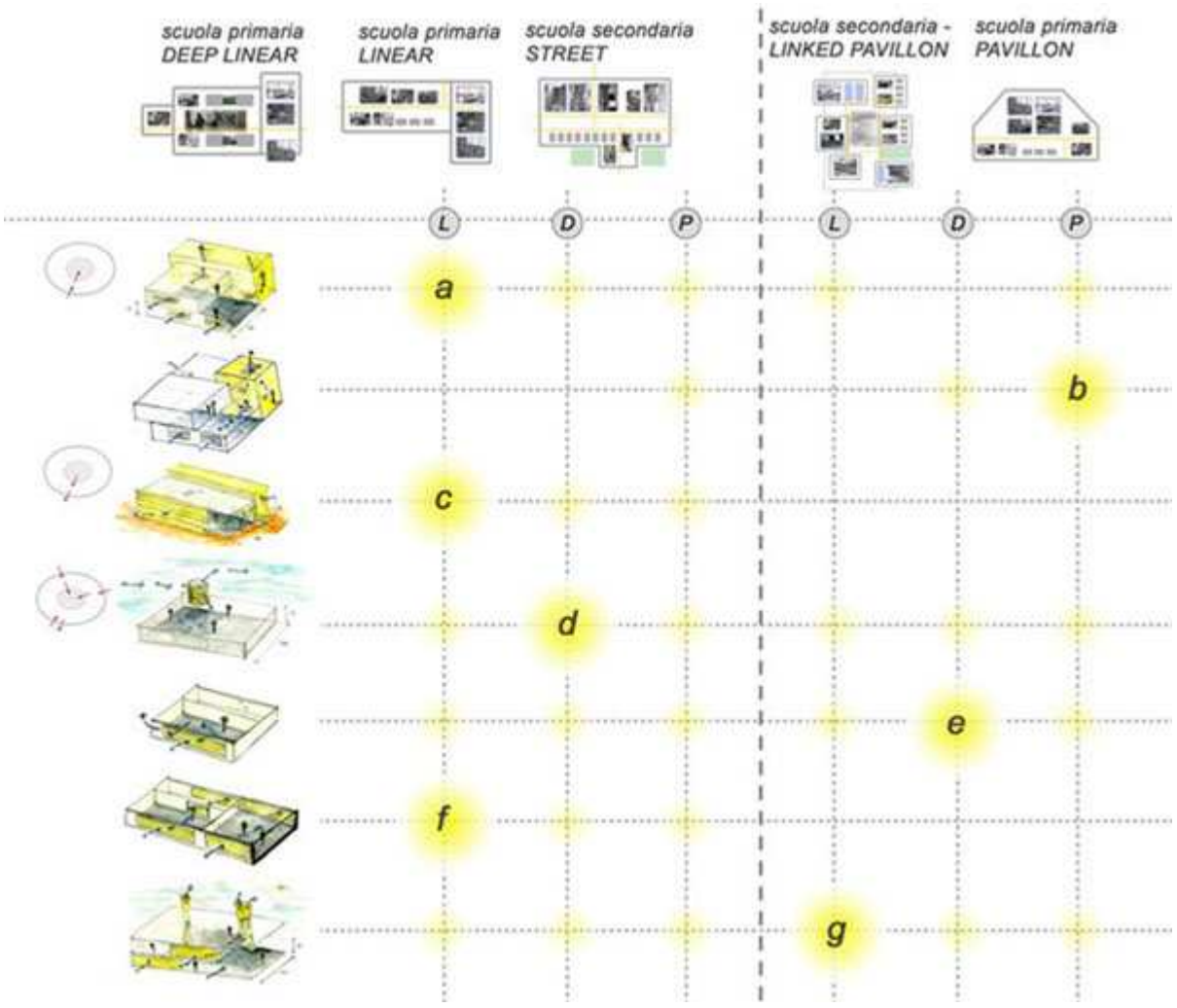
POLITECNICO DI TORINO
FIRST SCHOOL OF ARCHITECTURE
Master of Science in Architecture (Construction)
Honors theses

Natural ventilation in architectural design: the case of educational buildings
by Elisa Sirombo
Tutor: Marco Filippi

The thesis aims to study different natural ventilation systems for a school building, investigating the relationship between system technology and design in order to experience an integrated design approach that considers all aspects related to the IAQ and architectural design. Starting assumptions are as follows

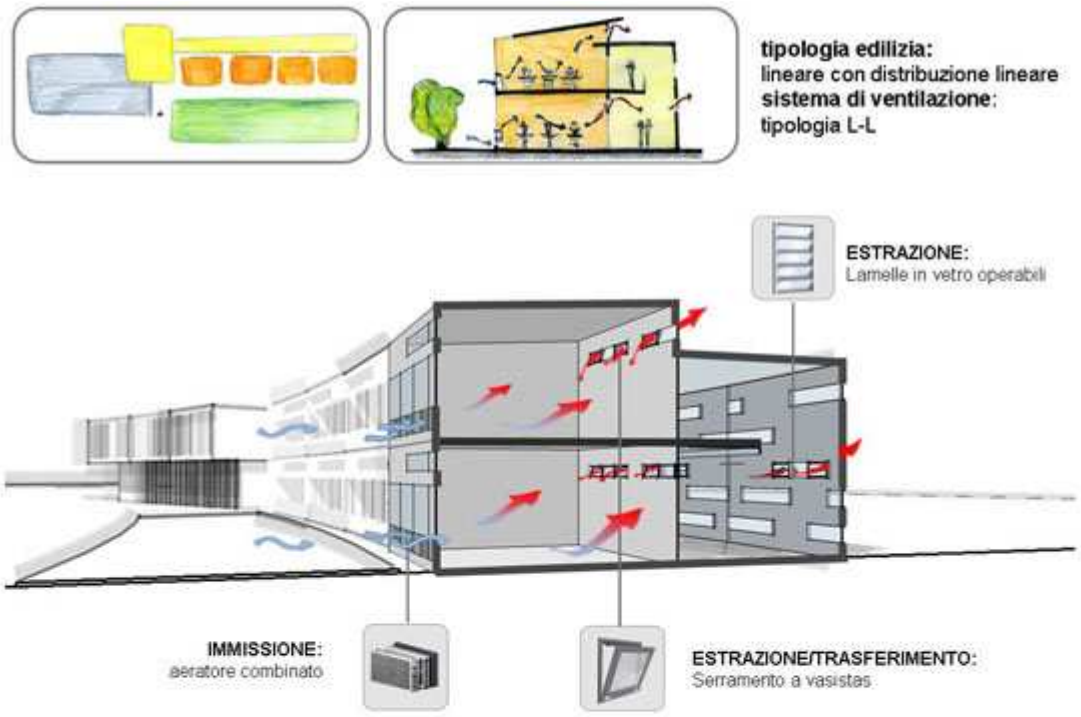
1. natural ventilation could maintain an adequate level of IAQ and may contribute to summer cooling, providing a substantial energy saving during construction and operation;
2. in school environments there is generally a lack of air quality and much concern about that, since schools present a much higher occupancy than any other building. A high concentration of indoor pollutants have a significant adverse impact on the health of students, on their learning capacity and performance.

The thesis is divided into three sections.
The first deals with the basic theory of natural ventilation, exposing the different driving forces, the laws that describe and quantify the phenomenon and the classification of different ventilation strategies. Moreover, there is a description of all the possible components of a natural ventilation system, divided into intake openings, exhaust opening and airflow path. This section also explores the architectural implications of natural ventilation, consequences considered as design input which could inform the project. Furthermore, it emphasizes a close relationship existing between the building morphology and the efficiency of natural ventilation system, as the building becomes the main airflow path.
The second section introduces the theme of sustainable school building, a sector that has experienced considerable development in recent years. First, I investigated the state of the art through the analysis of some case studies, and then I study new trends in school functional design in accordance with new educational models.
In the third section, starting from the natural ventilation strategies described in section I and the school layout in section II, I defined a set of architectural school concepts derived from the interweaving relationship.



Matrix of analysis between the different school layouts and the natural ventilation strategies

As result, I defined a series of architectural concepts that integrate natural ventilation and functional design issues; for each of them, there are notes about the architectural, spatial and technological implications. Sizing of the ventilation system, according to the IAQ Procedure for Ventilation in ASHRAE 62.1 2004, is a performance based calculation. The mean internal CO_2 concentration is acceptable between a range from 1500 and 1800 ppm. Ventilation systems are simulated with a multizone software –CONTAM-, which considers each homogeneous zone of the building as a node in an equations system of mass balance. It allow to estimate the ventilation rate and concentration of pollutants indoor. The clarity of results and times in which they are achieved, makes numerical simulation a useful tool for verification of technical solutions adopted in the architectural design phase.

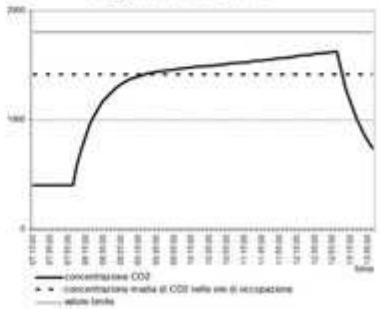


Ventilazione e qualità dell'aria

Strategia e componenti

I	T	E	Strategia
Stagione fredda			
0,14m²	-	0,1m²	Apertura continua
0,14m²	0,2m²	0,28m²	Apertura continua
Stagione calda			
0,28m²	-	0,30m²	Apertura continua
0,28m²	0,5m²	0,56m²	Apertura continua

Stagione fredda/calda



concentrazione media CO_2 → **1400- 1470 ppm**
n = 2,5 – 2,4 1/h
Qv = 3340 W

Example of an architectural concept (F) – linear type school building with cross ventilation strategy. Building layout and natural ventilation strategy (system components and performances)

Architectural implications of concept F – The architecture is influenced by the ventilation strategy as follows:
1) plan depth, as the distance between inflow and outflow openings must be minor than 5 times the height of the room;
2) roof section in order to allow the air extraction in the upper level;
3) the pattern of the facade due to ventilation openings

For further information, e-mail:
Elisa Sirombo: elisa.sirombo@libero.it