AN APPROACH TO HOUSING FLEXIBILITY*

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1. Introduction

Flexibility is a term much in circulation abused, misunderstood by the majority of architects, even it has been taken as a prescription for any system or object movable by nature. The actual misunderstanding arises from its abstruseness, not yet crystallized as a trend. In its architectural meaning it is a ramified concept, its core includes some classes involving three generations. To be acquainted with them, one has to go back to its sources.

2. Sources of flexibility

Flexibility in general has two main sources.

2.1 The theoretical source: philosophy

It has three trends. The first is the *futurist* philosophy emerging early in this century (1909) as a reaction against the conservativism of artistic theories. This philosophy worshipped the movement in terms of dynamics. The essence of translation of this philosophy to architectural language can be condensed into "Architecture has to be understood as a power to freely and boldly harmonize environment and man" [1].

Although the changes of this century are rapid and radical with short cycles, the present architecture does not keep pace with the future in the short run. So the architecture must be a transient one, our houses will last less time than we shall do, and every generation will have to make its own [1]. In those days this thought was considered as an upsetting one, but it incited some architects to embrace it in practice. On this spot, there is a pause until the exhibition of »*Weissenhofsiedlung at Stuttgart*« in 1927. It seems that "revolutionary thought" behind that exhibition might be affected by the echo of this philosophy, especially the works of *Mies van der Rohe*, *Adolf Rading* and

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Le Corbusier since they took the movement — "the futurists' belief" — as a new path toward the interior of their houses with different expressions, disobedient to the ideas prevailing at that time. If this inference is right, it is an excuse to infere that this philosophy had its influence not only in recent days, but also by that time, 1927. Accordingly it can be considered that these projects were the first incarnations of the futurist building philosophy in terms of houses. By other words, the flexibility originated from the futurist philosophy.

This was the first stream. The second was the philosophy of *libertarians*, such as *Arsène-Henri* Brothers. First they were affected by the propaganda of materialism as a philosophy. They tried to translate some of its building principles into housing. This is seen from their advocacy to the following notions behind the design at their housing project in Rheims in 1955 [4].

a) If there is a finite space, in which each person ought to have the right to his liberty without impinging on others, then it is in his home, private, inviolable and secret. So every one should be able to fit out his home as he wishes, including the right to make mistakes, as part of the freedom.

b) The differences that exist between people ought to be respected, allowing personal tastes, tendencies, reflections, ideology. So each person ought to be able to express himself at will. His home should be personalized.

c) Each person possesses a powerful creative potential and everything he does should embody a creative dimension, to have some original dimension to be unique, new. If not, he is confined to the behaviorist "conditioned reflex" to receive information by copying, recopying, imitating, reproducing. So each person should be able in his home to make a creative act by organizing his space, based on his own circumstances. Even being a co-author brings a gratification. These are the basic ideas underlying Arsène-Henri's work.

The last philosophy was that embraced by J. N. HABRAKEN in 1961 by publishing his thesis "De Draged en de Mensen" ("Supports of People"). His philosophy was based on "*involving people in housing process*" as users. He interpreted his philosophy by the analysis of the actual building process in which the architect — as a matter of fact — cannot act alone. This can be understood from his interpretation: "If you want to change a process, all the parties involved have to participate, but you can start by defining the new role of the architect — and from that came what might be called a design methodology. The problem is that you don't design the finished dwelling but things that will be put together by other people whom you don't know and who will come in later. A lot of decisions have to be made after the designer has finished his work and he does not know who is going to make them. That means that you need some kind of design methodology, which is based on design as a decision-making process. This is a continuous process in which the architect comes in at a certain point and makes decisions with other people,

leaves the job again and then other people come in and make decisions" [2]. This interpretation declared that Habraken's aim was to allow people to assume responsibility for their own homes, and to take part in the housing process.

In spite of that the three previous philosophies are diverse in their motives, all of them aim at one goal which may be interpreted as to supply people a tool, and leave them to reshape their domains as their circumstances change.

Transmission of the preceding theoretical ideas to the practice can be recapitulated in the following.

2.2 Engineering source: machinery

The Industrial Revolution reversed anything dominating production, transferred it from handicraft to industrialized production. Today the machine has the voice of authority, since mechanization and standardization play a steadily increasing role, and this tendency is growing with technology which has the original mission to give man freedom to become a personality. Industrialization in itself means the repetition of operations, resulting in mass production [3]. To produce a functional unit on the basis of mass production technique requires to divide it into elements and components so that they can easily be produced and assembled as a building system [5].

Although no all-industrialized system exists, the trend towards the expansion of systems from closed to open ones did not stop, but tends to component building and open plan.

The standardization permitting the systems to be put side by side, "the open plan" is easier achieved with these building systems. This means that it is possible to obtain flexibility not only within the inner space of the building, but also between the building elements, layouts, types, space function and architectural expression.

In final account the philosophies are swaying from involving people to share the housing process and to assume responsibility for their dwellings, as "libertarians", to authorize them to make what they wish within their domains in compliance with "materialism", to the extreme as "futurists" craving to dispense with old-fashioned dwelling and to change it to a new one fit to the new requirements. On the other hand the evolution of the building systems proceeds from closed to open systems and strives to standard building components.

From the previous variety of the philosophical theories and engineering evolution it can be inferred that all of them aim at building the flexible dwelling.

By fusing all the philosophical aspirations and the engineering evolution in the fields of construction, materials and technology, flexibility arises.

According to the precedings, the term "flexibility" in relation to buildings can be interpreted as "the pliability of the building to the user's will", and righteously given building systems and objects belonging to two or more classes of flexibility, but the one which has only one property must be named by its definitions but not flexible.

3. Classification of flexibility

There are some possibilities to adapt the dwelling to these different theories. To this aim not only the recent stage of flexibility has to be determined, but also the order of classification (Fig. 1).

3.1 First generation

The existent materials and the available technology result in the first generation of flexibility, including various types.

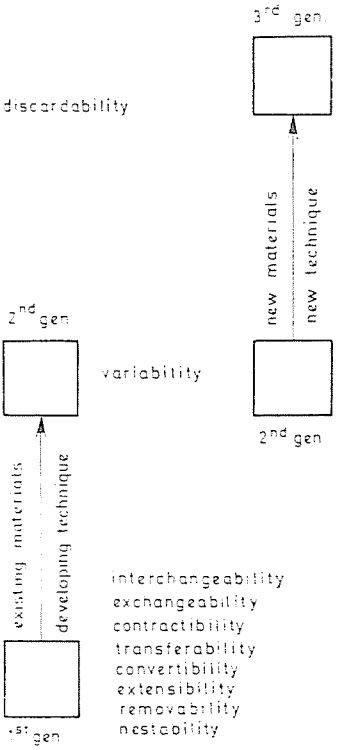

Fig. 1. Classification of flexibility

3.11 Interchangeability

To design the dwelling's internal space — with permanent boundaries — to allow dynamic interaction between its rooms, this quality of flexibility can be named "interchangeability".

3.12 Exchangeability and convertibility

The libertarians after *Habraken* demand to build dwellings which are spacious enough and of a general design such as to permit different patterns of time detachable units. This kind of dwelling allows to exchange the layout and to convert the space function. This quality of flexibility can be named "exchangeability" for the first, and "convertibility" for the second kind.

3.13 Extensibility

means to design the nucleus space in a way to accept connection with other spaces by "add on or add in" or both. The dwelling can be extended in three dimensions. This quality of flexibility can be named "extensibility".

3.14 Retractability

means to design the nucleus space in a way to accept retraction in one, two, or three dimensions, this quality can be named "retractability".

3.15 Nestability and removability

To design the structure of the block of flats in a way to permit nesting or removing the inhabitable units. This quality of flexibility can be named "nestability" for the first, and "removability" for the second kind.

3.16 Transferability

This quality of the dwelling space designed in a way to permit transfer from one place to the other can be named "transferability".

3.2 Second generation: "variability"

Construction with the existent materials but higher developed technology will utilize standard building components. Deletion from, or addition to, the material components would result in variety in the architectural expression

in terms of form, type, layout, use, . . . and so on. This stage in the development of current features, the second generation of flexibility, can be named "variability".

3.3 Third generation: "discardability"

The futurist theory argues for building dwellings with much shorter lives, so that they can be abandoned and demolished as soon as they are functionally out of date. Actually this kind of dwellings would need new materials and technology that are inexistent at present, but may be found in the future. This stage in the dwelling development may rank higher the third generation of flexibility to be named "discardability".

At the first glance, one may feel there is an interference between these classes of flexibility. The correct definition will be illustrated on interchangeability.

4. Definition of »interchangeability«

According to the previous classification, "interchangeability" is the term for the efficiency of the internal dwelling space to allow dynamic interaction between its components. To find a definition it will be useful to return to empirical behaviourist studies, which admit that the human behaviour is affected by dependent and independent variables. The behaviour will change with these variables and differ from one to the other, even on the scale of large groups and nations, or small groups as families. Hence, the outcome will be different people. Naturally, different people with different behaviours want different things in terms of functional needs.

Since the functional needs will lead to the diversification of the functional space, even for a given function, to overcome this deficiency, building regulations specify maximum and minimum dimensions of a given functional space. Also the convention and the logic of architectural profession imply a certain relationship, location, arrangement, and vicinity for the dwelling components to be considered in the dwelling design.

Many concrete examples can be given from the practice such as: Maximum and minimum dimensions of the living rooms differ from those of the detached W.C. The relationship between two functional spaces is subject to the influence of the preferred functional relationship between the kitchen and the living room. So is the kitchen to the lobby, the bathroom to the bedrooms. Again, it is unfavourable to connect directly the bedroom with the lobby or to make them facing the external corridors. The number of separate bedrooms must keep pace with the family structure and family type. The location of the specific

functional spaces has to suit the function, for instance, it is unfavorable to locate the living room far from the lobby, the study in the noisy zone, the kitchen far from the living room and the lobby, the bathroom far from the bedrooms, and so on. The arrangement and vicinity have to obey the logic such as: it is illogical to arrange wet area to face the street while the living or bedrooms are deprived of it. Moreover a good vicinity is to have the kitchen adjacent to the other wet areas, from the aspects of sanitary engineering and economy.

If the circumstances change, new functional needs may arise and require to be accommodated. Accordingly, the actual design may not satisfy them with its actual room number, dimensions, areas, location, arrangement and vicinity as variables. Hence the new functional needs require new parameters.

Within the actual dwelling enclosure, adding or cutting down the actual space in terms of dimensions and areas to satisfy the new functional needs will be to the detriment or benefit of the other functional spaces, as an interaction between flat's components.

To alter the actual arrangement, location, or vicinity of the flat's components in order to satisfy the new functional needs, an exchange will take place between them. Alteration of the arrangement, location and vicinity is an interactive process.

Naturally, all these interactions involve movement in terms of dynamics.

Dynamic interaction is the efficiency of the dwelling components — rooms — to alter their numbers, dimensions, areas, locations, arrangement and vicinities.

The dwelling enabled by its enclosure to dynamic interaction has a flexible nature. Accordingly, interchangeability is the dwelling's efficiency to allow internal dynamic interaction between its components to be altered as circumstances change.

5. Current development

Although the first application of internal flexibility — interchangeability — goes back to the thirties, it has not outgrown its infancy. Namely survey of the available publications shows that "flexible" projects are scarce in comparison with their history. Some have already been erected, others constructed in a limited number as experimental buildings, and the rest never got farther than the drawing board. This may be attributed mainly to doubts against the actual advantages of flexibility, in addition to some restrictive problems still awaiting solution.

The limited scope of, and the space shortage for this study do not allow more than to mention in short its emaciated development.

The first application of the internal flexibility in dwellings was at the "Weissenhofsiedlung" exhibition in Stuttgart, 1927, featuring *Mies van der Rohe*'s "framed apartment house", *Adolf Rading* and his use of sliding-folding partitions running on tracks in the ceiling and floor, and the double house by *Le Corbusier*, in which the space was transformed for day and night use.

Some years later, *Jean Prouvé* has produced several projects (Fig. 2) in which the plan layout was modifiable such as the Meudon houses. Orming project (Fig. 3) was built in a suburb of Stockholm by *Joran Curman* and *Ulf Gillberg* in 1967. The design of *Habraken*'s system "Margins and zones" (Fig. 4) defined possibilities for layout of detachable units within a supporting structure. The *Montereau* project (Fig. 5) gave 40 to 120 m² of unobstructed

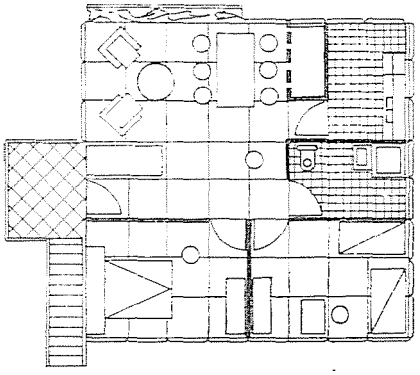

Fig. 2. The Meudon House

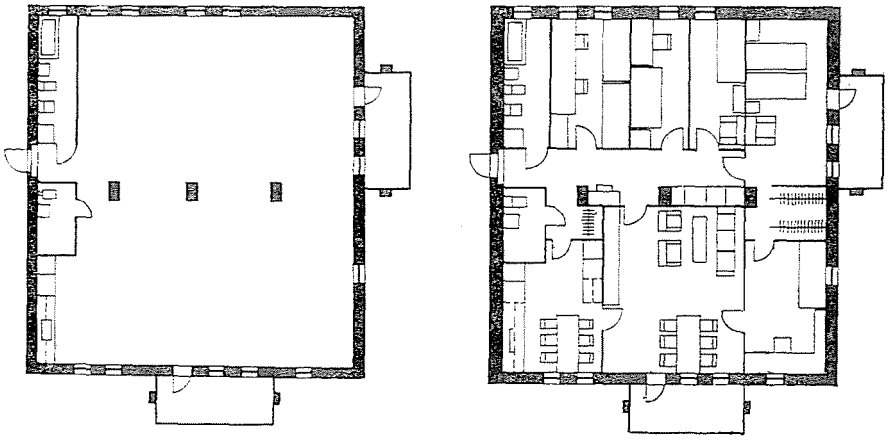

Fig. 3. The Orming project

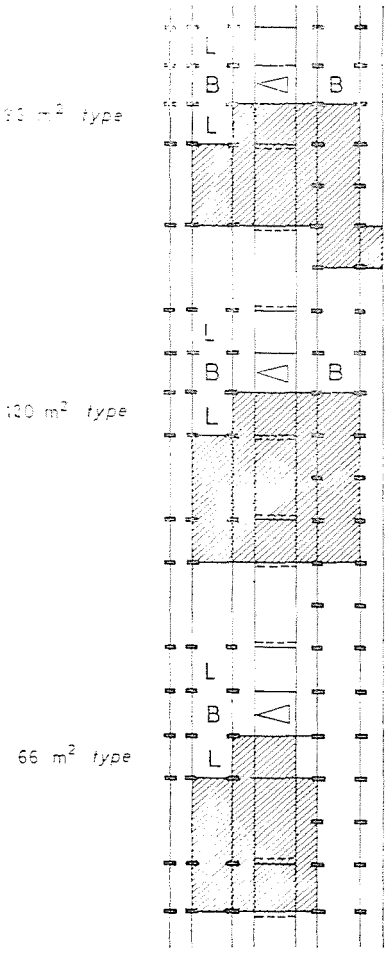

Fig. 4. Zones and margin system

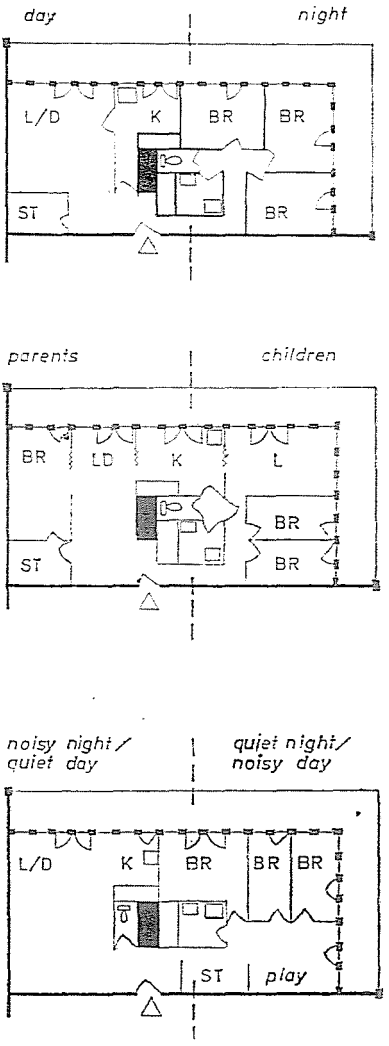

Fig. 5. The Montereau project

area without cross-walls or intermediate columns — with a single column, surrounded by the core of hygienical compartments. Finally, in the "flexible housing" (Fig. 6) the movable walls allowed various ways of living.

Although the previous projects differ by solution, due to the diversification of the architect's approach to flexibility. all of them meet flexibility stipulations.

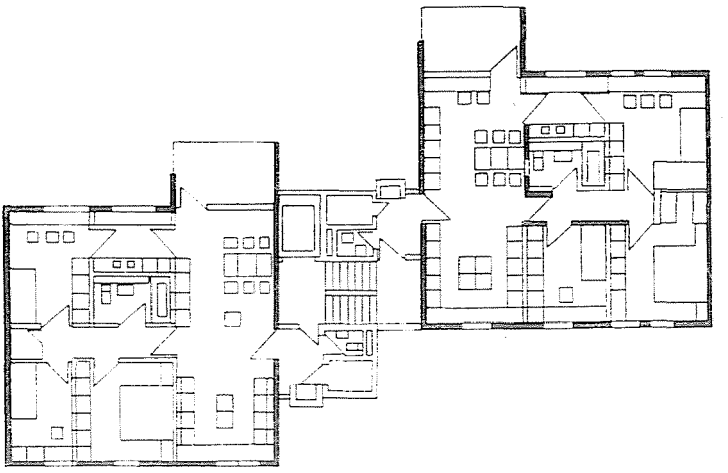

Fig. 6. Dortmund-Barop. Palmweide project

6. Stipulations for flexibility classes

As expounded before, there are different classes of flexibility and every one has its own characteristic, accordingly has its own stipulations. It is difficult to confront all these stipulations but it is possible to give an idea of their variety.

"Discardability" stipulates to dispense with the dwelling and bid it farewell as soon as it becomes functionally outdated. In the same manner "Variability": to change the use of certain building components; "Convertibility": the same to building scale; "Nestability": functions fitted to each other of a finite structure; "Extensibility": the possibility to occupy part of the unbuilt lot in certain types of dwellings; "Exchangeability": the mutual acceptance of adjacent zones, and "Interchangeability": the allowance for dynamic interaction between the dwelling parts.

Concerning the last one — as a goal of this article — its stipulations can be optimized from the following aspects:

6.1. Doors and windows should be placed as far as possible to allow a variety of uses to be made of the room.

6.2 Ground plan form should allow many different allocations of functions to rooms and variety of zoning possibilities.

6.3 Service systems should be detached from the basic building fabric as far as possible and should be readily accessible.

6.4 Plan form should allow a variety of interconnections between rooms.

6.5 A wide range of alternative uses of space must be possible at a minimum cost.

6.6 Avoid expression of room functions on the façade, such as extreme variations of window size, or balconies to living room only.

6.7 Avoid central lights and other space-making constraints, which can be considered as the main stipulation.

Interchangeability raises many problems, which deprive it from ascendency of the dwelling space.

7. Problems of interchangeability

The analysis of the quoted attempts to interchangeability pointed to some problems.

7.1 The fettered dynamic interaction

This problem arises from the presence of some obstacles within the internal space such as: intermediate columns and fixed hygienical compartments either inside or out of it. When the user wishes to alter his dwelling's design, naturally, he has to take them into consideration. Hence the freedom he needs will be restricted according to the fettered dynamic interaction. To utilize the full possibility of the interchangeability, the internal space of the dwelling must be free from obstacles.

7.2 Ventilation of the inner rooms

This problem arises from building inner rooms without natural ventilation. Obviously these rooms will be unhealthy, and the user is unwilling to accept this inconvenient. Even if it could not be helped, he will follow that has been done in the Orming project — to leave a gap as a fanlight — killing the "privacy". So he will be facing two vital problems, which will motivate redesign of his space, keeping an eye on avoiding such rooms.

7.3 The loss of privacy

This problem can emerge from the use of lightweight partitions to the detriment of acoustic privacy due to inadequate sound damping of either up-to-date lightweight, or traditional cavity brick partitions. (Actual research on sound damping materials is rather promising.)

7.4 The electrical connections

Recently this problem has been solved by avoiding the central light, and nesting the light and socket outlets in the skirting of the partitions. This solution is successfully applied in most projects.

7.5 Service zone stiffness

Dwelling can be divided into two zones: the living and the service zones. Among them, interchangeability could only be realized in the living zone, while the service zone is not yet interchangeable. This zone is too rigid to interchange kitchen, bathroom and WC. According to the sanitary and economical regulations, compartments connected to the rigid vertical pipestack must be vertically superposed on constructive floors of the edifice by rigid horizontal pipe network, the appliances are connected with the risers.

These compartments are themselves rigid in form, besides, they accommodate multiple functions and different forms of appliances, in spite of their smallness in area, still adding to their complexity. This complexity caused that the architects and hygienical specialists mostly refrained from dealing with this zone from the aspect of interchangeability.

There have been some attempts to solve this problem from different aspects.

8. Solution attempts (Fig. 7)

8.1 Fixed wet wall

A precast or assembly wall contains the pipes either encased in concrete or mounted in grooves. The vertical pipes are encased in concrete or inserted in the gap between the two wall layers. The branches and junctions are fitted in grooves in accessible position as for e.g. the "Hungarian prefabricated plumbing unit".

Although this solution offers a wider choice of kitchen and bathroom design and relation to adjacent spaces, but it defines to a certain degree the arrangement of the appliances in the space relating to the position of the wet wall.

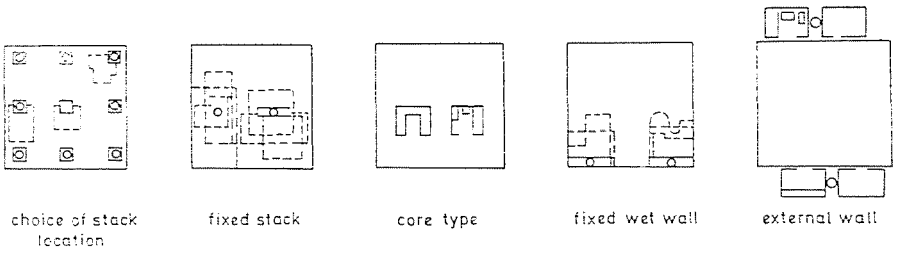

Fig. 7. Attempts to ease the service zone stiffness

8.2 Core type

This solution consists in using prefabricated finished bathroom and kitchen compartments provided with all appliances and connections as moulded or pre-assembled systems. This solution hampers altering of the wet compartments. in addition. the access to the other parts of the dwelling must be determined in advance.

8.3 Choice of stack location

In a strive to freely locate the wet compartments in alternative places, the architect resorted to establish some alternative pipe stacks within the internal space ready to be connected to the finished prefabricated compartments. Although this solution offers a wide choice for alternative locations and connections. it has some disadvantages.

First, its extra costs outgrow its advantages, second, the possibility of alteration confines the other dwelling parts, besides, cupboards are needed to conceal unused pipestacks in living rooms. Third, some constraints arise within the dwelling's internal space which consequently prevent the free dynamic interaction.

8.4 External core type

In this solution the architect displaced the wet area outside the internal space, leaving there the living zone alone. This solution limited the access to other living areas, and the dynamic interaction became confined to the living zone.

8.5 The fixed stack

This solution involves a fixed location for the pipe stack to which the finished prefabricated compartments of pre-defined dimensions, areas, and forms can be connected according to the desired arrangements.

9. Conclusion

Although there is a variety of solutions, neither of them allows dynamic interaction to be achieved even in locating the stack. Also neither of these solutions corresponds to interchangeability. So all these attempts pointed out the architect's inability to penetrate to the root of the problem.

As a conclusion, the situation is really in need of other solutions adaptable to interchangeability. These solutions have to be extracted from the exposition and evaluation of the existing possibilities in the scope of the problem, and the adapted ones must not only satisfy the requirements of interchangeability, but also feature logic and economy in production and application.

Summary

Flexibility is an obscure term, often abused. Scrutiny to its sources reveal that its bulb includes many classes falling under three generations, and every one has its stipulations. One of these is interchangeability introduced through its definition and problems. The major one is the stiffness of the hygienical compartments, depriving it from predominating over the internal space.

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