TECHNOLOGICAL DESIGN FOR BIOCLIMATIC ARCHITECTURE. STRATEGIES AND NATURAL VENTILATION SYSTEMS FOR PASSIVE COOLING IN ENVIRONMENTAL AND ENERGY RETROFIT IN THE MEDITERRANEAN CLIMATE

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The research, whose approach is aimed at bringing together professionals, researchers and building scientists, investigates the potential of the technological systems of natural ventilation for improvement of environmental comfort, air quality and reduction of energy consumption, in energy retrofits of the existing building stock in the Mediterranean climate (Calcerano 2015).
Firstly the thesis gives an interpretation of the technological design closely linked to the challenges of climate change. The study analyses the creative design approaches which are most related to rationality or feeling (Arredi 2006) and suggests a vision of subsystems (compositional, functional, structural) integrated with the environment subsystem which is called to acquire a complementary role with the others. This view is opposed to determinism arising from the methods and some cues are then offered for disciplinary reconnection: the first is related to critical regionalism (Los 1990) and the narratological model (which borrows the plot-fabula split arising from literature research of the Russian formalists to allow integrated management of compositional aspects with other quantifiable aspects Tucci and Calcerano 2015); the second is related to the redefinition of the relationship between design and physics, with a hint of what is called "the paradox of simulation systems"(Yannas 1989).
The second chapter outlines the scientific, regulatory and climatic research framework between the dual often conflicting goals of comfort and energy consumption reduction, while the third chapter makes a synthesis (which is then verified by a survey of case studies in the fourth chapter) of numerous existing natural ventilation classifications (Allard 1998; Aynsley 2007; Santamouris and Asimakopoulos 1996; Grosso 1997; Tucci 2012; Heiselberg 2006; Linden 1999; Cecafosso 2011) up to a framework of the currently available technological systems for the use of natural ventilation in buildings .
Fifth and Sixth chapters develop the experimental phase of the research, defining the state of the art of numerical simulations as a decision support tool for the design (Calcerano and Cecchini 2014), later describing the modelling in all its characteristics (Calcerano and Cecchini 2015).
The correlational analysis of the results (in terms of performance indicators of discomfort hours relative reduction potential, energy consumption relative reduction potential and air changes per hours) is shown through discussions, synthetic schemes and graphic maps of the relationships between the parameters investigated (Krzywinski et al. 2009).
The seventh chapter develops an IT decision support system (DSS) for the early design stages originated from the experimental results. A simple preliminary investigation phase is required to use the tool, the data gathered is used as input parameters to define design constraints on the building to be retrofitted (climate, microclimate, building constraints). The most suitable natural ventilation system is then proposed by the DSS. The tool also allows the designer to intuitively navigate through the performances of different natural and hybrid ventilation systems both in quantitative (i.e. the results of the experimental phase) and qualitative (requirements, objectives and performances of the systems) terms, in order to adjust some design parameters, refining at the same time the design sensibility of the professional.
The results of the thesis are a further step forward in reconnecting professional practice and research, particularly suited to bring the professionals to use complex technological systems such as those that take advantage of natural ventilation. The thesis also demonstrates the effectiveness of minimally invasive retrofitting solution on the existing building stock such as the implementation of an automatic control on existing openings to exploit single sided or cross natural ventilation, even in disadvantaged climates with low daily thermal range and high average temperatures. The results also define a set of parameters (incorporated in the DSS) that can be used to optimise the design of natural ventilation systems along with their automatic control.
Passive systems and natural ventilation systems are destined to take on a key role in the building sector in reducing energy consumption in spite of ever-increasing indoor comfort requirements.
Technological research reaffirms its strategic mission of scientific investigation to support bioclimatic architecture, that, thanks to its holistic and systemic approach and its multidisciplinary ability to deal with complexity, is a key scientific branch capable to take on the formidable challenges (and opportunities) offered by the environmental issue.

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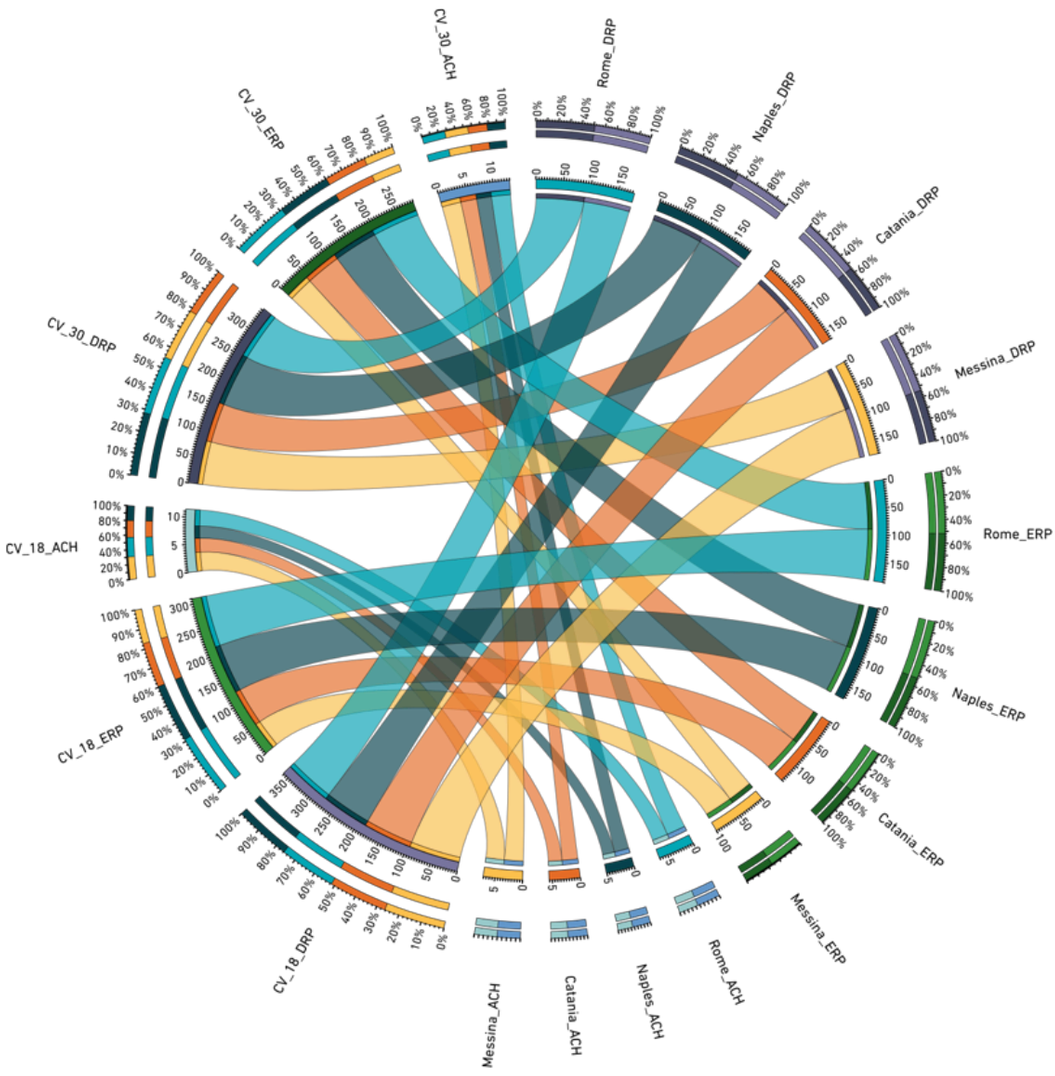

Fig. 1 - Example of the Cross Ventilation (CV) simulation results expressed in terms of performance indicators (DRP_Discomfort hours reduction potential, ERP_Energy consumption Reduction Potential, ACH_ air changes per hour) for various combinations of technological system, thermal mass (heavy-30cm and medium heavy 18cm), and strategic location (Rome, Naples Catania and Messina).

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