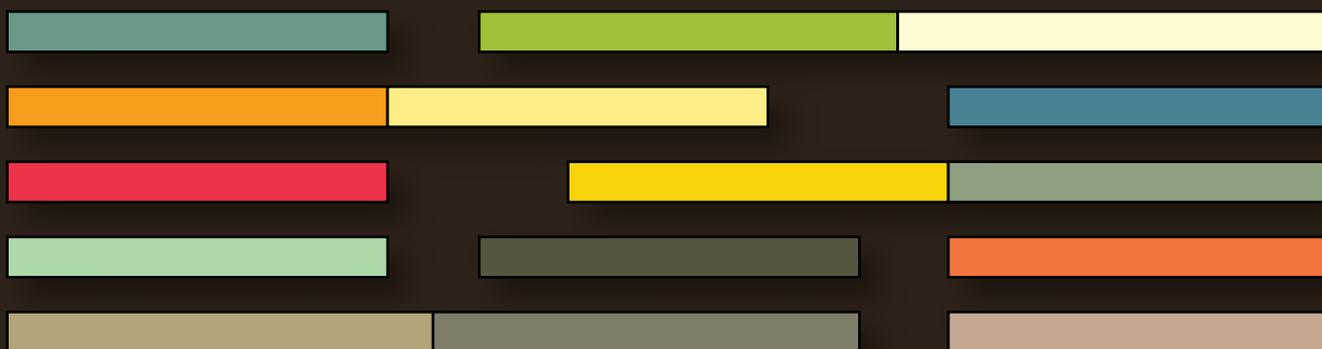


# EDULEARN<sup>17</sup>

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9TH INTERNATIONAL CONFERENCE  
ON EDUCATION AND NEW LEARNING  
TECHNOLOGIES

BARCELONA (SPAIN)  
3RD - 5TH OF JULY, 2017



## CONFERENCE PROCEEDINGS



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PROCEEDINGS**

**Published by**  
IATED Academy  
iated.org

**EDULEARN17 Proceedings**  
9th International Conference on Education and New Learning Technologies  
July 3rd-5th, 2017 — Barcelona, Spain

**Edited by**  
L. Gómez Chova, A. López Martínez, I. Candel Torres  
IATED Academy

**ISBN: 978-84-697-3777-4**  
**ISSN: 2340-1117**  
**Depósito Legal: V-1538-2017**

Book cover designed by  
J.L. Bernat

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# **SUSTAINABLE SCHOOL FOR MED AREA: AN INTERNATIONAL DESIGN EXPERIENCE IN THE ENVIRONMENTAL DESIGN COURSE OF THE ARCHITECTURE SCHOOL AT THE UNIVERSITY OF FLORENCE**

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## **Abstract**

The paper describes teaching methodology and results of the international workshop “Sustainable Schools for Med Area” within an agreement between the University of Florence (Italy) and the University of Bojaca (Colombia).

Educational buildings represent, in fact, 17% of the European stock of buildings and approximately 12% of average, non-residential, energy consumption in Europe. Furthermore, Europe’s school building stock is relatively old and has poor energy performances. The European Energy Efficiency Directive provides that, from 1 January 2018, all new public buildings, included schools and kindergartens, should be built to achieve high standard of energy efficiency, reducing their energy consumption to zero. However many barriers hamper the implementation of this prevision, in particular the lack of knowledge of new generation of architects, on environmental aspects and innovative technologies, to use in design process to achieve the nZEB targets.

To overcoming this gap, the methodological approach developed during the international design workshop “Sustainable School for Med Area” organized for the students of school of architecture of Florence and University of Bojaca, was focused on following main points:

- 1 Improvement the building’s envelope (opaque and transparent) to avoid energy losses in wintertime and increase its performance in summer, (with solar shading and ventilation components dedicated, etc...);
- 2 Improvement of the indoor environment quality referring to ventilation, passive cooling, daylight, to upgrade the classrooms requirements;
- 3 Improvement of energy generation on site by using active renewable energy sources, beside the passive gains integrated in the school buildings.

This teaching approach has allowed to the Italian and Colombian students to find new sustainable design solutions that are able to decrease the energy consumption of school buildings how required from EU legislation and, in the same time, has contributed to shaping a “Thriving Future”, by facilitating transfer of knowledge and skills from the market requirements into the design professions, how required from contemporary environmental and societal challenges.

Keywords: Sustainable Design Education, Energy Efficiency, School Buildings, Design Studio.

## **1 INTRODUCTION**

The architectural research seminar “Sustainable Schools for Med Area” is part of an international cooperation agreement between the Italian University of Florence and the Colombian University of Bojaca. The cooperation has been started in 2016 and still in progress. Furthermore, it was part of the didactic experience developed in the Laboratory on Environmental Design of the Department of Architecture in the Florence University, in the year 2016-2017.

The research and the teaching activities have been focused on design and renovation of the school building located in the Med Area in order to improve their indoor comfort and decrease their energy consumption with objective to achieve the nZEB standard.

In particular the goal of the international workshop was to promote the challenges of sustainability and energy efficiency, developing a new design approach and new professional skills for the architect of the future that will be called to work in the South Europe.

The urban context chosen as case study was Lucca (LU), in Tuscany (IT), where two Public Administrations (the Municipality and the Province) have signed a collaboration agreement with the University of Florence in order to develop new sustainable projects for their school buildings.

In particular, during the seminar the Italian and Columbian students worked on two projects:

- The design of the new nursery and primary school in Sorbano (LU) for the Municipality.
- The renovation and the design of a new building for the secondary school “E. Fermi” for the Province.

Working on these two case studies, have allowed fostering the transfer of knowledge between the teachers, researchers and students involved. The projects outcomes are innovative design solutions that could be repurposed also in other school of Italian cities. The work developed during the seminar was linked to the specific geographical, economic, cultural and social condition of Europe School Buildings stock and in particular wanted to answer to the Energy Efficiency Performance Building directives on the topic of build a new generation of nearly Zero Energy Buildings.

The opportunity to working in mixed team (Italian and Colombian students) allowed them to increase their relational skills by the exchange of knowledge between differentiated design and technological teaching approaches, heavily influenced by Italian and Columbian schools of architecture.

## **2 SCHOOL BUILDINGS IN ITALY: EMERGENCY VS INNOVATION**

In Italy actually there are fifty-one thousand educational buildings: more than half were built before 1976 (the year of first Italian law on building energy efficiency L.373/76); 40% were built before 1971 (the year of first Italian law on seismic safety); and only 9.6% were built between 1991 and 2015, and therefore up to standards in both structural and energy terms (1). These data underlines the low degree of investments from the Italian Government in schools during the past twenty-five years and the ageing state of Italian school buildings, and underscores a state of structural emergency which adds to the need for adapting the school buildings, from an environmental point of view, to the new educational guidelines regarding educational programs.

The need to optimize time and costs of retrofitting projects so to build new school buildings, should also lead to project solutions to integrate in the envelope of school buildings innovative technological solution to: improve the indoor comfort; to increase the mechanical, thermo-hygrometric and acoustic performances and to produce renewable energies. It is necessary, in fact, to resolve the structural lack through financial funds that are able to promote research and projects to find new requalification solutions able to improve the energy efficiency of existing school and/or to design of new ones according to the nZEB standard. Therefore, to reduce the cost of energy renovation and construction of school buildings, it is necessary to find sources or financial support that permit to amortize the initial costs, similar, in some cases, to the price of construction of new buildings.

The safety updating and energy requalification of the school buildings are, in fact, urgent issues to address, both for the Public Administrations and for the sector of scientific research, that from twenty years have been trying to fill the gap of an old national regulation concerning school buildings (L. 412 of 3 August, 1975) developing many research projects on assessment tools, capable of programming a time framework for the schools retrofitting (Renew School, Teenergy School, School of the Future, School Vent Cool, Zemedes, etc.), and on the common ground of a cost-benefit analysis, linked to the possibility to amortize over time the cost of deep renovation through energy savings (Energy Concept Adviser for Educational Buildings and VERYSchool, etc.).

It is fundamental for the professionals involved in the design and retrofitting process to learn how to participate, from the preliminary phases of the project, together with the public administration, in the choice of non-repayable and/or low interest rate financial support that allows obtaining a reduction of the investment necessary for the fulfillment of specific energy and/or functional and/or structural objectives. Moreover, this economic instance determines projects, which already from the concept phase, must be developed in the same time of an energy analysis carried out together with an assessment that permits both energy saving in terms of heating, cooling and lighting, and access to possible national and/or international fiscal bonuses.

In addition, the urgency of the emergency and the need to respond to international educational guidelines should induce professionals in the construction sector of school buildings to find new answers also through innovative spatial solutions, capable of transforming educational environments

into dynamic and multi-functional dimensional entities. The sequence of the different educational moments, which require variable student-teacher or student-student settings, is, in fact, at the base of an innovative idea of the school building, which must be capable of guaranteeing the integration, complementarity and inter-operability of its spaces, including the use of new technologies. The schools of the future must, in fact, become Smart Schools, where will be possible to use intelligent devices in order to improve educational activities. Furthermore they should be able to reflect the innovative and sustainable features of the Smart City, where the Educational System acquires a strategic role in the urban policies in order to build opportunities and projects for a green city. In this future vision of our cities the school buildings will become strategic hubs capable of generating educational and participative processes, involving the community towards the adoption of new lifestyles, in which citizen will be able to share technological growth, urban transformations, and economic, social and cultural changes.

Starting from these analyses of the state of the art in the frame of retrofit and design of school building in Italy, this building typology was chosen as design topic and as case study in the international workshop carried out at the Environmental Design Lab of the degree in Architecture of the University of Florence. The workshop on school buildings, in fact, was originated in the need to give concrete and innovative answers to the state of energy and structural emergency in which educational buildings find themselves, both in our country and in all Europe.

### **3 THEACHING METHODOLOGY**

The adopted teaching methodology was developed to respond to complex issues of environmental and social assessment, in particular for the design of school building. The complexity of the topic has also requested a strong discipline contamination (social, urban, pedagogical, etc.), supported by a deep work of field analysis on site.

The workshop was divided into four phases:

- 1 A preliminary phase, held at the University of Florence, characterized by multidisciplinary lectures by Italian and Colombian professors, on issues of school building design and sustainability, as well as on the role of architectural research. The training objective was to provide to the students basic knowledge and methodological tools necessary to approach the design phases.
- 2 A first day of teaching activity in Lucca, focused on the analysis of the state of the art by a survey of the project area and a meeting with the local administrator of the Lucca Municipality (fig.1).
- 3 A phase of design workshop focused on fieldwork on environmental conditions, urban settlement characteristics, construction techniques, as well as a phase of social analysis, determining the real needs of users. In this phase the students worked with technicians of the Lucca Municipality in order to know their objectives and design requests. Furthermore, these moments of knowledge was characterized by brainstorming, among Italian and Colombian teachers and students, to develop and define the strategic objectives of the projects.
- 4 A final phase of synthesis, held at the University of Florence (fig.2), during which the Italian and Columbian students worked out on project proposals using all workshop outcomes. Moreover, in this last phase, the educational contributions were focused on the communication strategies and results dissemination, oriented to produce scientific publications and to promote the participation of students in architectural international competitions.

In addition, to overcoming the gap of absence of innovative technological solution and design methodology to answer at the structural emergency that characterize the school building sector, the methodological approach of the design experimentation developed during the International Workshop was focused on following main points:

- 1 Improvement the building's envelope thermo-hygrometric performance to avoid energy losses in wintertime and overheating in summer months;
- 2 Improvement indoor comfort regarding to ventilation and passive cooling, daylight, to upgrade the classrooms requirements;
- 3 Improvement energy generation on site by using active renewable energy sources, beside the passive gains integrated in the school buildings.

This teaching approach allowed to the students to find new sustainable design solutions that are able to decrease the energy consumptions of school buildings how required from EU legislations and, in the same time, contributed to shaping a “Thriving Future”, by facilitating transfer of knowledge and skills from the market requirements into the design professions, how requested from contemporary environmental and societal challenges.

The structure of the seminar was developed offering a full range of activities to achieve innovative and competitive skills, as expected by Dublin Descriptors (2). In detail, the purpose was to stimulate cognitively the students to apply the knowledge acquired during their Architecture study, in an interdisciplinary way, enhanced with ethical and social input typical of the complex urban phenomena. Additionally the goal has been learning to communicate in clear and precise matters, the project proposals to the several customers.

The possibility to develop two project for two real case studies, provided from the Province and Municipality of Lucca, was an excellent opportunity to enable students to "learn to work in the complexity, experimental manner in real conditions of the project (3), dealing with " a broad and trans-disciplinary context focused on knowledge, methods and tools to respond to specific verifiable parameters" (4).



*Figure 1. The meeting with local administrators in Lucca.*

In detail, thanks to the need to design in real situations, was possible to set the discussion on the environmental project “based on a systemic and performance disciplinary approach within the process stages related to the design, production and management of works and artifacts (4)”. This methodological approach allowed the young architects to “express their project ability according to a knowledge and progressive ‘revelation’ (5) path, in which have a prominent role activities, timing, cost, quality, and aspects of production, management and operations, whose declination takes place also on the basis of experimental and innovative instrument or the verifiability of the results. (4)

The design of the two school buildings was developed according to Italian regulation on school buildings (L. 5/7/1975) and to the recent draft of the ministry's Guidelines on educational buildings (D. M. 11/04/2013), as well as to the Italian regulations regarding energy savings (L. 195/2005 and subsequent modifications and additions), the accessibility of public buildings (L. 13/89) and fire and seismic safety, with a focus on the topic of environmental, social and economic sustainability.

The guidelines of European Directives 31/2010 and 27/2012 were followed, with a strong orientation toward nZEB model. For this reason the students have analyzed the case studies at the technological

detail's scale, with the objective to choose systems, as well as building envelopes and equipment components in order to guarantee the energy autonomy of the school buildings, and to allow the production of renewable energy also, so as to reduce environmental pressure within the urban area of the project.

Finally the students had to develop their project following a required/performance approach, with the goal to design smart and flexible spaces, functional to the most advanced teaching and learning systems. Environmental adaptability characterized, also, the design of outside spaces too, reconfiguring the schools case studies as “Civic Centers”, able to become an urban catalyst, valorizing social, cultural and educational instances.

A special attention was placed to the link between the design of the new volumes and the existing buildings, and between the project as a whole and the environmental and urban context of reference, including, when possible, new functions that provide opportunities for usage outside of school hours and by external users.



*Figure 2. The design activity during the week of workshop in Florence with the Italian and Columbian students.*

#### **4 THE CASE STUDIES**

In response to the requests from the Province and the Municipality of Lucca, involved in the International Workshop like virtual customer, the students worked on the design of a new School building for the Municipality of Lucca and on the renovation and expansion of a Secondary School Building for the Province of Lucca (fig.3), following described.

## 4.1 The renovation and expansion of the Secondary School Building Enrico Fermi

The existing school Building “E. Fermi” was characterized from a planimetric distribution where the educational spaces were aligned on two axes oriented north south and east west. For this reason the classrooms had many problems with day lighting, when were exposed to north, and with overheating, when were oriented to south. In addition, in the external space there were not green or sport areas, and parking spaces were not sufficient for the needs of the school users.

Starting from this analysis of the state of the art the Province of Lucca required us to work on the design of existing building renovation and on the project of a new building where to place:

- New classrooms for the Scientific High School, that was located in a another old building in the center of Lucca.
- The Library, with spaces that could be used also from the citizen that live near the school.

According to the requirements of the Public Administration of Lucca and with the methodological approach developed in the frame of the Workshop, the students were asked to:

- 1 Design the new buildings addition, with the use of innovative, anti-seismic, ecological and efficient technologies, in order to reduce the energy consumptions for heating and cooling during all year;
- 2 Integrate on the roof of existing and new building, PV panels for producing the necessary electricity for running a heat pump to provide heat for low-temperature heating systems;
- 3 Refurbishment the envelope of the existing buildings, to improve their energy performance and changing their architectural appearance;
- 4 Increase the volume of the school building (20%), through the design of integrated greenhouses.



Figure 3. The location of the two case studies in Lucca. In the red circle the E. Fermi School area, in the yellow circle the Sorbano School area.

## 4.2 The new nursery and primary school in Sorbano, Lucca

The second case study, chosen for the design exercise, was a new school building for the neighborhood Sorbano in Lucca, where placed a nursery and a primary school, as required from the Municipality of Lucca and from the Competition of Ideas “The Good School”, issued by the Italian Government in the autumn of 2015. The area to build the new school was placed near a public park. The goal of the design exercise and the Italian Competition was of developing “an open-air school

where it is possible to live and learn in nature, in the open air and in the community. A school where the pupils learn together with the other citizen”.

Furthermore, answering to required of the Municipality of Lucca the project was focused on the followings objectives:

- Reflecting on the need to design innovative, flexible and user-friendly educational environments, designed in accordance with educational needs;
- Designing spaces for educational activities from the point of view of indoor comfort and social interaction;
- Reflecting on the need to design attractive spaces to contrast the phenomenon of educational dispersion;
- Promoting environmental, energy and economic sustainability through a swift building process and use of recycled materials and renewable sources;
- Promoting a major opening of the school toward the territory, thus transforming it into a vital center and a point of reference for the community;
- Guaranteeing the presence of spaces for teachers devoted to professional collaboration and individual work;
- Including places dedicated to research, such as libraries and study areas;
- Devising a greater flexibility in terms of opening times so as to be able to use spaces after school for carrying out several activities, thus also allowing money to come in for maintaining the structure;
- Designing buildings conceived as educational tools: aimed at developing both technical and sensory competencies;
- Ensuring the presence of green areas: rethinking the relationship between the building and the surrounding natural environment depending on teaching and learning activities.

## 5 RESULTS

All the young architects involved in the workshop have approached to the project with awareness and attention. Both in the design of the renovation of the High School “E. Fermi” and in the project of the Primary School of Sorbano, the students carried out a careful assessment of energy consumptions, developing design proposals focused on the adoption an holistic design approach (fig.4) where the attention on the planimetric distribution is associated with the necessity to choose the best orientation in order to improve the indoor comfort and to reduce the energy consumption for heating and cooling by the adoption of innovative technological solution for the building envelope. Moreover, they have proposed solutions characterized by the choice of drywall construction systems with the purpose of reducing times and costs of the construction and to guarantee the formal continuity with the existing building, thanks to the possibility of replicating in series the building envelope solutions.

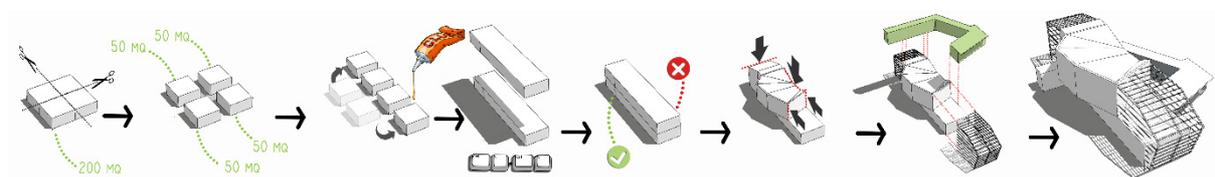


Figure 4. The design concept for the Sorbano School.

In particular:

- The designs of the new building for the “E. Fermi” School were characterized by the adoption of compact volumes so to minimize thermal dispersions. Moreover, the south orientation of the new classrooms was chosen from the students after a preliminary phase of simulations (fig.5) in order to know exactly the incidence of the solar radiation on the envelope so to define passive and active solar strategies to reduce the energy consumptions for heating and cooling. In addition, both for design of the new building and for the renovation of the existing one, the

students have chosen pre-assembled envelope solutions characterized by use of natural materials in order to reduce the time of construction and to decrease the environmental impact of the school buildings. Finally, the classrooms and the other educational spaces were designed like modular, flexible and functional as required form the most advanced teaching and learning methodologies.

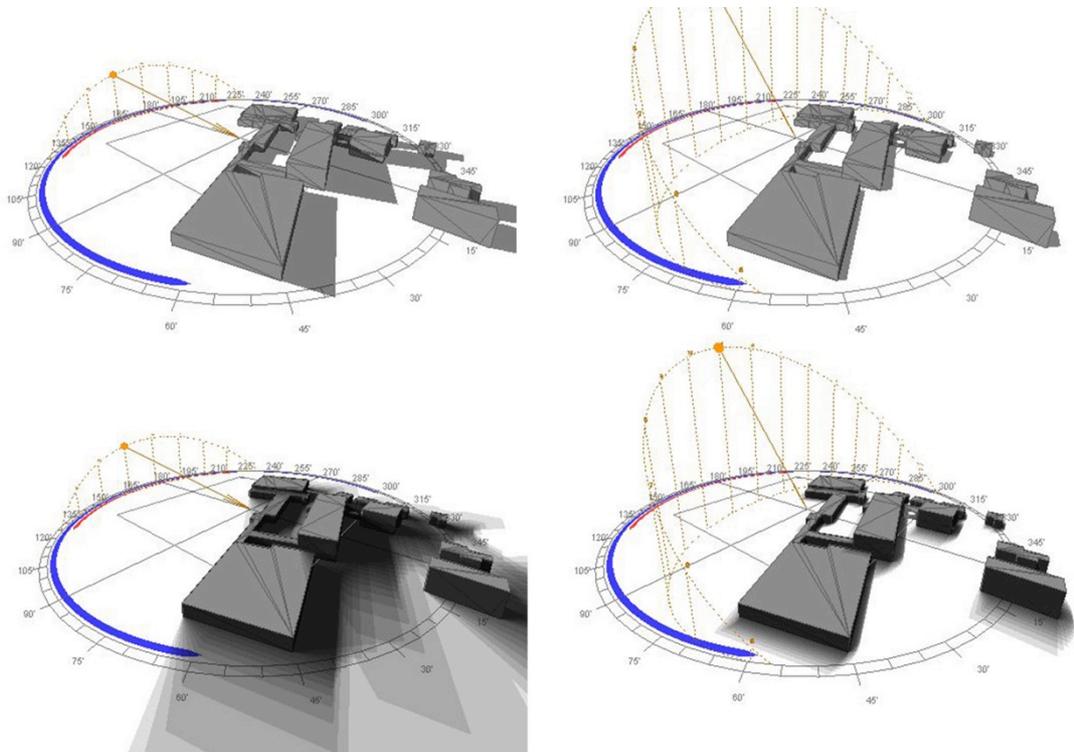


Figure 5. Solar Analysis of the new building for the Secondary School Fermi.

- In the design for the new school building in Sorbano (fig. 6) classrooms and other educational spaces were designed like modular environments able of responding to different educational contexts. For this reason, the internal walls were devised like pre-assembled technologies able changing the geometric configuration of the internal spaces in fast time, adapting them to multiple functional uses. Furthermore, in all projects developed in the workshop the students have integrated environmental solutions such as permeable materials for outdoor flooring and removable technology solutions for furniture and equipment.

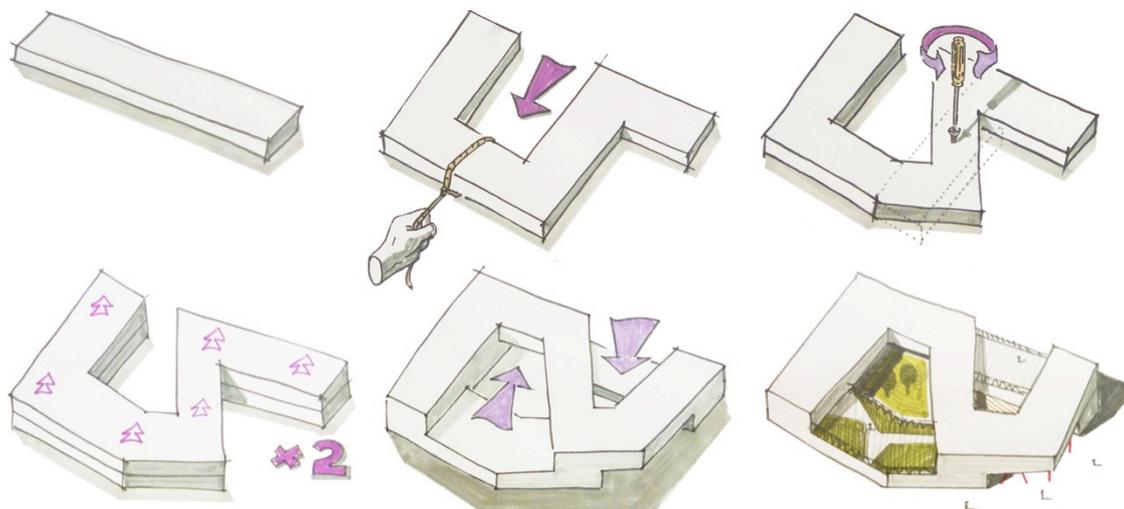


Figure 6. The design concept for the Sorbano School.

Another objective of the design phase was integrating technological solution in order to produce removable energy in situ and decrease the overall energy consumptions for heating and cooling. In order to achieve this goal all projects show a good design of the orientation of the building in order to maximize the contribution of the solar radiation and the natural ventilation. In addition, the decision to use green roofs improved the environmental integration of the building in the landscape of the city and, at the same time, it allowed reducing the heat island effect. The projects, also, envisage the use of strategies to maximize free energy inputs and minimize impacts on the environment. The building's orientation was set to exploit the beneficial effects of cross ventilation and allow the integration of passive technological systems such as solar greenhouses and ventilated facades. Finally, the preassembled technological solutions adopted for the envelope included the use of natural materials that allowed speeding up the construction phases and minimizing the environmental impact in the life cycle of the building, according to life cycle oriented approach (fig. 7).

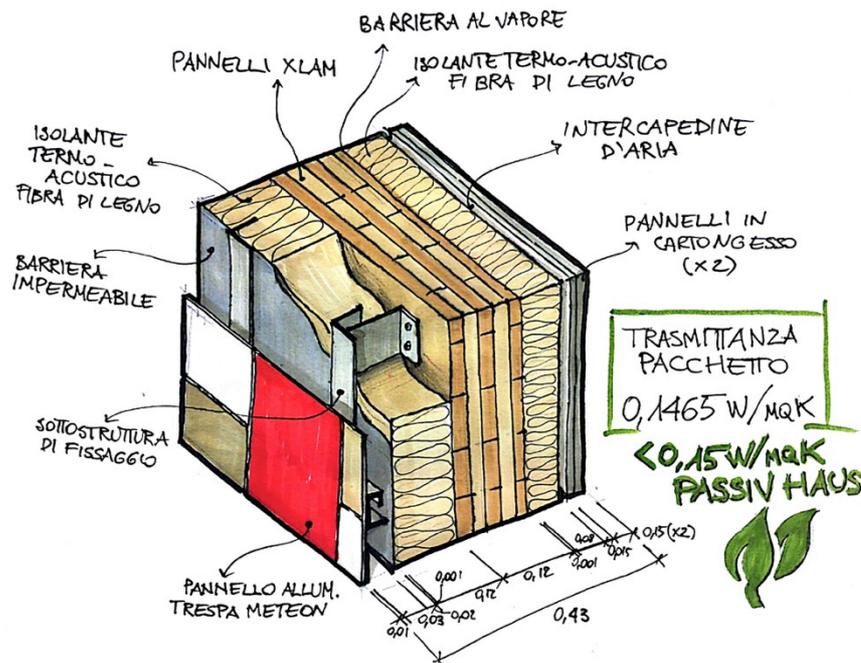


Figure 7. An envelope solution developed for the new school building of Sorbano.

## 6 CONCLUSION

The excellent results obtained with the projects developed during the Workshop activities show how the theory applied to the development of the design phase, led the students to re-think the approach to the project on the basis of the necessary environmental reflection, assessing architectural compositional, formal and technological choices; a new professional awareness that is independent of the simple aesthetic and dimensional results. In addition, the possibility of verifying technological solutions through the use of appropriate software and the constant reference to Environmental Control Techniques discipline, permitted the young architects to understand the need to combine the creative moments with quantitative validation ones, in order to guarantee the choice of the scenarios and configurations, with a lesser impact from the point of view of the entire life-cycle of the building.

The results of the workshop have been supported by the adopted teaching methodology: an active commitment to stimulate the creative re-thinking of local redevelopment dynamics through action design, as a participatory learning process.

Students shared innovative approaches: a design research based on a strong understanding of social and environmental local phenomena, in order to face today's challenges of sustainability from every point of view: environmental, social, economic.

According to the increasing necessity of improving the energy performance of the new and existing buildings, students experimented a new way of playing the role of an architect-designer, as an exponent of real people's needs and mediator of social interests (6) combining top-down and bottom-up approaches.

Effective and environmentally sustainable technology solutions become closely linked and integrated into architectural design solutions, often justified by a cost-benefit analysis indicating students' sensitivity to issues related to the cost of managing and maintaining public assets. Since the project concerns school buildings was in fact fundamental to reflect on the necessity to adopt materials, systems, components and equipment that guarantee durability and easy maintenance, as well as an excellent level of indoor comfort in both the existing and new school spaces.

The projects developed in the Environmental Design Lab have been capable of going beyond the simple academic approach, turning them into true projects with a level of detail and originality and in-depth analysis capable of being transformed into architectural solutions ready to be carried out and applied by the Public Administration. The quality of the results has validated the choice of teaching methods and has contributed to increase the cognitive maturity of the young architects linked to the technological and environmental choices made at the design scale.

The aim is that this experience, which hopefully will not be an isolated case in their cultural baggage, shall help them to reflect on the element of ethical commitment of the professional role that they are called to carry out in the years to come: a role that requires an increasing degree of specialization and care at the scale of technological detail for the integrated project, but especially of responsibility towards choices that can have irreversible effects on our future and on that of following generations.

## ACKNOWLEDGEMENTS

We would like to express our appreciation to the Province and Municipality of Lucca for their support during the fieldwork and to the students for their commitment. We also thank prof. Juan Martin Piaggio and Edilberto Molina Fuerte from University of Bojaca for the participation of the organization of the Workshop with their group of the students.

## REFERENCES

- [1] Legambiente, 2016.
- [2] [http://ec.europa.eu/education/policy/highereducation/bologna-process\\_en.htm](http://ec.europa.eu/education/policy/highereducation/bologna-process_en.htm)
- [3] M. C. Torricelli, "Progettazione tecnologica – Ricerca e pratica nel progetto di architettura", in «*Technè*», no. 2, pp. 16-23., 2012.
- [4] M. Lo Sasso, Il progetto come prodotto di ricerca scientifica, in «*Technè*», no 2, pp. 78-85, 2011.
- [5] M. Heidegger, La questione della tecnica, in *Saggi e discorsi*, Mursia, Milano, pp. 9, 10, 1976.
- [6] E. Manzini, *Design, When Everybody Designs*, MIT Press, Cambridge., 2015.