CLIMATE-RESPONSIVE URBAN AND BUILDING DESIGN

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Urban Design Criteria
in hot-dry climate areas

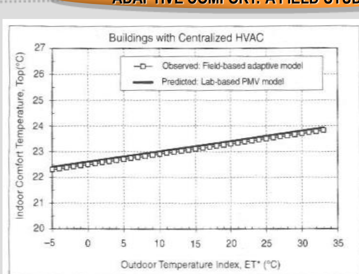
- Urban grid layout allowing northern wind penetration in streets and public spaces for summer outdoor comfort
- Barriers (walls, vegetation) protecting buildings from southern sand-bearing wind
- Multi-storey residential buildings laid along the N-S axis to allow for the apartments being naturally ventilated and cooled by airflow crossing the rooms from a inlet north-facing *malkaf* to outlet south-open solar chimneys; both elements are serving a single apartment for each storey of a vertical row by organ pipes-like ducts, distributing cold room-inlet air through ceiling and exhausting warm room-outlet air through vents on the bottom of southward walls.
- Building rows fairly closed to each other to project morning and afternoon shadows on, respectively, eastward and westward facades; alternatively, trees rows can be planted between buildings.

Urban Design Criteria
in hot-dry climate areas

- Trees and vegetation foreseen in a quantity higher than a threshold related to their potential for reducing heat island effect as well as absorbing carbon emissions.
- Pavement and external walls cladding materials characterised by low *albedo* (coefficient of short-wave thermal radiation) and low *emissivity* (coefficient of long-wave thermal radiation) to avoid outdoor overheating conditions.
- Outdoor elements and furniture laid out and designed to function as shading and warm wind barriers.
- Sprayed water, ponds, and fountains provided as evaporative cooling systems for outdoor spaces.

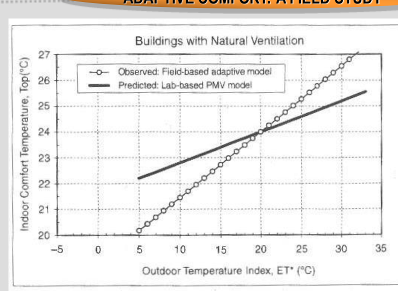
Building Design Criteria
in hot-climate areas

ADAPTIVE COMFORT: A FIELD STUDY



Study by a LBNB' team, Berkeley, 2003: comparison between indoor comfort conditions percepted and calculated, in sample buildings with centralised HVAC

ADAPTIVE COMFORT: A FIELD STUDY



Study by a LBNB' team, Berkeley, 2003: comparison between indoor comfort conditions percepted and calculated, in sample buildings with natural ventilation

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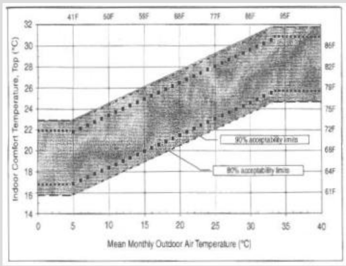
STANDARDS CHANGE AFTER RESULTS OF A FIELD STUDY ON ADAPTIVE COMFORT



Accepted indoor comfort temperature variation range as a function of outdoor air temperature in naturally ventilated buildings (ASHRAE Standards – 2004)

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PASSIVE VENTILATIVE COOLING

OBJECTIVE

Dissipation by natural means of the heat stored in a room, and causing discomfort, due to uncontrolled solar radiation, convective exchange, and internal gains.

TECHNIQUES

thermal sinks

- microclimate PVC → outdoor air
- geothermal PVC → ground
- evaporative PVC → vaporised water

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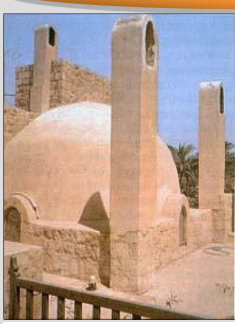
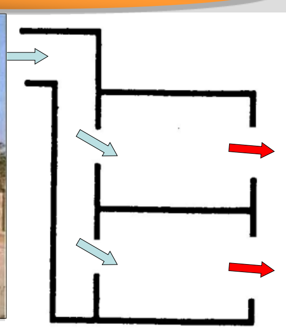
ARCHETYPES of m-PVC: wind catcher



City of Cairo, Egypt



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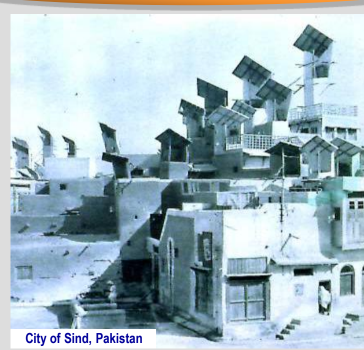
ARCHETYPES of m-PVC: wind catchers



City of Sind, Pakistan

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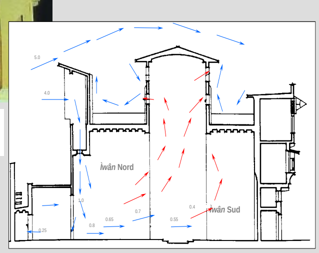
ARCHETYPES of m-PVC: wind-buoyancy-driven

Central guest room (*qa'a*) in Othman Katkhuda's house, Cairo, Egypt, ca. 1350 A.D.



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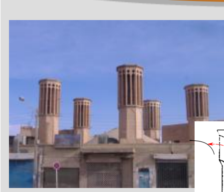
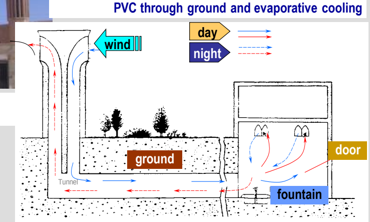
ARCHETYPES of combined-PVC: wind-buoyancy-driven



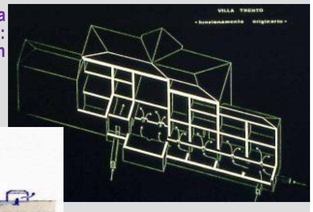
Persian Wind Towers (*Badgir*), Iran.

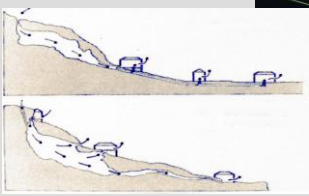
PVC through ground and evaporative cooling



ARCHETYPE of g-PVC

Renaissance Palladian Villa "Trento" at Costoza (VI), Italy: longitudinal cross section





Natural underground ducts called "covoli", with extension of artificial tunnels built by Ancient Romans for a calcareous quarry.

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ARCHETYPE of g-PVC

Renaissance Palladian Villa "Trento" at Costoza (VI), Italy, with natural underground ducts called "covoli"

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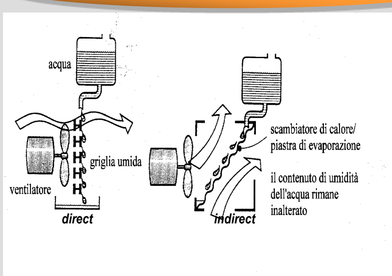
FUNCTIONAL SCHEME of e-PVC



Room evaporative hybrid ventilative cooling system.

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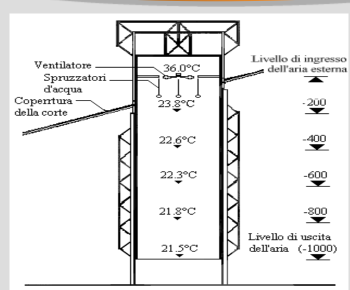
EXAMPLE of e-PVC



Downdraft evaporative hybrid ventilative cooling system, Negev, Israel.

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Examples of building design with m-PVC

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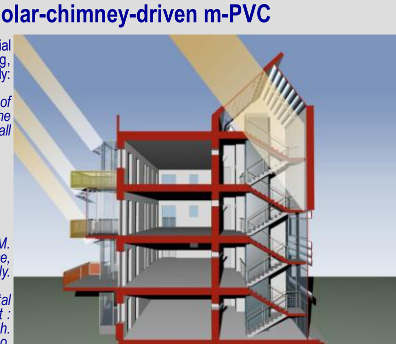
Solar-chimney-driven m-PVC

Design of a residential building, Rome, Italy:

3-D representation of solar irradiation on the chimney wall



Designer: Arch. M. Irene Cardillo, Rome, Italy.

Environmental Consultant : Prof. arch. M. Grosso.

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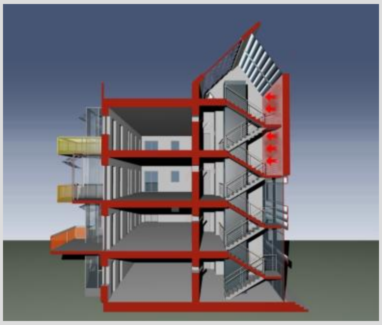
Solar-chimney-driven m-PVC

Design of a residential building, Rome, Italy:

3-D representation of night re-irradiation from the solar chimney wall.

Designer : Arch. M. Irene Cardillo, Rome, Italy.

Environmental Consultant : Prof. arch. M. Grosso.



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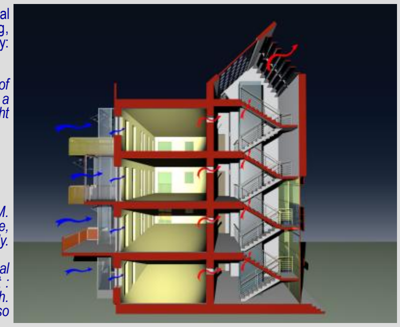
Solar-chimney-driven m-PVC

Design of a residential building, Rome, Italy:

3-D representation of airflow during a summer night

Designer : Arch. M. Irene Cardillo, Rome, Italy.

Environmental Consultant : Prof. arch. M. Grosso



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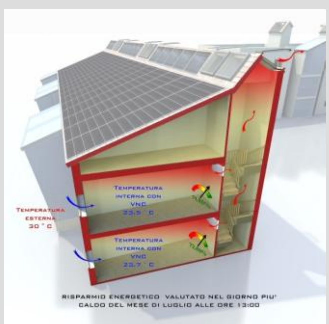
Solar-chimney-driven m-PVC

Design of a residential-tertiary compound, Cabiate, Como, Italy:

Perspective section with representation of CNV flows and results from an energy simulation for a terrace house with stack effect in a North-facing stairways cavity

Designer: Arch. M. Irene Cardillo, Rome, Italy.

Environmental Consultant: Prof. arch. M. Grosso



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Solar-chimney-driven m-PVC

Design of a residential-tertiary compound, Cabiate, Como, Italy:

Perspective section with representation of CNV flows and results from an energy simulation for a multi-apartment building with North-facing dedicated stack cavity

Designer: Arch. M. Irene Cardillo, Rome, Italy.

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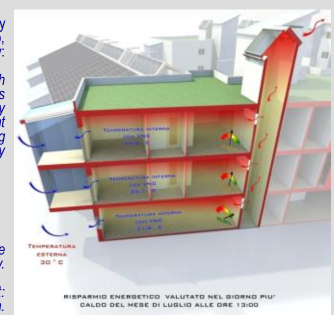

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Solar-chimney-driven m-PVC

Design of a residential-tertiary compound, Cabiate, Como, Italy:

Perspective section with representation of CNV flows for a multi-apartment building with dedicated central stack cavity

Designer: Arch. M. Irene Cardillo, Rome, Italy.

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Solar-chimney-driven m-PVC

Design of a residential-tertiary compound, Cabiate, Como, Italy:

Perspective section with representation of CNV flows and results from an energy simulation for a multi-apartment building with stack effect in a South-facing stairways cavity

Designer: Arch. M. Irene Cardillo, Rome.

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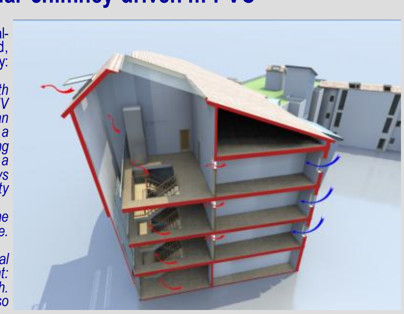

Examples of buildings with PVC systems

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Stack-driven m-PVC

Queen's Building, De Montfort University, Leicester, UK, Archh. Ford & Short: *general view with the stack towers.*

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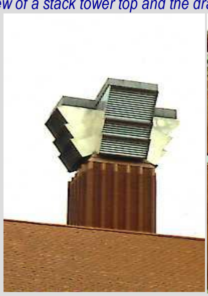
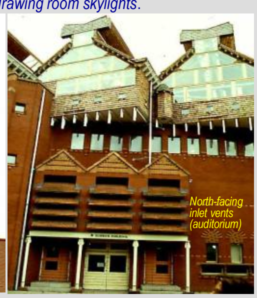
Stack-driven m-PVC

Queen's Building, De Montfort University, Leicester, UK, Archh. Ford & Short: *view of a stack tower top and the drawing room skylights.*





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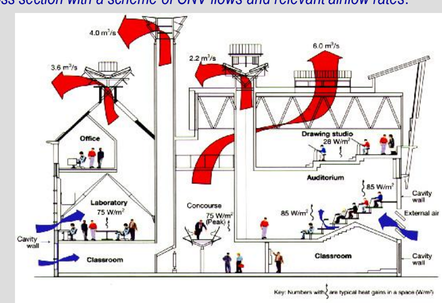
Stack-driven m-PVC

Queen's Building, De Montfort University, Leicester, UK, Archh. Ford & Short: *cross section with a scheme of CNV flows and relevant airflow rates.*



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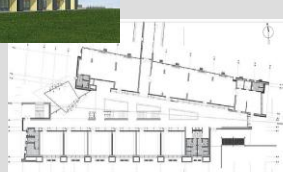
Junior high school building "L. Orsini", Imola, Italy:



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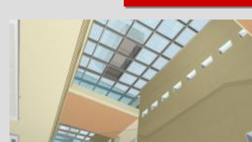
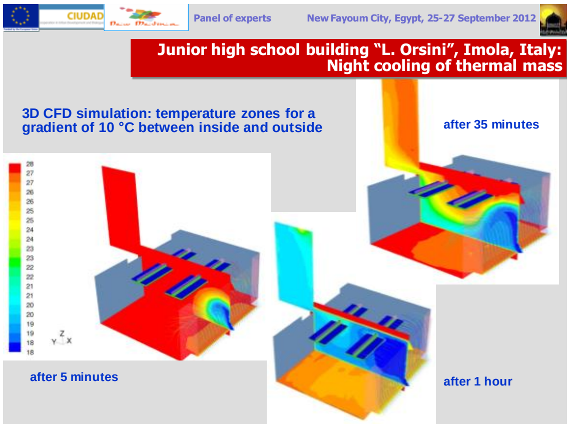
Junior high school building "L. Orsini", Imola, Italy: Night cooling of thermal mass



Atrium glazed roof with the exhaust air stack vented clerestory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Junior high school building "L. Orsini", Imola, Italy:
Night cooling of thermal mass
3D CFD simulation: temperature zones for a
gradient of 10 °C between inside and outside
after 35 minutes
after 5 minutes
after 1 hour


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Junior high school building "L. Orsini", Imola, Italy:
Geothermal PVC
Air-to-earth heat
exchangers in the Junior
high school building in
Imola (Bologna), Italy