

Research for Development

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Buildings for Education

A Multidisciplinary Overview
of The Design of School Buildings

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Politecnico
di Milano 

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Research for Development

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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.

The Paths to Innovation: Tools, Models and Processes

Massimiliano Bocciarelli, Laura Daglio and Raffaella Neri

The following Section focuses on the development and application of tools and approaches aimed at introducing original solutions to the design of schools, in order to improve the final quality of the buildings through a control of the construction process and of the relations among the diverse actors involved and to better respond to the changing demands of education and learning models.

Accordingly, the presented chapters highlight innovation trends in the design of educational facilities, including the construction of new buildings as well as the renovation of the existing heritage. In particular, the case studies collected reveal three main environments where to trace possible paths of enhancement.

First, the potentials emerging from the adoption of Building Information Modeling (BIM) softwares are disclosed, triggering a new approach to the overall construction process, able to improve the collaboration among the different stakeholders in charge. In fact, the building/renovation of a school belongs to the public works typology, thus involving the compliance with a complex set of national regulations aimed at costs and quality control from the design to the bidding, to the construction and also to the operation and the maintenance phases. The sharing of information and knowledge among the designers, contractors and the client is considered a crucial element to improve the efficiency of the process in terms of final results and scheduling, as well as to avoid possible unexpected interferences and over-budget problems.

The case study of the School of Melzo reports the positive experience of the application of the BIM process to control the information workflows during the design phase and the public procurement, including all graphic and performance information, organised in a database associated to the objects of the model. Moreover, the bidding evaluation and the construction phases were managed through the BIM tool providing a successful outcome, together with raising the awareness of the need for a necessary upgrading of the existing regulations to embed the advantages offered by the softwares.

In the experience of the School of Liscate the BIM is an instrument for the experimentation of a new contract typology for the delivery of public works within

the Italian national regulatory context—the Framework Alliance Contract—which introduces a collaborative approach in the management of the process, bridging the gap between design and construction. A mutual agreement among parties (design teams, contractors and suppliers) is established, allowing for the improved sharing of information to align the interests of the different economic operators, to reduce inefficiencies in the supply chain, mistakes and misunderstandings among the professionals, to increase transparency and responsibility towards both the client and the other collaboration components.

The case study of the Progetto Iscol@ presents a more predictive than managerial application of the BIM tool: the optimisation of the school spaces quality in terms of fruition and use performances. Following the evolution of the learning methodologies, the interactions of the users in the educational environments is acquiring a significant role, thus requiring a special attention on the comfort and characters of space and on the school layout and organisation. Through the merging of different softwares currently available on the market, a solution to carry out a pre-occupancy simulation is developed, experimented on three schools and consequently implemented to remove overcrowding phenomena, improve safety and simultaneously reduce inefficient areas where low interactions occur.

In the design for the San Severino Marche High school and the Inveruno facility a second approach is discussed, concerning the multidisciplinary development of the project since the initial phase, again involving the BIM as a useful management tool and to share data. The information is exchanged horizontally, among the professionals with different specialisations and vertically, through the detailing design, in order to reduce the process duration and to enhance the performances in spite of the high complexity of the buildings. The public services have been conceived considering their respective symbolic role for the reference community. The San Severino Marche Technical College experiments a research collaboration with the goal of supporting design activities related to emergency situations. The new building, in fact, replaces the one destroyed after the 2016 earthquake in Central Italy and showcases a possible well timed intervention after the disastrous events, in addition to innovative constructive strategies. The collaborative design strategy adopted for the Inveruno case study aims at responding to the representative character, not only of the school as a public facility for the entire community, but also as a pivotal urban space and new civic centre of the town.

Finally, the impact of the rapidly evolving learning and teaching models on the design and organisation of the school spaces are addressed and examined. The project for the prefabricated “*Carro di Tespi*” pavilion offers a possible solution to add innovative learning spaces to the existing traditional school complexes, whose layouts are still based on outdated educational programmes. The proposed system can also be assembled as a temporary structure to provide shelter for education activities in areas affected by natural disasters.

The last theoretical contribution argues on the issue of space in the era of 2.0–3.0 schools; a significant question as already introduced by the Progetto Iscol@. In fact, according to the most recent learning and teaching methodologies, space detains a specific educational character and can be considered as a third teacher. Organizing

space thus means organizing the metaphor of knowledge. New forms of teaching and learning, involving individuals or organized in groups and workshops, require layouts of greater spatial complexity and richness, yet to be flexible and multi-functional, and to reproduce the existing rapidly evolving situation.

In a rapidly changing society and culture, school design aims at providing the best learning environment implementing an adaptive heritage to be offered for the education of the future generations.