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Passive and Low Energy Architecture

PLEA2011

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ARCHITECTURE & SUSTAINABLE DEVELOPMENT

Magali Bodart
Arnaud Evrard
Editors

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RENEWAL/REFURBISHMENT

Life Architecture

Open and sustainable building for a strategic dwelling system

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The research proposes a new approach to the issue of residence; at the center of its focus lies the user within the complexity of his needs and his interaction with the environment, aiming at environmental and social sustainability. The research manifests itself through the identification of an open settlement/housing system which sets out in three different scales of intervention (urban, of the building, of the single dwelling). For each scale, the research defines functional, social and environmental rules, thereby becoming a tool capable of flexibly responding to the uses' variety and dynamism and to the context's characteristics, providing high functional and quality standards. The application of this methodology results not in immobile and closed buildings but in open and multi-shaped ones, which are constantly changing in time along with social and environmental variations, are able to conserve resources, use renewable energy sources, assess the entire life cycle of the employed products and promote sustainable social dynamics. The housing image originates from the totality of choices and transformations brought by each individual, even though contained inside some general rules. Thus, it is not a homogeneous, fixed and pre-configured solution but a complexity which reflects the complexity of the human actions and the environmental system of which humans are a part.

Keywords: open and green building, user, transformability, adaptability, social and environmental sustainability

1. STATEMENT

Life Architecture is an approach for housing that focuses on the user within the complexity of his quantitative and qualitative needs (spatio-functional, socio-relational, comfort-environmental).

This approach holds today a particular meaning due to the renewed connection between man and the environment. A new *space-for-action* is thereby taking shape so that the architectural project becomes a tool for sustainability in all its forms.

This space sets out in three design dimensions: *strategic*, *systemic* and *holistic*. *Systemic* in that the different design levels which come into play have to be associated together [1]. *Strategic* since in the definition of the relationship between user and designers, there are determinable and indeterminable aspects [2]. *Holistic* since such an approach calls for righteous processes of interaction between disciplines, competences and knowledge fields in order to define answers for the proposed questions [3].

2. PRELIMINARY CONSIDERATIONS

The research follows the steps of a contemplation about modes of evolving relations between the designer and the user in the last decades, with a particular reference to the project of the daily-used spaces.

G. Nardi [4] claims that, in the past, a wide-spread technical ability strictly connected to the materialistic culture and an expression of a direct tie between design, construction and use, ensured a more compatible approach to transformations in their social and environmental aspects and a great attention to available resources and their management.

On the contrary, today, the complexity of each intervention's phases and the larger availability of technologies have clearly distinguished the designer's figure from those of the producer, the constructor and the end user. This entails that often there is no relationship between the designer and the end user. The former, has carried out needs (real or induced) analysis, and has made choices which would be later imposed on the end user playing the role of the passive consumer. In this way, it is the designer who retains the knowledge of the materials, the techniques and the processes, and the proposed solutions prove to be indifferent to the socio-economic and environmental contexts. The user/dweller loses, compared to the past, the awareness of the *product* and the ability to interact with it.

Such considerations are well reconciled with a contemplation of the present conditions of the Italian architectural heritage which is prevailingly composed of neighborhoods and artefacts produced throughout the second half of the past century. This heritage has clearly demonstrated the limitations and the consequences of the scarce attention of the designer to the input stemming from the changes housing dynamics and the new interaction modes between the dweller, the building and the environment.

From here, a reduction of the system of requirements into a uniform quantity of norms and limitations originated; the schematization and the regulation adapted at that time have proved to be too approximate and generic. All this has, on the one hand, reduced the user into a "end consumer" of a finite and not transformable "product", and on the other, an excessive design rationalization and an economic optimization have lead to a low building quality. The dweller's action, where it emerges, has been reduced into the overlaying of interventions, more or less efficient, in making up for the deficiency in the dwelling spaces. Today, we find ourselves facing an enormous building heritage which does not correspond any more to the social, functional, hygienic and energy-environmental requirements.

In the light of these considerations, the dweller cannot remain a "neutral" element in the design process of residential spaces, but has to become an integrated and active part, since his actions and his ability to interact with the environmental system influences positively or negatively the pursuit of sustainability objectives (social, economic, and environmental).

This does not imply that the programming and planning should be assigned to the community, but it is the designer who should interpret the interaction between the dweller and the environment, and between the dweller's needs and the specific environmental and social conditions of the context [5].

This introduction implies that, in an aware and socially and environmentally responsible design process, it is not enough to quantify the housing needs nor to procede through use behavioral models. It is necessary to identify use aspects on the basis of qualitative parameters and dynamics that depict the user/dweller in his daily activities, in the differentiated uses of space, and in the types of relationships with communal and public spaces, in the temporality of the functional needs. Since desires and needs are variable dimensions, thus, they don't require design solutions which freeze the choices at the moment of the building construction, but rather an open design approach, qualitative and adaptive.

3. RESEARCH OBJECTIVE

The objective proposed by the research is to fine-tune a design and operation strategy based on the realization of settlement/housing construction systems that are open and sustainable, endowed with a high functional and environmental quality, ensuring forms of socialization and exchange between the dwellers.

The design strategy, with reference to recent experiences of *open and green-building* [6], is based on four points:

1. the reconsideration of the user as the central figure in the design and construction process.
2. the articulation of the project at different levels of intervention: urban, building, single dwelling
3. the innovative use of existing prefabricated reinforced concrete construction systems for the realization of the supporting structure which resolves the aspects of the positioning in the lot and of the urban relationships with the residential settlement;
4. the use of light, flexible and reversible technological and construction systems which guarantee spatial flexibility and the transformability of the dwelling in time, adapting itself to the mutations of needs and housing modes.

Based on this introduction, the executed experimentation goes further than working itself out in a project with finite and closed solutions, the experimentation takes shape in a design methodology and an operative strategy in order to define a matrix of possible spatio-functional configurations in constructing residential settlements with high environmental quality and low energy consumption.

4. INTERVENTION STRATEGY

The design strategy sets out in three different but interacting scales of intervention:

- urban scale;
- scale of the building;
- scale of the single dwelling.

4.1. Urban scale

The settlement/ housing system at the urban scale is composed of a series of levels (floors), specific functions are assigned to each level and adjusted to the relationship with the urban and environmental context.

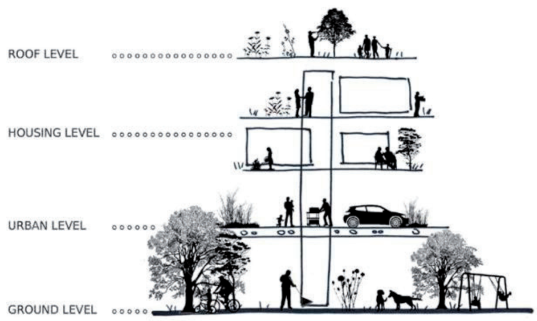

Figure 1: Ideogrammatic schematization of the levels which constitute the system.

ground level_ The system-building, elevated from the terrain level, leaves space underneath for greenery, for pedestrians and bicycles, for urban gardens, for children play areas and for open-air activities. Beyond the advantages of the pervasive green space in residential areas (especially in areas inside the city), These solutions permits the reduction of soil consumption, a greater adaptation of the building to the site morphology, the reduction of pith, and a better management of rain water (which filtring through the terrain revives its water-bearing layers without overweighing the public sewerage system or the purifying implants).

urban level_ the first floor of the settlement/ housing is reserved to communal/collective spaces: the square, parking areas (screened by vegetation which tempers the visual impact, acting also as a filter for polluting dust).

housing level_ the following floors are for the most part set to residential functions. Each floor has the same potential facilities, in terms of accessibility, occupiable surfaces, and areas dedicated to gardens and services.

roof level_ the building's top is usable and it accomodates collective areas and services, and it is covered by various types of greenery, which in addition to its more pleasing exploitation of space, contributes to the reduction of the solar radiation captation, and the increase of thermic insulation, due to its ability to retain water and to reduce polluting agents present in the atmosphere.

The various *levels* which constitute the building-system are connected by a series of ramps, which, in addition to providing access to the various floors, are themselves of collective and green spaces capable of transforming the building in a vertical city, connected to the existing city. The ramps become, moreover, a technological *device* since, in their interior, they provide for a system of meteoric water collection with the purpose of water reuse.

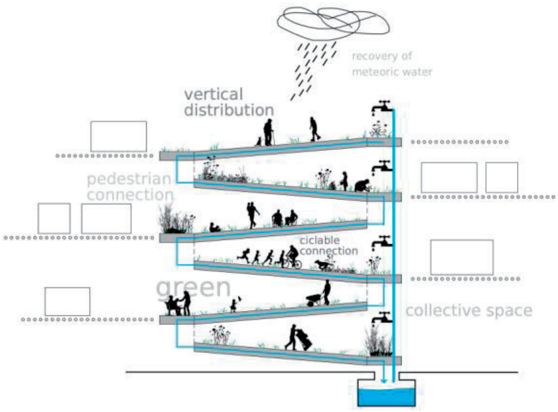

Figure 2: Schematization of the system of ramps that connect the various levels.

4.2. Building scale

At the scale of the building, the design strategy uncovers many common elements and methodological references with the experience of the *Open Building*, initiated by N. John Habraken [7] and by the SAR in the seventies, with the research by Daniel Chenut [8] on the flexibility of the dwelling and with the most recent experimentation of the *Green Building* [9].

The building-system is composed of a supporting structure of precast photo-catalytic reinforced concrete pillars and floors (capable of absorbing consistent proportions of air pollution) of the type TX Active product from the Italcementi. Each floor is provided with technological devices and necessary plants to satisfy the present and future housing needs, as well as communal and green spaces. The supporting system, in addition to forming the sufficiently firm and modular grid which accommodates the single dwellings, undertakes the task of establishing relationships with the terrain and with the urban surroundings.

For each residential floor, there is a subdivision of the supporting structure's surface, this is in response to the necessity of establishing the positions of private spaces (open or closed) in relation to the communal spaces.

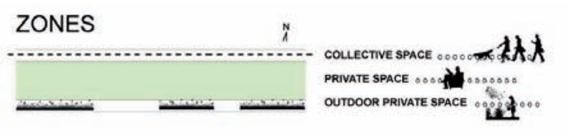

Figure 3: Scheme of the subdivision of the residential floor into zones according to the relation with the exterior.

The residential floors can accommodate more dwellings (apartments) and each family nucleus has a maximum taken up surface of 200m^2, in addition to a fixed provision of three invariant *devices* of a technological, functional and environmental nature.

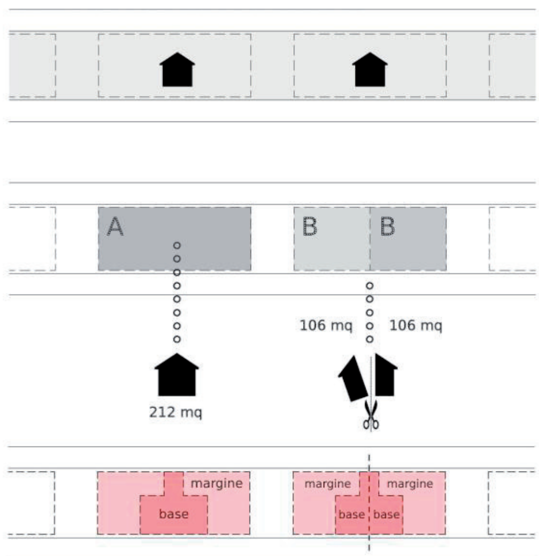

Figure 4: Schematization of the organization of the surfaces dedicated to the dwellings in housing level.

The *technological device* is composed of a nucleus in C precast reinforced concrete which contains the technological implants serving the dwellings and their entrances.

The *functional device* is a space which acts as a connector, from the spatial-distributive point of view as well as the plant-engineering, thereby ensuring the complete functionality of the house's spaces in all the possible configurations.

The *environmental device* is composed of a greenhouse and gardens both with south exposure, so that, if properly used, contribute to the reduction of the energy demands of the dwelling, through the accumulation of heat in certain periods of year, the reduction of solar irradiation in the other periods, and the reduction of CO_2 in the atmosphere. Endowing each dwelling with the kitchen garden guarantees the possibility of self-supply of essential goods.

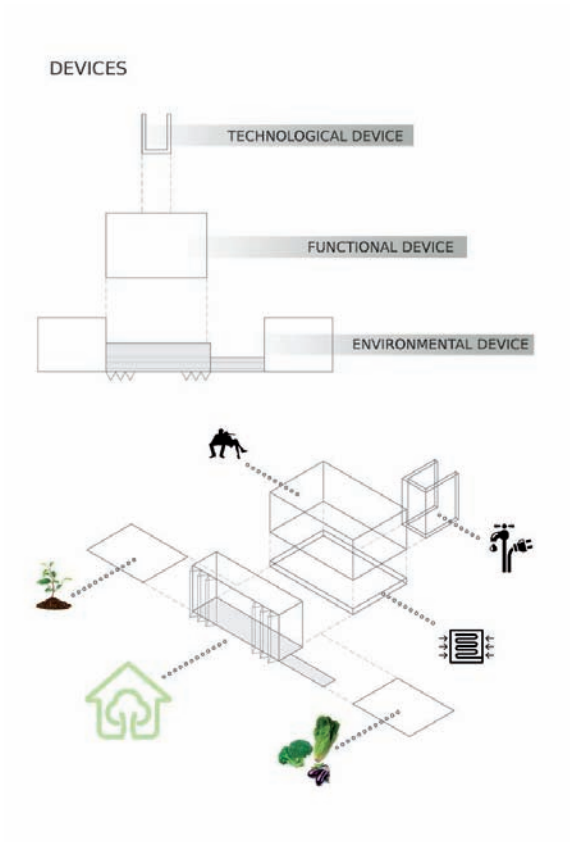

Figure 5: Scheme of the devices.

4.3. The scale of the single dwelling

Around these three *devices*, the dwelling is constructed. In its initial and possible future configurations, the dwelling is carried through on the basis of a modular grid which is derived from the micro-module that coincides with the supporting structure's pace. Based on the modular grid (in modules and sub-modules), functional spaces defining and configuring the residential unit are assembled.

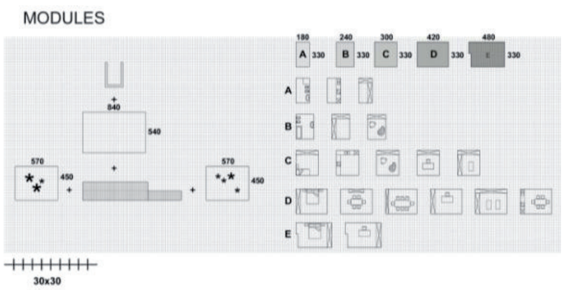

Figure 6: the construction of spaces based on the module and the association among spaces and some of the possible functions.

The different combinations around the three *devices* (technological, functional and environmental) allows the dwelling to have different spatial solutions, to be adaptable to the users' real requirements (and not to estimated uses), and transformable according to the variation of exigencies in time (for example, the variation of the family nucleus, the economic conditions, new functional requirements or simply the replacement of the occupants).

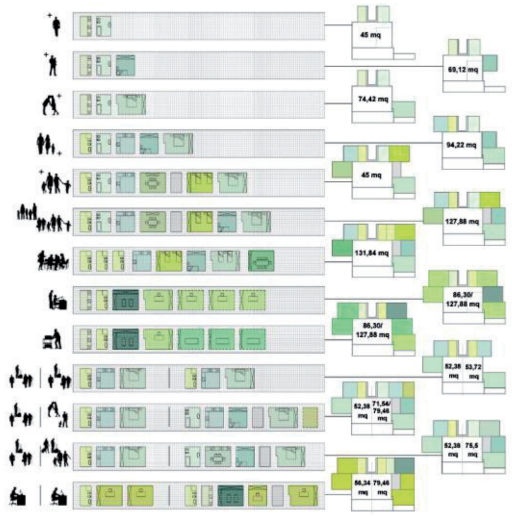

Figure 7: Scheme of some possible configurations of the dwelling in relation to the users.

For a greater adaptability of the system, the surface dedicated to a dwelling (surface of type A) can be divided (surface of type B), allowing the occupation of the same surface by two residential units, which although they share the same fixed equipment (devices), enjoy all the characteristics and the independence of a typical dwelling.

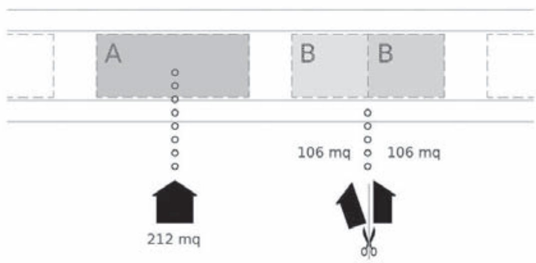

Figure 8: Surfaces of type A and surfaces of type B.

The combination of modules, which configure the residential unit, does not occur in an arbitrary mode, rather, it follows certain basic rules which guarantee meeting the qualitative standards. These rules are concerned with the positioning of the rooms according to the orientation, the nucleus of the technological implants and to the class of spaces to which they belong (services, activities of a specific nature or to general activities).

The construction of the dwellings takes place by means of employing light building systems and industrial products from the catalogue. In order to facilitate adaptation, customization and transformation of the system and of the dwellings and in order to guarantee a good overall maintenance of the building. We propose an innovative use of technology and of wood and steel construction systems which are available in the market (such as *Massiv holz*, *Platefom frame*, *X-Lam*, *Cold-Steel Frame building*, dry cladding systems, etc.) easily assembled and dismantled. The use of dry assembled construction technologies plays a fundamental role in the adaptability of spaces and the reversibility of their constituent elements, thereby, allowing the dismantling of the used materials and their later recycling, reducing in this way the overall impact on the environment [10].

The user's participation in the construction of his own house comes not only through choosing spaces and construction technologies to build them, but also through finishing and managing the assigned green spaces (gardens and kitchen gardens).

Choosing the construction technology and the finishes sets the contextual characteristics as reference points and considers the possibility to deliver local products. The variability of the offered construction possibilities makes the system adaptable to different situations, therefore environmentally compatible with different settlement contexts.

The personalization action, both in the initial phase and in the subsequent modifications of the dwellings, is not exclusively entrusted to the user but it is guided and controlled by planners, which coordinate the realization process, through a catalogue of shared solutions.

Regarding resources management, the system, beyond the reduction of energy resources, introduces active renewable energy production systems compatible with the available resources in the specific intervention area. In any case, the system provides for the treatment of rain water and sewage, each treated differently for its reuse thanks to the installation of constructed wetland implants which was possible thanks to the *ground level* characteristics.

5. THE CASE STUDY: VALLEMIANO NEIGHBORHOOD IN ANCONA (ITALY)

In order to verify the design strategy, it was experimentally applied to a first case study in an urban area in the city of Ancona (Italy). The area, at present, is occupied by some disused buildings, a sports facility and a parking. The area is almost 37.000 m^2 and is placed inside the consolidated urban tissue. Its most important characteristics are the presence of the railway which defines the southern limit of the area, an overpass which divides the area crosswise, and two different urban levels. The site is close to the city's principal road network and to its entrance.

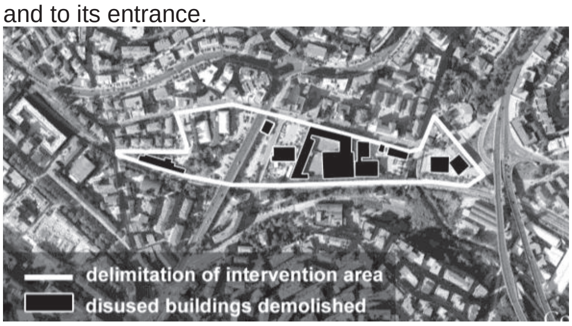

Figure 9: Aerial photo of the intervention area placed inside the consolidated urban tissue. The project includes the demolition of disused buildings pre-existed and re-naturalization of the terrain of entire area.

The application of the proposed system in this area provides a response to the dwelling demands as explained above, and has permitted us to work on some critical issues raised by the places' actual state.

The work on the *ground level* has called for a re-naturalization of the terrain, previously cleared of pre-existences, with consequent benefits in terms of the permeability and of a more sustainable water cycle with the economic repercussions due to less commitment to public sewerage and sewage treatment plants. The introduction of a large green surface confronts the deficiency of green areas and spaces for open-air activities in the existing urban tissue and reduces the heat island phenomenon typical of urbanized areas. The *urban level* in the specific case, in addition to providing areas dedicated to parking, services and other public spaces, has efficiently established a relationship between the different existing urban levels, a relationship, which, in the present state is almost absent, generating a fluidity of relations not only between the different levels but also between different parts of the neighborhood. In this case the two levels (ground and urban) are connected to a pathway, which in parallel to the railway breaks the area borderlines connecting the levels with the open spaces, the pathways, the sport facilities (already present in the area and adjacent to it) and the services within a larger surrounding (all the way to the harbour).

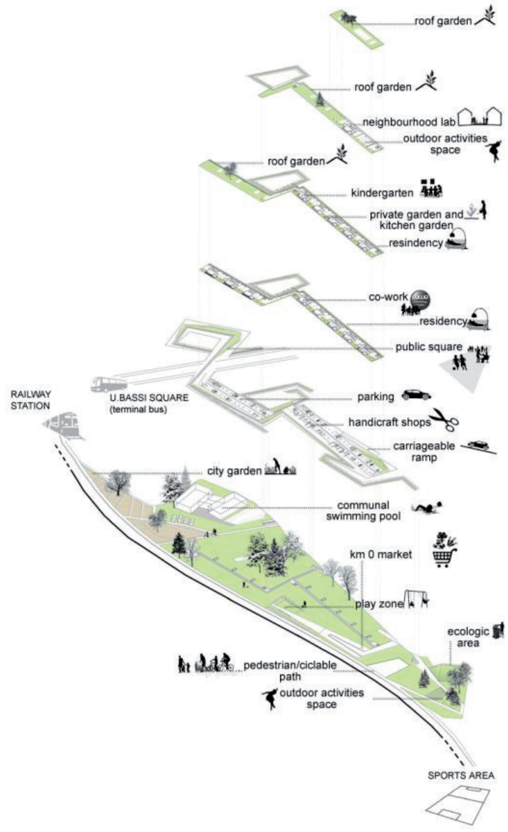

Figure 10: Intervention stratification.

Adapting itself to the context in which it is set, the system reads some dynamics of use of existing external spaces (areas dedicated to sports, small gardens, etc.) and includes them seeking to develop them.

Figure 11: West elevation.

Figure 12: Perspective.

This first experimentation, in addition to demonstrating the large applicative potential inherent in the proposed methodological approach, has been a kind of first verification which has permitted, according to a recursive process, to re-examine and reformulate some spatio-functional and dimensional aspects of the system.

6. RESULTS

From the first application of the developed design strategy on a real case the following results are derived:

- Open and multi-shaped buildings, in constant change in time due to the variation of internal (social) and external (environmental) conditions. The image of housing derives from the totality of choices and transformations carried out by each individual, even though within some general rules. Thus, not pre-configured solutions, but a rich variety of solutions which reflects the complexity inherent in human actions and the surrounding environmental system.
- A “project democracy” which provides equal conditions to all inhabitants. Each dwelling, in fact, has the same orientation and has at its disposal the same facilities in terms of accessibility, spaces, and accessibility to services (distributed vertically in the building all the way to the roof), avoiding the traditional distinction in terms of value between the ground level and the above levels.
- User's active partecipation which emerges in all process, design, construction and maintenance phases. The possibility to act directly on the user's own dwelling guarantees a greater satisfaction on the user's side who develops a deeper interest in its management and maintenance, with evident benefits in terms of common maintenance and improvement of ecological efficiency of the buildings.
- A mix of residences, communal spaces and common services (self- directed kindergarten, spaces of co-working, artisanal shops, spaces for open-air activities, etc.) which are consequences of the verticality of the urban system, which, also due to the ramps connecting the different floors, guarantees a greater vitality of places and a better chance for exchange and socialization.
- A considerable presence of green areas, which, in addition to the greater psycho-physical well-being and the higher quality of open spaces it guarantees, carries out an important role in controlling solar radiation and the quantity of polluting substances in the air and in the purification of water (natural purification processes of rain water which reach the water-bearing layers, processes of constructed wetland for the reuse of rain and sewage water).

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