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## **MODULAR, SUSTAINABLE AND CUSTOMIZED: PROJECTS FOR CONTEMPORARY HOME**

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### **Abstract**

The home is the place where the intimacy of living is manifested but it is also the fundamental place in which relationships with the outside world are built.

The truest sense of domestic space is expressed in the opposition between the interior dimension and collective aspirations. A society's needs and aspirations are reflected in the transformations of the home, the city's basic unit and constituent element.

The history of the dwelling can be read as the history of the relationship between the desire for self-representation of an inner world and the desire for identification and recognition within a community.

Based on these considerations, one of the themes of the research carried out by HousingLab - Sapienza of Rome - is to develop low-cost projects for houses with formal and environmental qualities that can be customized and tailored to individual needs. To meet the demands of a large and heterogeneous public, these projects must refer to processes regulating the production of goods for mass consumption.

But how to reconcile industrialization and mass production with the need for individual expression or with the desire to freely give form to a home, modify it, and define its character according to individual taste and the characteristics of its environmental and urban context?

The goal is to create a catalogue of dwellings based on a system of a limited number of easy-to-assemble standardized and prefabricated components that can generate controlled, but extremely varied and flexible, configurations of domestic space in order to accommodate different needs both in relationship to individual taste as well as to different locations. The paper will present some of the design hypotheses developed by HousingLab - Sapien, highlighting the relationship between architectural quality, energy, environmental and economic sustainability and the innovation of the proposed solutions.

**Keywords:** customisation, housing, quality production, user participation, sustainable development, prefabrication.

### **Introduction**

The accelerated growth process of urban peripheries occurred in last few years calls for a comprehensive analysis of the methods and strategies to be implemented in these areas. In this process, it is necessary to take into account several issues, such as the characterization of the new urban landscape and its sustainability, the relationships between the new city areas and the existing city and the influence of urban transformations and changes in lifestyle on the design of the dwelling. In this scenario the subject of dwellings design in suburban areas of the contemporary city represents a crucial aspect of architectural research. Contemporary life changes in effect require substantial changes in the way of designing residences both at urban and building scale, starting from the research which was suspended for a long time, of dwellings and building type. In Italy, as in other countries, the transformation of the family, the immigration of new inhabitants and the increasing age of the population, together with new dynamics in the world of employment such as job insecurity and nomadism of youth, are changing

the needs for dwelling. Moreover, sustainability changes the conception of the home and the city, moving towards three different dimensions: environmental, social and economic. We think that only an integrated approach to these themes can change the way to organise spaces and functions inside contemporary houses. The proposals for the housing projects presented in this paper are based on the study of settlement and building types suitable for the transformations of the society. These studies have been elaborated within the HousingLab - DiAP - Sapienza of Rome<sup>1</sup> and constitute the experimental phase of our research, which aims defining design criteria for new residential building projects within urban peripheral areas. The design criteria moves from the assumption that the new settlements should be based on social, economic and environmental sustainability at all project scales, from urban layout to aggregation of buildings, organization of residential units and selection of appropriated technologies and materials. Based on the above considerations, four aspects have emerged.

The first one is the design of living units that are not self-contained while being integrated with existing buildings. New systems of public space, services and houses may create a network in the urban context to enhance the related potential and at the same time to enable different levels of social life.

The second aspect concern with the relationships between the new constructions and the urban and natural landscape to avoid the current formal and linguistic homologation.

The third aspect concerns with the need to design multiple housing solutions, with variations and flexibility in order to create urban systems that are suited for a vast array of people. The fourth aspect is related to renewed attention to prefabrication, depending in particular on the need to reduce energy consumption and efficiency in manufacturing that allows industrial approaches to building production, borrowed from other sectors of the manufacturing industry.

#### **Building types and living unit**

Innovating the organization of buildings, by keeping into account environmental as well as living conditions of inhabitants, constitutes one of the tools to achieve a better quality of the urban environment and life of individuals. The buildings that strive to meet the social demand – which is today very much diversified and continually changing – should provide a large variety of dwellings in terms of:

- Type and size allowing variability of interior space arrangement and dimensions;
- Long-term flexibility to allow the possibility of re-combining and dividing the living units;
- A System to accommodate the request of any small increase of volume.

Lastly one of the essential aspects that should be considered during the design phase of living units is the customization of the home space to accommodate the different tastes and lifestyles of his in-habitants.

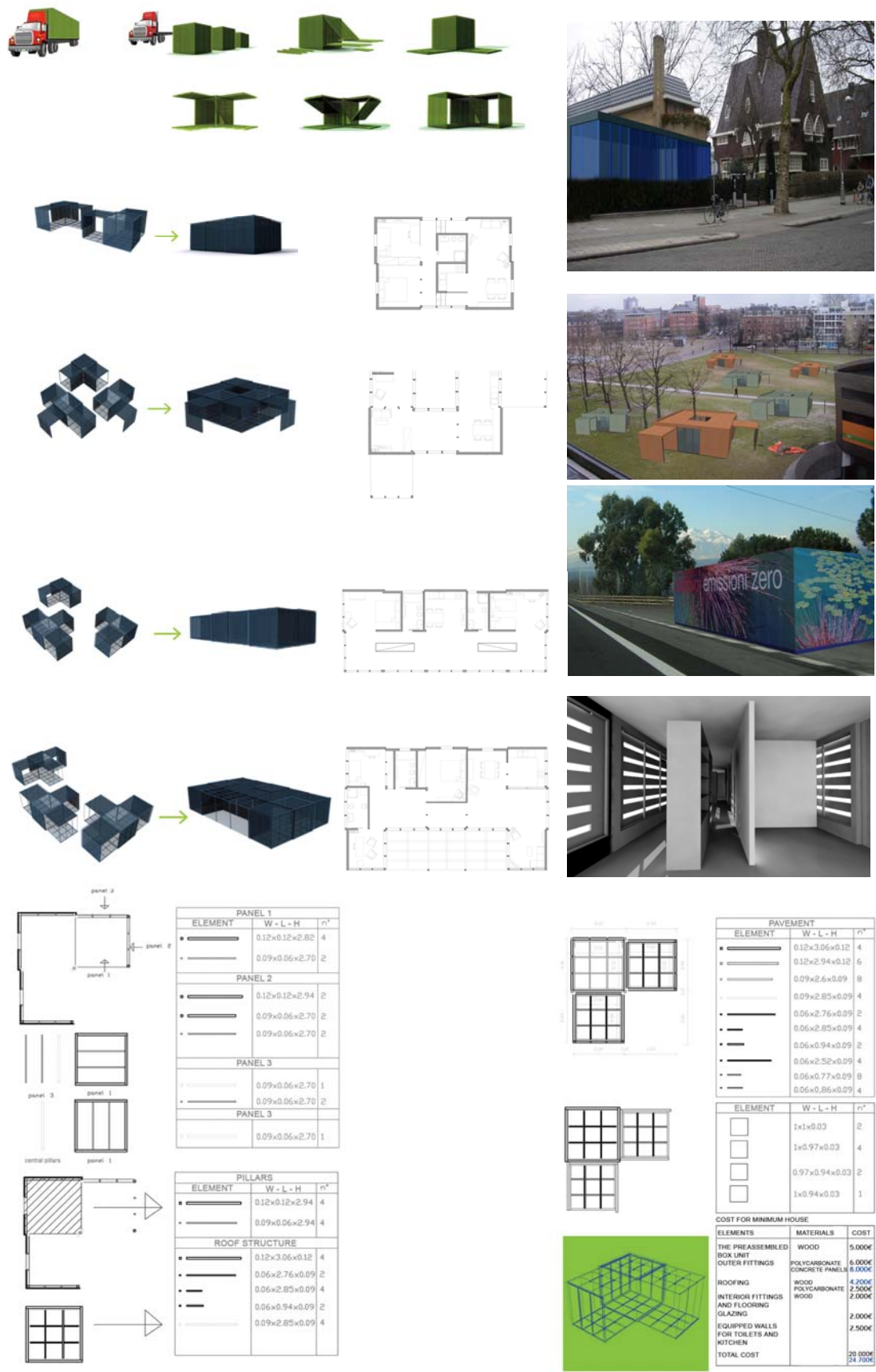
#### **Homes and customization**

One of the main issues of contemporary housing projects is to develop sustainable and low-cost solutions for houses with formal and environmental qualities that can be customized and tailored to individual needs. To meet the demands of a large and heterogeneous public, these projects must refer to processes regulating the production of goods for mass consumption similar to those used for airplanes, cars, and other objects of design. In fact, inside the factory, the prefabrication process reduces the waste of the raw materials by exact computation of material required. Recycling in fact is easier than building on site, and the constant search to improve the quality of each component constitutes a guarantee of a building's performance, above all in terms of energy consumption. Finally, producing a building in a factory and then constructing it on site, in a short period of time, reduces the impact of the job site itself, with its well-known risks of acoustic and environmental pollution, and the dangers associated with construction equipment. But how to reconcile industrialization and mass production with the need for individual expression or with the desire to freely give form to a home, modify it, and define its character according to individual taste and the characteristics of its

environmental and urban context? Naturally, the idea of the home as an industrial product must be accepted by the future inhabitants. Therefore to overcome this problem, prefabricators making room for architectural experimentation. The projects that we are illustrating below should ensure by showing existence of a poetic that involves the organisation of the plans and volumes of the modular and prefabricated dwelling and at the same time refusing clichés. Specifically, the following projects deal - at different scales - with the questions discussed above.

**The custom-made home. “Living box”, 2005**

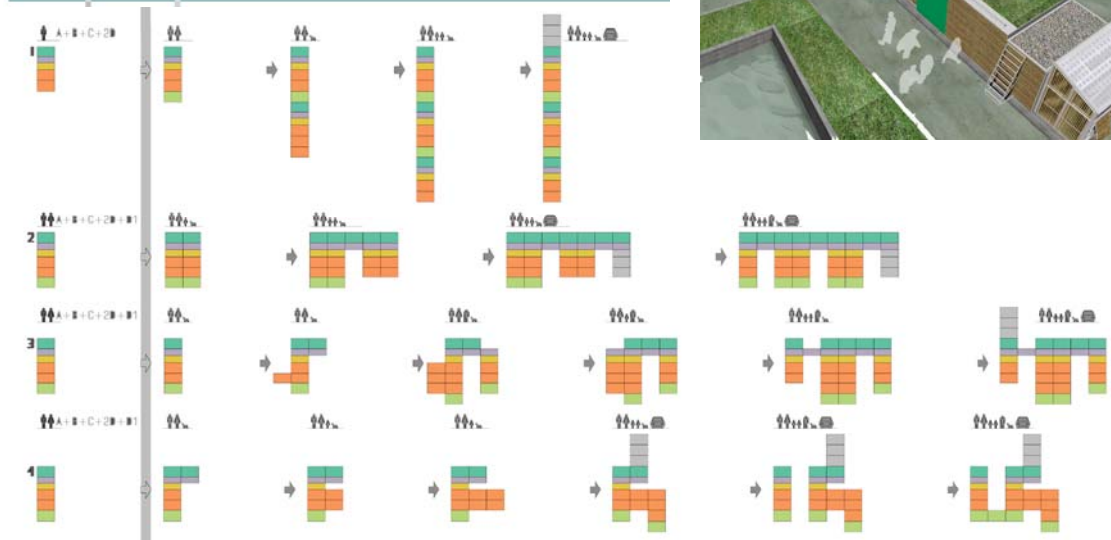
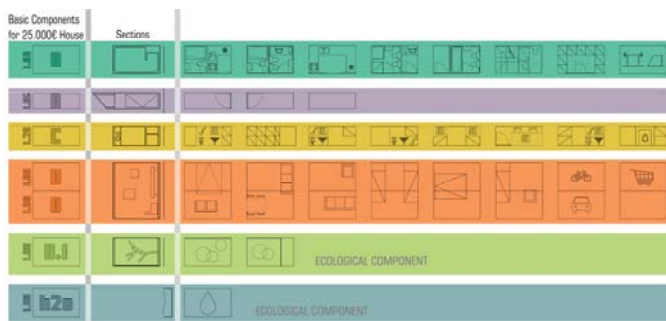
One of the themes of the research carried out by HousingLab - Sapienza of Rome - is to develop low cost projects for houses with formal and environmental qualities that can be customized and tailored to individual needs. To meet the demands of a large and heterogeneous public, these projects must refer to processes regulating the production of goods for mass consumption. “Living box” responds to the need to personalize the home by identifying a basic kit of pre-assembled units, industrially built off the building site to which combine components on the spot. All easily transportable. The main aim is to create homes with a limited number of standardized and easy-to-assemble prefab components to choose from a catalogue, that are able to generate controlled spatial configurations of the domestic environment. These components should be flexible enough to follow the different needs both in terms of personal taste of the inhabitants and in terms of adapting to differing local situations. The “custom-made home” is conceived for a broad social strata, low costs and flexibility to respond to all needs and favouring self-building and self-definition of domestic space. On the private market applications could be in tourism or temporary vacation homes. A useful use of the model is in social housing, to respond to house-shortage emergencies for the most needy or in case of natural calamities. The basic unit is a “box”, prefabricated, whose square faces with side length equal to 3 meters, are composed by wooden frames. The layout and number of sides that can be opened with respect to the two that are fixed (floor and roof), allows different configurations of the basic unit and of the bearing structure of the house. The use of wood is suggested for its relatively low cost, lightness and reversibility, though the “box” can be made with other materials that present similar prerequisites. The basic “box” unit is a container of components to assemble on the site. Its limited dimensions allow also road transportation, up to a max of 3 elements per vehicle. The basic units are positioned following a precise sequence to obtain the desired configuration. Once they are opened, the other components inside are assembled. The floor is mounted before opening the basic units to guarantee stability to the system. Once the bearing structure of the house is up, the other components can be assembled. Only one person is needed to set up the structure. The combination of basic units, from two to three “boxes” per vehicle, provides different types of homes. The maximum height is two stories. Simplicity and versatility allow an extremely simple and quick reconfiguration of domestic space, by increasing or diminishing the number of units according to the needs of the family. From the different combinations of house various urban forms are generated: from the single family home to simple rows or courtyards, to mixed schemes forming more complex patterns. The preassembled components of the basic “box” are: frames, bracing and internal partitions, ground floor and roof. The ground slab is to be assembled on the site. By choosing wood for the bearing structure of the “custom-made home” the attention is focused on the use of natural materials, non-polluting and reusable, with high thermal inertia. Solar panels on the roof and ventilated façades for the outer walls are an integrated part of the design. The components to be chosen and assembled on the site are: outer fittings, interior fittings and flooring, glazing, roofing, equipped walls for toilets. These components can be chosen through a catalogue together with the basic unit among industrially produced components, thus obtaining a complete kit to send to destination with one trip the house will be built in.



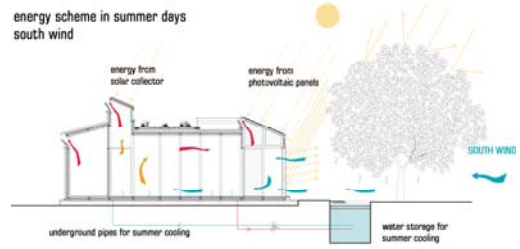
**Figura 2:** International Design Competition “The custom-made home - Living Box”, Italy, 2005  
 Project by D. Mandolesi (HousingLab - DiAP - Sapienza of Rome), P. Colamarino

### **Ecohousing kit – Caterpillar. “Ikea Stiftung”, 2008**

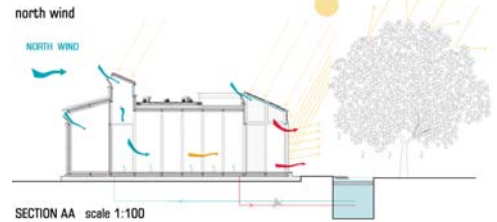
The competition promoted by IKEA on the home of the future has given the opportunity to experiment the potential inherent in a house intended as an assembling kit. This is a not new subject in the history of architecture. Many architects have tackled with the design of houses to be serially produced, such as Le Corbusier with “Maison Citrohan”, the house to be serially produced just like automobiles, Wright with “Assembled House” (1931), a house with three minimal units to be widened based on the user’s needs. In the 1940s Wachsmann and Gropius - migrated from Germany - designed the “Packaged House” for the American market - a single storey, with a straightforward rectangular plan, a light pitched roof and a porch - but the project was a true failure. For Wachsmann - as Colin Davies says - the Packaged House was not really a house, not a locus for the lives of real people, not even a machine for living in; it was an abstract geometrical system, tending always towards mathematical perfection. Buckminster Fuller designed Wichita House a hybridized version of two prototypes never assembled. Built by Graham in 1948 it was one of the most innovative individual family house but like the Dymaxion, the Wichita House would enter the annals of replicable utopian homes that would never see the light of day. In 1945 John Entenza, the editor of Arts and Architecture magazine, launched the Case Study House Program and commissioned to various architects projects of single dwellings to be mass produced. Among these is Ray and Charles Eames Case study House 8 which will become their own home and studio but it will never be added in a catalogue; moreover the Eames never developed their catalogue component house idea. Too innovative was considered the Maison Coque proposed to Citroën by Jean Prouvé in the early Fifties. The House for the Abbé Pierre (Prouvé, 1956) as well the Case study House 8 was built as a single prototype and it was never mass produced, probably it was considered too a radical solution the bearing structure facilities unit located in the middle of the living room. None of these and other examples has ever gotten past the prototype stage. Colin Davies claimed that no designer was really determined to built such houses. “With the possible exception of Frank Lloyd Wright’s Usonian, all of the above houses were designed with serious intention of putting them into mass production” Nonetheless, a market demand did exist. Buying houses on catalogue during the early years of the twentieth century in the United States was a rather common practice. Several companies offered mail order houses, the most important was Sears Roebuck which, between 1908 and 1945, had produced more than four hundred and fifty different house types and sold about 70.000 units, without any famous architect’s contributions. Even in Europe many prefabricated timber houses were built in the suburbs of several cities between the 1920 and 1930. Lastly, IKEA in 1996 started to produce houses for the Swedish and British market to meet the desperate need for low-cost housing. The HousingLab proposal can be placed in this scenario, and is based on the aggregation of a number of modules to be selected from a catalogue, and mounted according to several extensible and transformable configurations. The modules are designed to be manufactured off-site, transported to the site by truck, and dry-built in a very short time. The specific design of each module is determined by functional needs and bioclimatic needs. Indeed the house can provide its own energetic balance thanks to a passive solar gain system joined to an active solar gain system. There are several types of modules: a service module, with bathroom, kitchen, laundry room, wardrobe and stairs; a distribution module. It is the tallest module and works as a solar collector; a wired module with connections to the data communication network; room. Two modules create different configurations of living room, dining room, bedroom and office; greenhouse; tank for the collection of water. The smallest house (28.00 sqm) is composed of 6 modules. In order to best exploit natural sources (sun and wind) the modules should be mounted along the North/South direction. Starting from the minimal unit, it is possible to create a varying number of configurations that can meet several needs for personalization, flexibility and adaptability.



energy scheme in summer days  
south wind



north wind



SECTION AA scale 1:100



**Figura 3:** International Design Competition IKEA Stiftung, 2008  
Project by: M.Calzolaretti, A.DeCesaris (HousingLab -DiAP- Sapienza of Rome) with C.Acosta Fontana, C.Bisceglia, M.DeLicio, L.Aletta, S.Andrikou, L.Carriero-

### The new Italian social housing. “Cohousing at Fidenza”, 2005

The competition “La Nuova Casa Popolare Italiana” with its explicit request for non-conventional solutions has offered HousingLab the opportunity to investigate the potential of co-housing soft forms able to satisfy people’s contemporary demands. One-family households in fact are no longer the only reference model of those who look for a place to live. New subjects are soliciting the market, which has not adjusted yet to the changes in progress. In Italy, there are approx six million singles. However, it is not sure that they wish to remain such. Furthermore they have friends, lovers, children from previous marriages to accommodate and therefore need a dwelling that can be transformed and is flexible. Even among young couples and people over fifty years of age there are those who prefer forms of space and service sharing, which offer economic savings and an opportunity for meeting and building social cohesion. Furthermore, temporary dwellings with communal services that can simplify daily routines are becoming indispensable due to the ever-increasing number of relocations for economic reasons. Shared living therefore – cleansed of the hippie-like nostalgic aura of the Sixties – appears today as a possible strategy for sustainable development. HousingLab proposal consists of an aggregation of minimal units that guarantee a more private dimension, clustered around communal areas. The individual space is composed of a 20/27-sqm-wide minimal living unit in which several functional areas are organized, namely, bathroom, closet/wardrobe, bed, TV/office station. Another 1.50-sqm-wide space intended as a balcony can be enclosed and used for different purposes. Multiple minimal living units aggregate around communal spaces and form dwellings of various dimensions. Two possible ways to aggregate the units have been experimented. Horizontally: in this case the units constitute aggregated independent units, each of them having a separate entrance and consisting of two levels. Vertical aggregation comprises four stories of the building, in which three minimal units on the ground floor are grouped around the communal area. A flight of stairs and an elevator allow access to the roofing shaded by photovoltaic panels. Based on the analysis of climatic conditions it has emerged that 5 months are considered extremely cold, two fairly cold, three comfortable and two hot, and winds are practically non-existent throughout the year. In winter therefore solar power can give a significant contribution to the energy requirements of the buildings. To this purpose the following systems have been implemented: collection of solar energy and heat storage, distribution and retaining. As for the summer, the goal was to ease natural ventilation and heat rejection by means of solar pipes and blocks, which work as heat accumulators during the winter season and also serve the purpose of releasing hot air. The facilities are built with AS-Holzbau system wood boards. Energy sustainability is guaranteed by the photovoltaic panels laid on the roof of the blocks and used as sunscreen on the terrace of the tallest building (total surface: 252 sqm).



**Figura 5:** National Design Competition “ La nuova casa popolare italiana”, Fidenza, Italy, 2005  
Project by A.De Cesaris (HousingLab - DiAP- Sapienza of Rome), M.Aprile, R. Battistacci, C. Bisceglia, M. Calzolaretti, M.De Licio. Second Prize



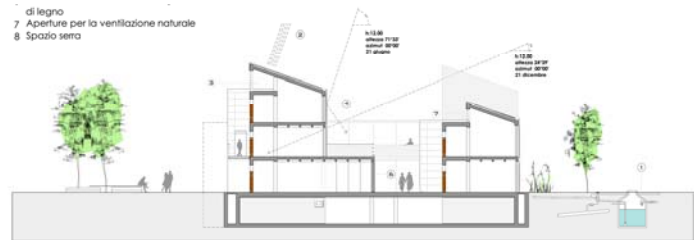
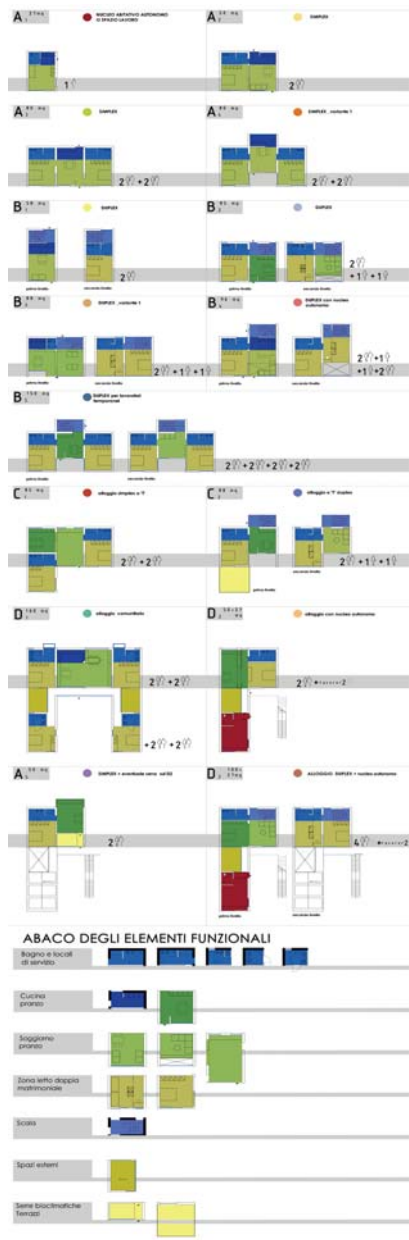


**Figura 5:** National Design Competition “La nuova casa popolare italiana”, Fidenza, Italy, 2005  
 Project by A.De Cesaris (HousingLab - DiAP- Sapienza of Rome), M.Aprile, R. Battistacci, C. Bisceglia,  
 M. Calzolaretti, M.De Licio. Second Prize.

**New social housing model. “Fano solidale”, 2009**

The social, economic and social changes occurred in the last decade have re-opened the debate and design research relative to such an essential and necessary good such as a house. Meeting a complex and variegated demand for homes in fact requires targeted strategies in relation to which some issues are seemingly a priority that can no longer be postponed. Privileging the development of social housing constitutes one of the crucial points to tackle two of the most critical aspects for many of our urban contexts. Re-thinking the relationship between private and public to build a communal dimension of living in the light of the new demands brought about by immigration and globalization equals to reconsidering the relationship between building types and urban fabric. Pursuing economic and environmental sustainability of residential building also implies an overall reconsideration of urban and architectural choices, construction processes and systems and the ways of using the house and the entire neighbourhood. Finally, thinking about the human and symbolic implications of a home, searching for models able to reconcile individual needs and community life in a public, shared and participated dimension means tackling the issues of identity and flexibility of the use of domestic space as well as thinking about the whole of the “elements of a gradual filter between public and private” – open spaces, green areas, distribution avenues, trade places, ecc. – which are a fundamental and unavoidable part of residential design. The convention-based project for residences and service facilities in San Lazzaro, a peripheral area of the city of Fano, can be placed in this scenario of theoretical considerations. As the project represents a meaningful opportunity for the definition of new dwelling models, it sees in the system of vacuums and public spaces which different dimensions,

characteristics and spans alternate with building volumes the backbone of the new layout. The objective is the definition of a centre on a neighbourhood scale characterized by multiple functions, a place that can offer different opportunities and a better life quality in spaces suited for children, young and elderly people and families. To achieve these goals, the structuring spine of the new urban design is incorporated within an ample pedestrian promenade that crosses the area diagonally. The urban project is made up of three linear systems of housing integrated with services, public space, rest areas, and meeting places for local residents. Great emphasis is placed on green space which is closely integrated with the system of pedestrian walkways, public spaces and squares. The elements composing the housing unit are numerically reduced in order to standardize them. They can be combined to obtain a large number of spatial solutions and dimensions and thus satisfy the housing needs of different users: students, the elderly, the traditional family. The variety of possible combinations overcomes any concern about monotony and at the same time allows control of volumetric and linguistic quality. Finally, the project addresses environmental sustainability and overall efficiency through the following choices: use of ventilation and natural lighting compatible with the site's climatic characteristics; use of building technologies and innovative mechanical systems with low environmental impact; integration of components that produce energy from renewable energy sources (RES).



SEZIONE aa  
scala 1:200

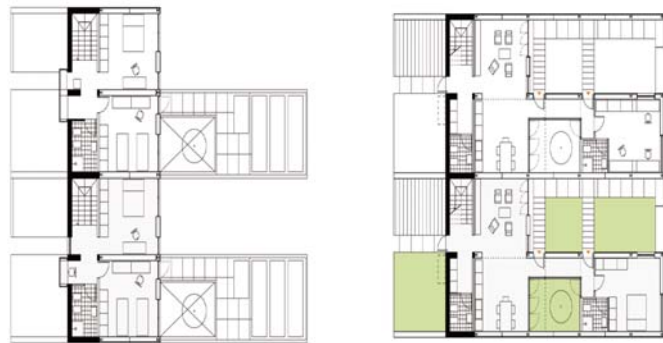


Figura 6: Design Competition for Social Housing at Fano, Italy, 2009. Project by D.Mandolesi, M. Calzolaretti (HousingLab - DiAP - Sapienza of Rome), D. Carfagna, L. De Vincenti, A. Felici. Second Prize.

## Conclusions

The projects described above are characterized by an homogeneous methodological approach that provide solutions able to be generalized. In all cases a system of modular components has been defined. This system of modular components can be aggregated in different ways in order to create a wide array of variations of living units and building types. They can be combined in order to obtain a large number of spatial solutions and dimensions and thus satisfy the housing needs of different users: students, the elderly, the traditional family, ecc. The variety of possible combinations overcomes any concern about monotony and at the same time allows control of volumetric and linguistic quality. In addition, the HousingLab experiences presented herein constitutes an important opportunity to test and verify a working method procedure to tackle the issue of house design to be applied to many and diverse conditions.

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