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Sustainable Design based on Healthy Environment and Energy Use in Residential Communities

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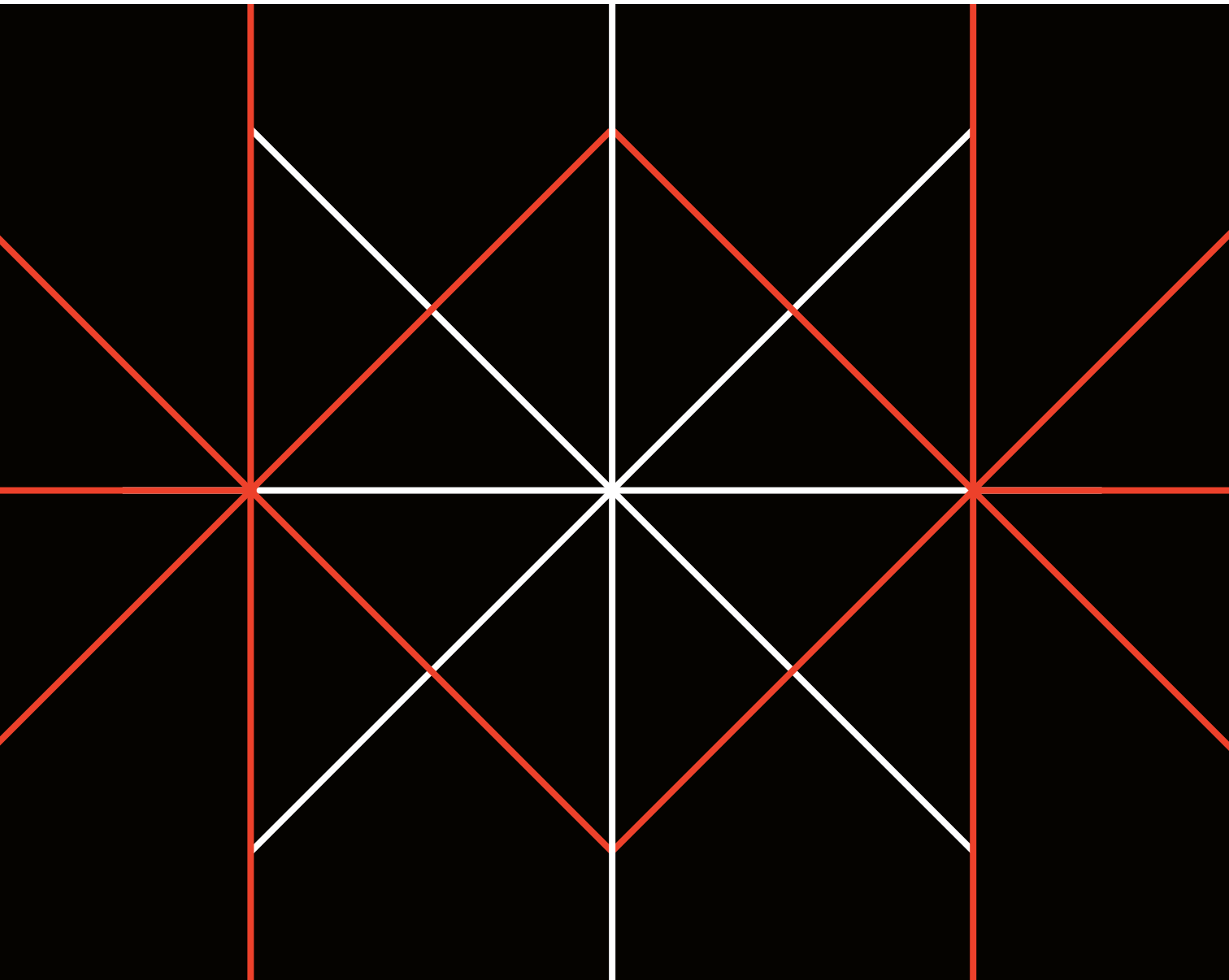
SPACE

DASP Yearbook 2023



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DASP Yearbook 2023

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PhD in Architecture.
History and Project

Politecnico di Torino
DAD - Department of Architecture and Design

SUSTAINABLE DESIGN BASED ON HEALTHY ENVIRONMENT AND ENERGY USE IN RESIDENTIAL COMMUNITIES

Bin Li

Cycle
37° - Visiting PhD/co-tutelle agreement

Year
-

Supervisors
Luca Caneparo, Weihong Guo

Research Group
-

↑ Yuedao residential community in Jiangmen, China

Gazzera residential community in Aosta, Italy ↓

Research cases
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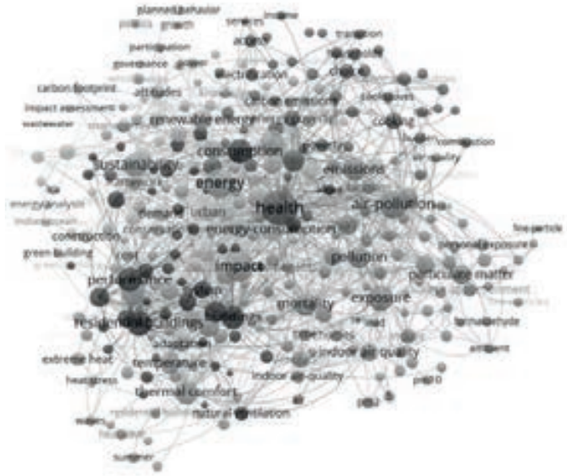

Research status
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This research focuses on sustainable design based on healthy environment and energy use in residential communities. The whole thesis contains six chapters.

Chapter 1, Introduction, shows the background, objects, methods, research targets, research significance and research framework. Human activity for health is inevitably accompanied by energy consumption. The more fossil energy consumption with carbon emissions, the more intensified climate change will occur. Climate change, including global warming, stimulates humans to use more energy to deal with the problems. However, this vicious circle should be broken. Global warming reached 1.1℃ above 1850-1900 in 2011-2020 according to the Synthesis Report of the IPCC (Intergovernmental Panel on Climate Change) Sixth Assessment Report (AR6) published on March 19, 2023. Moreover, based on *Our World in Data*, the remaining years of global coal, gas and oil are only 139, 49 and 54, respectively, from 2020. The residential sector is the third highest energy consumer, following the industrial and transportation sectors. It contains vast energy saving and producing potentials. Therefore, the research focuses on residential communities, which remain the majority globally. Based on qualitative, quantitative and mixed methods, the research tries to contribute to solving problems by sustainable design.

Chapter 2, Research Status, contains three aspects of developing concepts, current standards and research projects. The developing concepts focus on sustainable design, healthy environment and energy use, which can be traced back to the 1970s, especially in the Report of the United Nations Conference on the Human Environment in 1972. Even though some concepts were generated earlier than this, this research aimed to clarify that the development of these issues is still not mature at all. So the research should be paid attention. The related applicable standards in health and energy aspects, such as WELL, LEED and others, have been analyzed. The sorted-out contents will support the following research cases application. Moreover, the research projects in practice will help understand the state of the art about sustainable design demonstrations worldwide. Therefore, combining theory and practice will be helpful for a comprehensive conclusion.

Chapter 3 from the *full life cycle concern, different levels focus*, and open source and reduce expenditure aspects to figure out the design principles. The *full life cycle* for sustainable development, whether for health or energy conservation, is essential, especially for the Architecture major. A good architectural design will help achieve these goals and solve the problems once and for all. Moreover, the different scale objectives should apply different methods. Therefore, the three levels of the community plan, architecture design, and detail implementation should pay attention. Importantly, *open source and reduced expenditure* are needed to achieve a healthy environment and energy conservation. This design principle is established based on the passive, active and renewable-combined design.

Chapter 4, Design Methods. Based on the design principles, the design methods should be clear. The first is the *matrix design method*, which aims to analyze the design principles further to condense the design methods that this research needs. The three design principles are cross researched each other. After the analysis, the *different levels focus* interact with *open source and reduce expenditure* in the design stage of *full life cycle concern* left for establishing the matrix design method. However, only using the matrix design method to achieve the research goals is insufficient. The design plans can be multiple. Therefore, the *multiple design decision making* based on the Analytic Hierarchy Process (AHP) / Analytic Network Process (ANP) of multiple-criteria decision analysis (MCDA) is used to purify a plan from the multiple plans. However, the AHP / ANP of MCDA generally chooses one from the limited options. Therefore, *multi-design optimization* is established based on multi-objective optimization. It aims to get the Pareto Front Solutions by the software to attempt to choose the optimal one from countless options. Thus, the design methods are established for the following research.

Chapter 5, Research Cases. This chapter tries to apply the design principles and methods to the projects. On the one hand, it was achieving theory combined with practice. On the other hand, it used some projects to check the validity of research results, although some projects cannot be built up due to actual conditions. The first project is a residential building that got the first prize in Fangyuan Design Competition designed by the author. Even though this is only an architectural competition, it represents the approval of relevant experts for the content of the competition. This project applied the matrix design method for the passive aspect at the architectural design level. The second research case is the 2022 Solar Decathlon Europe residential community. This project was analyzed and discussed by *multiple design decision making* method based on the onsite investigation and literature review. The third project is Gazzera Residential Community which applied the *multi-design optimization* method under the guidance of supervisors based on onsite monitoring and interview. In short, this chapter applies and tests the above research results in some cases.

Finally, Chapter 6 makes the discussion and conclusion from contributions, limitations and summary aspects. This research is trying to apply sustainable design in healthy environment with proper energy use for residential communities to achieve sustainable development in the future.

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