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# TOWARDS AN OPEN AND USER DRIVEN HOUSING ARCHITECTURE

## Layers principle, infrastructure types and technical devices

Departing from John Habraken theories, this paper puts forward a study on the design opportunities that the separation Support and infill offers, by means of a thorough examination of the infrastructure concept. By means of the analysis of open building projects, it is proposed a study of the different levels of the infrastructural design, developing a catalogue of technical devices running through the scales of the infrastructure[1]. It is intended to develop a set of strategies and solutions, conceived under the premise of understanding the dwelling as an open system –able to change over time-, which facilitates the user appropriation and participation.

### SUPPORT AND INFILL. OPEN BUILDING PRINCIPLES

In 1962, dutch architect N.John Habraken published the seminal book De Dragers en de Mensen, translated and published into English as *Supports: an alternative to mass housing*. At that time, Europe was going through a major housing shortage because many buildings had been destroyed during the World War II. Habraken's text is a critique of the repetitive, massive, homogeneous constructions built in the postwar era to alleviate this shortage.

The plot of the book is developed from a fundamental question which remains in effect. According to Habraken, the main problem of residential architecture is that it is built for people, who will never have the slightest chance to make basic decisions about their living environment. Against the idea of a house as a consumer, repetitive and finished product, Habraken proposes the concept of house as a process. A dwelling is understood as the relationship of the dweller with his environment, a natural relation based on the acts of our daily lives and it is deeply rooted in the foundations of our existence.

However, the book is not limited to expose his censure, but includes a specific proposal as alternative. This proposal is based on identifying two levels of control in a collective housing building; the act of building and the act of dwelling-, separating what remains, the collective part controlled by the community; – which depends strictly of the regulations, structure, and installations -, the "base building", from that which can be transformable and can be adapted to suit the user, like the interior divisions, closets or kitchens and bathrooms, the separable units or infill[2]. Habraken's support and infill separation, is part of a broader reflection on our cities and territory. Our built environment is a live organism, a never ending changing process driven by rules and principles difficult to control and predict, which serves to our needs thanks only to its continuous adaptation and transformation. Open building principles[3], are based on the perception of this built environment as a multi-layered structure, where five primary physical systems are recognized.

Within a city, we can identify the urban structure, the urban tissue (blocks), the buildings, the infill components and the actual furniture. Each of these systems has a different life span and is related to different levels of control and responsibility –different agents acting on each level-. Our built environment is sustainable to the extend that each system is transformed independently and part by part. In short, architecture is understood as a system formed by subsystems, part at the same time of larger systems[4].

[1] The content of this paper synthesizes the findings of the MA by research *Open Building in the collective housing of the 21st century. Possibilities and limitations*, carried out at the Kingston Faculty of Architecture (2010-2011). As part of that research, sixteen Open Building case studies were analysed.

[2] Habraken, Nicholas John and Mignucci, Andres (2010) Soportes: Vivienda y Ciudad. Instituto de Arquitectura Tropical. Editorial on line.

[3] The Open building organization, created in 1992, receives the theoretical legacy of Habraken and the SAR. Nowadays is a network of initiatives dedicated to the implementation of these principles.

[4] Habraken & Mignucci (2010).

## INFRASTRUCTURE TYPES AND OPEN DESIGN

To our interest, this layer structure, can be developed further in the specific field of collective housing. As Stewart Brand (1994) explains in his *Shearing layers* diagram[5], every building consists of a hierarchical system of layers and components, each of which has a different life cycle and inherently changes at a different speed. The site is permanent, the structure can last 30 to 300 years, the skin 30 to 50 years, the services 7 to 20, the space plan 3 to 5 and the stuff (furniture) under 3 years.

Brand's layers diagram suggests the need to design and build each of these components independently and autonomously, to allow the more durable layers of slow change not to block the transformation of quick layers, avoiding to be affected by their reforms and updates.

This further subdivision, allows for a deeper interpretation of the initial separation of Support and infill –permanent-changeable-, since the infrastructure[6] can be provided at different scales of intensity, therefore, the "Support" or "Base Building" can adopt different configurations, offering different possibilities from the architectural point of view and different degrees of participation.

This "continuum of openness", starts from the autonomous or self-build house, which nonetheless for sure has infrastructure. Next step through is the infrastructures as a skeleton, as an envelope, as services and the infrastructure with open spaces (all of them part of the study). In the last step we find the conventional housing provision where the scenery is fixed, and finally the turnkey super-luxury housing where everything down to the art on the walls and the appropriate cutlery is provided. In what follows, I will summarize the main characteristics of these infrastructure types[7]:

### Infrastructure as skeleton

In this first scenario the infrastructure is formed by the load bearing structure and the access (galleries and cores), belonging the rest of the components to the infill. This separation allows one to design each house in an individual way and independently to the others, inside the infrastructure formed by the columns, beams and slabs. Therefore, this scenario follows the original definition of support as it was proposed by John Habraken.

In this case, the internal partitions of each house, as well as the façade, are not part of the infrastructure, giving the architect a great freedom in the design of each house. Hence, an infrastructure as skeleton is a construction able to accommodate houses which can be constructed, modified and demolished without affecting each other; in other words, we are talking about autonomous houses in a high-rise building.

The reality is that there have been many collective housing projects where the interior of the units was freely designed; however, few projects have permitted the exterior walls to be freely located. The *Next 21* building in Osaka (Japan, 1994) and the *Okohaus* complex in Berlin (Germany, 1982) were carried out following these principles.

### Infrastructure as envelope

In this second scenario, the external enclosure becomes part of the infrastructure, acting as a common element representative of the whole building. This is the case for instance of the speculative office buildings which have operated for decades on the basis of these two construction phases.

When we plan an infrastructure as envelope our attention will point mainly to four aspects of the project; the design of the perimeter and envelope, the relation between floor to floor height, and the depth of the floor plan, the position of the service and access core (lifts, stairs and ducts), and the structural system. Our interest as designers will then focus on achieving the best optimization of the space, an open plan system which facilitates diverse possibilities of subdivision[8]. The *Solids* development in Amsterdam (The Netherlands, 2010) is an example of infrastructure as envelope.

### Infrastructure as services

In this third situation, the services (kitchen and bathrooms), become part of the infrastructural system along with the facade, access and structure. That is to say, the position of the services is fixed in the floor plan and therefore not controlled by the user.

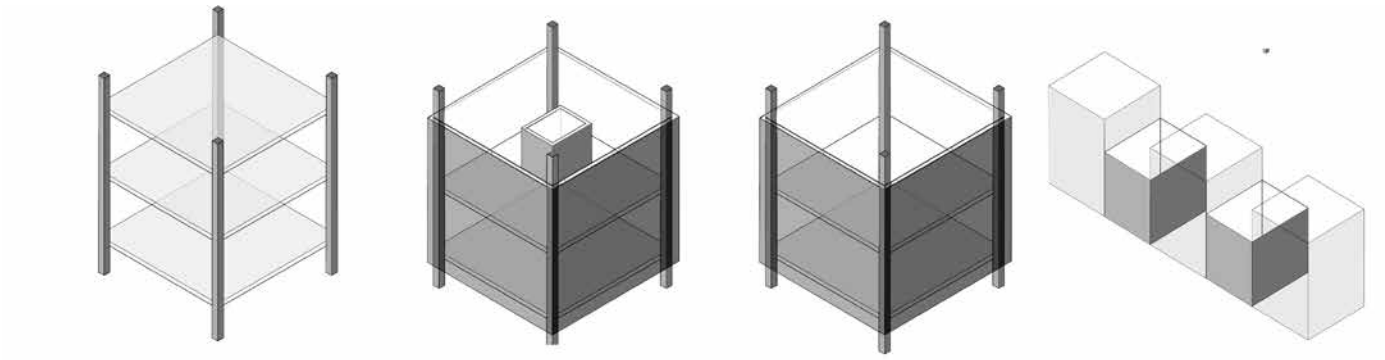
When our intention is to plan a housing unit departing from the services as a basic infrastructural element, we should consider carefully the way of grouping the services and its strategic position in the floor plan. Also, it is essential facilitating an easy registration of the installations as well as the possibility of upgrading the equipment to meet the changing needs of users over time. Grouping together the service spaces, enables a more efficient use of the installations, since it allows for minimization of the number of ducts needed, and to allocate them in an easy position for its registration and maintenance.

[5] Brand, Stewart (1994).How Buildings Learn: what happens after they´re built. New York: Viking.

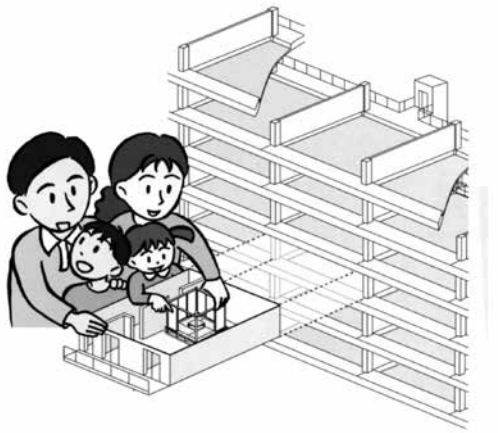
[6] The term infrastructure is used throughout the paper to make reference to the fixed and collective components of the building.

[7] For more information on regard of the infrastructure types, read the Chapter 4.1. of the research mentioned.

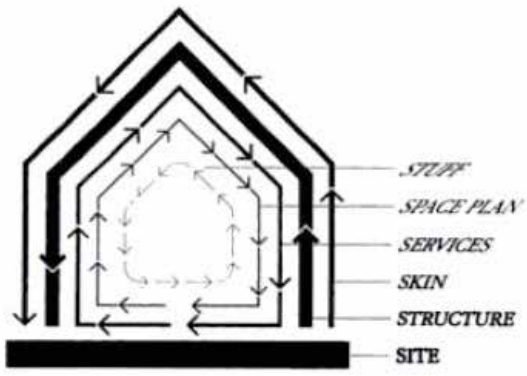
[8] Paricio, Ignacio and Sust, Xavier (1998) La vivienda contemporánea: programa y tecnología Cataluña: ITCC.



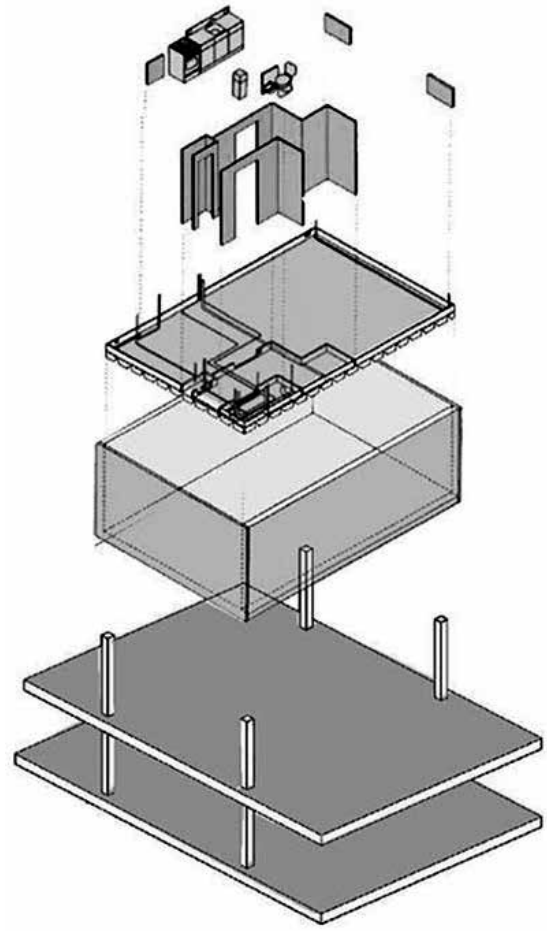
(fig.3). Infrastructure as skeleton, envelope, infrastructure as services and infrastructure with open space.



(fig.1) Support and infill separation.




(fig.2) Shearing layers diagram.



(fig.4). Layers of the infrastructure.

## TECHNICAL DEVICES- *STRUCTURES*

**PREFABRICATED STRUCTURE OF LARGE SPANS (+12m).**

PREFABRICATED STRUCTURE-BASED ON CONCRETE PILLARS, BEAMS AND ALVEOLAR SLAB FLOORS WHICH ALLOW TO FREE UP THE INTERIOR SPACE WITHOUT STRUCTURAL ELEMENTS (OPEN PLAN).

**PREFABRICATED STRUCTURE OF MID SPANS (6m).**

PREFABRICATED STRUCTURE-BASED ON CONCRETE PILLARS, BEAMS AND ALVEOLAR SLAB FLOORS WHICH ALLOW TO FREE UP THE INTERIOR SPACE ARRANGEMENT TO AND EXTEND.

**THREE-DIMENSIONAL METAL STRUCTURE (MECANO).**

STRUCTURAL METALLIC MESH BASED ON INDUSTRIALIZED BEAMS AND PILLARS, RIGID JOINTS. DRY CONSTRUCTION WHICH ALLOWS TO ASSEMBLE A THREE-DIMENSIONAL NEUTRAL GRID.

**APPROPIABLE-NEGOTIABLE STRUCTURE.**

STRUCTURE THAT ENABLES THE NEGOTIATION FOR OBTAINING EXTRA AREA OR VOLUME FOR PRIVATE OR COLLECTIVE USE ALONG TIME.

**BASE- STOREY STRUCTURE.**

PLOTS AVAILABLE TO EACH USER FOR VOLUMETRIC APPROPIATION OVER TIME. IT ALLOWS A VARIATION IN THE WAY OF SQUATERING THE STRUCTURE.

**PATTERN- TYPE STRUCTURE.**

BASED ON REPETITION, IT IS MADE OF THE SUM OF COMPOSITIONAL VARIATIONS . GENERATING A STRUCTURE COMPOSED OF SEVERAL COMPONENTS ABLE TO ALLOW A VARIETY OF APPROPIATION.

**ISOTROPIC PERIMETRAL MESH STRUCTURE.**

STRUCTURAL ISOTROPIC METAL INDUSTRIALIZED MESH THAT GENERATES A GREAT DEGREE OF ADAPTABILITY IN THE PLOT, FREEING UP THE INTERNAL SPACE.

**DIVIDING WALLS CONCRETE STRUCTURE.**

DIVIDING WALLS CONCRETE STRUCTURES IN BETWEEN DWELLINGS AND INTERMEDIATE FLOOR SLABS ABLE TO COVER SPANS UP TO 7 METERS.

(Fig.5)

## TECHNICAL DEVICES- STRUCTURES + *ENVELOPES*

**PREFABRICATED CONCRETE PANELS.**

FAÇADE MADE OF CONCRETE PREFABRICATED PANELS IN LARGE AND MEDIUM SIZE, ALLOWING A QUICK ASSEMBLY AND POSSIBLE SUBSEQUENT MODIFICATIONS.

**ENVELOPE WITH A REGULAR WINDOW LAYOUT.**

NEUTRAL FAÇADE WITH A REGULAR DISTRIBUTION OF WINDOWS THAT PROVIDES A FLEXIBLE INTERIOR LAYOUT THAT ENABLES MULTI-FUNCTIONAL USE OF SPACES.

**IMPROVE-ABLE MULTI-LAYER SKIN.**

ENVELOPE FORMED BY A SERIES OF LAYERS WHICH CAN BE CHANGED AND COMPLETED UNDER THE USER NEEDS ALONG TIME.

**UNFINISHED MULTI-LAYER THRESHOLD.**

INTERMEDIATE SPACE BETWEEN INSIDE AND OUTSIDE, AN ACTIVE BOUNDARY SUBJECT TO ACTIVITY. THOUGHT BY THE ARCHITECT TO BE MODIFIED BY USER OR GROUP OVER TIME.

**MODULAR CUSTOMIZED FAÇADE.**

FACED SYSTEM BASED ON MODULAR PANELS, WHICH ALLOW THE USER TO CHOOSE BETWEEN VARIOUS OPTIONS OF PERFORMANCE, LOOK AND PRICE.

**FAÇADE PLUG-IN.**

FACED SYSTEM BASED ON MODULAR PANELS, WHICH ENABLES TO PLUG IN THE SERVICE SPACES TO THE PROVIDED CONNECTIONS.

**APPROPIABLE VERTICAL GARDEN FAÇADE.**

TRIDIMENSIONAL CAVITY IN FAÇADE FOR ALLOCATION OF VEGETATION WHICH PERFOMS AS AN ENVIRONMENTAL DEVICE AS WELL AS AN EXTERNAL AREA OF APPROPRIATION FOR THE USER.

**FOLDING BALCONY FAÇADE.**

POSSIBILITY OF OUTER AND DEDICATED SPACE ASSOCIATED TO EACH DWELLING. CAN BE FOLDED UP AND DOWN DEPENDING ON THE REQUIREMENTS OF THE DIFFERENT SEASONS ALONG THE YEAR.

(Fig.6)

## TECHNICAL DEVICES- STRUCTURES + ENVELOPE + *SERVICES*

**PREFABRICATED TECHNICAL SERVICES CORE.**

PREFABRICATED OFF-SITE. INCLUDES THE WATER, SANITARY AND CLIMATIZATION INSTALLATIONS GROUPING TOGETHER THE SERVICE SPACES OF THE HOUSE, KITCHEN, BATHROOM AND LAUNDRY.

**ADAPTABLE TECHNICAL SERVICES CORE.**

BASIC TECHNICAL SERVICES MODULE WHICH ALLOWS MULTIPLE CONFIGURATIONS AND SUBSEQUENT EXTENSIONS UNDER THE USER NEEDS.

**TECHNICAL COLUMNS AS DOMESTIC INFRASTRUCTURES.**

VERTICAL ROOM FOR SERVICES WHICH AS AN INFRASTRUCTURAL SUPPORT ALLOWS TO "PLUG IN" DIFFERENT HOUSING FACILITIES ALONG TIME.HOUSING FACILITIES ALONG TIME.

**TECHNICAL CEILLING FOR HORIZONTAL SERVICES.**

HORIZONTAL CAVITY TO ALLOCATE INSTALLATIONS WHICH ALLOWS THE PLACEMENT OF SERVICE SPACES IN ANY POSITION. FACILITATES SPATIAL RE-ARRANGEMENT.

**TECHNICAL FLOOR FOR HORIZONTAL SERVICES.**

HORIZONTAL CAVITY TO ALLOCATE INSTALLATIONS WHICH ALLOWS THE PLACEMENT OF SERVICE SPACES IN ANY POSITION. FACILITATES SPATIAL RE-ARRANGEMENT.

**COURTYARD SET ELEMENT.**

ALLOWS SPATIAL ASSAMBLY OF DWELLINGS AND SETS. ENABLES THE FORMAL AND FUNCTIONAL RENEWAL OF THE BUILDING AS WELL AS THE URBAN RENEWAL OVER TIME.

**MODULAR KITCHEN SYSTEM.**

INDEPENDENT KITCHEN DESIGN SYSTEM FORMED BY DETACHABLE COMPONENTS WHICH MAY BE ADQCUIRED SUCCESSIVELY AND CAN BE FITTED BY MEANS OF "DRY" OPERATIONS WITHOUT MAJOR MODIFICATIONS.

**ADAPTABLE BATHROOM FITTING FURNITURE.**

BATHROOM SANITARY INSTALLATION FORMED BY INDEPENDENT FURNITURE WHICH ARE COMPONENTS THAT CAN BE PLACED IN DIFFERENT POSITIONS OF THE DWELLING.

(Fig.7)

## TECHNICAL DEVICES- STRUCTURES + ENVELOPES + SERVICES + *INFILLS*

**EXTERNAL APPROPIABLE ROOM OR SPATIAL RESERVE.**

OUTER SPACE AVAILABLE THAT ALLOWS THE REAR HOUSING GROWTH AND A SUPPLEMENT AND ALTERNATIVE USE OVER TIME.

**DIVIDED DOUBLE HEIGHT SPACE.**

INTERIOR DOUBLE HEIGHT SPACE THAT CAN BE SUDIVIDED HORIZONTALLY IN HORIZONTAL ALLOWING FOR ALTERNATIVE USE OVER TIME.

**LIGHT PARTITION AND FLOOR SLAB OF DRY CONSTRUCTION .**

DRY PARTITION AND SLAB CONSTRUCTION SYSTEM. ALLOWS THE INTERIOR REVERSIBILITY DISTRIBUTION AND THE ADDITION-SUBTRACTION OF ADJACENT SPACES OF A DWELLING. NEW PROPERTY DYNAMICS.

**RESISTANT CONTINUOUS PAVING.**

FACILITATES THE REVERSIBILITY OF THE INTERNAL ARRANGEMENT OVER TIME.

**SLIDING AND MOVABLE PARTITIONS SYSTEM.**

ALLOWS THE DISTRIBUTION AND VARIABILITY AS WELL AS THE COMPLEXICATION OF USE AND FUNCTIONS OF THE DWELLING. IT PROMOTES THE USE OF SMALL SPACES.

**DIVIDING STORAGE WALLS.**

CABINETS STORAGE WALLS. ALLOWS FLEXIBLE ARRANGEMENTS PROMOTING THE USE OF SMALL SPACES AND THE MAXIMUM EXPLOITATION OF THE DWELLING AREA.

**DO IT YOURSELF CABINETS.**

MOUNTABLE AND DEMOUNTABLE STORAGE UNIT INSTALLE BY THE INHABITANT. AVAILABLE IN DIFFERENT MEASURES, AND PRICE RANGES.

**CABINET- BACKPACK- CONTAINER.**

MULTIPURPOSE CONTAINER OF FURNITURE AND FUNCTIONS WHICH PROVIDES A FLEXIBLE USE TO THE SERVED SPACE. FOLD AND UNFOLD MECHANISM.

(Fig.8)

The project *Balance Wohnparks*, situated in Wallisellen (Switzerland, 2000) shows the possibilities which come up when our aim is to design a house departing from the services as a basic infrastructural element.

### Infrastructures with open space

In this case, the infrastructural system has an open available space that can be appropriated by the user over time, providing more flexibility in use. This open space is not common to all the building infrastructures, but its consideration is relevant to the study, since it allows the possibility of extension of the house.

This available space is not just any space, but areas which are suggestive and have potential for occupation; terrace roofs which allow extensions, courtyards which can be filled in, or double high spaces which allow later subdivisions. It can be external or internal, allowing for the possibility of internal (embrio house) or external growth (seed house). At the early stage, an open space is an unfinished space, but to ensure its proper functionality the architect has to think of the different ways in which it can be appropriated and finished, designing it accordingly.

The *Elemental Chile* project in Iquique(Chile, 2004) and the *Evolutive house* Perugia (Italy, 1978) are two examples infrastructures with open space.

## THE TECHNICAL AND CULTURAL QUALITIES OF THE INFRASTRUCTURE

In the previous section, I have exposed the possibilities of open design in collective housing. However, during the analysis, it has become increasingly clear that achieving a time based housing architecture, is by no means exclusively a matter of design. That is to say, ensuring the long life of the infrastructure is not only about designing an open system which can enable a flexible use over time. If the infrastructure is to remain over time it will need to achieve two extra characteristics; its technical and cultural qualities.

When I talk about the technical qualities, I refer to the mentioned need of looking at the building as a composition of subsystems, with the aim of identifying different lifespans, and designing and constructing them accordingly. Some of the subsystems may be purely technical and they can not last for ever, like for instance the drain pipe and ducts which need to be changed every 15 years. In this case the technical solution implemented will consider the changeability as a basic condition of the subsystem.

On the other hand there are other components, like the structure, the access or the façade, which should be constructed and executed to endure, so the technicality should point to the robustness of these components, that is to say, their capacity to last longer. However, these components part of the infrastructural system can not be built and designed as a merely and purely technical strength, they need a cultural strength as well, otherwise the infrastructure will not last. To illustrate this point in regard to the double-quality of the infrastructure, I will refer to two counterexamples.

On one hand, we have the well known case of the Japanese temples. These temples built in wood and by means of traditional methods, have been retained over hundreds of years, except that the method of retention is to be ritually rebuilt exactly in the same manner every 20 or 30 years. This is a counter example in the sense that such a temple lacks pure technical robustness, but has a cultural robustness which ensures that it lasts longer than any building with mere technical robustness.

On the other hand we have the case of the many extremely robust modernist or brutalist buildings in the United Kingdom and elsewhere, which are being destroyed and replaced by less robust buildings. In most cases these buildings, being made of pre-cast or sometimes pre-cast reinforced concrete, are extremely difficult to demolish but demolished they are, since –among other reasons- they do not currently have a cultural robustness.

### Catalogue of devices

In what follows, it is proposed to develop a catalogue of technical devices running through the different scales of the infrastructure, structure, envelope, services and fit-out elements. The main aim is to utilize as a project tool the features and characteristics positively identified in the analysed projects.

The intention is to arrive at design and construction devices which facilitate the adaptation of spaces to different lifestyles, with the resident as the axis in the design of his habitat.. The strategy is guided by a search for building systems which do not turn into obstacles for future alterations of the house. Looked at them in a flexible and open manner, they can become technical elements which, for instance, allow the increase of surface, the modification of the internal arrangement or an easy updating of installations[9].

### The domestication of open building

One of the usual comments on Open Building implementation, has to do with the high-technology systems frequently used and the specialization of the construction solutions adopted. The explanation to this tendency is easy to put forward. At the moment that a house is divided in subsystems, each building component becomes an isolated element, which can be exhaustively scanned and examined under the specialised knowledge of the industrialised processes[10].

[9] Montaner, Josep Maria, Muxi, Zaida and Falagan,David.H (2011) Tools for inhabiting the present. Housing in the 21st century. Barcelona: Master Laboratorio de la vivienda del siglo XXI.

[10] Schneider, Tatjana and Till, Jeremy (2007).Flexible Housing. Oxford: The architectural press.

Although this may bring in the potential for an improvement of its technical characteristics and performance, this customization and specialization can also turn these systems into sophisticated solutions which are not always accessible –understandable/manageable by the final users-. This can imply the requirement of expertise knowledge for its installation or update, and potentially, can make difficult the interaction or identification between dweller and dwelling.

Tatjana Schneider and Jeremy Till note in *Flexible housing*: "In his own work Habraken is insistent on the connection between the methods of making and the act of dwelling. What is striking in reading Supports is the power of the polemic concerning the housing as dwelling. It is clear that far from being a technical manual, Supports is first a book about the interdependence of dweller and dwelling. Construction is not seen as an end itself but as a means to an end. In this way Supports can be read as ethics of construction"[11].

In the book Supports, Habraken lucidly identifies the natural relation between dweller and dwelling, and how this primary force shapes our built environment. User participation –moreover appropriation, modification or intervention on the dwelling-, is essential to ensure the welfare and care of the house. In this sense, the text can be understood as a critique of user's exclusion of housing production process, an the consequences at the urban level of this lack of involvement.

Analysing Open Building trajectory and its seminal projects, one gets the feeling that the emphasis on industrialization and modularity, has taken over the making of housing and its broader cultural, social and urban implications[12]. The initial attention to user involvement and the essential interdependence dweller/dwelling, has been largely attenuated by the subsequent interest on the possibilities of industrialization and the development of infill systems, which paradoxically, can -potentially- become obstacles to this natural relationship.

Within this context, I understand that one of the challenges of housing industrialization in general and Open Building in particular, should be the development of solutions that -not losing its fulfilment-, can be easy for the non-expert to appreciate and use. In this fashion, the catalogue of devices looks for a "domestication" and standardisation of the Open Building, in the sense that points to simple, accessible, relatively conventional and easy usable solutions, with the intention of enabling the user to take control over his dwelling.

They should not be understood as specific building components, but as a standard set of tools, which could help to develop new construction and design solutions. To sum up, the intention has been to bring the layer principle-at the roots of Open Building theory-, to its very basic condition of simplicity and clarity, and its ultimate aim of user involvement and time based housing design.

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[11] Ibid.p 171.
[12] Ibid.