Massimo PERRICCIOLI
Monica ROSSI
Roberto RUGGIERO

SAD School of Architecture and Design "Eduardo Vittoria"
University of Camerino
Ascoli Piceno
ITALY

Environmentally Sensitive Architectural Projects: High Quality, Low Cost, Energy Efficient Social Housing in Different Italian Climate Zones

The educational structure of the Design Studio in Architectural Construction - characterised by the centrality of the class in "Technological Design Studio" and the parallel teaching of "Environmental Control Systems" - provides students with the theoretical, methodological and operative tools required to design architectural space in its spatial-formal, technological-constructive and energy-environmental dimensions.

Second year students are encouraged to consider in their projects the relationships between architecture and construction, technological solutions and aesthetic results, structural elements and energy-environmental control systems, building materials and environmental comfort, high energy performance and low-cost, innovation and resources saving, inhabitants needs and carbon footprint in a complex educational process whose final objective is an *environmentally sensitive architectural project*.

In a contemporary world characterized by economic crisis, growing consumption of non-renewable resources and lack of housing for low-income people, the challenge of the Design Studio in Architectural Construction in the academic year 2012-2013 was to design "high quality, low cost, energy efficient social housing in different Italian climate zones". Whereas "high quality" means not only spatial quality, but also *energy efficiency* and *climate sensitivity*.

From an educational point of view, this theme is particularly efficient because, in addition to imposing the students an architectural problem, it encourages them to tackle social, environmental and economic issues.

In order to facilitate the relationship and the interchange of knowledge between teachers and students in the design process, second year students are divided into three parallel classes of Design Studio in Architectural Construction that have worked out the same program and the same design exercise. Each of these classes was accompanied by two teachers (one of Technological Design Studio and one Environmental Control Systems) one young tutor and attended by approximately 60 students.

Educational objectives

Environmental educational objectives of the Design Studio in Architectural Construction can be summarized in the following top-ten.

1) *Ethical approach* to the project. From the "how to do" to "why to do".
2) *Sustainable approach*, including social and economic sustainability.
3) *Awareness in planning*. Each project determines modifications of the environment. Designers (in this case architecture students, who will be the designers of the future) should foresee these modifications and be able to "control" their consequences.
4) Analysis of the socio-*cultural, technological-constructive and climatic-environmental specific conditions* as basis of an "*appropriate environmental project*". The same architectural project is not necessarily sustainable in different contexts and climate zones.
5) Design project as *recursive design process* characterized by a systemic approach.
6) *Quality* (in its larger concept) *as "results" of the architectural project*.

7) *Reduction of energy demand in all the phases* - designing, building, managing and demolition – as a result of appropriate design choices, applied technologies, used materials and also inhabitants' life style.
8) *Passive systems of energy saving and supply combined to active systems*. Passive and active systems have to be formally and functionally integrated with the architectural project.
9) *Attention to the inhabitants' needs* to improve their live quality also when needs are changing during the use of the buildings.
10) *"Off the shelf", low cost designing*. Use of dry assembly, removability and maintainability of parts and components, with consequent economical and environmental resource savings.

Teaching methodology

The design experience that students gain in the design studio is *a holistic non-linear recursive design process* in which all the design choices during the various design phases and at the different scales are finalized to develop a high environmental quality design project and to "master" (or at least to consider) the complexity of relations, the multiplicity of techniques, know-how and skills and the consequences for the environment, that converge within the process of designing, manufacturing and building contemporary architecture.

To achieve this goal a methodology, characterized by a systemic approach, has been developed. This teaching/designing methodology works at three different designing scales: *district, building* and *constructive*, with three different designing levels: *spatial-formal, technological-constructive* and *energy-environmental*. Students are encouraged to design at the three different scales, taking into account (for each of these scales) the issues related to the three mentioned levels and the interactions between different designing levels and designing scales.

Therefore in the 15 design studio weeks students are supported by theoretical lessons, seminars, presentation of case studies as best practice examples, contact with public administration and building component manufacturing companies as well as project reviews. All these activities are intended to involve students in a comprehensive planning process that simulates the entire creative, design and constructive process in which the building organism is "broken down" into its parts and it is "reassembled" in the design project.

Objective of this process is to achieve a *manifold quality*: spatial quality, formal quality, technological quality, constructive quality, environmental quality, indoor and outdoor comfort quality; in quick the *life quality of the inhabitants*. Quality not as a sum of many partial-qualities, but as the result of a comprehensive approach towards the environmental design project.

Designing social housing: different user needs that change over time

Social housing can be defined as *"housing for households whose needs are not met by the open market and where there are rules for allocating housing to benefiting households"* (definition of social housing, Cecodhas, 2006). In particular an official definition

of social housing in Italy is *"dwellings rented on a permanent basis; also to be considered as social housing are dwellings built or rehabilitated through public and private contribution or the use of public funding, rented for at least eight years and also sold at affordable prices, with the goal of achieving a social mix".*

With the intention to obtain the above mentioned *social mix* and to improve the social life of the disadvantaged families that will live in this social housing, each students' design proposal must include:

- at least three different types of housing units, characterized by different sizes (from 28 to 100 square meters) and different users (for example: singles, young couples, single parents, families, couples with 1 to 4 children, older people with limited mobility, families with disabilities, out of town students, temporary foreign workers with distant families, newly arrived immigrants, home-workers etc.);
- indoor common spaces (for example: meeting room, laundry room, bicycle storage room, children's playroom, gym, etc.);
- indoor common and meeting spaces (for example: squares, covered squares, pedestrian and cycle paths, children's playground, etc.).

Another feature of social housing is that the dwellings are not property dwellings, but they are rented to low income families. So it is possible that not only the inhabitants' needs change over the time, but also that the inhabitants change every couple of years and that therefore the space requirements will be totally different. Accordingly the dwellings - designed by students in the Design Studio in Architectural Construction - have to be able to be easily and cheaply modified, repeatedly over time. To achieve this goal it is necessary to use appropriate technologies and devices and to plan in advance many possible configurations of the dwellings.

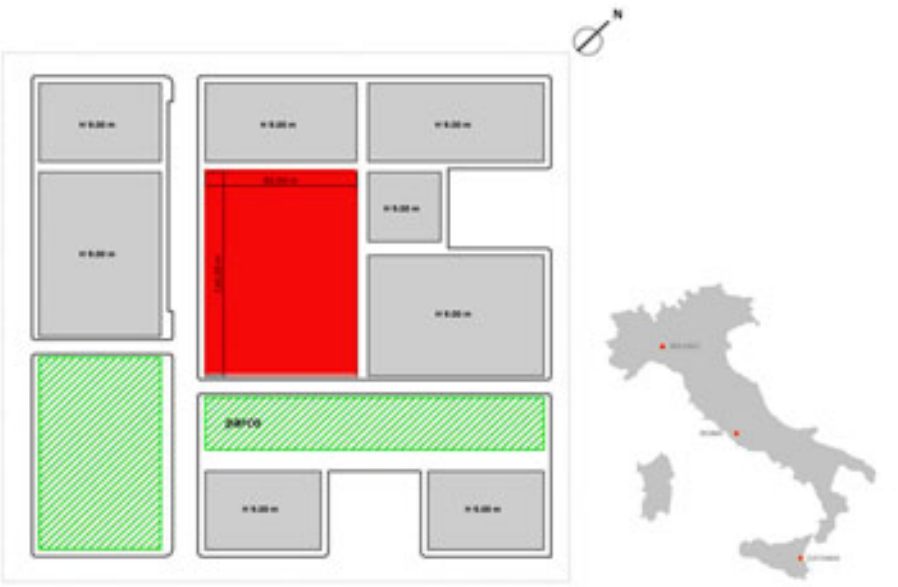

Fig. 1

Plan of the "virtual site" located in three Italian cities: Milan, Rome and Catania.

Designing with the climate: three different climate zones

Another important issue, addressed in this design studio is the relationship of design projects with the context in which this will be engaged. Indeed does an architecture in order to be truly environmentally compatible need to interact not only with the urban and social context, but also with the climate and environmental context.

The site for the design exercise was a "virtual site" (characterized by buildings and green spaces) located in three Italian cities: Milan, Rome and Catania (Figure 1).

Designing in three different cities - characterized by different climate conditions – helps students to understand that the same architectural project is not necessarily sustainable in different contexts. So students were divided into three big groups (one for each location). Each one started the design work with the climate analyzes of its location. From the second week of classes, these large groups were further divided into small working groups (two students, in rare cases three), to develop a design proposal.

The idea of using the same site and locate it in different climatic zones, has the didactic purpose to make projects in different climate zones easily comparable (Figure 2). Indeed in this way it is possible to see how the same site (with the same orienta-

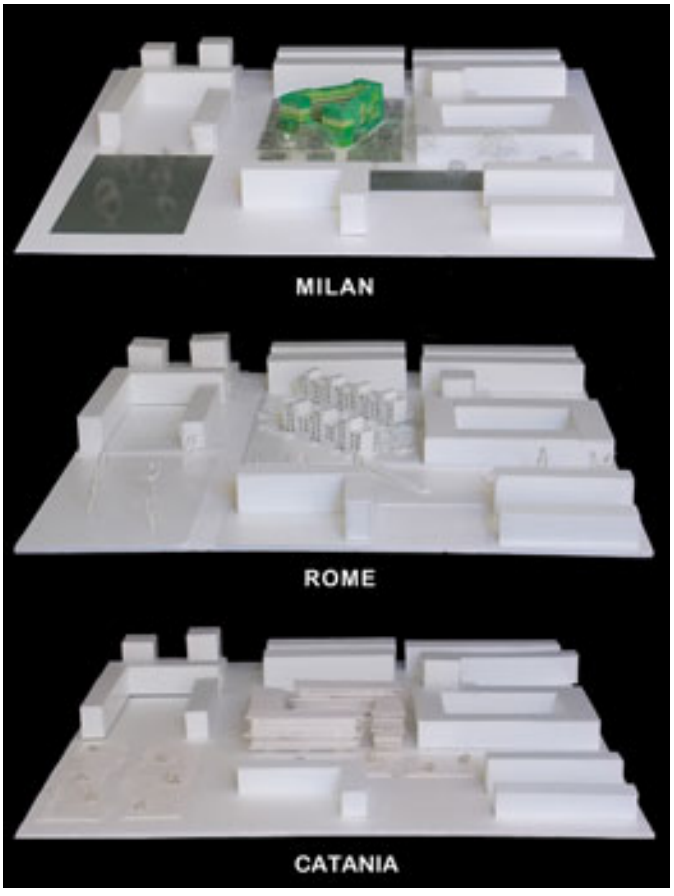

Fig. 2
Three different projects in the three different cities. Models – scale 1:500. Students: Alessia Celani and Chiara Corradetti (Milan), Christian Falistocco and Davide Fusca (Rome), Lorenzo Marani and Arianna Marinelli (Catania), professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.

tion, the same pre-existing buildings, the same streets, the same green areas, etc.) and only changing the climatic characteristics, very different projects are obtained.

For example projects located in Milan are characterized by compact buildings that seek to reduce heat loss and protect the indoor and the outdoor spaces from the cold winds, particularly in the winter time. For buildings located in Rome, students have developed both summer and winter strategies. In contrast, in projects located in Catania students have focused their work on preventing overheating in the summer months using appropriate natural ventilation, solar shading elements and water cooling systems.

Presentation modality of the design proposal

At the end of the semester student groups are invited to give a public oral presentation of their projects supported by appropriate drawings and models at different scales.

Drawings are organized in 5 separate tables corresponding to 5 "strategies": *concept, urban, building, living* and *constructive* (Figures 3 to 8). For each strategy the drawing highlights the contributions of the two parts that characterize the Design Studio in Architectural Construction: Technological Design Studio and Environmental Control Systems.

- *Table 1 - Concept strategy.* In this drawing the vision of the project is presented, highlighting the main design choices from a spatial-functional, energy-environmental and technological-constructive point of view and indicating the main objectives in relation to the quality of life of the inhabitants and to the "climate sensitivity" of the architectural project. With this first drawing students try to "sell" their design proposal and identify the types of users who will live in their social housing.
- *Table 2 - Urban strategy.* This drawing incorporates climate analysis of the site (temperatures, humidity, prevalent winds etc.), two master plans (scale 1:500) of the ground level and of the roof level, where the position on the site is shown (the orientation and the shape of the buildings are motivated by a careful urban and climate analysis), at least two sections of the site (skylines) and three-dimensional studies of the shadows on the site on different days of the year. This last study aims to show how the building or the building complex have been positioned to maximize (or minimize) the solar exposure of the façades and of the outdoor spaces according to the climate zone. Also the design of the common outdoor spaces (relationship with the existing buildings, streets and parks, walking and cycling routes, green areas, children's areas, bicycle storage, parking etc.) are an important part of the design project at the urban scale.
- *Table 3 - Building strategy.* This strategy is presented with plants, elevations and sections (scale 1:200) of the building or buildings, diagrams which show the relationship between "service spaces" (stairs, elements of horizontal distribution like gallery or corridors) and "served spaces" (residential units and indoor common spaces) at the building scale. The plants of the buildings show also the different typologies of residential units. This table contains also climatic/energy sections of the housing complex, including the identification of the active and passive environmental control devices under various environmental conditions (summer/

winter, night/day). This drawings are based on the results of using a quick energy modelling software or energy simulations, with the help of which the students selected and dimensioned the used equipment.

- *Table 4 - Living strategy*. In this drawing two or three types of dwellings are presented with plans with furniture, sections and elevations in scale 1:50. Diagrams show the relationship between "service spaces" (kitchen, bathroom, closet etc.) and "served spaces" (living room, bedroom etc.) at the scale of the dwelling. Furthermore, this table highlights the flexibility of the apartments and the possibility to modify and to use these in the future in a different way or by different users. The size of the rooms are in accordance with Italian legislation for social housing. They are therefore quite small.
- *Table 5 - Constructive strategy part 1*. This drawing includes one or more details elevation and vertical and horizontal sections, (scale 1:20 with details scale 1:10), that aim at defining the function and "value of the position" of each technical element and developing the critical connections between building components. An important part of this design is the legend that lists all materials, the layers, the thickness and the related manufacturing companies. Each element (like external walls, roof etc.) has also to be checked with respect to its energy performance (thermal transmittance U, superficial mass Ms, thermal time shift φ, decrement factor Fa and periodic thermal transmittance Ymn).
- *Table 5 - Constructive strategy part 2*. In this table technological and constructive aspects of the design proposal are presented with an exploded axonometric of the architectural organism, which permits the clear identification of the building system, "exploded" into its component parts (structure, external envelope, roof, internal partitions, etc.). Students have to use in each design real products, systems and components, that that can actually be purchased on normal market.

Each group of students is also invited to present their project proposal with the support of two models.

The first one, in scale 1: 500, includes not only the considered site, but also the adjacent lots und is a "three dimensional view" of the Table 2 - Urban strategy. Indeed this model shows the design choices at the urban scale: the spatial organization of the site, the shape of the building complex, the outdoor spaces, pedestrian and cycle paths, access to the lot and the relationship with the existing buildings, roads and parks.

The second one is a model of a structural bay (scale 1:50) in which it is possible to distinguish the constructive system from the "cover elements" (exterior walls, roof, etc..) that generally are movable and in which it is possible to see the layering of the building elements (Figure 9).

Results of the design exercise: innovation of the students' work

As in any Design Studio, the results of the students' work have been very different from each other and characterized by heterogeneous levels of quality.

However, it is possible to summarize that the most part of students' design proposals focus on the search for innovative solutions and experimentation, in terms of quality of the spaces, used technology and environmental approach.

Fig. 3

Example of *concept strategy, urban strategy and building strategy*. Students: Christian Falistocco and Davide Fusca, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.

Fig. 4

Example of *living strategy, constructive strategy and model*. Students: Christian Falistocco and Davide Fusca, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.

Fig. 5

Example of *concept strategy, urban strategy and building strategy*. Students: Alessandra Di Cerbo, Maria Francesca Iuresca, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.

Fig. 6

Example of *living strategy, constructive strategy and model*. Students: Alessandra Di Cerbo, Maria Francesca Iuresca, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.

Fig. 7

Example of *concept strategy, urban strategy and building strategy*. Students: Flavio Nughes, Francesco Paolo Russo and Andrea Ulisse, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.

Fig. 8

Example of *living strategy, constructive strategy and model*. Students: Flavio Nughes, Francesco Paolo Russo and Andrea Ulisse, professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.

Fig. 9

Examples of structural models (scale 1:50). Students: Flavio Nughes, Francesco Paolo Russo and Andrea Ulisse (left), Alessandro Biagioli and Silvia Lisi (right), professors: Monica Rossi, Simone Tascini, tutor: Angelo Figliola.

The main innovations of the students' work, regarding low cost - high quality housing are:

a) Conception of *innovative environmental* projects in which the reduction of energy consumption and the maximization of the indoor and outdoor thermal comfort are obtained not only with the application of passive, active and hybrid environmental control systems, reactive building envelopes, natural ventilation and day lighting systems, solar shading devices, Trombe walls, green houses etc.; but also with appropriate design choices like building orientation, location of the different functions in the building and with parameters not directly connected with the architectural project, that again can be influenced by the architectural project like inhabitants' life style or use of public transport.

b) Development of *flexible housing systems adaptable to modifications of exigencies.* Indeed most of the working groups have not conceived the project as a finished solution, but as an ongoing project that changes and transforms over time. This innovative space conception, while safeguarding qualities of privacy, proposes new forms of spatial organisation in relation to the requests made by a progressively

less conventional and more fragmented group of users (that do not necessarily belong to the same family), application of systems characterised by the transformability and adaptability of spaces according to the modification of needs by existing residents or needs of new users.

c) Use of *prefabricated building systems*, lightweight components and technologies and "off the shelf" materials and products (not really commonly used in Italy), preferably assembled using "dry" connection techniques. Development of simple modular structures comprised of small sized elements; technical-functional devices focused on the optimisation and rationalisation of spatial-functional performance.

Conclusion

The very demanding design experience proposed in the Design Studio in Architectural Construction 2012-2013 at SAD-UNICAM was much appreciated by the second

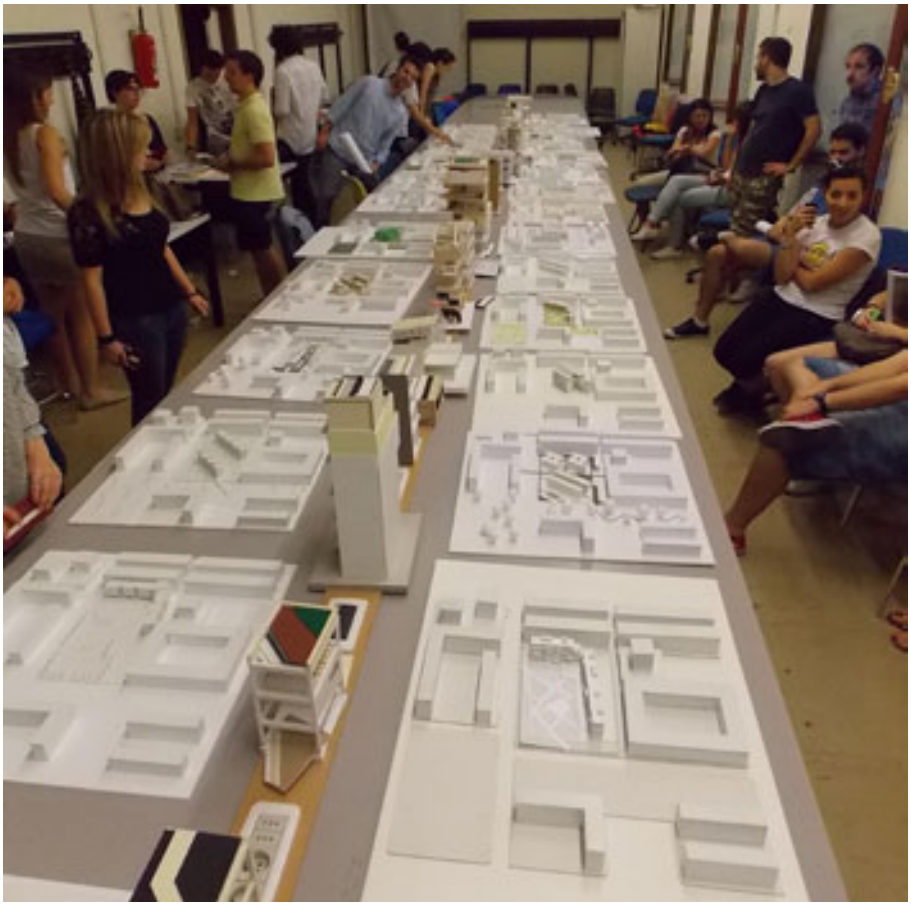

Fig. 10
Students and models on the day of the presentation of the design proposals.

year students that - in the 15 weeks of the course - participated actively in the many proposed activities and worked hard and passionately on their design proposal.

The design theme "*high quality, low cost, energy efficient social housing in different Italian climate zones*" has been an interesting opportunity for the personal development of the students, whose work has achieved more than satisfactory results.

Actually the biggest result was not the project itself, but how students approached a new design methodology and a responsible and environmental approach towards the architectural project and the fact that - for the first time in their short college career - they have set themselves questions concerning the social, economic, ethical and environmental issues of architecture.

References

Low cost, low Energy, quality architecture, 2009, Milano:BE-MA Editrice.

Social housing in Europe, 2008, Milano: Abitare Segesta.

Techne Social housing, 2012, vol. 4.

Brown, G Z, Dekay, M & Barbhaya D 2000, *Sun, Wind & Light: Architectural Design Strategies* Hoboken: John Wiley & Sons Inc.

CECODHAS Housing Europe, 2006, [Online], Available: www.housingeurope.eu [10 Jan 2006].

Corbellini, C 2012, *Housing is back in town* Milano: Lettera Ventidue.

Hausladen, G, Liedl, P & de Saldanha, M 2012, *Building to Suit the Climate. A Handbook* Berlin: Birkhäuser.

Schittich, C (ed.) 2007, *Cost-Effective Building* Basel-Boston-Berlin: Birkhäuser.