

Research for Development

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# Buildings for Education

A Multidisciplinary Overview  
of The Design of School Buildings

Fondazione  
Politecnico  
di Milano 

 Springer Open

# Research for Development

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Laura Daglio · Raffaella Neri  
Editors

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# Preface

This book belongs to a series, which aims at emphasizing the impact of the multidisciplinary approach practiced by ABC Department scientists to face timely challenges in the industry of the built environment. Following the concept that innovation happens as different researches stimulate each other, skills and integrated disciplines are brought together within the department, generating a diversity of theoretical and applied studies.

Therefore, the books present a structured vision of the many possible approaches—within the field of architecture and civil engineering—to the development of researches dealing with the processes of planning, design, construction, management, and transformation of the built environment. Each book contains a selection of essays reporting researches and projects, developed during the last six years within the ABC Department (Architecture, Built Environment, and Construction Engineering) of Politecnico di Milano, concerning a cutting-edge field in the international scenario of the construction sector. The design of schools has been recognized as one of the hottest topics in architectural research, also for the criticalities detected in the current conditions of Italian school buildings.

The papers have been chosen on the basis of their capability to describe the outputs and the potentialities of researches and projects, giving a report on experiences well rooted in the reality and at the same time introducing innovative perspectives for the future.

With the aim of exploring the evolutionary scenario of school design as an architectural topic, the collected papers were selected according to a comprehensive and multidisciplinary overview. Researches on typology and spatial organization are enriched through the contribution of a historical and social perspective to enlarge the focus on the urban role of the school buildings. Moreover, innovative approaches and tools have been highlighted both in the design process and in the education techniques. The presented experiences include best practices of

consistent and coordinated contributions of the several disciplines involved in the design of school buildings, also implementing digital tools. Finally, the issues related to the challenges of the existing built stock triggered the development of more technical and specialized, albeit multidisciplinary, investigations and case studies' reports.

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## About the Editors

**Stefano Della Torre** Graduated in Civil Engineering and in Architecture, he is a full professor in restoration at the Politecnico di Milano. He is the director of the ABC Department - Architecture, Built environment and Construction engineering. He is the author of more than 250 publications. He serves as an advisor for CARIPLO Foundation (Cultural districts) Province of Como and Lombardy Region (policies of programmed conservation of historical-architectural heritage). He is the president of Building SMART Italia - national chapter of association Building SMART international.

**Massimiliano Bocciarelli** is an associate professor at the Politecnico of Milan, he has been lecturing in the areas of structural and solid mechanics at the School of Industrial Engineering and of steel and concrete structures within the School of Architecture. He graduated at the Politecnico di Milano, completed a Master of Science in Structural Engineering at Chalmers University of Technology in Sweden and a Ph.D. in Structural Engineering at the Politecnico di Milano. His research interests have been primarily focused on numerical methods for the modeling of the service and ultimate behavior of materials and structures with particular regard to the diagnosis of masonry historical structures. He is author of more than 40 papers on international journals and two book chapters.

**Laura Daglio, Ph.D.** is a registered architect and an associate professor of Architectural Technology at the Politecnico di Milano (Department of Architecture, the Built Environment and Construction Engineering) where she works on research issues concerning building and construction design with a special interest in social housing, environmental design and sustainability in architecture for new construction as well as renovation. She is involved in research programs funded by Ministries and Public Bodies at different levels and in international projects. She is the author of books, essays, articles in reviews and of academic papers included in international conference proceedings, on topics related to sustainability in architecture and environmental comfort at different scales. She has been in charge

of various projects for public and private buildings' new construction and refurbishment and achieved mentions and awards in design competitions.

**Raffaella Neri** Graduated in Architecture in 1986, she is a full professor at the Politecnico di Milano. In 1993 she gained her Ph.D. in Architectural Composition from IUAV, Venice, with a dissertation entitled, "Essay on construction. Research into the role of construction and architectural design in relation to type and decoration". In 1994–1995 she worked on organizing the exhibition entitled, "The Center elsewhere" (coordinated by A. Monestiroli), La Triennale di Milano. Since 2003 she has been a member of the teaching staff body for the Ph.D. in Architectural Composition at IUAV, Venice. Her research activities include the theory of architecture, urban design and the role of construction in design. In recent years she has studied compositional principles for residential developments and the issue of redevelopment of brownfield sites and former military zones. She participates in design contests, winning the Luigi Cosenza National Architecture Award in 1996.

# Management, Transformation and Enhancement of the Built Heritage

Massimiliano Bocciarelli, Laura Daglio and Raffaella Neri

Most part of the school building heritage in Italy is old (it dates back mainly to the 1960s and 1970s) and is not appropriate both to the modern teaching systems and to the current levels of safety and efficiency required by the current legislation on seismic vulnerability, energy saving and fire safety. For this reason, in Italy a vast program of reorganization, requalification and consolidation of existing school buildings has been recently launched and financed on a public basis.

Often the buildings that currently host schools consist of historic constructions belonging to the cultural heritage and this makes the reorganization, requalification and consolidation processes even more difficult in order to deal with and to respect the historical cultural value of the building.

This need of reorganization of the school buildings is often due also to a process concerning the transformation of educational and pedagogical approaches, aimed at improving the effectiveness of the learning models.

On a broader scale, all these needs offer the possibility of redesigning complex existing buildings and developing projects that play an important role also at the urban level by becoming reference places, opportunities for redevelopment of degraded parts of a city, cultural and civic centers.

These themes have long been a field of great interest, experimentation and application of researches aimed at developing projects, models and intervention strategies for the upgrading of existing educational buildings, where the synergetic combination of the different disciplines and skills involved has always been fundamental to the success of the intervention.

The possibility of giving old places a new identity, to update buildings according to the new educational and teaching models, to develop projects that take into account the needs of energy savings and structural safety, has been deeply investigated in the following chapters, describing the recent activities which have been carried out at the Politecnico di Milano (Department of Architecture, Built Environment and Construction engineering) in relation to the before mentioned topics.

The works presented turn out to be particularly innovative in view of the effort to propose interventions, not as a mere statement of rules or design methodologies, but with strategies able to deal with the current situation of the school institutes in terms of financial resources and the need to not interrupt the normal school activity.

On the national territory, the school building situation results to be rather diversified in several aspects, the most important of which are structural and fire safety and energy saving. With respect to this issue, the first chapter presents an effective control system and a decision-making process for the identification of the priorities in the intervention needs.

The reuse of existing historical buildings for the implementation of modern teaching systems is investigated in the two following Chapters, concerning the project for the transfer of some departments of the Brera Academy to the area of Scalo Farini located in the center of Milan. Particular relevance is given to the design of the new teaching spaces, in due respect of the conservation of the historical evidence of the existing construction, as a part of the urban regeneration project of the whole former marshalling yard area.

A similar aim is pursued in the contribution by Poggioli, which includes studies and projects for the architectural conservation and the reutilization of the monastery of San Sepolcro in Piacenza, by inserting spaces for a new university of medicine and nursing, within the overall regeneration project of the area of the Guglielmo da Saliceto Hospital.

Regarding structural safety, in Italy, numerous seismic evaluation programs of public buildings have been implemented with Ordinances 3274/2003 and 3362/2004, which highlighted the high vulnerability of school buildings, especially of the older ones, built without any seismic protection and, sometimes, in a state of degradation. The reduction of the seismic vulnerability of these buildings requires huge financial resources. Consequently, the possibility of opting for seismic improvement rather than for full adaptation must be carefully considered in order to intervene more quickly and on a greater number of buildings with the same budget, and by carrying out structural interventions without interfering with the normal school activity. With respect to this issue, the Chapters by Calabrese et al. and D'Antino et al. describe the use of fabric-reinforced cementitious matrix (FRCM) and composite-reinforced mortar (CRM) as externally bonded reinforcement of existing masonry structures (the former) and to strengthen different types of slabs (the latter), on the basis of the results obtained from an experimental campaign conducted at the Politecnico di Milano.

The final two chapters describe some research and consulting activities aimed at the energy and environmental requalification of different existing school buildings located in Italy. Particular relevance is given to the definition of the optimal energy performance targets as a compromise among different aspects: energy saving, life cycle cost of retrofitting works and environmental enhancement in terms of the use of ecological materials, the recycling of demolition materials or the use of renewable energy sources.