1920s and 30s. Gropius' Bauhaus building in Germany, Pierre Chareau's all-glass conversion in Paris and Sir Owen Williams' factory for Boots Ltd in England in 1932 proceeded the articulation of the large scale transparent and translucent wall.
Additional raises in size and material strength led to yet more impressive utilization of glass. The modification of frameless glazing and the expansion of suspended glass techniques permitted even greater glass facades to be constructed with no evident structural support. **Walls turn out to be vistas rather than obstacles and clear glass, as a totally transparent surface, uncluttered by structural barriers, achieved its conceptual limit.** The gap between the technology of glass and Mies' vision of the ultimate wall was finally closed; **the fortress window after 1,500 years finally became the whole castle.**

The spatial connection between inside and outside, the Austrian – American architect **Richard Neutra** represented more shrewdly than any other modern architect obtains new meaning. It is perceived as nullifying the divergence between the object-like character of the house and its spatial continuity with the outside infinity. The free-plan, a principle of modernism, which smoothens and **nullifies the conventional difference between space and object, is considered as a therapeutic technique, rather than as a belief of form and space.**
Richard Neutra was in fact **fascinated by this treatment of corners with glass by Wright, which offered visual openness and protection against air movements that are prone to be particularly strong at a corner of a building**. This curiosity in corner further reflected his examination that 'in the free landscape or on restricted sites, surrounding circumstances very often invite a more or less diagonal relationship of a building and openness at a corner'. Following and developing Wright's treatment of corner further, Neutra was capable to reach a concordance between interior and exterior in a dramatic fascion. Concerning this, Neutra has explained:

"…window seats, bay windows, sills, shutters, blinds, curtains, screens, filters all emphatically declared the multiple functions and the recognizable position of the window, both from the outside and on the inside of architecture. Since the 20th century the growth in size of glass panes, culminating in the invention of the glass curtain wall, has generalized the window: it is now everywhere and nowhere. Glass, which initially seemed the perfect partner for the window, took over entirely…"

Rem Koolhaas, Funtamentals - Venice Biennale, 2014

“Sometimes fascinating affinities can be developed between interiors and outside spaces which a lying directly ”in front” of them but in slanted direction. Sometimes such diagonal outlooks are of the greatest charm and significance. They may even lie directly and diagonally opposite to entrances to interior rooms or to areas within them which are dedicated to outlook when the rising sun changes the color of clouds over the water are, a lake, the sea; or it may be just an interestingly shaped or blooming tree which becomes a soul refreshing feature by making a corner transparent.”
(Baek, 2016)

Nonetheless, Robert Neutra’s attention went beyond the visual combination of what is near and what is far and was connected with the issue **to increase activities of dwelling.** Taking into consideration **Miller House**, **the corner was granted an expanded roof. Without a doubt, this extra covering improves one’s visual experience from the inside towards the outside, as it frames the sight to the desert. Still, it was as well a device, which has contributed to the increase of the practices of dwelling inside; indeed, it has formulated a shade on the periphery of the house where the corner and the daybed were placed. The space below the expanded roof was occupied by a lap pool, a device which, in connection with the ceiling inside, reflects and softens the otherwise intense quality of light before it is introduced to the interior. To the south of the corner was a screened porch expanding the inside dwelling activities to the outside. Finally the design of the window at the corner itself merits to be observed upon in this respect.**
It was separated in two different parts: bottom and top. The bottom part is created of one single pane of fixed glass. Conversely, the top part is additionally created of three vertically proportioned units, among which the two nearby to the corner are operable. **This window- an ensemble of two different sections – assumes different roles: filtering through the bottom section a direct wind for the inhabitant who stays on the daybed, and at the same time admitting wind not directly through the upper section.** The previous accepts to what Robert Neutra describes as violent winds, which according to him “have been recognized by tests as

Fig.24 - Richard Neutra , Miller House, 1936

troublesome to conceptual numerical brain operations". (Baek, 2016)
Moreover, there are different advantages that appear from the latter. First, it introduces wind in a refreshing manner, like a breeze, which functions as the carrier of non-visual qualities of the outside environment, such as smell, humidity and sound. In the second place, the fireplace advantages from this introduction of wind which carrier oxygen. Certainly, the fireplace is tangentially placed from the axis along which the wind flows in.
Nonetheless, this is exactly what Neutra imagined for the relationship between fire and wind. Through the development of tangential encounter between two, Neutra keeps away from a situation in which the fire increases wildly and seeks to leave fire appropriate for the dwelling activities of the inhabitants. Concerning this, the daybed was the place where one could experience the synchronized mutuality of forces that involve fire, water, wind and light. Additionally, they encountered and acted together with each other in an agreeable way. As a result, this point makes clear the divergence of Neutra's anchorage from that of Wright. Neutra's anchorage was not merely related to the hearth. Nor was it confined within the concern of generating a cubism-like dynamic visual composition in which the far and the near respond in concordance.

During the 1910s and 1920s, modernism had started to characterize **corners as didactic sites revealing the opportunities of the new architecture**. Furthermore, corners usually abut windows, which are as well advantaged sites for discovering the relation of architecture to visuality and systems of representation.

"Uniquely in Neutra, however, the corner and the window merge into an indefinite environment complexly articulated through window-walls that offer the inhabitant not just visual opportunities but vectors for bodily and spatial traffic between inside and out."
(Lavin, 1999, p.8)

This occurrence in architecture's long negotiation between inside and outside more effectively shows two extraordinary phenomenon: architecture's establishment of a new understanding in its engagement with the environment and architecture's discovery of a human issue understood in psycho physiological rather than platonic or mechanical terms. According to Lavyn (1999) the architectural methods Neutra set up in order to influence this relationship focused on the glass corners of his post-war houses, particularly in the public rooms and, to a lesser extent, the bedrooms. Concerning this, Lavyn (1999) has pointed out that two planes of floor-to-ceiling expanses of plate glass join in a mitered edge to produce a '***glazed environment of intense spatial ambiguity. 'Oscillation between opacity and transparency, interiority and exteriority, solidity and fluidity generates perceptual confusion.***' (Lavyn, 1999).
These psychic and visual effects of what Neutra named "throbbing" intensity are additionally increased by the accumulation in the corner of a series of architectural details (Lavyn, 1999).

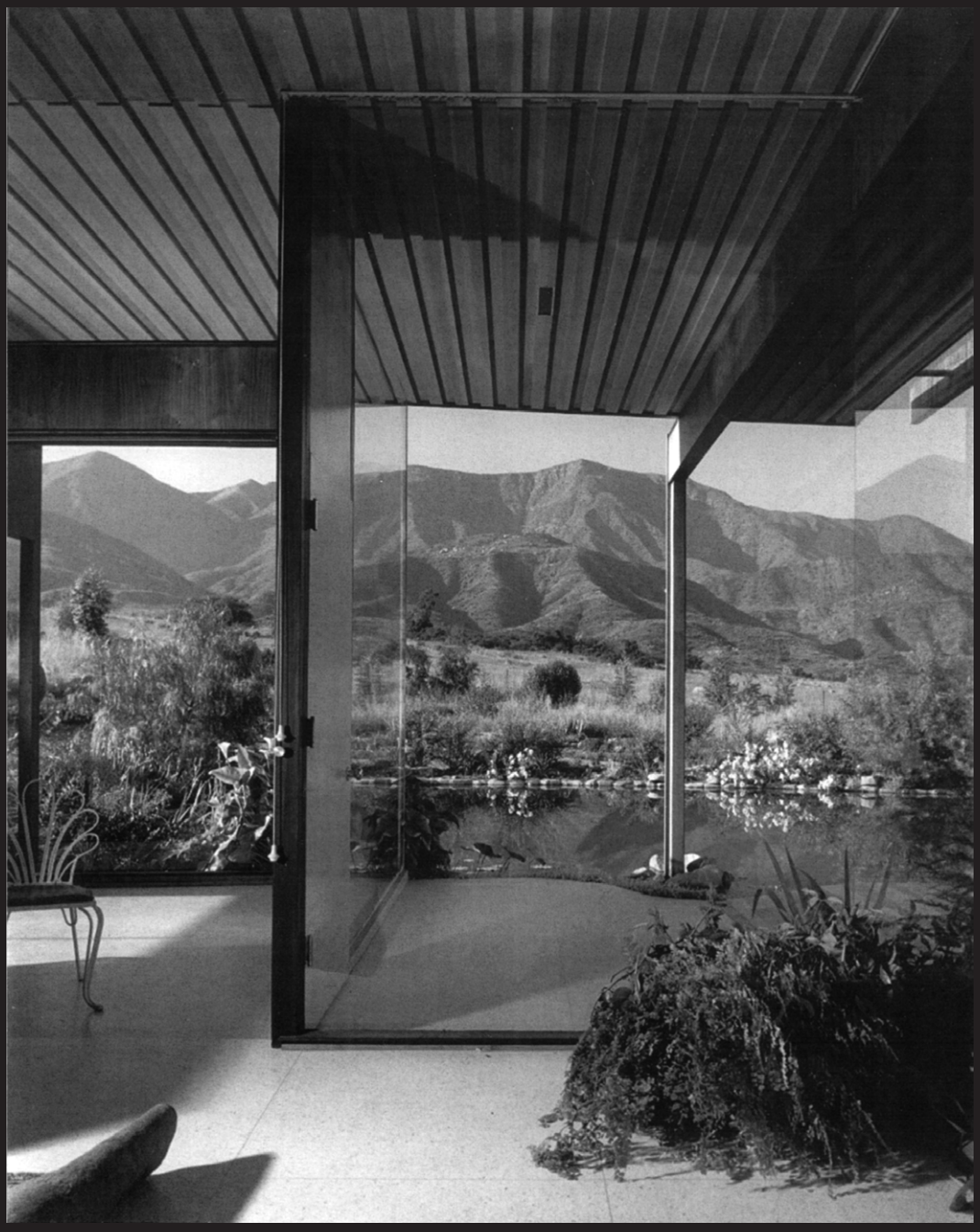
"Spider legs extend rafters and ceiling beams to the exterior, displacing and confusing the location of structure. The use of glass represses the distinction among walls, doors, and windows, combining visually as well as functionally these normally distinct architectural elements. Large exterior overhangs prohibit reflections from

Richard Neutra, Chuey House, Los Angeles, California, 1956

forming on the glass surfaces. At night, exterior lights maintain surface transparency and thus spatial continuity. Materials move without interruption from inside to outside and across both floors and ceilings...Finally, mirrors placed strategically adjacent to windows multiply ad infinitum these elements of energetic ambiguity."
(Lavin, 1999, p.17)

Since the beginning of the last century, high modernism had imagined about the transformative influence of glass structures. However, for the most part, the objective of architects had been to create clearness and transparency. Le Corbusier explained the requirement for window-walls but predicted these elements as static structures closing the interior within. Improvements in glazing technology had long since allowed windows to increase in scale and to proliferate in even modest homes: there was no self-respecting post-war suburban residence that did not have a picture window. Lavyn (1999) has argued that merely with Neutra does the window both increase beyond the scale of a picture, yet renounce from changing the whole structure into a glass box.

"The window-wall corner no longer primarily frames a view, as with Le Corbusier, nor delineates a classically conceived or geometrically precise space. Instead, Neutra's corners suggest an amorphous leak in the structure of the house - a topological billowing of a domestic membrane that creates a highly indeterminate and almost viscous environment. *Neutra maintained that in these corners, saturated with Reich's orgone energy, architectural physiognomy would interact with human physiology to produce psychological satisfaction and pleasure."*
(Lavin, 1999, p.17)



Richard Neutra, Chuey House, Los Angeles, California, 1956

Rapidly increasing improvements in the size and strength of glass since the 1950s, particularly the revolutionary float process and the reinforcing and armoring of glass have been translated in its absolute integration as a main element in modern construction. Still, all was not good. Waiting next to the raising usage of glass and the architect's development of its light and weathering properties, was the increasing **problem of environmental control.** During the 60s there was the first universal consciousness of ecology as a science, of global and strategic resource planning and of **resource exhaustion and energy crisis.** As a result, the energy crisis liberated architects and consumers to **look at the performance on their buildings: Mies' wonderwall was recognised as an energy problem.** Davies and Rogers (1981, p.55) has explained that they were caught respecting the concept but with the technological panties round the knees; **single glazing started to be a problem.**

Unconcerned, the glass sector, drawing on the precedents of colder climates occured with their perfect answer- more glass! **Double glazing - twice the performance at a little more than twice the price.** Moreover, light, space and glass could live over again and the architectural principles were obvious; there was still an up-market vote to the vision of double glazing. **New thermal building rules connected the amount of**

glass in an envelope to the performance of the envelope generally (Davies and Rogers, 1981).
Nevertheless, after some years the great glass wall had come under straight attack, not from an aesthetic point of view, which might probably have been supposed and defended, but from an **energy, economic and performance** point of view, a novel upstart in a territory until now mainly occupied by aesthetic issues. The glass sector backed the vision of energy budgeting.
The industry identified that a south facing window in the correct sort of building is a net energy gainer over the year and therefore the architectural principles might be assuaged again. While the north walls lost everything excluding some widespread all-sky radiation.

"South-facing glass with woolly overcoats is the new look, or long thin east·west buildings maximising their solar gain potential like lizards basking on a sunlit stone." (Davies and Rogers, 1981, p.56)

Mies' wonderwall was heavily under attack. Can we never return to the transparent skin? Must we say goodbye to glass? Has the pendulum started to swing over again towards the leaded lights in the enormous walls of yesteryear? Can we ever evolve a new architecture based upon intelligent passive energy design?
These were some questions posed by Richard Rogers and Mike Davies in the early eighties thinking about novel solutions to deal with the actual environmental concerns. In their article **A Wall for all the seasons (1981)**, they describe how architecture of high insulation values and small window areas, preferably on southerly walls only, was the logical response to the energy problem and the new thermal regulations. Yet their architectural concerns with light and space, legibility, function, meaning and quality will not be submerged in an acceptance of architecture of insulated overcoats and minimal window areas whatever the price of energy.

"Mies' great glass wall is not up to rigours of the new thermal demands: our 20th-century wall, the very fabric which defines our

building volumes is not performing adequately in the new context of energy economy. We must redesign again. We must evolve general design strategies for energy economical buildings, in which highly insulated fabric and efficient services measures will play a major part. But we will still be searching for light, for views, for a contact with the external world; and that means glass, large amounts of glass as part of the building fabric. (Davies and Rogers, 1981, p.56)

What was the glass sector's response this time? **Triple glazing, gas filled triple glazing, quadruple glazing, even deeper filters and tints, increased reflectivity, increased blind one –sided walls;** increased elements which work in a good way in one situation and in a bad way in another? It was apparent in the energy context of the following decades or two that the outlook of glasses lied in **high performance products with much increased thermal reliability** (Davies and Rogers, 1981).

"But if the thermal qualities of the wall are so bad, how did glass get so far? The scale of its use before the turn of the century was invariably related to the window its surround sill and its secondary equipment. ***Glass worked in combination with other elements; curtains to stop light and sound entering, to stop leakage of heat, shutters to reflect heat, blinds to stop glare, lace curtains to screen view and to pier through. Glass worked with other simple but effective environmental control devices, controlled by the occupants of the space."***
(Davies and Rogers, 1981, p.56)

Davies and Rogers (1981) pointed out that much of our modern building fabric has evolved without recourse to these **small scale traditional environmental control device,** depending on progressively more powerful and energy consuming building services plant and equipment to heat and cool the different building zones. During the summer, extreme incoming radiation entering through glass makes the servicing: system work hard to combat heat build-up. During the winter extreme heat loss makes the servicing system work to add heat to the internal environment. Taking into

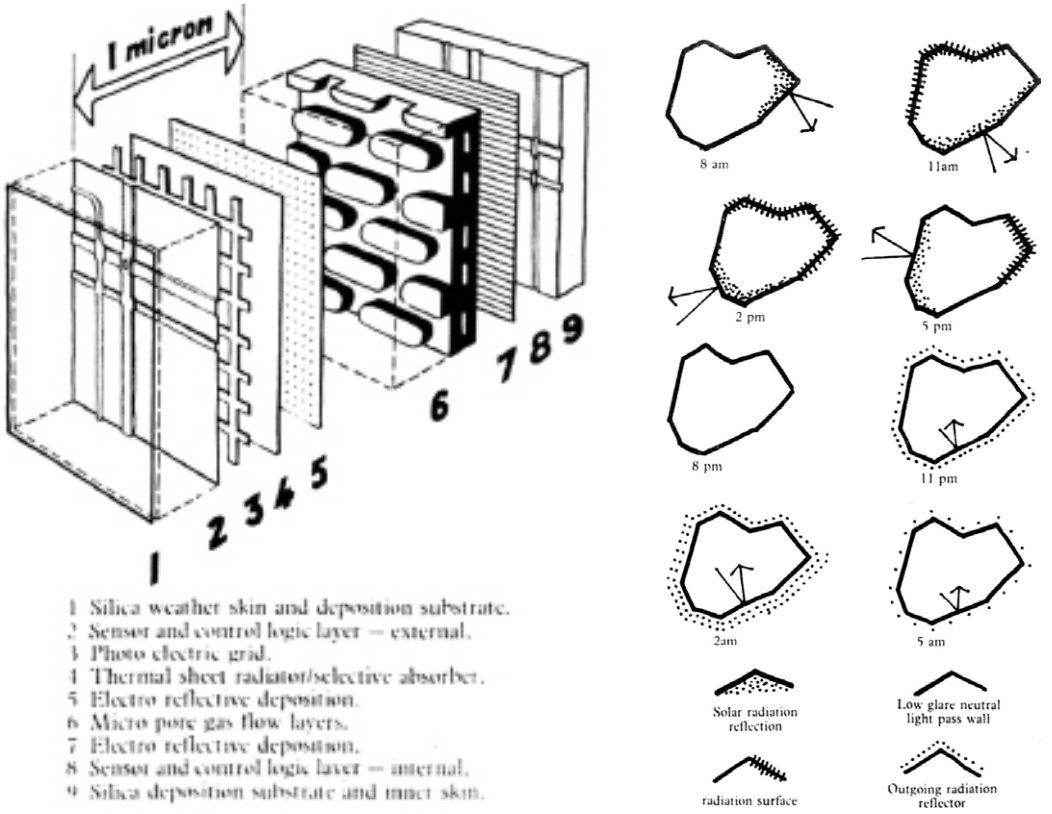


Fig. 25 - Davies' image of the polivalent wall assemblage

consideration both cases, energy is being wasted owning to the poor facade performance.

Mies' tower equipped with lace curtains, shutters, blinds and velvet drapes would actually perform better than it would as a clear glass tower although the building clearly cannot have such devices.

One conclusion appears to be predictable. In the first place, there is glass with its characteristics of impermeability, longevity and trans massive properties, and on the second place, a range of quality modulators of heat, light and sound transfer, both of which are required for a whole performance. (Davies and Rogers, 1981)

" We need to develop a new integrated window wall where all these elements are one where multiple performances are integrated in one single element. What is needed is an environmental diode, a progressive thermal and spectral switching device, a dynamic interactive

***multi-capability processor acting as building skin**. The diode is logically based on the remarkable physical properties of glass but will have to incorporate a greater range of thermal and visual adaptive capabilities in one **polyvalent product. This environmental diode, a polyvalent wall as the envelope of a building will remove the distinction between solid and transparent, as it will be capable of replacing both conditions and will dynamically regulate energy flow in either direction dispensing upon external and internal conditions, monitor and control light levels and constant ratios as necessary in all points in the envelope**. The wall would be capable or energy transfer along its surface adding to or removing energy from building zones which are too hot or cold, trading energy surplus for energy need."* (Davies and Rogers, 1981, p.57)

During the 70s, the energy crisis was alarming and a raised number of low tech double well assemblages looking for energy saving answers. In the 1967, **Felix Trombe**, a French engineer, constructed the original solar heater and built up the **Trombe Wall, a type of passive solar wall** that could perform as ventilation engine in the summer and heating device in the winter. In this assemblage, **a wall with two layers, a glass external layer, and a high termal mass internal layer**, is constructed on a south facing façade.
Short-wave ultraviolet light goes throughout the glass roughly unconstrained and is soaked up by the high mass wall. This thermal mass then re-radiates in the far infrared spectrum which not capable to go back throughout the glass without difficulty, **heats the air inside the cavity.** The incorporation of vents at the top and bottom of the wall to circulate cool air generates a system that works all year and in various climates. Trombe wall signalled a development of double glazing technologies from mechanical to passive, concurring with the 70s oil crisis.
The quest fir transparency that characterized **the first embodiments of the double wall were substituted by additional thick walls able of making available thermal inertia to the system. Rather than a "neutralizing wall," double skins become a device for climatic adaptation.** During the late 70s and 80s, **Lee Porter Butler** started promoting and

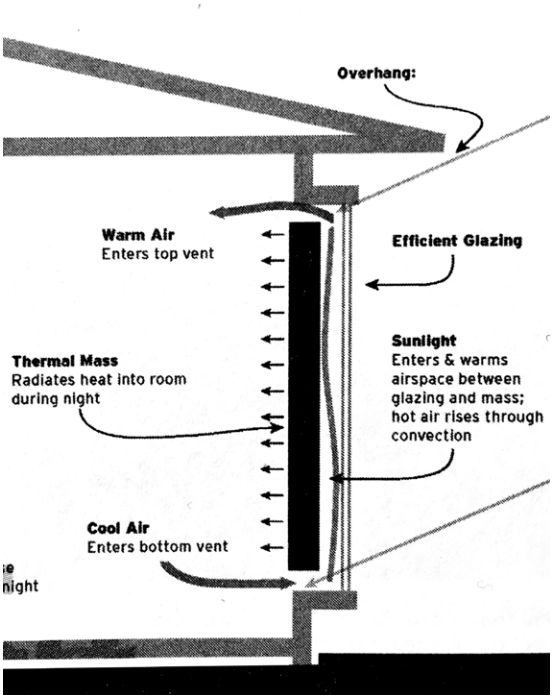


Fig. 26 - Trombe wall. During the day the sun heats the thermal mass and generates air flow throughout the house. At night, the thermal mass continues to slowly let off heat, keeping the temperature of the house moderate, even with no direct sunlight.

Fig.27 - Trombe wall interior showing thermal mass, cavity and outer glass

building **Double Envelope Houses**. In fact, these houses were first and foremost a building, with a **thirty centimetres cavity between the walls and a larger south-facing solarium. The cycle of hot and cold air between the two layers would maintain the internal building buffered.**
Subject to much disbelief concerning to their environmental advantages, these homes turn out to be the center of a discussion related to environmental technologies. In this respect, public criticism of this building type created the Double Envelope House, and probably the double façade itself, to the recognized as an innovation, and a bold although mistaken fad: more and idiom of green-washing than in fact affective environmental device.

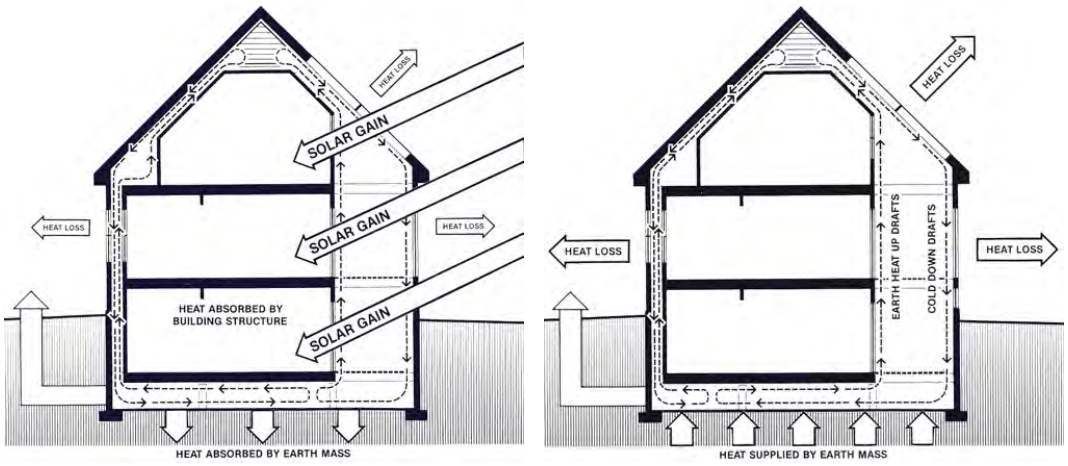


Fig.28 - Light would enter a main south-facing solarium and heat air within the cavity. As the heated air rose, a natural convection-flow loop would generate, drawing cool air up through either the subfloor or cooling tubes in the earth.

Today, the double envelope is experiencing extinction. Not only does it consume a significant amount of space that is problematic to recuperate in a financial equation, but, some tests performed in the 90s have revealed, it needs intensive maintenance.
An entirely different trend can be observed in the expansion and occupation of these liminal spaces, no longer exclusively devoted to technology, but increasingly occupied by secondary programs. This is probably the comeback of unique galleries in Galicia, or to the conservatories discovered by the Northern European aristocrats. The solariums of Lee Porter Butler's Double Envelope Homes of the '70s and the environ-

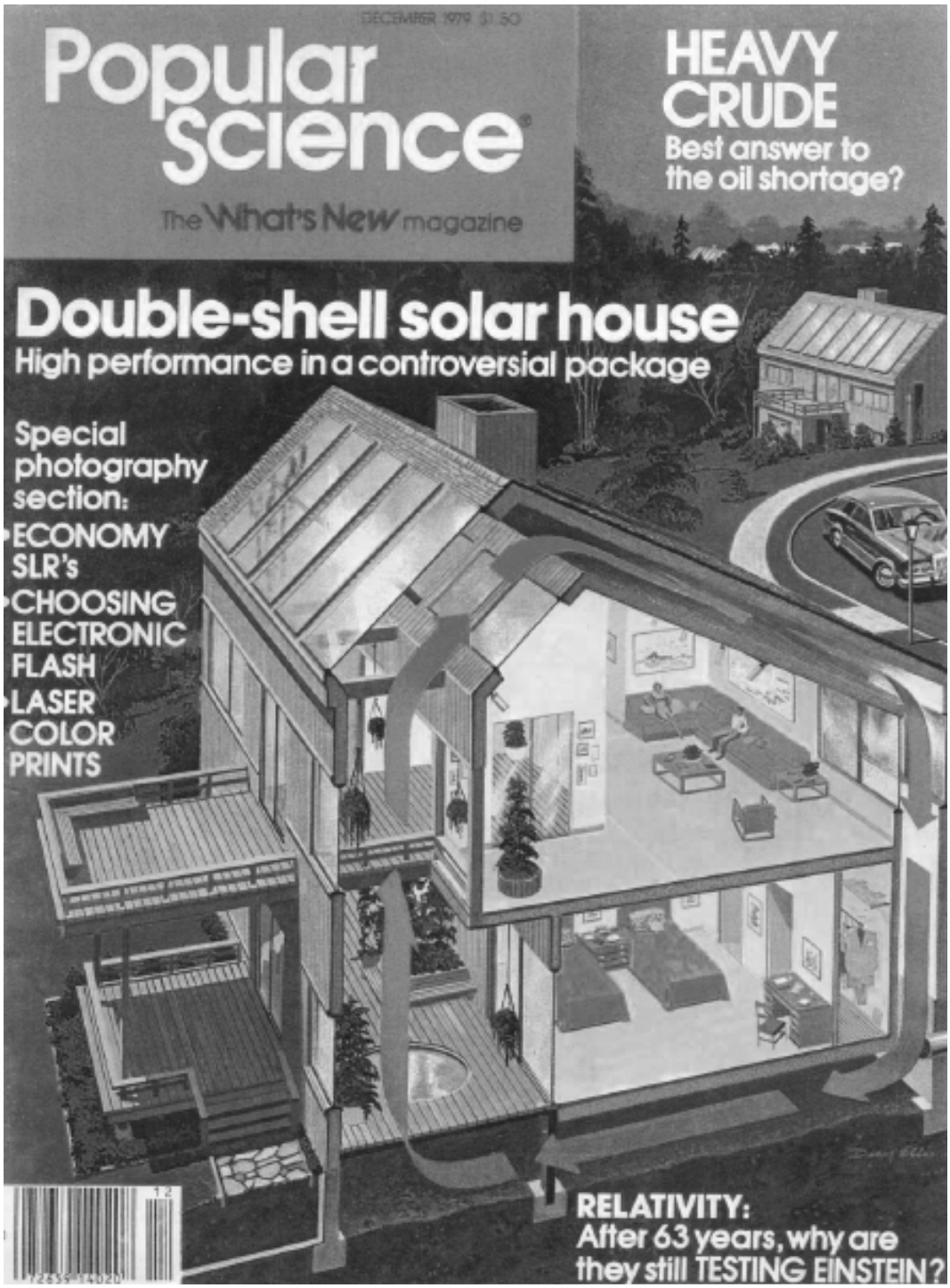


Fig.29 - Cover story about Butler in Popular Science Magazine

mental movement can be as well taken into considerations as ancestors to these trends. **After many attempts of uneven success over the last few decades, it transpired that the effective performance of the double wall assemblage depends on the possibility of enlarging it to the point that it can perform as a programmed space with a different environmental performance, turning the area between the interior and the exterior into an occupiable buffer space. The progressive reoccupation of these liminal climates not simply with individuals but as well with plants and greenery is a contemporary tendency.**

The SANAA's project for the extension of the IVAN Museum in Valencia will cover the whole block, including the exterior areas, in a transparent "Skin" that will increase the volume of the building and **create new public spaces between the "Skin" and the existing building.** The "Skin" **is a light, perforated metal which allows daylight, wind and rain to gently pass through. The public space within mixes natural and conditioned air to create a semi-indoor/outdoor space.**
The program, including the existing building which is converted to galleries, new and old city foyer, roof terrace, sculpture gardens, and children's terrace are unified by the "Skin." Through careful study of the skin geometry and **reutilizing excess conditioned air, SANAA's aim was to create different microclimate within this space so that it can be used through extended times of the year.** *"We want to create a semi indoor/outdoor space which feels like areas of filtered light under large trees"* says Kazuyo Sejima

Lacaton and Vassal's work discovers this opportunity by repurposing low cost, low performance greenhouse technology. Low cost building technologies are used to provide a considerable raise of building space which, though it is only **partially conditioned may be used for buffer programs. The systematic introduction of a type of space which is neither internal nor external, where certain parts of the program can be located is an inventive assemblage, where the double wall is coupled with economies and functions, which develop new building typologies.**

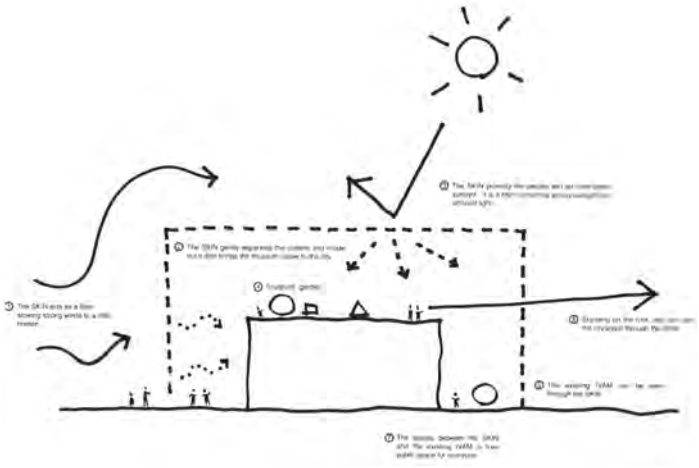


Fig.30 - SANAA's sketch for IVAN Museum, Valencia

Fig.30 - SANAA's render for IVAN Museum, Valencia

DOUBLE SPACE

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Taking into consideration a climate that is hostile in order to live en plein air, the usage of **greenhouse systems appeared as a method to incorporate exterior spaces** into Lacaton & Vassal's work. Through the use of simple ventilation and shading systems, the greenhouse carefully balances exterior brightness and temperature with interior air-flow and humidity in order to create an optimal interior climate. In the Latapie House, 1993, Lacaton & Vassal connected a conservatory to the key body of the home, which includes all the spaces detailed in the brief and normal interior climate.

During the winter, the conservatory's semi-transparent polycarbonate façade captures the warmth of the sun and creates an interior temperature that is slightly warmer than the outside. The facade was furnished with ventilation panels and it can be to a certain extent opened to cross-ventilate the conservatory throughout the summer, producing a climate so enjoyable that the occupants have re-appropriated the space as an extension of their living room.

What becomes apparent in the Latapie House is that **the treatment of a climatic threshold as a volume rather than a surface has a profound spatial implication. By displacing the project's boundary to include an enclosed exterior space, the greenhouse becomes an extension of the original dwelling house.**

When applied to larger projects, this principle causes a dramatic jump in scale.

In the Nantes School of Architecture, the conservatory takes the shape of double-height polycarbonate clad volumes which, in addition serving a climatic function, add 5,000 square meters of **"extra space"; combined with the school's exterior spaces, these un programmed spaces double the project's surface area.**

The total size and openness of the un-programmed spaces introduce the school with a potential that Lacaton and Vassal first find out in the public spaces of African cities. In the Djeema-el-Fnaa square, Lacaton and Vassal examined a dynamic relationship between the built fabric and individuals. The active square is by no means predefined by its architecture and it is placed in the city centre of Marrakesh, in Morocco; indeed, this is usually the case in public spaces in Europe. As an alternative, with no formal separations, the square obtains its definition from the natural ac-

Fig.31 - Lacaton&Vassal, Ourcq Jaures Student & Social Housing. Paris

tivities it hosts and the ebb and flow of mass and traffic that go by it on every day basis. Taking into consideration large projects which acquire an urban scale, such as the Palais de Tokyo in Paris, the square appeared as a case of how activities within a space could be released from the strait-jacket of the plan.

In the design for the Nantes School of Architecture, the square provided a critical insight to how un-programmed spaces could engender new and unexpected dynamics, embodying the potential and life of large spaces that makes them infinitely adaptable.

An open structure for inventing climate and ambience

"...to us, envisaging an approach to climate through that of the structure, of mobility, of transparency, seems particularly rich. Today, however the rapport with the environment is exclusively defensive. Interior comfort only depends on calculations, which to us seems very chancy and paradoxically rather imprecise. In fact these calculations, which to us seems very chancy and paradoxically rather imprecise. In, fact these calculations only rest on the suppositions of a particular project, which would be erroneous once the building were complete.

Such reasoning is based not on everyday information but on the extreme example of the five worst days of the winter and the summer, the coldest and the hottest. These extremes determine the architecture, leading to over- insulation, over-protection, over-sizing the installation – and consequently to make the relation between inside-out more airtight. There is nothing intelligent in doing things that way.

One ought rather to stick to the 95% of normal conditions and find effective temporary solutions to extreme infrequent cases (or modulate uses at such moments). Otherwise, **one ends up** fabricating boxes that are too closed, too airtight, that one can never get out of.

One ought to imagine rooms in the same way one thinks of clothes – to respond to different moments and climates, you can add a shawl or put on a sweater (or take I off). This is much better than making people wear a heavy overcoat all year round. The thermal curtains we have been using widely for fifteen years now, the effectiveness of which is perfectly calculable today, responds well to the mobility of the envelope. **Thought the production of open structures we try to get the most out of the sun and the exterior inertia, but also to permit users themselves to fabricate the climate that suits them. Yet, the issue of the climate is never addressed lightly, positively and with good sense, but rather is seen as a sort of problem or enemy it is necessary to protect oneself from**. One does not rely on the intelligence of the residents to make a place work. Rather than trusting him, appealing to his own actions, one

hands him a sort of heavy machine he won't necessary feel at easy with that he then makes work in another way – eventually even ignoring the instructions.

... Between each space, simple systems of openings and passages, of sliding elements, of filters, curtains and mobile insulating materials offer the possibility of getting to the insulated space through the intermediary space then towards the exterior space, or directly from the insulated space into the exterior space. The system is dynamic, and the mobility and responsibility if the occupant is stimulated so that he plays with the climatic conditions, the seasons, summer weather or sunny mornings, cool evenings.

He is the heart of the system, conceived not as a technological instrument but as a tool that is easy to handle: entering, leaving, moving a sliding feature, drawing a curtain, using a winter garden. A certain number of elementary technologies such as anemometers, rain gauges and thermostats warn of discomfort or accident. The occupant is the main protagonist when it comes to his own climate and his movements, according to his mood or his character. Thanks to such devices, it is possible to combine energy-saving, comfort and the pleasure of being at home.

Likewise, when we work on adding a winter garden to a living space, we are striving for the climate to progress as the user feels it. A first sliding glass partition, endowed with efficient double-glazing and duplicated by a curtain, gives onto a temperate garden. Some lighter and less airtight partitions of polycarbonate in order to open up this garden, behind which a further curtain of another kind. By manipulating these different sequences, the inhabitant creates an astonishing number of situations which will be adapted to his character and to the climate."

Lacaton e Vassal, 2G International Architecture Magazine, n.60

Nantes school of Architecture

The Nantes School of Architecture considers a basically dissimilar method of conceptualizing low-cost architecture, in which a **minimal budget is related to maximum space**. As a result, it can be separated into **two types of spaces**. The first type of space account 15,000 square meters and it is composed of the program needed by the competition brief (classrooms, research facilities, administrative offices). **The second type roughly doubles the project's surface area by creating large, un-programmed spaces, adding 5,000 square meters of double-height enclosed exterior spaces, plus another 6,000 of exterior terraces and balconies**. Separated by floor-to-ceiling glass doors mounted on aluminium frames, programs can spill out of the first type of space into the second, **whose generic surface area can be adjusted through the extension of the building's intermediary structure.** Through the optimization of construction processes for the production of additional space, Lacaton & Vassal Architects more than doubled the project's practical surface area, from 12,500 to 26,000 square meters. In case programmed spaces comply with the base- line minimum that an architecture school requires to function, and then the un- programmed spaces, which make up half of the school's surface area, provide the school with new potential that is entirely unpredictable. **The fixed potential of these extra, non- programmed spaces provoked new dynamics both within the school and between the school and its instant context.**

Designed as an open-ended and multi-functional structure, the school of architecture consists of three concrete floor plates, which are made accessible by a continuous ramp that starts at the ground floor and continues to the rooftop. The seven- meter high ceilings between the floor plates are subdivided by a light- weight steel structure that supports intermediary floor levels. **The building's polycarbonate façade is pushed to the site's boundary, taking full advantage of the available surface area and blurring the visual boundary between the school and its immediate urban context.**

Paradoxically, it is precisely this primal move to create excess space

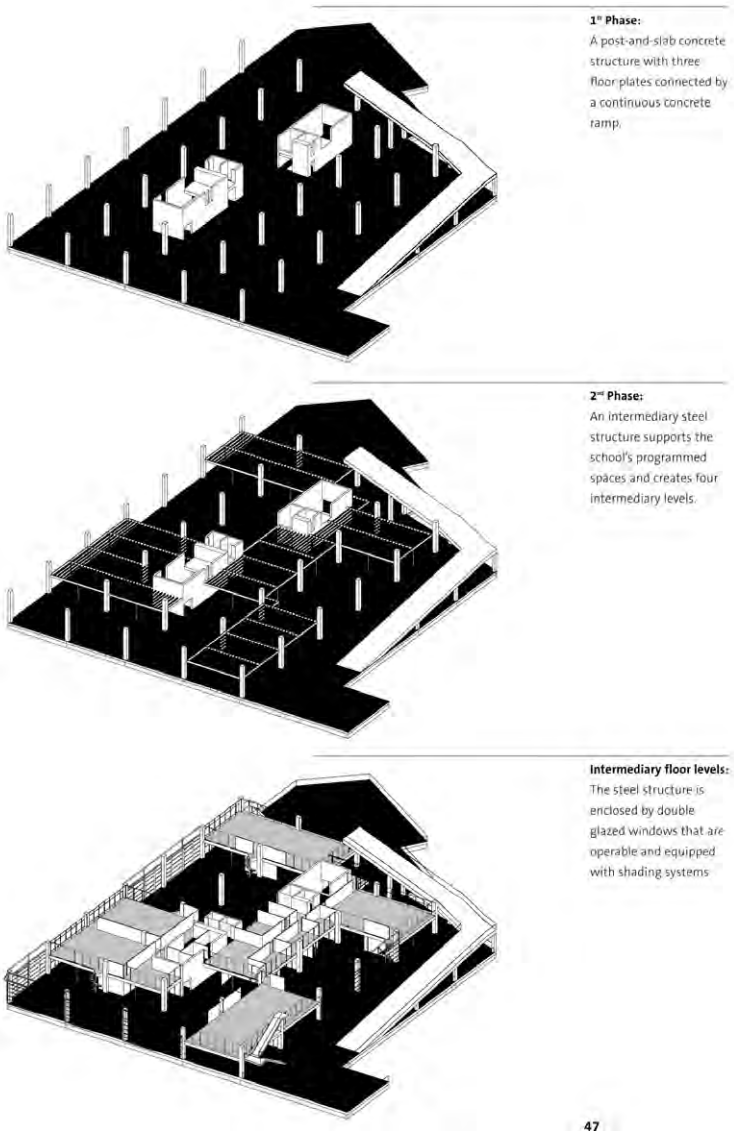

Fig.31 - Lacaton&Vassal, Nantes school of Architecture, phases

that makes the building ecologically, socially, and financially sustainable. The building's double-height un-programmed volumes, designed at the architect's discretion, provide the school with adaptable and multifunctional spaces that will allow the building to be repurposed rather than destroyed and built anew. Flanking both sides of the programmed, interior spaces and clad in polycarbonate panels, **these vol-**

umes retain solar heat during the winter and act as passive cooling mechanisms during the summer. Since this effectively eliminates the need for mechanical cooling systems, the rooftop is liberated from utility ducts, creating even more usable surface area. With an industrial load-bearing capacity, the rooftop is able to host large-scale events, engendering new cultural and financial dynamics between the school and the revitalizing city centre.

The way in which these additional spaces contribute to the building's sustainable mechanics demonstrates that there is no straightforward correlation between a project's surface area and its sustainability. In the past, the creation of extra spaces might have increased operational, programming, and energy costs, a burden disproportionally placed on the future proprietors and users of the building.

The establishment of two climatic zones integrates natural systems of thermal control to such a degree that the Nantes School of Architecture can do without mechanical cooling systems. The first zone consists of the school's programmed spaces that feature standard insulation and heating. These areas are surrounded by un-programmed double-height volumes, which, like horticultural greenhouses, optimize climatic conditions to produce an optimal interior temperature. Equipped with simple ventilation and shading systems, these spaces can adapt to warmer temperatures.

In the work of Lacaton & Vassal the spaces are flexible and they can be inverted according to seasons. They envision these intervention through the insertion of intermediary device between the inside and the outside, spaces of transition that permit the users to pass from one place to another, to invent new displacement.

Their work highlights the hidden potential of the wall assembage as a multilayered structure that permits the creation of intermediate spaces between the wall layers.

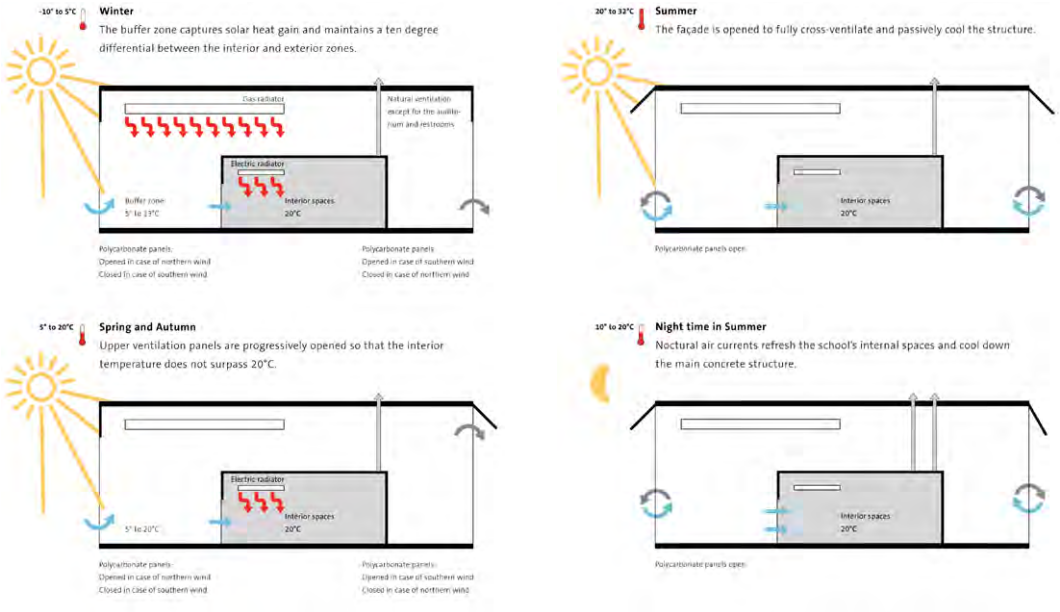

Fig. 32 - Winter / Summer diagrams. In the height of the summer, half of the school's polycarbonate façade can be opened up to allow for cross ventilation. The entire structure, with the exception of the auditorium and the restrooms, is naturally ventilated.
During the winter, the polycarbonate panels capture the sun's rays to generate solar heat gain. Reaching a temperature of 11 degrees Celsius in the winter, these spaces provide a buffer zone between the programmed spaces, which are heated by radiant panels, and the exterior climate, allowing for the implementation of smaller heating systems.

“The place where the oldest form of pipe surfaces, and where the pipes inside the body are most directly connected with the pipes inside the buildings, is where the psycho-sexual drama of the pipe is greatest. To sit on a toilet is literally to sit on a pipe.... To enter a bathroom is literally to enter the otherwise hidden cavities of the building itself, the inside of the inside. Not by chance does the room have the only internal door that always can be locked. The flush more emphatically defines the attempt to draw a line between inside and outside than any front door.“

Mark Wigley, Pipeless dream, Volume Magazine, n.37, Is this not a Pipe, 2013

“I essentially want to enlarge the ducts such as people can go inside of them. My work is not like the Centre Pompidou, where there in an empty space with ducts surrounding it, but rather the building itself in becoming a duct.” Philippe Rahm

WALL OF AIR

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The advance of technology made the wall more and more permeated with wiring and plumbing, insulation and acoustic engineering**,** even though it becomes increasingly naked, minimal and even transparent. Conducts, ducts, water mains and cables support biological and social life in spaces that are today held together by air-conditioning, electricity and telecommunication, as much as they are by form and materials. **Modern buildings are not equipped to function without machines.** Just consider the issue of thermal comfort and fresh air: walls, floors, ceilings and facades are inadequate sources of insulation, and so, **buildings rely on climate control machinery to maintain reasonable temperatures indoors.** In addition, a structure of any significant size and level of occupancy requires an arrangement of respirators and tubes to be fit for human habitation. Even with the assistance of natural ventilation, outside air must be mechanically pumped in and drawn out to circulate enough fresh air to inhabit the space comfortably.
However, as Mark Wigley (2013, p.22) have sayed in his article “Pipeless dream” :

“These tubes are rarely allowed to enter the space. They are asked to bring things in or take things away but are meant to remain outside. Pipes must always be close to us yet are unseen an unheard.”

In one of the most famous movies about architecture in the last 25 years, **Die Hard**, John McClane, a cop from New York on his Christmas holiday, moves through a Los Angeles high-rise named Nakatomi Plaza in principally every imaginable way but passing through its doors and hallways. The cop was equipped with a little more than a zippo lighter and a chip on his shoulder and he fought the invaders with architectural guerilla tactics; indeed, he avoided detection by **moving through ventilation ducts, elevator shafts, and apparently every other imaginable space except those programmed by an architect.** McClane is considered to be an infrastructure of almost unrestrained movement within the material struc-

Fig. 33 - Die Hard, John McTiernan, 1988-2013

ture of the building.

Geoff Manaugh (2010) branded the luminal territories that are strategically occupied in the Die Hard series as 'Nakatomi Space' taking into consideration the 'original tower' in the series, **where in building reveal near infinite interiors, able of being traversed through alla manner of non-architectural means.** [1]

Nakatomi Space. In a few words it explains a very complex vision- what Gilles Deleuze and Felix Guattari would name 'Rhozomatic Space', which, basically, is a **theoretical, nonhierarchical space constructed of elaborate connections and multiple points of access.**

Although the New York cop is certainly the hero of the movie, he is in fact a fugitive; a man selected, hunted, and forced to run away through the liminal spaces of Los Angeles high rise. John McClane's movements challenge any architectural program or conventional circulation. The fugitive exists outside of design. The actions of the cop are not foreseen by an architect, planner or engineer, as a result they have to become accustomed and invent. The mechanical ducts he crawls through and elevator shafts he climbs are often afterthoughts, consequences of architecture. In this regard, **architects are able to go to enormous lengths to keep these systems hidden and the outcome is usually an invisible labyrinth of**

1 Geoff Manaugh, 'Nakatomi Space', BLDGBLOG (January 11, 2010, http://www.bldgblog.com/2010/01/nakatomi-space/

articulation, a maze within a building, navigable only by current of hot and cold air. And certainly, the occasional New York City police officer.

"Die Hard is a movie about guts – the guts of the building and of its architect." (Stamp, 2013, p.157)

The design of the building has always had to make some **provision in plan and section, for these marginal consumption of environmental power** – chimneys for smoke, channels for water. Some architects, like the Adam brothers, made ingenious use of **'left' spaces in plan to provide concealed access for servants to light lamps and candles.**
Throughout the 19th century the working and living circumstances of people in developed societies caused environmental concerns of the highest urgency and inexplicable novelty. In view of the fact that protection of health was so significant an incentive to environmental study and reform, there should be no surprise at the significant part played by medical man in these fields. What may occurrence surprise today is that their advanced activities included straight action in the field of buildings. Their writing usually make known an intimate practical knowledge of the environmental performance of buildings, an expressed disrespect for the architectural profession's evident unconcern to such issues, proposals for the enhancement of building-design, and even the construction of reformed buildings by doctors themselves. For example, in Liverpool, **Dr. Hayward, constructed a house in the 1860's whose entire design was related to problems of ventilation and heating.**
The utilization of ascending/descending convection duct powered by waste heat was a very common form of air extract, in the period before appropriate funs were accessible.
In this regard, Banham (1969, p.36) has pointed out that in the design of the **Octagon House** is unusual the mode in which
"all the principal rooms open off closed lobbies, separated by doors from the hall and staircase. These lobbies superimposed exactly in plan, form a vertical supply duct (called a 'corridor' by Hayward) de-

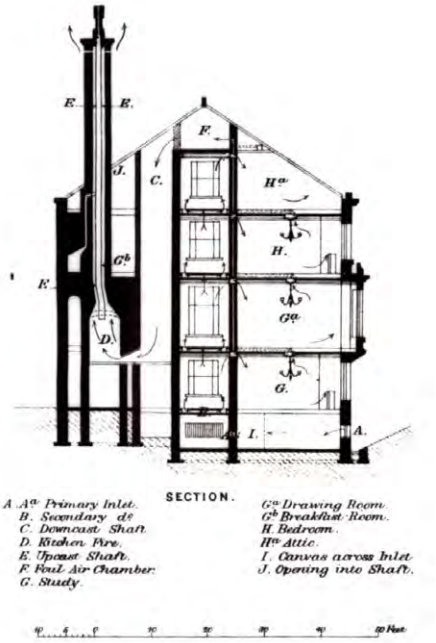


Fig.34 - Octagon House, Dr John Hayward, Liverpool, 1867

livering cleaned and warmed air to the rooms."

During the first years of the 20th century the very expansiveness of large buildings generated new environmental problems, not only from the vaster bulks of structural material involved or the greater volumes of air enclosed, but as well by upsetting external meteorological conditions by accumulating wind pressures, or overshadowing large areas of ground. Large mechanical devices were at hand to deal with at least the internal outcomes of these turbulences of usual scale. Concerning this, **Frank Lloyd Wright's Larkin Building (1904) is a watershed instant in architecture – a convergence of advanced technology, architecture, and management theory.** This building is a designed environment whose generative logic is the optimization of situations for well-organized work. In this respect, the author's harmony of constituent systems (architectural, mechanical, managerial) create a hermetically sealed, highly controlled interior space.

"The Larkin administration building was a simple cliff of brick hermetically sealed (one of the first air-conditioned buildings in the country) to keep the interior space clear of the poisonous gases in the smoke form the New York Central trains that puffed along beside

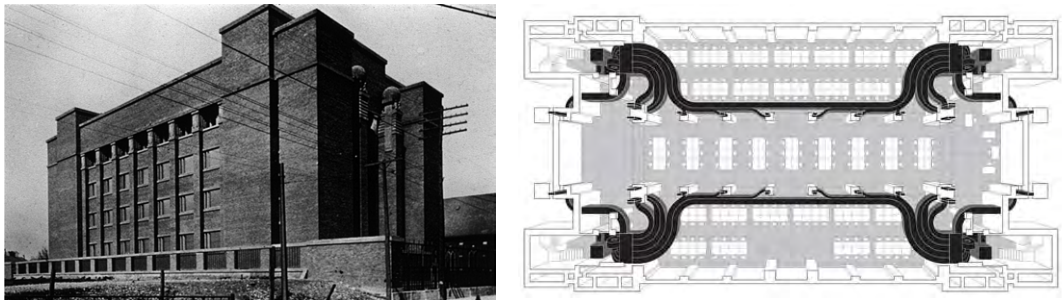


Fig 35 - Larkin Administration Building. Buffalo, NY. F.L.Wright, 1904
Also called the perfect wall, the single surface barrier emerged after World War I as the new tecnological paradigm of the building envelope. The idea of completely sealing - off interior air from the urban environment came at a time when cities were increasingly perceived as toxic. A century of industrialization and the rapid rise of the automobile created unprecedented levels of pollution and noise, resulting in a mentality obsessed with sealing out environmental pollution.

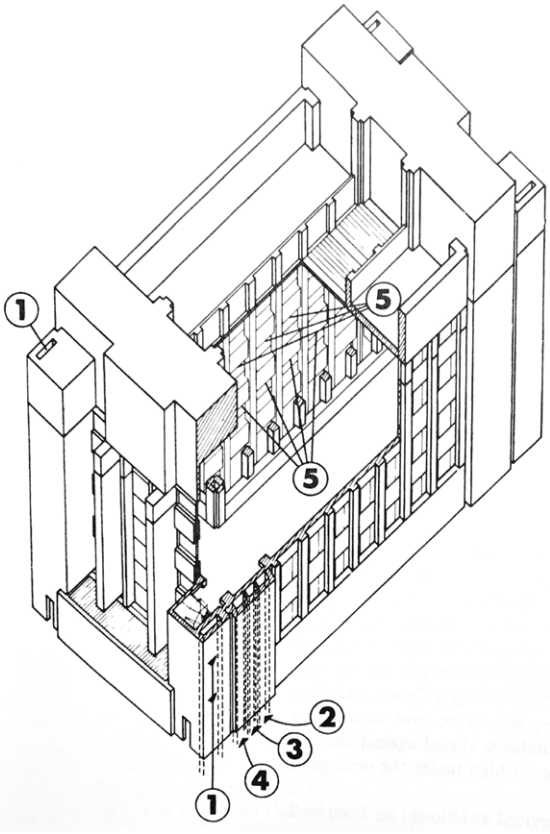


Fig.36 - Larkin Building: cut-away drawing showing the location of main air ducts.
1. Fresh air intake 2. Mischellaneous ducts and services 3. Foul air exhaust 4. Utilities 5. Tempered air outlets under balcony fronts and ceiling-beams

it." (Wright, 1943, p.150)

Banham (1969, p.90) has pointed out that historical and critical writing has tended to concentrate exclusively on the felicity of its interior spaces and their relationship to the great monumental volumes of the exterior, without observing that ***'the system of environmental management mediated crucially between interior and exterior form.'***

Not simply the utilization of a **huge single vessel of space circled with balconie**s roughly a requirement given the then state of artificial ventilation, but it was a flash of inspiration, about the **disposition of services to achieve that ventilation, that gave the magisterial form of the exterior.** The building's huge, open court incorporates the space of work. **The interior climate is itself managed by an early form of air conditioning whose physical plant, fans and compressors fortify the lithic corners of the building. A Baroque curlicue of cooling ducts unwinds from the cellar level mechanical plants previous to infiltrating the massive-looking columns (the ducts having been cunningly hidden by Wright's on-the-spot invention of the false-section).**

Banham (1969, p.92) has explained that The Larkin Building design is serves as a bridge between the history of modern architecture as frequently explained- the progress of structure and external form – and history of modern architecture understood as a progress of creating human environments.

In the following years, Le Corbusier has identified strategies for new approach to environmental management.Considered from today's distance, he was a prophet not simply in architectural language and urbanism but as well in recognizing the significance of a right mix between building design (passive measures, ventilation, mass, etc) and active systems (air control and mechanical distribution) for achieving comfort in buildings.

The two concepts which **Le Corbusier developed between 1926 and 1933 were the 'Mur neutralisant' and the 'Respiration exacte', both intended to work together because they were complementary.** He tried to implement them at the Cité de Refuge in Paris and the Centrosoyuz in Moscow, unsuccessfully in both cases. In relation to the Cité de Refuge

he sets out as follows:
We had been looking for an opportunity – it came: the Salvation Army hostel Cité de Refuge. Six hundred poor souls, men and women, live there. We gave them freely the ineffable joy of full sunlight. A thousand of square meters of glass wall lit every room, from floor to ceiling, from wall to wall… ***the glass was hermetically sealed, because warmed and filtered air circulates constantly inside, controlled by the heaters and funs.***
(Le Corbusier, 1937, p.25-26)

Put simply, his intention was to obtain an internal comfortable environment all year round and in all climates. He coined two names but in fact three aspects were required simultaneously:
1. A very high airtightness through the envelopes hence the idea of sealed glass (or sealed opaque walls) being part of the 'Mur neutralisant' concept. The intention was rightly to avoid air and heat flowing from inside to outside and viceversa.
2. A mechanical system of controlled ventilation capable of adjusting air temperature and humidity that is, a rough description of an air conditioning system. This was the idea behind **the 'Respiration exacte'**, which in fact comes from his colleague the engineer Gustave Lyon.
3. Finally, in order to allow glazed facades to act as external thermal en-

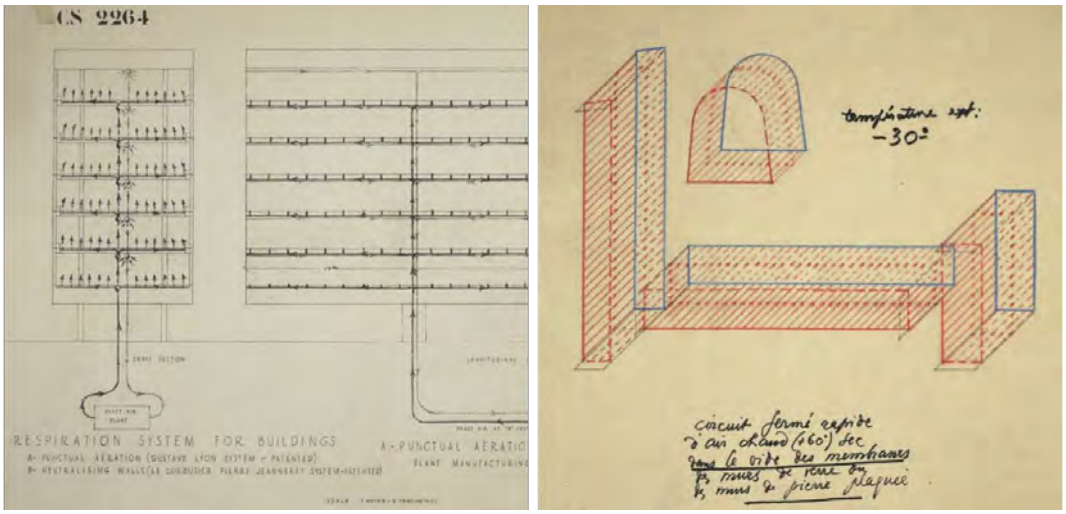


Fig.37 - Le Corbusier, Respiration exacte and Mur neutralisant as they were envisaged for the Centrosoyuz project in Moscow

velopes, an active device that neutralized energy flows (both in winter and in summer) through glazed surfaces: **the 'Mur neutralisant'**. This acted mainly as a barrier avoiding heat to flow insideout during winter and outsidein during summer.

Corbu delevoped an existing, **earlier device (water heat radiators installed between two parallel glazed walls**) into a more ambitious idea. By inserting air pipes around a sealed double glazed cavity he suggested that treated air could be blowed, warm in winter and cold in summer, **so as to neutralize the outer conditions.** This would allow the 'Respiration exact' system to maintain a constant internal temperature of 18C.

Inrelation to the 'Mur neutralisant', Le Corbusier had experienced a similar concept for the windows in his Villa Schwob in Switzerland by 1916, so that this seems to be his own development. **In the Ville Schwob very large windows were designed in two layers, with heating pipes between them, to prevent down draughts**. **In the same details for the Centrosoyuz (1929) he referred to them as Neutralising walls in glass or stone; quick closed circuit of dry hot air (winter) or cold (summer); The 'Mur neutralisant' was his baby; the 'Respiration exacte' was Lyon's.**

The glass solution was typical to the other Corbu 'Mur neutralisant' schemes; that for the opaque walls in Centrosoyuz reveals another great Corbu's intuition. **An enclosed air cavity between two walls of pink tufa stone** from the Caucasus would have been a very adequate thermal solution for opaque walls in Moscow, even if there was no hot air circuits inside. The Russian client ultimately dismissed the 'Mur neutralisant' system because of the lack of technical justification. At least they kept the double glazed wall, of which there were some previous examples built in Moscow. But the opaque wall as it was designed, even without blowed air in the cavity, would have been much better in terms of insulation than the onelayer stone wall finally built, with a thickness of 40cm.

The mixed technological innovation of the mur neutralisant and respiration exacte identified by Le Corbusier, with the help of G. Lyon, represented a novel explanation of the mechanization of the environment to solve the control of indoor climate in Modern Movement,

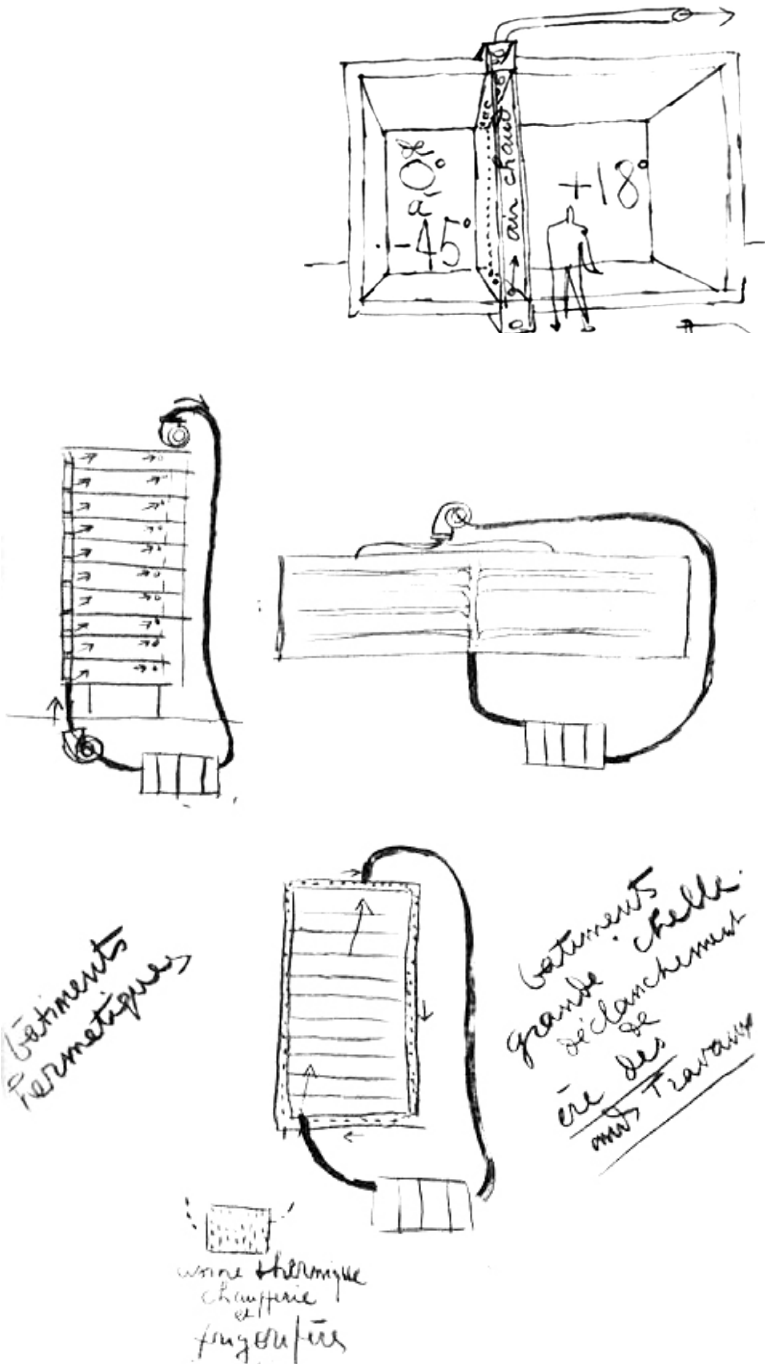
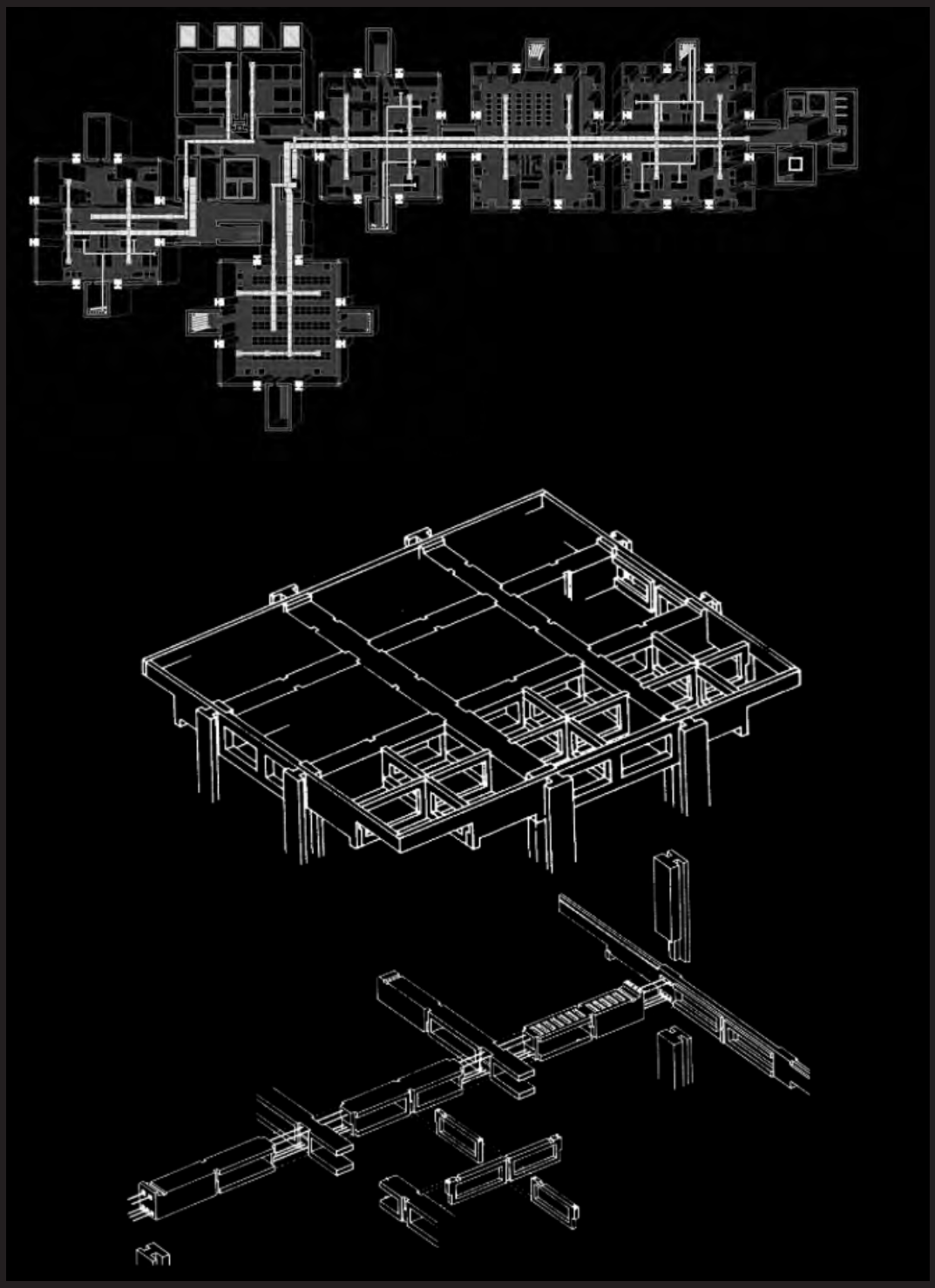


Fig.37 Description of the ‘Mur neutralisant’ and ‘Respiration exacte’, 1929

Richards Medical Laboratories, Louis Kahn, 1965

Kahns dialectic of served and servant space recognized the necessity of mechanical technology without celebrating technology as such, but rather presented a serious **recognition that the physical stuff of mechanicals must be relentlessly accommodated, and thereby controlled.**
Kahn's authoritative mastery of mechanical presence at **Richards is evidenced in the fluid integration of ducts and conduit in the depth of the building's precast concrete structure**. Rather than hiding the physical bulk of the mechanical services, Kahn left the plate open, exposed to the labs below. Exhaust hoods could thus be configured according to whim, connected to flexible ducts above: the ceiling plane as deus ex machina. Ultimately, the super-flexibility of Kahn's atelier-labs was undermined by the interventions of its users.
Scientists found the open-air atmosphere of Kahn's atelier-labs disturbing, and immediately set about populating the building with flimsy internal partitions as soon as the building was completed. Drop ceilings were installed soon thereafter, hiding Kahn's carefully considered network of mechanical systems, and preventing adequate air circulation for decades.

" In the Richards Laboratories, as he had done previously, Kahn managed to integrate the horizontal distribution of services within the laboratories' post-tensioned floor slabs. Here too, as in the AFL Medical Center, the structural grids are doubled and create a series of bi-directional interstitial channels, so that the horizontal network of services into the space fabric is all-pervasive. In this case, however, the system results from a scrupulous assembly of different elements and its hollow nature is expressed in the elegant solution of projecting corners where the thickness is reduced due to the decrease of stress thus exposing the interstitial voids. " (Cacciatore, 2011, p.85)



Richards Medical Laboratories. Philadelphia, PA. Louis Kahn, 1965.

as the tests realized by Saint Gobain engineers verify. Their outcomes analyze the attitude the mur neutralisant in the City of Refuge would have exhibited under various environmental and operating circumstances had the original design been entirely carried out.
Hence, the operating circumstances of the mur neutralisant and the indoor temperature values achieved in both winter and summer verify that, the active thermal system identified by Le Corbusier for monitoring indoor temperatures, makes it likely to achieve an isothermique thermal environment with alike comfort circumstances all through the year, in spite of outdoor temperature and solar radiation. The energy efficient integrated system of temperature monitoring was integrated into the building envelope. **This complete explanation of the relationship between architecture and energy was basically half a century at the forefront of environmental control systems with active façade systems designed with a view to building sustainability and energy efficiency. Had the mur neutralisant been performed following the original designs of Le Corbusier and Lyon, it would perhaps have created serious competition to the air conditioning systems built up in the 20th century with great achievement and hardly any technological rivalry.** This is a text written by Le Corbusier protecting his active air- handling standards for La Cité de Refuge in 1931:

"Our Invention, to stop the air at 18 degrees undergoing any external influence... These walls are envisaged in glass, stone, or mixed forms, consisting of a double membrane with a space of a few centimeters between them... a space that surrounds the building underneath, up the walls, over the roof terrace...*Another thermal plant is installed for heating and cooling, two fans, one blowing, one sucking; another closed circuit... Result, we control things so that the surface of the interior membrane holds 18 degrees"* says Le Corbusier

In The City of Refuge, his fascination with integrating novel technologies into architecture, did not manage to convince with the innovations which he had hoped would make available a solution to temperature control is-

sues. In fact, it was generally due to the barriers met in the building, which prevented the implementation of one of the most important technological innovations suggested by Le Corbusier: the mixture of the mur neutralisant and the respiration exacte.

As the scale and the complexity of building grow, the organizational demands of the supporting mechanical systems contend with a set of protocols based on a structurally derived diagrammatic language. **This results in two competing paradigms; the first is the structural composite, which has the advantage of abstract representational tools to negotiate between form and force, and as a result operates compositionally, and the second is the building environmental control system, which is organizational, and constrained by the performative limitations of the attached mechanism / appliances – the capacity to heat / cool a certain volume of air over time, for example.** Because poché has no formal agency, it is treated as essentially without form, and is organized based on structurally derived compositional criteria, and opportunistically sculpted to reinforce other spatial agendas.
It is likely that the renaissance of spatial tropes, born in the explosion of new materials and techniques that become available during the twentieth century, were not purely a response to the formal plasticity afforded by technology – thinness, transparency – but came as a result of attempting to reconcile the irreconcilable, **by developing compositional strategies that configured and camouflaged mechanical systems designed to manage temperature, forcing them to masquerade as systems developed to manage gravity.**
Something of response to this willfull lacuna of environmental control systems, the **Environmental Bubble (1965) project, conceived in collaboration between Reyner Banham and Francois Dallegret** is the architectural foil to the prototypical architecture associated with twentieth century modernism and is the **diagrammatic antithesis to Dom-ino.** The bubble is an architecture that inverts normative architectural conditions and subverts the disciplinary allegiance to the governing force of gravity; **it embraces temperature , by negating gravity**. **With the structure removed**

what remains is only what is hidden inside the poché. Complete architectural transparency is achieved by making the invisible visible. Like Dom-ino, the Environmental Bubble outlines a specific design agenda for dealing with poché. The bubble eliminates it in favor of expressing the environmental control system, and thus becomes architecture reduced solely to an atmosphere and its mechanical infrastructure. Structure both bearing and compositional, evaporate and the resulting spaces are composed of atmospheres, thermal zones,

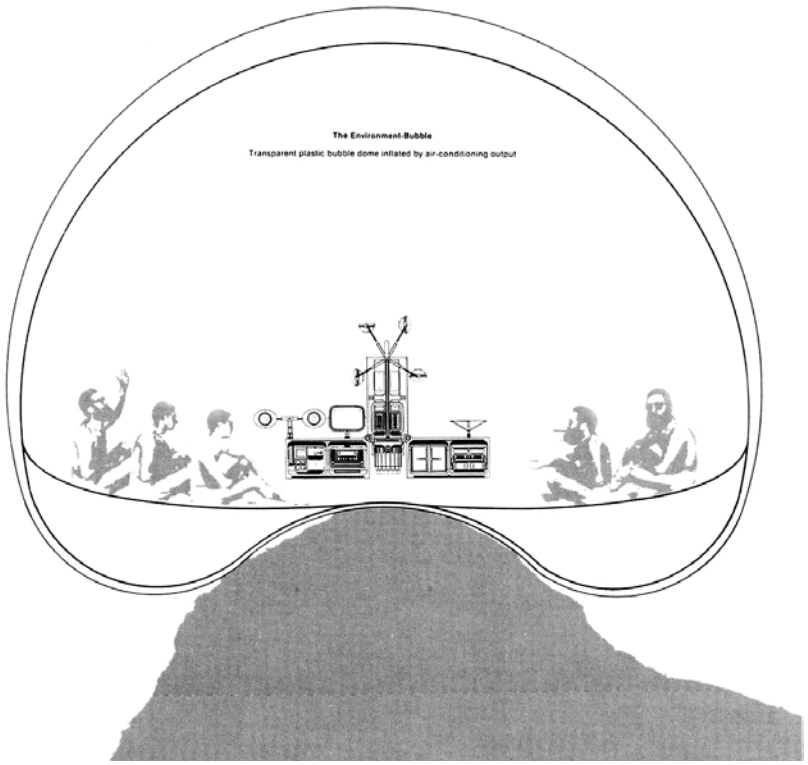


Fig.38 Environmental Bubble, Reyner Banham and Francois Dallegret, 1965
It is a “transparent plastic bubble dome inflated by air- conditioning output.” At its center is a Transportable Standard of Living Package that provides all mechanical services, entertainment, and so forth. This huge network of cables and tubes stands between the sky (with a TV antenna) and the ground (a septic unit) as an accumulating “baroque ensemble of domestic gadgets”. The drawing accompanies Banham’s 1965 essay “A Home is not a House”

and the pliant but ambiguous enclousure.
As the importance of mechanical systems was already pointed out by Banham in 1965, in the process of design and engineering the building scheme is first established, then the mechanical infrastructure is shaped to respond to the determined volumes, uses, and organization of spaces and programs. In order to balance thermal deficiencies, a system of heat exchangers, fans, chillers, ducts, dampeners, vents and diffusers is inserted into allocated zones. The machinery tends to be oversized because the network of parts is extensive and sinuous – diverted, since they are behind walls, floors and ceilings so as to remain covered inside the architecture's envelope. This sequence of professional services tends to diminish the system's effectiveness, and reproduces a submissive relationship to a pre-set form. In the article *'Machines for Architecture to be lived In'* Jeffrey Inaba argues:

"Thinking about what machines can make possible, not just what they make up for, can inject conceptual oxygen into the design process. Devising buildings that are less dependent on their mechanical systems, where mass and machines work together to sustainably treat the interior. Environmental control systems could be employed towards more inspired aim." (Inaba, 2013, p.4)

Concerning this, Philippe Rahm is interested in the way in which the materiality of the atmosphere is able to inform architecture. Thus, the process of evaporation represents a dispersion of limits, an overcoming of the structure of air itself. The management of levels of humidity introduces a new type of space in which linear changes in the floor plan form a landscape of wet and dry regions. By means of evaporation, a sensual relation is made between body - skin and respiration, and space – light and moisture. Also, **by organizing space around physical – chemical transformations, architecture of climatic zones and latitudes is produced, representing a departure from the thermal uniformity of traditional environments.**

In the project Convective Apartments located in Hamburg, Germany, the design of this condominium building is based on the natural law of Archimedes that makes warm air rise and cold air drop. Very often in an apartment, a real difference of temperature can be measured between the floor and the ceiling, a difference that could sometimes even be 10 °C. Depending on our physical activities and the thickness of our clothes, the temperature doesn't have to be the same in every room of the apartment. What **Phillipe Rahm proposes to shape the apartment into different depths and heights:** the space where we sleep will be lower while the bathroom will be higher. **I**n this way the apartment would become a **thermal landscape with different temperatures, where the inhabitant could wander around like in a natural landscape, looking for specific thermal qualities related to the season or the moment of the day.**

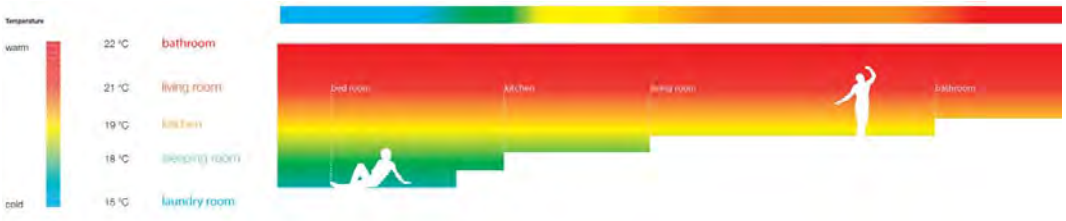


Fig. 39 - Section apartment, functions related to thermal zones, Philippe Rahm, 2010

By deforming the horizontal slabs of the floors, different heights of the spaces are created with different temperatures. **Their project modules and follows the path of the air and the light, from outside of the building to inside the apartments, from the landscape to the design of furniture.** Each step is thought intelligently to give to the air a certain quality. The materials that surround, shape and accompanying air are chosen to give to the air a certain value, a certain quality. **It starts with the outside air, which come following the main wind from the south-west.**

"This air arrives near the building north or south. At the south, we propose the darkest grass, in a very dark green, almost black, with a low albedo of 0.15, to absorb the maximum of the light to warm the soil and heat by conduction the ambient air around. An air intake is located here, in this sunny and warm place to take during the winter an air as hot as possible. At the north, on the contrary, we plant the

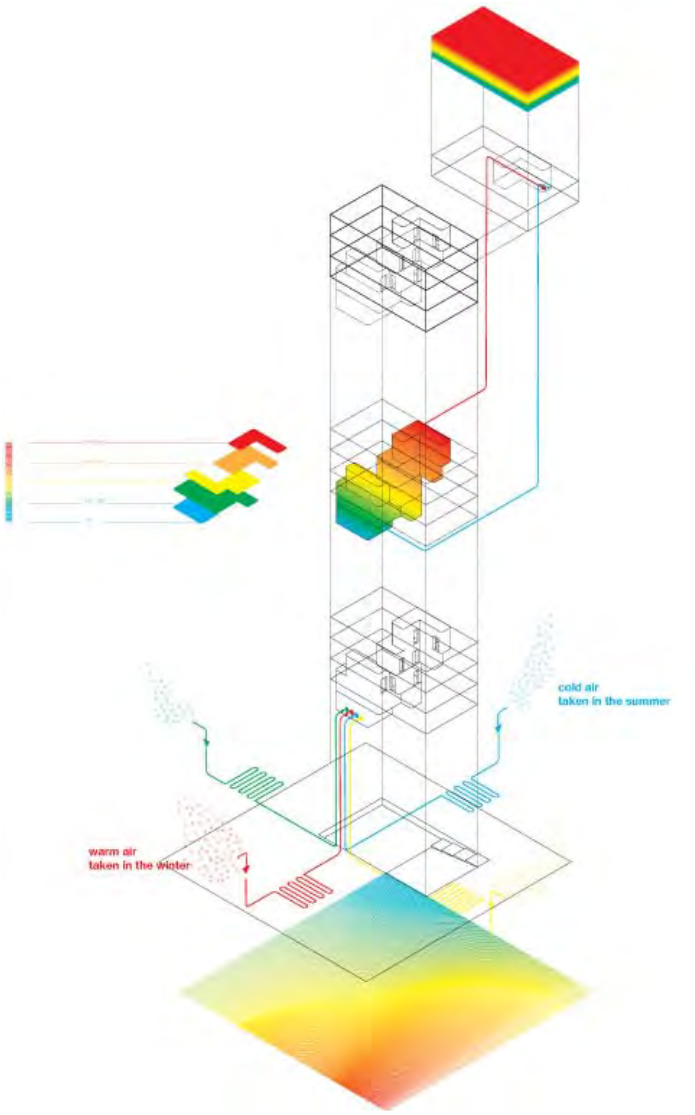


Fig. 40 - Double - flow air renewal system, alternative routes of the air renewal related to season and the time of the day, Philippe Rahm, 2010

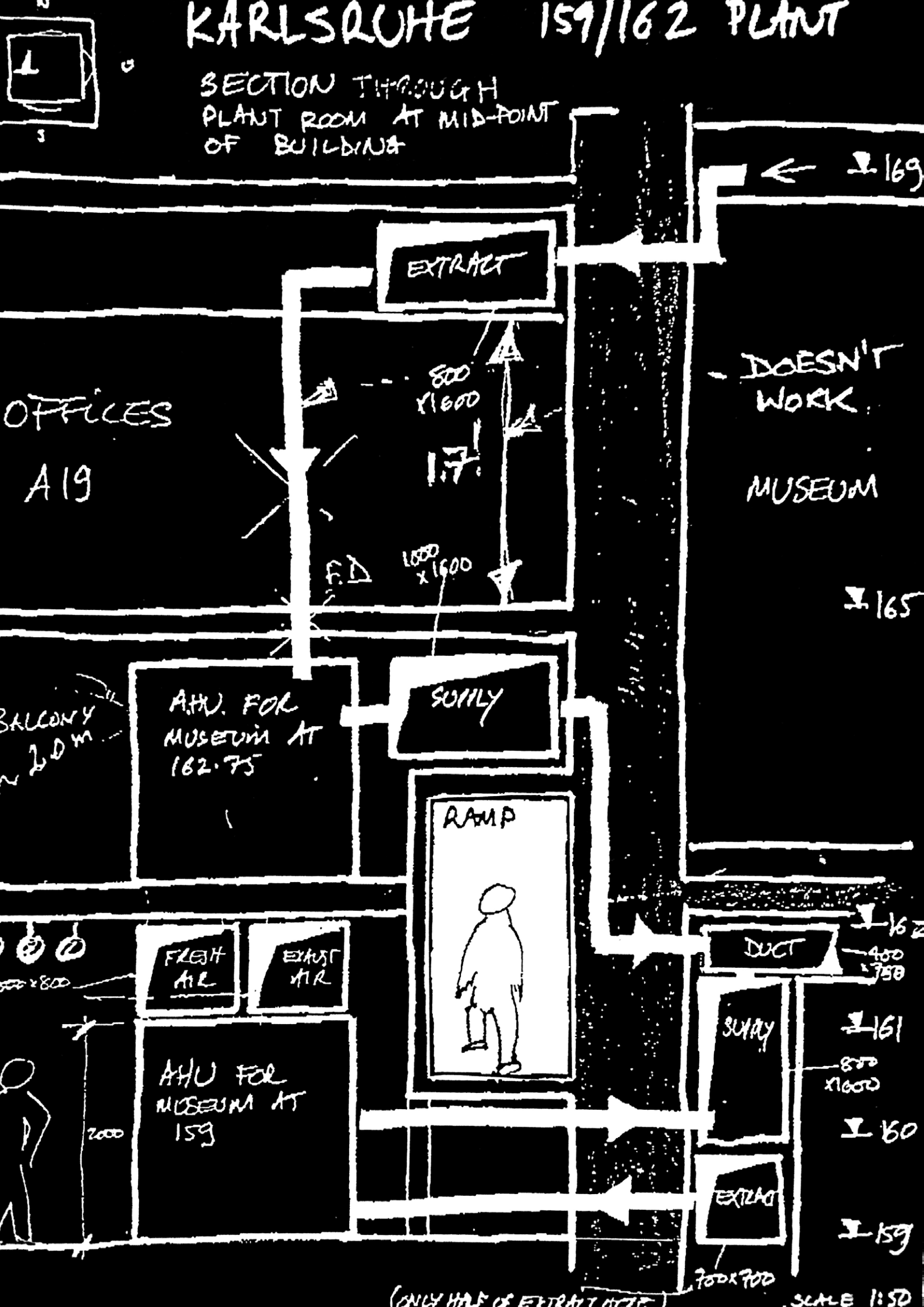
whitest green grass as possible, a very pale green, almost white, with a high albedo at 0.3 to reflect the maximum light to not heat the ground and reduce the heating of the air to the maximum, keeping it as fresh as possible. Mint with his refreshing properties is planted here. We propose also dense trees with deep shadows to enhance the freshness of the place. Here, in the most cold situation, we will take the air in summer, when it gets too hot. This air passes through a Ground-coupled heat exchanger to cool in more while arriving in the common area stairs." (Rahm, 2010)

"...The deeper the building, the more it depends on artifice for its servicing. Air is injected into its interior, used, and extracted; the inside core, inaccessible to daylight, is lit by fluorescent tubes (gasses in a permanent state of explosion). In the conventional solution – combining the claims of structure and services – the ducts carry air to and from the center are hung from the floor, then hidden behind a false ceiling. This zone of darkness is further stuffed with equipment for lighting, electricity, smoke detectors, sprinklers, computers, and other building "controls". **The section is no longer divided by discrete demarcations of individual floors; it has become a sandwich, a kind of conceptual zebra; free zones for human occupancy alternate with inaccessible bands of concrete, wirings and ducts...**.To avoid interference from the columns and their unwelcome inheritance, the structural grid widens, increasing the depth of the floor slabs. Ducts inflate to deliver greater perfection to even more distant destinations. Wiring proliferates , claiming more space.

The more sophisticated the building, the greater the expansion of inaccessible zones expropriating even larger parts of the section... Additional "disciplines" claim major reservations in section and plan (nobody knows exactly what for) in metaphysics of pragmatic precaution against "things" that "might" or "always" happen.

Idealism vs. philistinism: the section becomes battlefield; white and black compete for outright domination. (in some hospitals the dark bands of the section exceed 50% of the total and block 75% of the budget.) **The dark zone is not only strictly "useless" for the future inhabitants of the building; it also becomes conceptually inaccessible for the architect, who has become an intruder in his own project, boxed in, his domain a mere residue of the others' demands."**

Rem Koolhaas, Last Apples, SMLXL


KARLSRUHE 159/162 PLANT
SECTION THROUGH PLANT ROOM AT MID-POINT OF BUILDING
169
EXTRACT
800 x1600
OFFICES
A19
DOESN'T WORK
MUSEUM
F.D
1000 x1600
165
A.H.U. FOR MUSEUM AT 162.75
SUPPLY
RAMP
FRESH AIR
EXHAUST AIR
DUCT
400 x750
SUPPLY
161
800 x1600
A.H.U FOR MUSEUM AT 159
2000
160
EXTRACT
159
700x700
(ONLY HALF OF EXTRACT
SCALE 1:50

AIR DUCT

In the Ducth Embassy by OMA, a continuous trajectory reaching all eight stories shapes the building's internal communication. The workspaces are the 'leftover' areas after a trajectory was 'carved' out of the cube and are situated along the façade. Reception spaces are activated inside the cube. Other semi-public spaces are located closer to the main façade, and at one point cantilever out over the drop-off area. From the entry, the trajectory leads on via the library, meeting rooms, fitness area and restaurant to the roof terrace. The trajectory exploits the relationship with the context, river Spree, Television Tower, park ad wall of embassy residences; part of it is a 'diagonal void' through the building that allows one to see the tv tower from the park.

The slightly over pressurized trajectory works as a main airduct from which fresh air percolates to the offices to be drawn of via the double plenum façade. The ventilation concept is part of a strategy to integrate more function into one element. This integration strategy is also used for the structural concept. The internal walls adjacent to the trajectory are load bearing beams that cross over each other enough to bring loads down. Hereby big open spaces are created on the lower floors of the building. Load baring glass mullions, allowed to fall out in case of a fire while still leaving the superstructure in tact, support the floor slabs where the trajectory meets the façade.

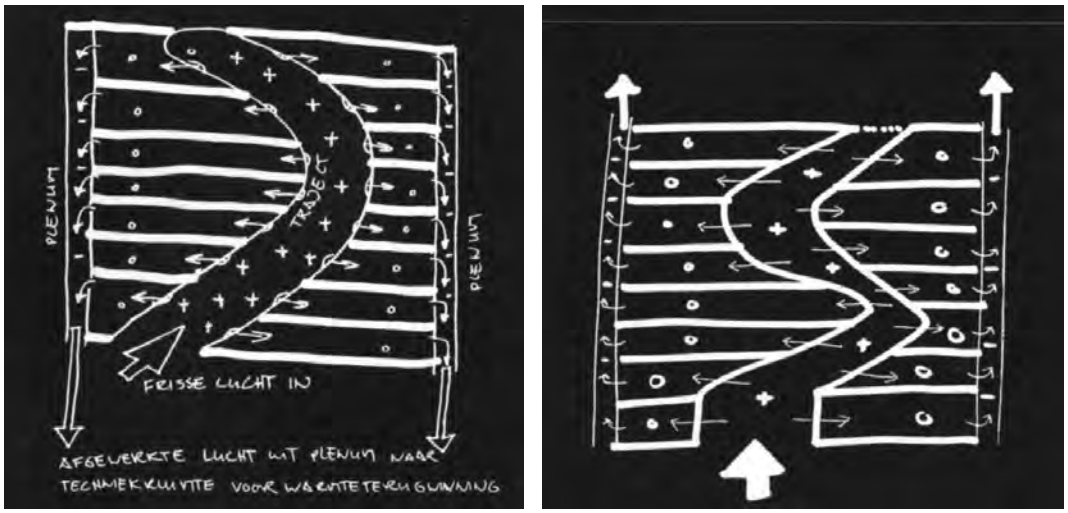


Fig. 41 - Air flow diagrams, OMA, 1997

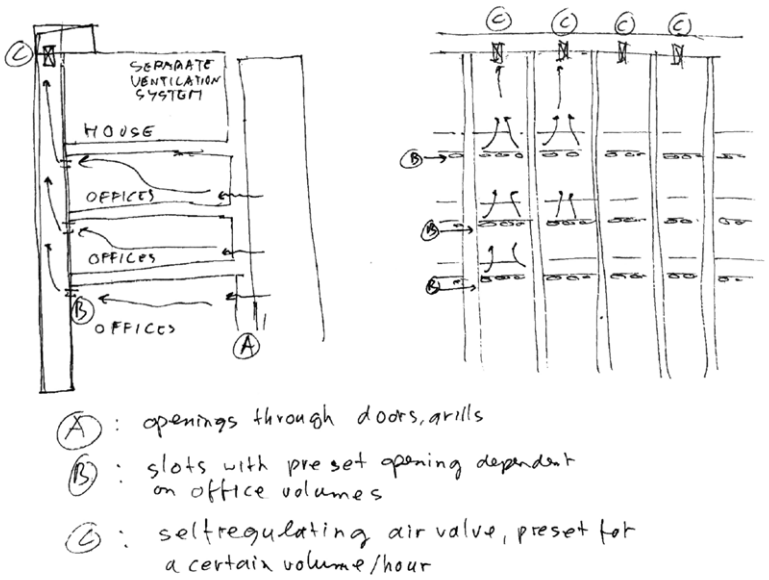


Fig. 42 - Air flow diagrams, OMA, 1997

Only the ground floor was provided with bullet-resistant glass; **the upper floor containing the offices have a double-leaf façade made of separate elements, which act as a chimney, carrying away the exhaust air.**

The embassy building is almost entirely devoid of ducts: all equipment particularly the ventilation, is part of the architecture. The Ventilation brings two elements into play: the route and the façade. The route is slightly over pressurized and works as the main fresh duct. Gaps opened along the walls are used to filter this air entering the offices behind. Then the stale air is expelled through the façade which is true double skin façade.

The space between the two sheets of plate glass is a sort of pressured air duct measuring 50 centimeters deep and 125 wide (the distance between the two pillars). This pressurized duct continues vertically through the full height of the building from one floor to the next. The façade can thus be interpreted as a sum of vertical chimneys in which the air is kept slightly depressed. At the top of each chimney, a self regulating valve ensures a constant hourly output.

A peripheral duct takes the stale air back to the treatment equipment in one of the opposite wings. After treatment, this air is fed back at the bottom of the route.

The façade is part of the structure: every two sections, a metal pillar ensures the stability of the concrete slabs in the floors. Narrow floor-to-ceiling windows

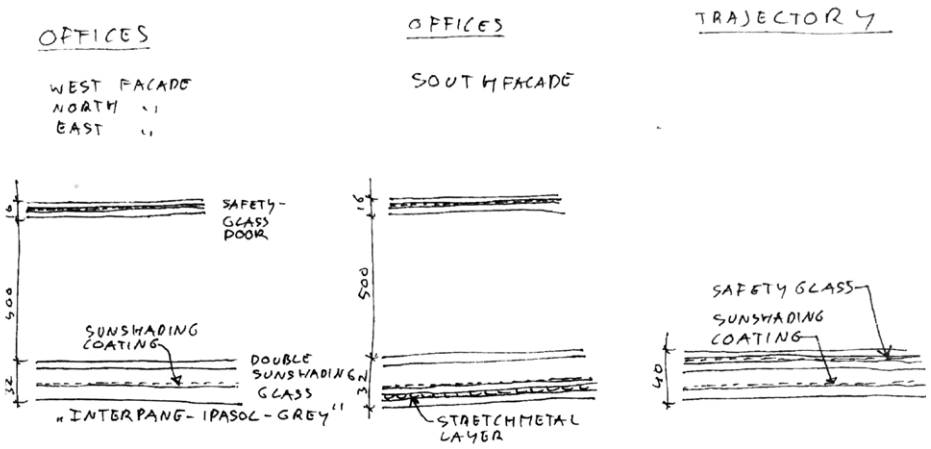


Fig. 42 - Facade layers, OMA, 1997

permit manual ventilation in alternation with these pillars.

The double skin is composed outwardly of double glazing with a clear grey film on the inner face, while the interior consist of Triplex safety glass. This façade can be opened to facilitate maintenance work. Sun shading for the offices south towards the Spree River is ensured by means of a thin aluminum lattice that is part of the interior glazing.

AIR PLENUM

SANAA'S Toledo Pavilion uses the mechanical systems to resolve the dense layering of interior spaces. The inventive method of thermal control afforded the architects elbowroom to shape the serpentine walls and diversify the types of internal configurations while fulfilling extremely different requirements among rooms.

This annex to the Toledo Museum of Art, is both an exhibition space for the museum's glass collection, and a glass making facility. Conceived as a single one-story volume penetrated by courtyards with sightlines through layers of transparent walls, the visitor's experience will always involve the surrounding greenery. **Individually each space is enclosed in clear glass, resulting in cavity walls that act as buffer zones between different climates; museum exhibition spaces, the glass making hot-shop and the outdoors.**

The plan is derived from a grid of various rectilinear shapes reflecting pro-

grammatic adjacencies, with room- to – room connections achieved using curving glass surfaces. Glass is wrapping the spaces forming continuous elevations, uninterrupted by corners. The visitor flows with the form trough a series of interconnected bubbles.

This cavity space, which was made between the bubbles like the backside of walls, was planned as air-conditioning buffer zone and responds to each room's different temperature and humidity requirements.

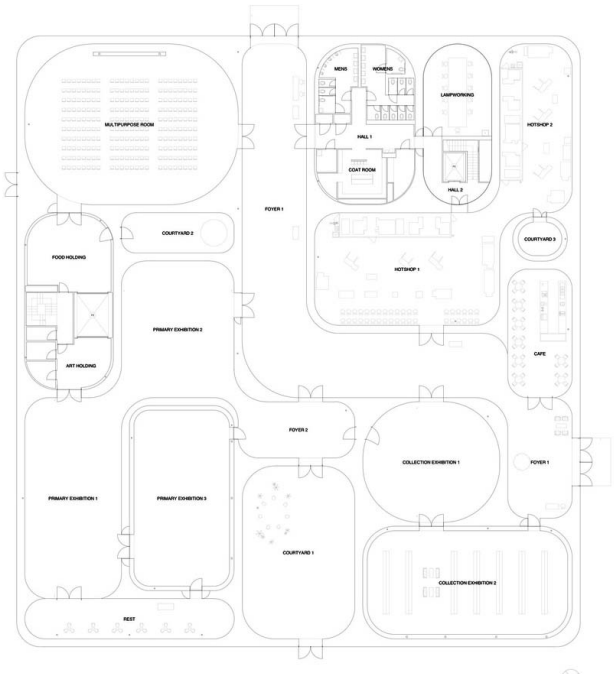


Fig. 43 - Groundfloor plan, SANAA, 1997

Fig. 44 - The double glass facade, SANAA, 2006

In SANAA's Glass Pavilion at the Toledo Museum of Art, the various spaces are treated like islands enclosed by walls of curved glass. The space between the layers of glass is an air plenum which serves the firm's aesthetic motives while hiding (in plain sight) their conditioning system. The plenum spaces are heated and cooled by a radiant system located in both floor and ceiling that creates a buffer between programs. The thermal isolation of spaces within the plenum produces a subtle microclimates as well as visual connection between interior, exterior, public and private.

The integration of mechanical systems into SANAA's design for the Glass Pavilion at the Toledo Museum of Art in 2004 was no small feat, since the glass building has few opaque walls in which to hide ducts and pipes. SANAA project architect Florian Idenburg worked with Transsolar director Matthias Schuler **to refine the design of the air cavities between the two layers of curved glass, allowing the architects to achieve an effect of uncompromised lightness and transparency.**

In an interview conducted by Jeffrey Inaba for Volume Magazine, their comments reveal the irreducibility of the mechanic and form to the architecture's effects. **The glass walls, and the spaces between them, protects the interior environment while producing the atmosphere of the experience – creating alternating vistas, and reflections, oblique views through curving panels, and sequences across open and enclosed spaces.**

Idenburg explains that at the beginning they were mainly concerned about how accommodating the **two main aspects of program in the building: one was to show glass and the other was to make glass.** So half of the building is for exhibition and half is for glass making facilities. Their challenge was to display glass witin glass, and to situate it so it could be seen properly.

Their first concept was about trying to show glass within a glass enclousure, while simultaneously enjoying being in the grove. They felt that it would be important to see both the making of the glass and the artifacts in a way that the visitors could see both the creation and the results of glass making. **They decided a hyper transparent scheme that could bring the two functions together.**

The two functions had very different climates; they need to create a constant humidity and temperature in the exhibition spaces, where as the workshop needed to be constantly heated because they have liquid glass and kilns in there. The furnaces need to be constantly running for the glass to be workable. So they were dealing with rather **extreme conditions that needed to be next to one another.**

In commonplace construction the walls contain building systems. In the most of today's commercial and residential buildings walls are filled with

Fig. 45 - The air plenum., SANAA, 2006

mechanical electrical and plumbing tubes. Modernist buildings which cladded walls all in glass moved the mechanical system to the ceiling and floor sandwiches. One can think of the Glass Pavilion as being akin to those modernist structure because it has glass walls; but the mechanical system concept is very different. **By doubling the walls, there is something more akin to the traditional poché space, only the poché is entirely visible rather than concealed. And rather than having the mechanical entirely located in the ceiling and floor, these walls are reactivated to play a role in the climate control though the tubes have disappeared.** Managing the stable, cool climate of the exhibition space and the fast flowing, warm climate of the production areas would be a challenge in its own. To deal with these challenges using entirely glass walls SANAA began with a grid, which basically allowed different functions to happen next to one another. And then they came up with the idea of filleted connections on the corner, to create different types of relationship that were not just straight adjacencies, but connected on the oblique. The rooms started to shift based on energy and climate in particular areas of the building. For example, the exhibition spaces are more sensitive to light and heat, so they were moved to the nord, to reduce their solar exposure. The hot shop and the glass making facilities were moved to the south, not because they needed heat, but because the south side faces the museum, which would show the activities and glowing kilns to those on the street. So the organization of the scheme was determined by the climate's behavior.

"The ways the different spaces were organized were by separate bubbles that were single glazed at first. But then we realized, because of the sound created in the glass making, we needed to make a double skin. So the bubbles become independent elements in a large glazed pavilion. ***Basically in looking at the plan these can be read as super thin, one-inch thick glass walls, or they can be read as poché walls that need to take care of the different climatic conditions. If you look at the cavity space, it wraps the entire building and acts as a tempered buffer between dramatic climates; it balances the entire system out.*** "(Idenburg, 2013, p.100)

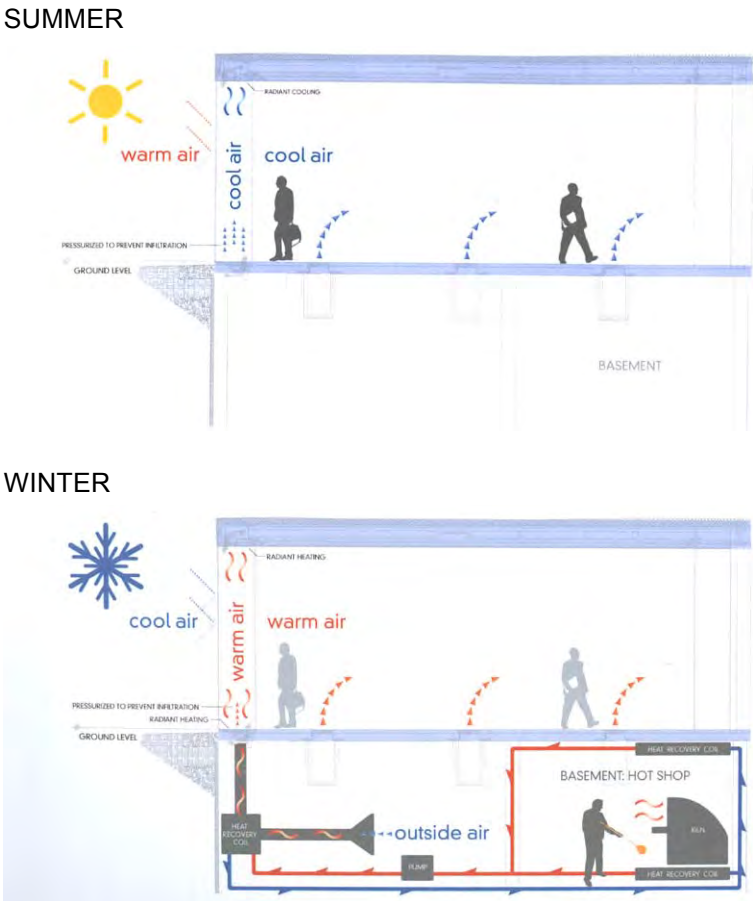


Fig. 46 - Section diagrams showing how the space between the layers of glass performs in summer and winter

SANAA initially worked with Cosentini Associates, who were the mechanical engineers of the project, which began using very traditional methods, such as trying to push as much air into the cavity to form a buffer between spaces. Cosentini thought of the cavity as an area to pump full of either cold or hot air that would have required a separation of the exterior cavity from the cavity of different spaces, something SANAA wanted to avoid at all costs. At that point they were introduced to to **Matthias Schuler from Transsolar, who immediately realized that the cavity should not be cut off. His scheme was opposite of Cosenini's, which was the idea to create complete stillness in that space there needed to be limited airflow with radiant heating and cooling.**

Both the floor and the ceiling in the cavity have coils running through them, either with hot or cold water. Beneath the furnaces are being reused directly by using the hot water or through a condenser. So a lot of the heating and cooling in those spaces is done through water not through air. **The cavities have very little air and are very stable.**

The radiant system in the cavity is taking care about the condensation as well. So when it's cold, the air in there is heated up by the radiant system, which heats the glass as well.. It is as a sort of thick IGU (Insulated Glazed Unit). In winter is much hotter in the cavity than it is in the interior space. In the summer, it's much colder in the cavity. Because people are never in the cavity, the temperature can be much more extreme.
The other key player involved in this discussion was Petra Blaisse, the designer of the curtain. The curtain, which is located inside the cavity, is playing a major role in ensuring the desired cavity climate. The mechanical engineers were experiencing challenges in trying to condition the cavity without creating an air storm. By increasing the velocity of air over the surface of the cavity in order to condition it, it increases the transfer coefficient, which means a reduction of the thermal resistance of the glazing. After long discussion with SANAA to evaluate different possibilities to coat the glazing the solution was to introduce the low-e coated curtain. In extreme winter conditions you can pull the curtain and have double the thermal resistance.

" What is interesting, and typical SANAA move, is that at first we were thinking of having air supply grills along the curved façade to blow warm air along the façade but they rejected it. They really wanted the glass to be floating on concrete and didn't want an optical disturbance. In the end we put diffusers in the floor away from the walls and reduced them in size so much that the air velocity that was blowing out of them was way above American standards. Later we did a one to one test with the client, where he tested the velocity's effect and SANAA insisted that if a visitor was disturbed by the airflow, he or she could step aside. That was the final test and the client agreed.It shows how protective SANAA is of their designs.

They are often unwilling to compromise their designs, so unusual mechanical systems need to be put in place. We were able to work together and prove that there are certain innovations that maintain the integrity of their designs and create a suitable building at the same time.”
(Schuler, 2013, p.103)

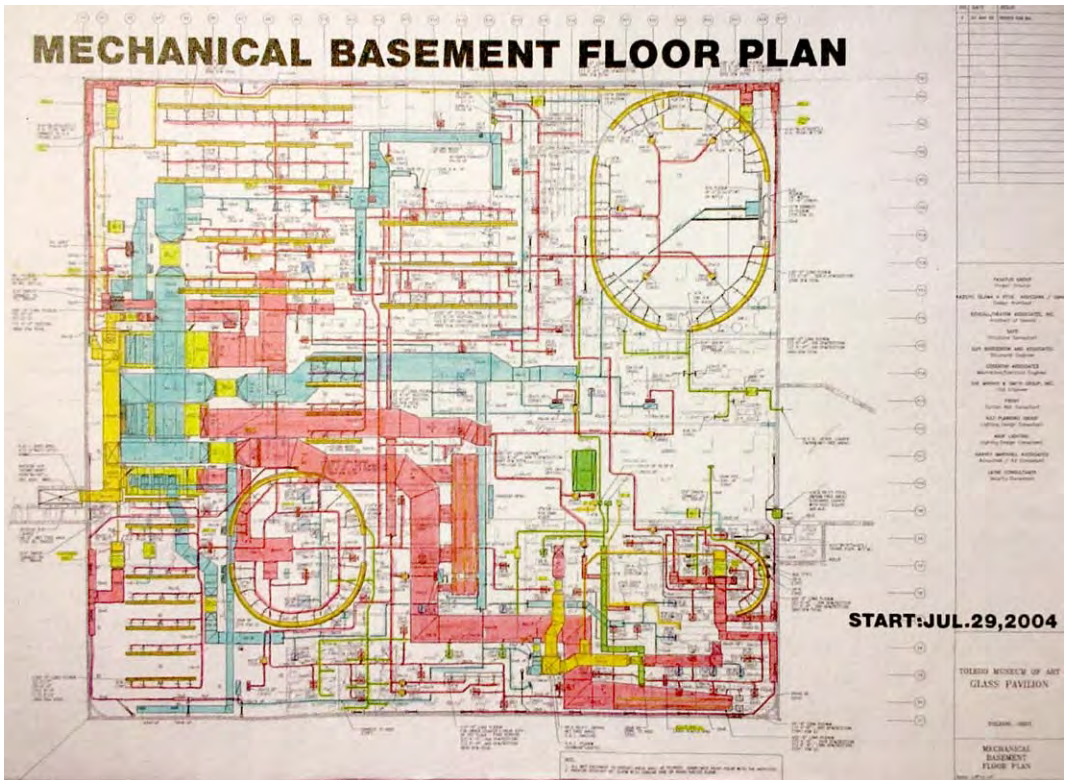


Fig.47 - Mechanical basement floor plan. Half of the basement floor is used for glass making facilities. The ducts are positioned on the right side of the plan. On the left where the mechanical rooms are, the major blue, green and yellow ducts are placed. On the bottom right, where the yellow duct is located, there is an open courtyard above, which is a smoking area for the glass blowers. The red shows the air that goes directly through the hot shops and cools the air in the glass shops towards the south façade. The ducts that stop in the middle mark where the audience sits to watch the glass blowing. So the red shows the cooling that happens in the hot shops, which is the hottest space. The blue shows also that air is also being taken in on the left side where there is a big air intake.

“Local Warming is a prototype that aims to challenge the status quo. Through the use of sophisticated motion sensing and autonomous control, the installation provides people with direct and localized warmth...
By standing in this location, the users can engage the system, and the warmth will follow them through space. By installing the system outdoors, the paradigm shifting possibilities are amplified. It provides the ability to manipulate unenclosed environments—in an efficient manner—to a degree allowing us to utterly blur the architectural boundary between interior and exterior beyond the removal of physical obstructions. When thought of as a responsive environment, the system exhibits a smart, data-driven, personalized form of climate control.”

MIT Senseable Lab, Local Warming. from the project description

WALL LESS

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In the introduction to his famous book *Architecture of well-tempered environment*, Banham point out **two different approaches to deal with environmental management:** building massive and permanent constructions that are bounded and contained by walls, and as an alternative way organizing activities around some central focus whose external boundaries are vague.

*"Culture whose members organise their environment by means of **massive structure tend to visualise space as they have lived in it, that is bounded and contained, limited by walls, floor and ceilings.***
*Against this, societies who do not build substantial structures tend to group their activities around some **central focus (power-operated solution) – a water hole, a shade tree, a fire, a great teacher- and inhabit space whose external boundaries are vague, adjustable according to functional need, and rarely regular.** The output of heat and light from camp-fire is effectively **zoned in concentric rings**, brightest and hottest close to the fire, coolest and darkest away from it, so that sleeping in an outer-ring activity, and pursuit requiring vision belong to inner rings. But at the same time, the distribution of heat is biased by the wind, and the trail of smoke renders the downwind side of the fire unappetising, so that concentric zoning is interrupt by other consideration of comfort or need."*
(Banham, 1969, p.20)

By the exploration of innovative local climatic devices this chapter would like to **challenge the wall materiality as a unique traditional way of bounding architectural space.**
While examinating the architectural potential as responsive medium, post-war artists and architects, usually in collaboration adapted cybernetics, semiotics and communication theories, try to give good reason for their efforts to animate physical construction and buildings. If in the studies of phenomenology, space can be regarded as an environment that is activated through the insight of its subjects, then the utilization of technology to stimulate the senses would in theory, intensify this effect: it would stimu-

late the body and **invoke new ways of inhabitation.**

It is necessary to mention that early attempts include kinetic constructions that involve the fifty meter high **Spatiodynamic Tower** (1954) by the French-Hungarian sculptor Nicolas Schoffer. Nicolas Shoffer's Tower **generated a field of sensory impacts that were environmental in scale,** different from the local impacts, created by appliance-sized machines that include cybernetician Gordon Pask's Musicolor Machines (1953); indeed, Shoffer's Spatiodynamic Tower was with vibrating cantilevered bars and cables, panels and perforated surfaces tilting with existing winds and a mechanized soundscape.

Moreover, **Shoffer's House with Invisible Walls** (1957) **has shown that technology networks could even substitute traditional architectural enclosures.** The author placed **two environmental conditions.** In the first place, one condition was heated, sonorous and colored with infra-red light. In the second place, the other condition was cool, silent and bathed in blue fluorescent light **in order to generate a threshold or so called, 'invisible wall' without constructing a physical separation.** The au-

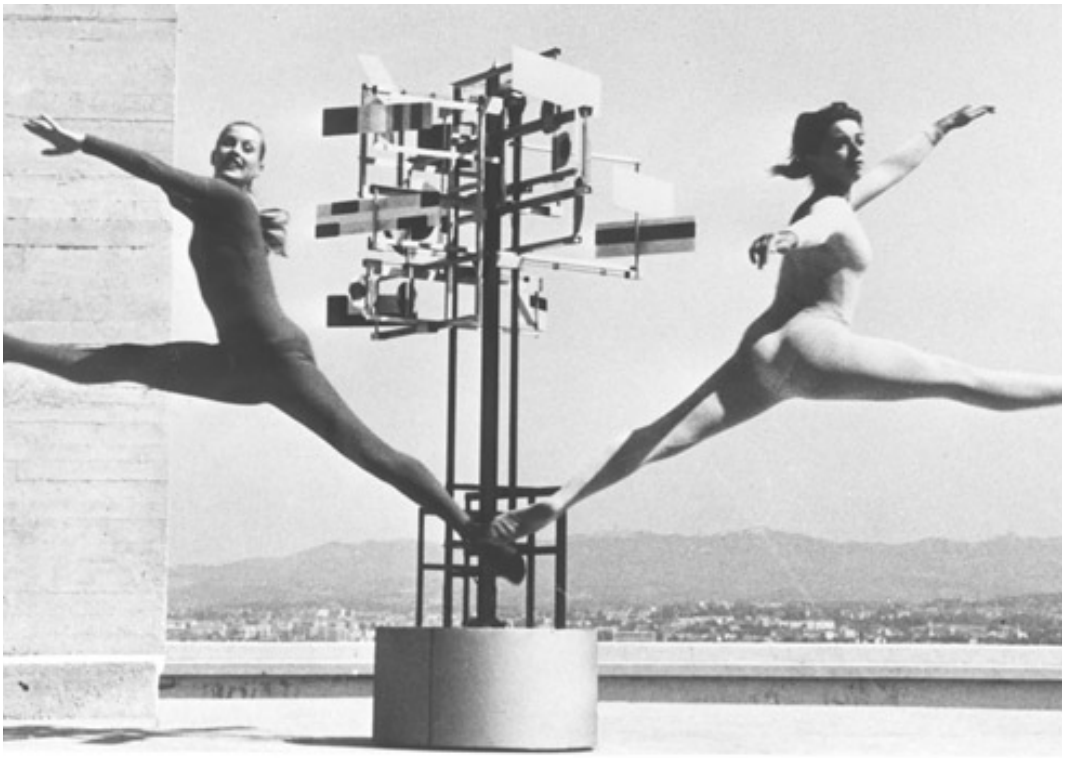

Fig.48 - CYSP 1 avant-garde art festival, Radiant City, Marseille, 1956

thor's examination of sensory apparatus into the environment shapes the body as an active node within the cybernetic construction of space. Nevertheless, with what the author named his first cybernetic sculpture in 1956, the body would require engaging an environment populated also by robotic species.

Shoffer made its first appearance as a 'robot dancer', CYSP-1, which was performed with Maurice Bejart's ballet dancers in numerous venues such as on the rooftop of Le Corbusier's Cité Radieuse in Marseilles. It is imperative to underline that a respected press acknowledged that the elements of indeterminacy in CYSP-1's movement give (it) a life and roughly organic sensibility.

In order to organize such **kinetic constructions for an urban scale, Nicolas Shoffer and the architect Claude Parent foresee a completely networked city. Their Cybernetic City** (1969) dotted Paris with towers subsequent to the model of the realized Cybernetic Tower for Liége (1961), but this **was capable of creating 'programmed climates'.** Electronic management of all the Cybernetic City's systems, from its Scientific

Fig. 49 - Nicolas Schöffer and Claude Parent developed cybernetic sculptures and proposed a cybernetic tower to be built in Paris. The tower would be self-networking and create adjustable climates, essentially working as a responsive animated building.

The idea was that the tower would run alongside Joan Littlewood and Cedric Price's 1962 experiment with technology and architecture, Fun Palace. Although Fun Palace was also never actually built, it was designed to link arts and sciences, entertainment and education, in a space welcoming to all – especially children and young people.

Research Centers to its Center for Sexual Recreation, repeated the idea that receptive networks could not only refashion the city, but as well connect city-dwellers to the most intimate levels.

At present, there are is a small number of works that put together cybernetics into program as notably as the project for the **Fun Palace** (1961-1964) by the architect **Cedric Price** together with the theatre director Joan Littlewood, and cybernetician Gordon Pask. In this regard, the Fun Palace would make available a **dynamic scaffold for leisure activity;** indeed, it is predicted as an open steel structure, serviced by moving gantry cranes that reassembled each of the building's elements that involve walls, platforms, catwalks, steerable escalators and mobile screens.
The Fun Palace form and structure, is similar to a large shipyard **in which enclosures** that involve theatres, cinemas, restaurants, workshops, rally areas, **can be brought together, moved, rearranged and scrapped constantly.** As a result, i**ts mechanically operated environmental controls** are such that it can be sited in a hard dirty industrial area inappropriate to more traditional types of amenities buildings. **Provisional spatial divisions that involve sky-blinds, vapor zones, and optical screens substituted fixed programmatic enclosures,** while circulation proliferated as impermanent catwalks, escalators and ramps. Additionally to suggesting architecture flexible in siting, program and form, Price pointed out that the discipline of architecture required to follow this example.
During the period of Kenzo Tange and Uzo Nishiyama, Expo '70 materialized a large number of the technological dreams of the previous decade under the topic "Progress and Harmony for Mankind". The building – sized **Osaka Demonstration Robot** by Metabolist architect Arata Isozaki **produced light, sound, and smoke in answer to a variety of forms of data collected from its environment,** in a way significant of Shoffer's CYSP -1. Experimentations in Art and Tecnology's **(E.A.T.) Pepsi Pavilion,** a group effort of artists, engineers and scientists under the direction of Bell Labs engineer Billy Kluver and artist Robert Rauschenberg, **changed a preceding geodesic dome into an electronic cloud.** For the opening the dome was surrounded by Fujiko Nakaya's water vapor

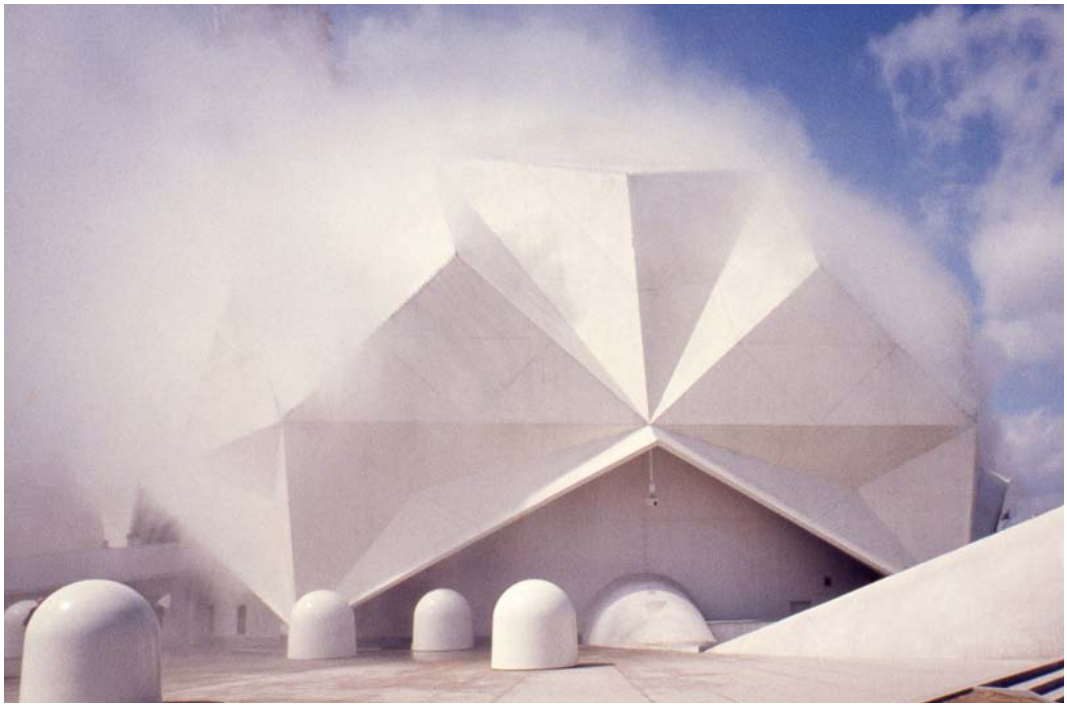

Fig.50 - Pepsi Pavilion, Experimentations in Art and Tecnology's (E.A.T.), Osaka, 1970

cloud, its entrance buzzing with the electronic activity of Robert Breer's sonorous "Floats" and active colored lights. In the interior of the pavilion, a ninetyfoot spherical mirror exaggerated the effects of lase light and sound displays. The interior program, in the end considered too expensive by Pepsi, would have permitted visitors to shap[e] their own reality from the materials, processes, and structures set in motion by its creators: the totality producing what E.A.T would energetically explain as a **"living" responsive environment.**

The historic effect of such cibernetically-charged atmospheres can be measured by their return in contemporary architecture. In this respect, for the Swiss Expo 2001, **Diller and Scofidio suggested the cloud-like Blur building replacing the building enclosure with a vapour envelope** preserved by a network of nozzles, environmental sensors, and water systems. The light and sound effects of E.A.T.'s Pepsi Pavilion are at this time collapsed into a "braincoat"- a raincoat covered with sensors – with which to navigate the foggy environment. The cybernetic interface staged by the Blur building materializes a number of post-human topics.

Schoffer, Price and E.A.T made cybernetic atmospheres, which are re-

visited as a sensory landscape of temperature and fragrance in **Phillipe Rahm's Gulf Stream projects** (2008). Furthermore, the vision of Rahm related to architecture freed from formal and pragmatic observations; in effect, one o**pen to meteorological and seasonal variations, informs Rahm's project for residences devoid of walls but divided in different climatic zones.**

"The thermodynamic phenomena of the Gulf Stream is one of the most fascinating model for thinking architecture today because it gives a route to escape from the normalization and the homogenization of the modern space." (Rahm, 2008)

As described by Rahm the Gulf Stream is considered to be a climatic phenomenon which is generated by the polarization in the space of two divergent thermal sources. Firstly, there is one high cold source at one side. Secondly, there is one low warm source at the other side. As a result, this thermal polarization in the space creates a convective movement of air, which **identifies various zones with various temperatures.**

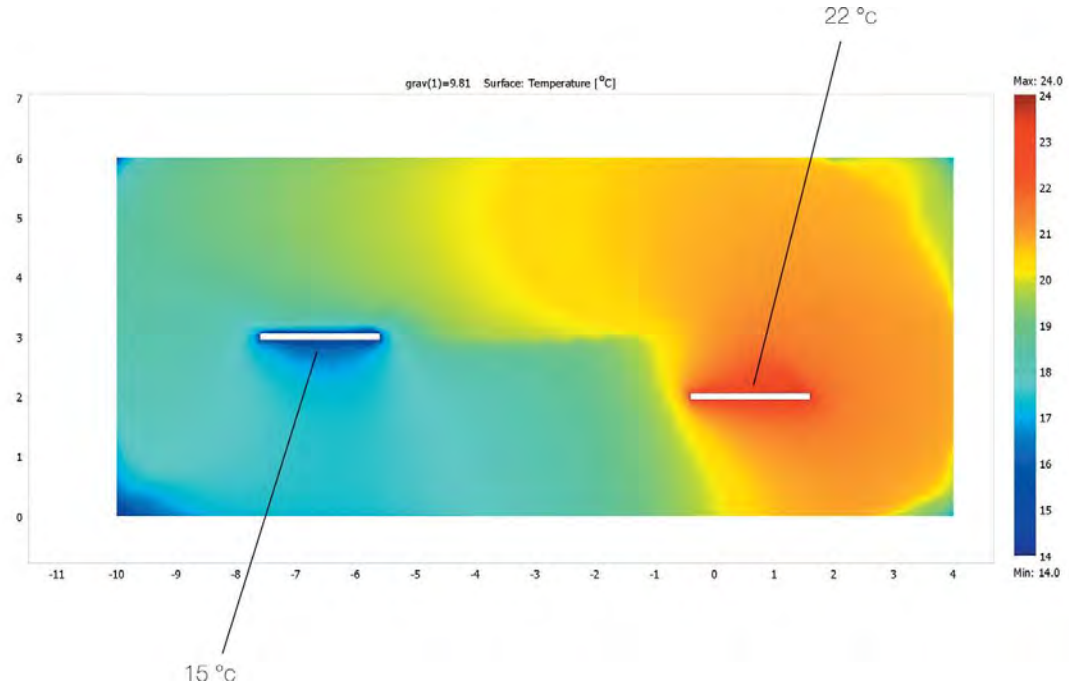

Fig.51 - Philippe Rahm, Housing and studio for Dominique Gonzalez-Foerster, temperature diagram, 2008

Modernization is translated in homogeneous, consistent spaces in which the temperature is regulated around 21 degrees says Rahm, so their objective becomes the re-establishing of diversity between body and space, with its temperature, to permit seasonal movement within the house, migrations, from downstairs to upstairs, from cold to warm, winter and summer, dressed and undressed. Nowadays, challenged with the desire to economize energy resources, the demand is to set up in every building, and even each room, a specifically calculated thermal capacity as to use only the energy that is strictly essential.
As an alternative of worming all spaces at the desired temperature around 21°C, the Rahm suggest to create in the house two sources of heat, like two divergent thermal poles generating a thermodynamic tension inside the all house. Firstly, the one pole should be cold at 15 °C and located in the upper layers of air of the house. Secondly, the opposed pole should be warm, at 22°C located in the lower layers of the space. Regarding this, a movement of air will be created by this divergence of temperatures and positions in the space;
With the help of thermal model software they examine the variation of tem-

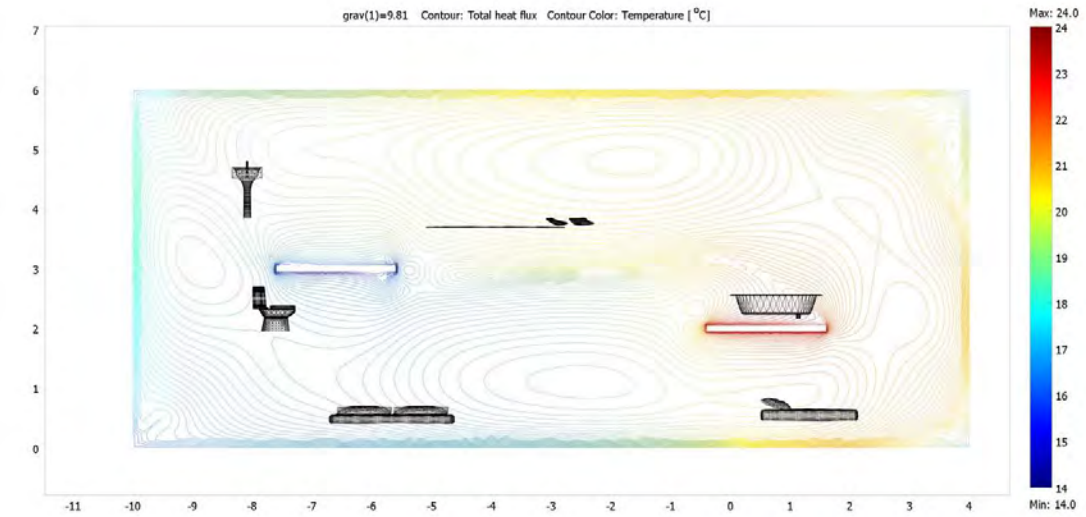

Fig.52 - Philippe Rahm, Housing and studio for Dominique Gonzalez-Foerster, activities distribution diagram, 2008

perature and his distribution in all the space and **discover then places for activities taking into consideration the specific temperatures.**
Hence, the project process is upturned: an indoor climate is in the first place produced and in the second place, functions are liberally decided anywhere in the space connected to the thermal quality needed depending of activities, clothes, and personal wishes. In this regard, an ecological and economic gain is achieved at the same time by generating in the whole house a decreased average of temperature at 18°C in its place of the 20°C in a standard heating system. **The floors and the open spaces are thus created to follow the form taken by the air in the whole high of the building, according to the vertical air movements in relation to temperature, and the functions that are proposed consequently.** Subsequently, different functions take their places in a clear way on this stratification from the coldest to the warmest.

"Two horizontal metal planes are extended at different heights. The lower plane is heated to 22°C, the upper one is cooled to 15°C. Like a miniature Gulf Stream, their position creates a movement of air using the natural phenomenon of convection, in which rising hot air cools on contact with the upper cool sheet and, falling, is then reheated on contact with the hot sheet, thus creating a constant thermal flow, akin to an invisible landscape." (Rahm, 2008)

The crucial focal point of Rahm, is not the generation of homogeneous, established space, but of a plastic, climatic dynamic, the activation of forces and polarities that **create a landscape of heat.** As a result, the architecture is exactly structures on a current of air, opening up a fluid, airy, atmospheric space. In fact, this architecture is related to the construction of meteorology; **the shapes of the house will be cut out from the shapes of the thermal movement offered by the thermal model.** The resident may move around in the invisible landscape between 15°C and 26°C, temperatures at the two limits of the concept of comfort, and liberally choose a climate in accordance with his or her activity, clothing, dietary, sporting or social desires.

While envisioning the project for the **Jade Eco Park** in Taiwan, Rahm explored the concept of a **park as a sort of climatic filter for its surroundings**. This concept was widespread in the 18th century. Olmsted created Central Park in New York as a green land that has to clean the air, for the health of the people that live in this city, while Pierre L'Enfant suggested two of the parks in Paris and the trees in its boulevards.

"It was not a romantic idea of greening the city—the tree was a machine to create shadows and to cool the street during the summer."

Rahm's early issues with Jade Eco Park- the warm, humid weather and the city's polluted air- were much the same.

Fig.53 - Philippe Rahm, Jade Eco Park, 2011

Fig.54 - Philippe Rahm, Jade Eco Park, 2011

"We started to analyze [the existing conditions of the site] with a dynamic computer model to see where it would be cooler, where it would be dryer, and where it would be less polluted," Rahm says.

Moreover, the subsequent step was to introduce trees to improve these characteristics-once with heavy plants to support evaporation and cool the air in certain areas, some with floating roots to absorb humidity and dehydrate the air in other places, and those that can absorb pollutants somewhere else.

Mixed together over them were oversized mechanical devices that would perform alike functions: cooling, drying, and cleaning the air in an artificial, accurate way. Visually and spatially, Jade Eco Park is a **composition of plantings and architectural follies,** very similar to the grand old urban landscapes that inspired Rahm.

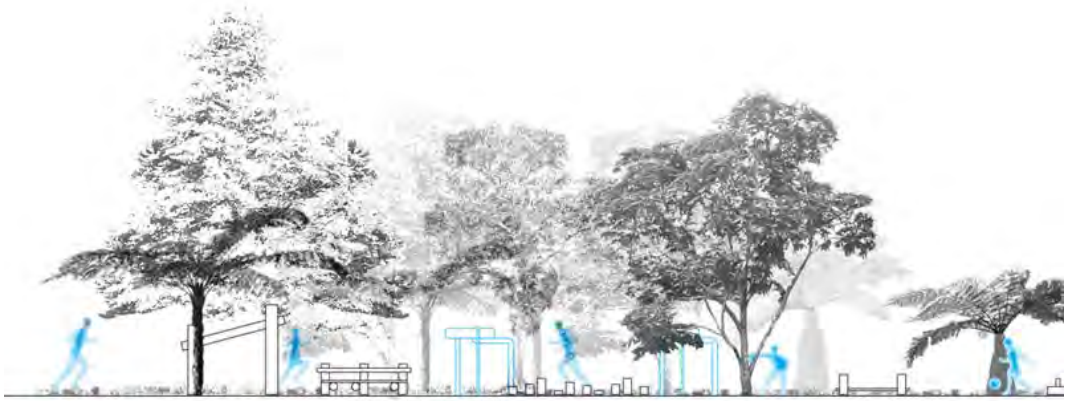

Fig.55 - Philippe Rahm, Jade Eco Park, section, 2011

Rahm has explained that yet, it will feel very diverse, since "It creates some random situations", which means that from time to time here it will be cold, dry and clean, but there it could be cold, dry, and polluted, or cold, humid and polluted. Therefore, each person is free to go where he/she desires.

All of this is completed as sustainably as possible; indeed, **air is cooled through heat exchange with the city's water or with decreased temperatures underground, via geothermal channels.** A 75,300-square-foot stretch of photovoltaic offers all the electricity the park requires, and much more. Not simply are the lights monitored in an automatic way, but **sensors placed about every 50 feet offer real-time data on tempera-**

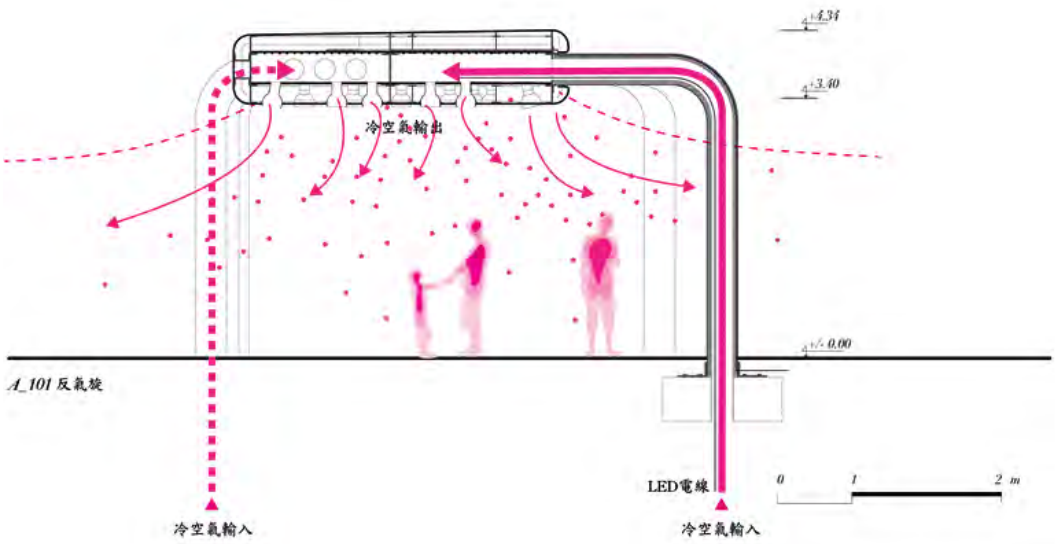

Fig.56 - Philippe Rahm, Jade Eco Park, Antycyclone, 2011

Fig.57 - Philippe Rahm, Jade Eco Park, Antycyclone, 2011
The construction of the Antycyclone, which blows out naturally cooled air. The design underwent rigorous testing and simulations for climatic conditions to quantify the speed of the air. The device is is being built after an intensive testing process.

ture and humidity and therefore, the climatic devices can be turned on or off as needed. The capability to so delicately modulate energy utilization and climatic conditions has enormous inference for the field of sustainable design.

"I have no image of the design at the beginning," he said. "We are trying to use the climate as an element in designing. But not in the Modernist way, determining function and place. We want to create a multiplicity and diversity of [atmospheric] qualities."

Similarly, Carlo Ratti from the MIT Sensible Lab suggests the **Personal Cloud as a tool that generates mobile, responsive clouds of fresh air that follow individuals as they move under a canopy.** A collection of responsive nebulizers is directed by sophisticated motion sensing, creating an **individual climate for each inhabitant**. **Personal cooling 'clouds' follow individuals through space,** guaranteeing ever-present comfort while enhancing overall energy efficiency by orders of magnitude. The Cloud Cast system works through aluminium rods that are built-in with sensors into the ceiling. In the moment the ultrasonic sensors notice the presence of individuals by interpreting the echoes from high-frequency sound waves, they make active a cool mist.
Misters are widespread cooling devices for outdoor patios and walkways in hot climates. However, the innovative characteristic of the Cloud Cast is that if concentrates on misting individuals, and it does not waste energy when a space is not busy. **Individual Cloud belongs to a larger collection of studies on location-based temperature control infrastructure**, which discover how to make public spaces in cities such as Dubai, more liveable and sustainable by synchronizing human presence with climate control.
Emma Greer, project manager from Carlo Ratti Associati has explained that: *"We envision the city of the future to be a place designed for people, giving them a chance to actually shape their environment and to fully experience their everyday lives and interactions". "Projects like Personal Cloud could help to make such a vision a reality."*

Fig.58 - Carlo Ratti Associati,Cloud Cast, UAE summit, 2015

Fig.59 - Carlo Ratti Associati, Cloud Cast, UAE summit, 2015

A previous research by the MIT Senseable City Laboratory has made known a significant lack of connection between building occupancy and the energy consumption of heating systems. It is essential to mention that the commercial buildings alone account for more than 20% of United States energy consumption. Therefore, there is an **important possibility to conserve energy through the utilization of dynamically monitored highly localized heating; indeed, put the heat where individuals are**. For instance, huge amounts of energy are wasted on empty offices during night; dark corners of empty rooms in incompletely occupied buildings are heated only because no improved solutions are present.

Similarly, homes run their natural gas furnace while their occupants are working. While ultimately there has been enhanced preservation of pervasive heating through developments in materials and construction, **MIT Sensible Lab suppose essential shift in climate control strategy towards inhabitant-localized heating** will reach an order of magnitude enhancement in heating efficiency.

Local Warming is considered to be an example that intends to challenge the status quo. Through the utilization of sophisticated motion sensing and independent control, the installation offers individuals with direct and localized heat. An infrared energy beam follows the consumer's movement so they can be comfortably warm in an otherwise cold environment and therefore, inefficiencies of ambient heating are avoid jointly. For this installation, the consumers are greeted by a carpet marked symbolic foot prints. By standing in this place, the consumers can connect with the system, and the heat will follow them through the space.

"By installing the system outdoors, the paradigm shifting possibilities are amplified. It provides the ability to manipulate unenclosed environments—in an efficient manner—to a degree allowing us to utterly blur the architectural boundary between interior and exterior beyond the removal of physical obstructions. When thought of as a responsive environment, the system exhibits a smart, data-driven, personalized form of climate control." (Ratti, 2014)

Fig.60 - MIT Senseable Lab, Local Warming, 2014

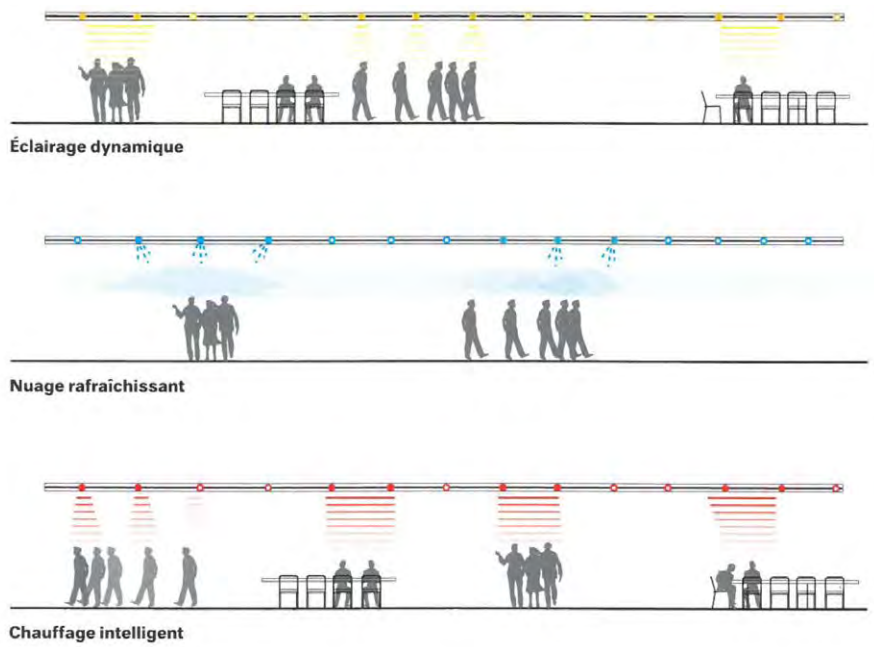

Fig.61 - MIT Senseable Lab, Local Warming, 2014

Furthermore, **Local Warming discovers an idea for future of heating systems, proposing highly efficient, dynamic, and intelligent transmission of heat.** By offering a captivating yet intangible experience where users can utilize energy in this groundbreaking direct way, the authors utilize this installation to communicate **an original paradigm in the sustainable use of energy.**

These contemporary examples remind us that the dream of dispensing with architecture‘s physical divisions and instead embedding the body in an environment of technological effects, such as what Schöffer achieved with relatively primitive means in 1957, has only intensified in architecture today.

This innovative local climatic devices challenges the wall materiality as a unique traditional way of bounding architectural space. With the use of such devices we can envision new ways of organizing our homes and cities, where the traditional wall could be free up from its thermal function dissolving its consistency and weight.

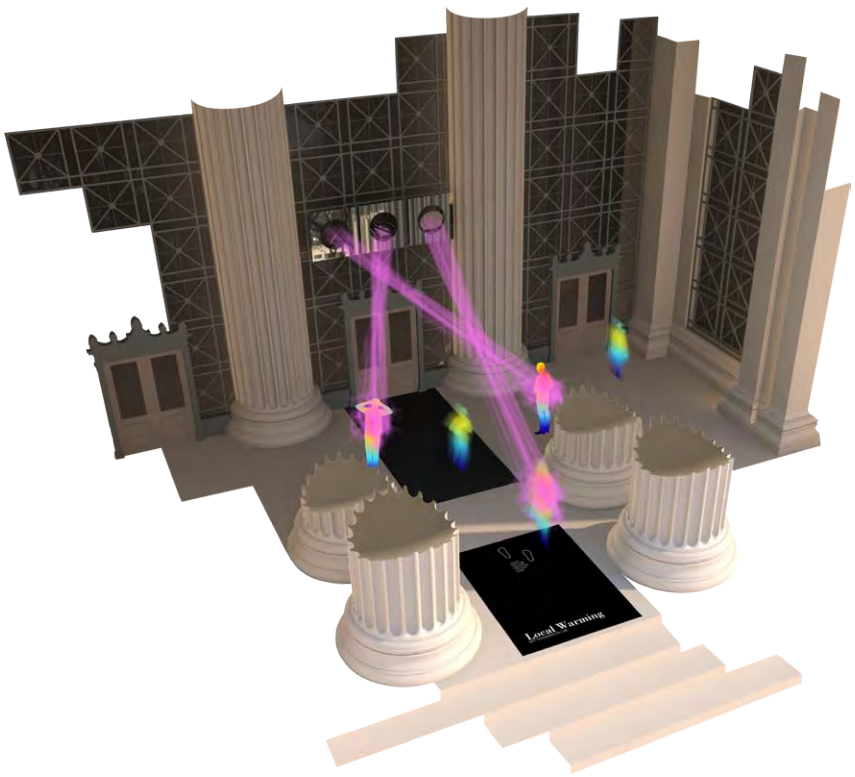

Fig.62 - MIT Senseable Lab, Local Warming, 2014

“Designing from the outside in, as well as the inside out, creates necessary tensions, which help make architecture. Since the inside is different from the outside, the wall, the point of change becomes an architectural event.
Architecture occurs at the meeting of interior and exterior forces of use and space. These interior and environmental forces are both general and particular, generic and circumstantial. Architecture as the wall between the inside and the outside becomes the spatial record of this resolution and its drama. And by recognizing the difference between the inside and the outside, architecture opens the door once again to an urbanistic point of view.”

Complexity and Contradiction in Architecture, Robert Venturi, 1966

CONCLUSIONS

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"We protect ourselves, we barricade ourselves in. Doors stop and separate. The doors break space in two, split it, prevent osmosis, impose a partition. On one side me and my place, the private, the domestic; on the other side, other people, the world, the public, the politics. You can't simply let yourself slide from one into the other, can't pass from one to the other, neither in one direction nor in the other. You have to have the password, have to cross the threshold, have to show your credentials, have to communicate, just as the prisoner communicates with the world outside..."
(Perec, 1997)

The relationship between inside and outside today is exclusively defensive. This phenomenon related to protection and isolation is evident at the scale of architecture as at the macro scale dealing of urban and geographic issues and contests. Almost a quarter of a century after the Iron Curtain came down, the walls are rising up again. In steel and concrete, with watchtowers and barbed wire, mankind is building separation barriers at a rate perhaps unequalled in history - at least 6,000 miles in the last decade alone, according to The Guardian analysis (2013). For as long as mankind has been building, we have been building walls: around cities, along borders, across disputed lands; to protect, keep out, demarcate and divide. [1]

The Modernism's promise for an open and accessible world and the Postmodernism dream for a global liquid territory have been transformed in their opposites: a ghostly and meandering nightmare of prohibitions, limits, walls, barriers and fences. Instead of enlarging the world has become closed on its own.

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1 In response to the proposal by the American President Donald Trump to build a 1,600-kilometer-long wall on the border between the US and Mexico, different architectural offices came up with conceptual and provocative design solution for the megalomaniac task. I would like to point out few of them: the Trump's Mexican border wall envisioned as Barragán-inspired pink barrier tby Mexican firm Estudio 3.14, IKEA flat-pack furniture kit that shows how to cheaply build Trump's wall and the Power Wall by the Dutch architect Jurgen van der Ploeg that thought how to make is as sustainable as possible.

In the name of sicurity and sustainability, architecture is becoming exclusionary and so alien to its surroundings. Rather than learning from other disciplines how living conditions could be better designed, building regulations force architects to surround themselves with thick walls, small windows, and a maximum amount of insulation. Commercial thick insulation layers might lower the operating energy, but at the same time consume extreme amounts of grey energy to produce and are highly unrecyclable.
The interior comfort in buildings only depends on calculations, which often uncertain and rather imprecise, based on the extreme example of the worst days in summer and winter, the hottest and the coldest. The architecture becomes a consequence of these extremes, leading to **over –sizing, over-insulation, and over-protection, making the relation between inside and outside more and more closed and airtight**. **The result is the fabrication of boxes that one can never get out of.**

Moreover, with the advent of the energy crisis and the environmental awareness, **the architectural enclosure continues to stratify producing different packages of wall assemblages.** Moreover a huge amount of devices takes part of it and manages the exchange between the inside and the outside: natural and artificial thermal insulation, double and triple air chambers, heat exchang- ers, controlled mechanical ventilation, biometric and electronic access devices. The discontinuity between the various elements taking part of these compositions is usually relying on a **thin layer of air cavity inaccessible to public and exclusively devoted to technology.** These residual spaces between elements consume a significant amount of space that is problematic to recuperate in a financial equation and are often difficult to maintain.

“Residual space is sometimes awkward. Like structural poché it is seldom economic. It is always leftover, inflected toward something more important beyond itself. The qualifications, contrasts, and tensions inherent in these spaces are perhaps cogent to Kahn’s statement that “a building should have bad spaces as well as good spaces.”, continues Venturi (1966)
This zone of darkness is packed with accessories for electricity, lighting,

sprinklers, computers, smoke detectors and other controlling devices hidden by false walls and ceilings. **Open spaces for human activities alternate with inaccessible bands of poché, made of concrete, wiring and ducts**. The more sophisticated the building, the greater the expansion of inaccessible zones expropriating even larger parts of the plan and section. As Koolhaas states in Last Aplles(1995) :

“The dark zone is not only strictly “useless” for the future inhabitants of the building; it also becomes conceptually inaccessible for the architect, who ‘has become an intruder in his own project, boxed in, his domain a mere residue of the others’ demands.”

Scenery from Colombiana by Olivier Megaton, 2011

It quickly becomes apparent that urban policies, building codes and construction logics push innovation into the margins of architecture; it is in these margins, that the current dissertation is placed searching for innovative approaches staring from the wall system and hoping to re-establish a **line of communication between inside and outside, public and private, architecture and nature, and between the allied fields of architecture and technology. By abandoning the wall as a full-contact**

arrangement of different materials, a set of in-between layers could define a new architecture.
The four main chapters suggest strategies that use the wall as a space of relation between the parts, accommodating different functions and programs in their thickness. The quoted examples represent a transition from more separated to gradually more hybrid and blurred solutions, envisioning liminal environments between architecture and nature, public and private, building and city.

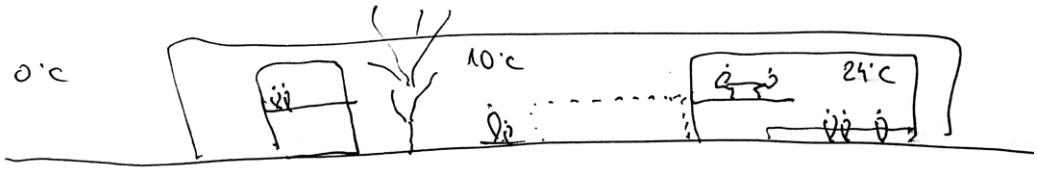
The thick wall expresses the idea of unified space, internal and independent, in which individual elements are linked by means of continuous spatial transitions determined by the wall thickness.

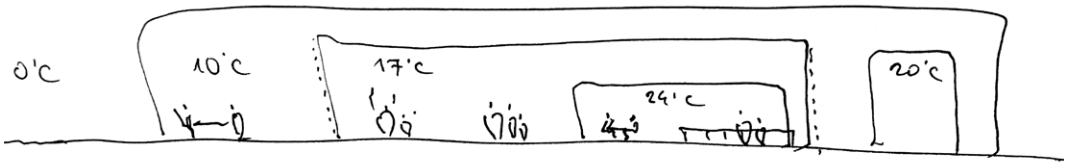
"The essential purpose of the interiors of buildings is to enclose rather than direct space, and to separate the inside from the outside."

Kahn's servant spaces which sometimes harbor mechanical equipment, and the poché in the walls of Roman architecture are alternative means of accommodating an inside different from the outside. Très Grande Bibliothèque by OMA uses thickness to accommodate and simplify a huge amount of programmatic requests. While adopting the same strategy of carving voids and cavities for deterring the main architectural spaces as a result of this process, the appearance of the building it totally different.
Served and servant spaces, main and auxiliary spaces, solid and void, positive and negative, figure and ground could be reversible and reciprocally interchangeable entities, seemingly able to go back and forth between their dialectic conditions.
The poché is no more a result uniquely of compositional strategies deriving from structural criteria, but its cavities could integrate both structure and mechanical services, programmed and unprogrammed spaces.

Wall assemblages suggest a strategy related to the idea of a gradient. No more a bipolar space, but a continuous transition. The displacement of the various elements composing the wall system can amplify the poché and

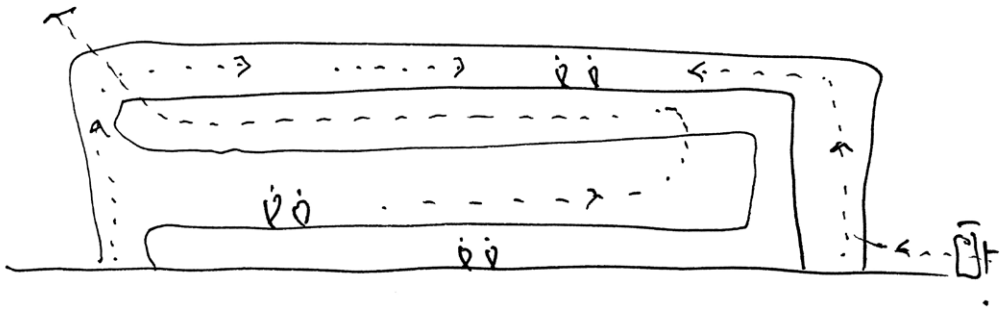
make it inhabitable, while enriching the overall experience of architecture. This method also questions the actual tendency of hard edge boundary between the inside and the outside, suggesting solutions that could reduce or augment the inhabitable space in relation to seasons, and as such deal with climate and energy efficiency of buildings.



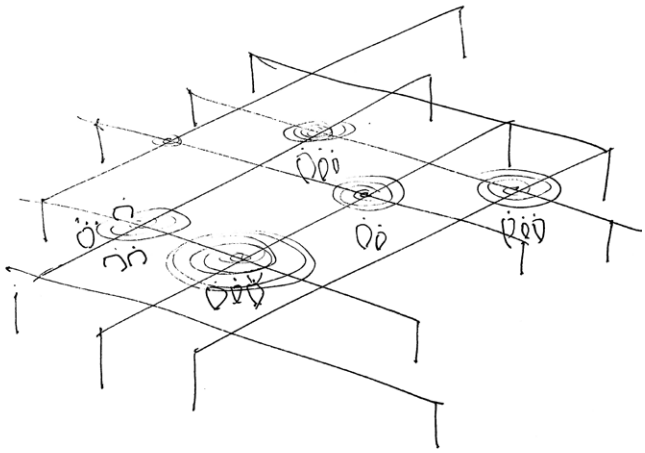


Lacaton & Vassal permit these interventions through the insertion of intermediary devices, placed between the space containing the program and the exterior façade. These elements of transitions permit the user to pass from one space to another, to experience a change of emotion, to invent new displacements. As they describe in their essay “An open structure for inventing climate and ambience” (2G magazine, N.60, 2012):
“Between each space, simple systems of openings and passages, of sliding elements, of filters, curtains and mobile insulating materials offer the possibility of getting to the insulated space through the intermediary space then towards the exterior space, or directly from the insulated space into the exterior space. The system is dynamic, and the mobility and responsibility if the occupant is stimulated so that he plays with the climatic conditions, the seasons, summer weather or sunny mornings, cool evenings.”

Walls of air wants to points out that the mechanical system has become a fundamental part of our buildings, in terms of occupied space and budget. Usually architects neglected this topic, envisioning technical spaces inaccessible and hidden inside the poché. As coined by Banham (1969) 'the new poché' is the interstitial grey space of almost – habitable spaces comprised of dropped ceilings; mechanical, electrical, and utilities chases; plumbing and more plumbing.
Walls of air suggests strategies on how this latent space could play a crucial role in the project, and inject new oxygen in the design process. No more ducts exhibited like baroque ensemble of technological gadgets but spaces envisioned for the moviment of people and the moviment of air.



Wall less suggests alternative means for generating confortable climatic ambiences no more devoted to the use of massive structure or hard layers of thermal insulation but to sophisticated technological devices. Free up from this weight, new open perimeter become means of organizing spaces with vague and nebulous boundaries.
Movable gradations around central focus could become a new paradigmatic way of conceiving inhabitable space, much more related to the idea of local portable clouds that follow us during day, night and seasons and create our own climatic environments. As MIT Sensible City Lab explain in their Local Warming Project (Fundamentals, 2014):
An array of dynamic infrared heating elements are guided by sophisticated motion tracking, creating a precise personal (and personalized) climate



for each occupant. These individual thermal clouds follow people through space, ensuring ubiquitous comfort while improving overall energy efficiency by orders of magnitudes.
From grotto to fire pit, from victorian pipes to central heating and suburban thermostats, man has exerted more and more control over his temperature. "The fireside circle could no longer save as a social glue. The old social fabric – tied together by enforced commonalities of location and schedule – no longer coheres. What shall replaced it? A new paradigm of local warming could spark vibrant encounters as people share their personal climates. The ultimate inversion of the hearth is complete: man no longer seeks heat- heat seeks man".

The idea that architecture belong in one place and technology in another is comparatively new in history, and its effect on architecture which should be the most complete of the arts of mankind has been paralizing. The art of architecture become increasingly divorced from the practice of making and operating buildings. As Banham explains (Architecture of Well Tempered Environments,1968, p.11)

"Because of the failure of the architectural profession to almost literally – keep its house in order, it fell to another body of men to assume responsibility for the maintenance of decent environmental conditions: everybody from plumbers to consulting engineers."

They represented another culture so estranged that most architects held it beneath antipathy, and still do. The works and opinions of this other culture have been allowed to infringe as little as possible on the teaching of architecture schools, where the preoccupation still continues to be with the production of elegant graphic compositions rendering the merely structural aspects of plan, elevation, and sometimes section. '*Never mind all that environmental rubbish, get on with your architecture'. (Banham, 1968, p.11)*

The dissertation wants to settle this gap, through an overall reflection on the wall system that can call for a new integration between the parts, unveiling unconventional relations between interior and exterior spaces, architecture and technology. Questioning the traditional systems of enclosure the thesis outlines a further reflection on the urban scale, addressing the possibility of interpreting architectural layout as the index for the constitution of an idea of the city. Different liminal spaces could structure different types of cities?
Moving between material and immaterial, thick and thin, integration and closure, wall(les)s questions the consistency and spatiality of architectural boundaries opening up to new interpretations on city and urban landscape.

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