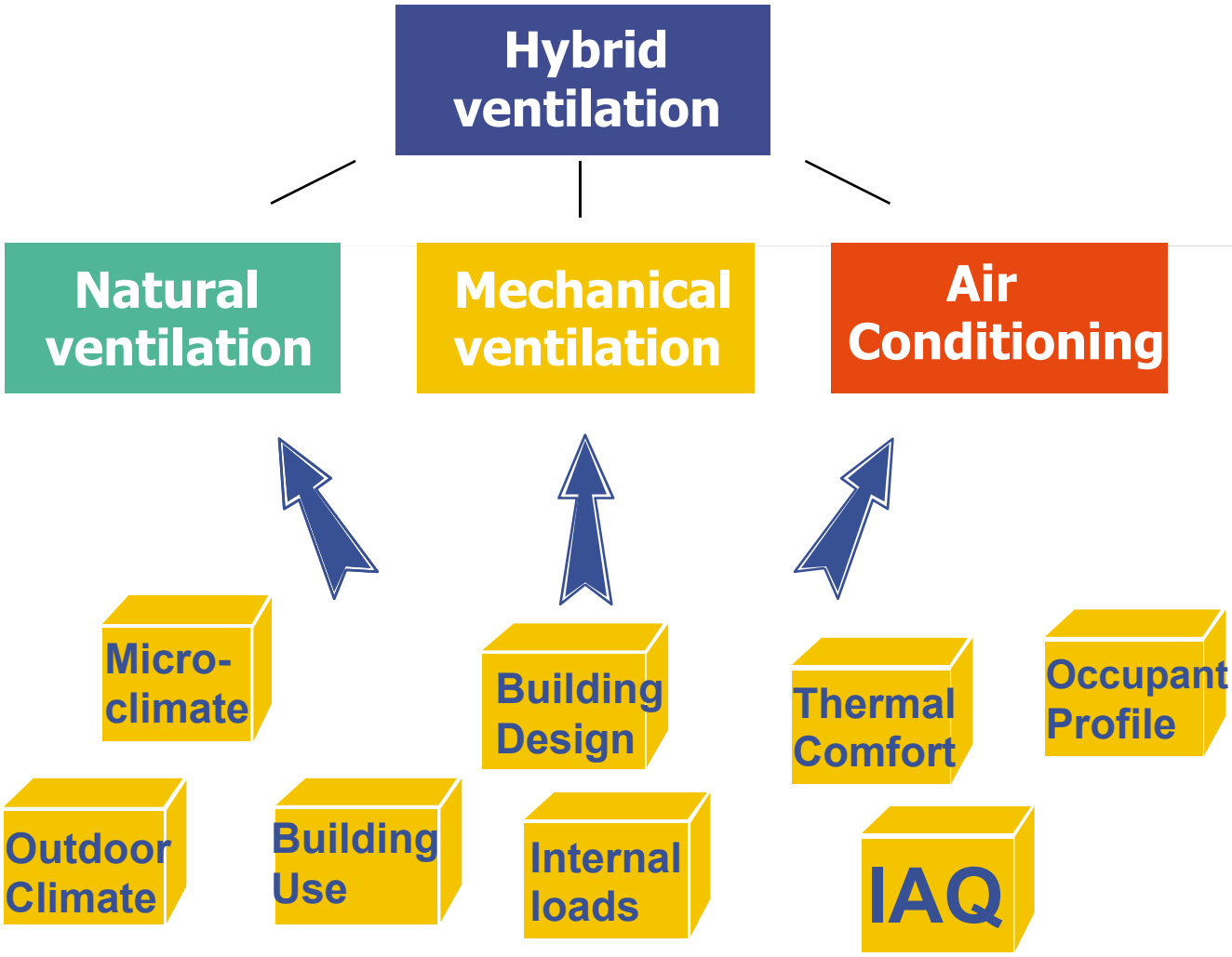
Workshop: What's so Great about Natural Ventilation?

Prof. Per Heiselberg,
Hybrid Ventilation Centre, Department of Civil Engineering
Aalborg University, Denmark

Ventilation Solutions



Natural Ventilation Advantages

- ☺ No fans are needed and therefore no electricity use and a low noise level
- ☺ High user satisfaction because of a high degree of individual control of the indoor climate as well as a direct and visible response to user interventions
- ☺ Can be used for both ventilation and passive cooling
- ☺ Improved air quality outside heating season
- ☺ Has to be integrated with building design
- ☺ Easy to combine with other passive energy technologies like dayligthting

Natural Ventilation Disadvantages

- ☹ Depend on outdoor climatic conditions (temperature, humidity)
- ☹ Natural driving forces can for longer periods be quite small, which limits possibilities for application of filtration and heat recovery, that might result in poor indoor air quality and/or increased energy use for heating
- ☹ Results in limitation in the choice of building layout
- ☹ Outdoor dust and traffic noise requires special solutions
- ☹ It is difficult to fulfill requirements to thermal comfort in winter if preheating of incomming air is not applied
- ☹ The air flow rate will always be dependent of the natural driving forces as well as the occupant's control. This might result in an increased energy consumption
- ☹ The indoor temperature will variate more than for mechanical systems

Natural Ventilation Principles

- Single-sided ventilation
- Cross ventilation (wind driven)

- Stack ventilation (thermal bouyancy)
- Combined cross and stack ventilation

Hybrid Ventilation Strategies

- Alternating or combined natural and mechanical ventilation

- Fan assisted natural ventilation

- Stack and wind supported mechanical ventilation

NCC Headquarters, Copenhagen, Denmark

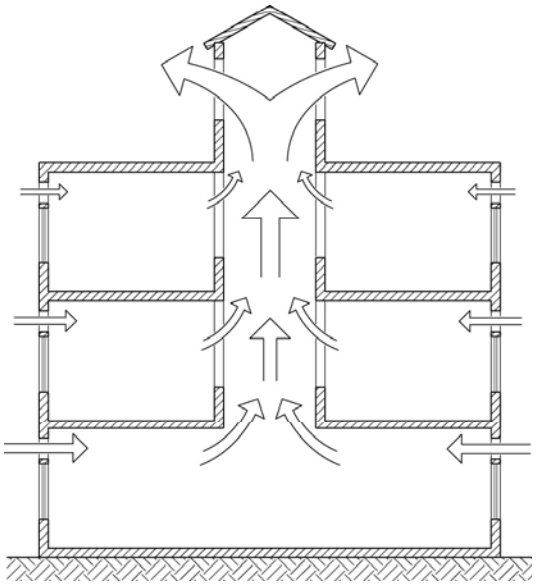
Floor area: 7875 m²
675 personer

NCC Headquarters, Copenhagen, Denmark

Openings in roof

Openings in facades on all floors

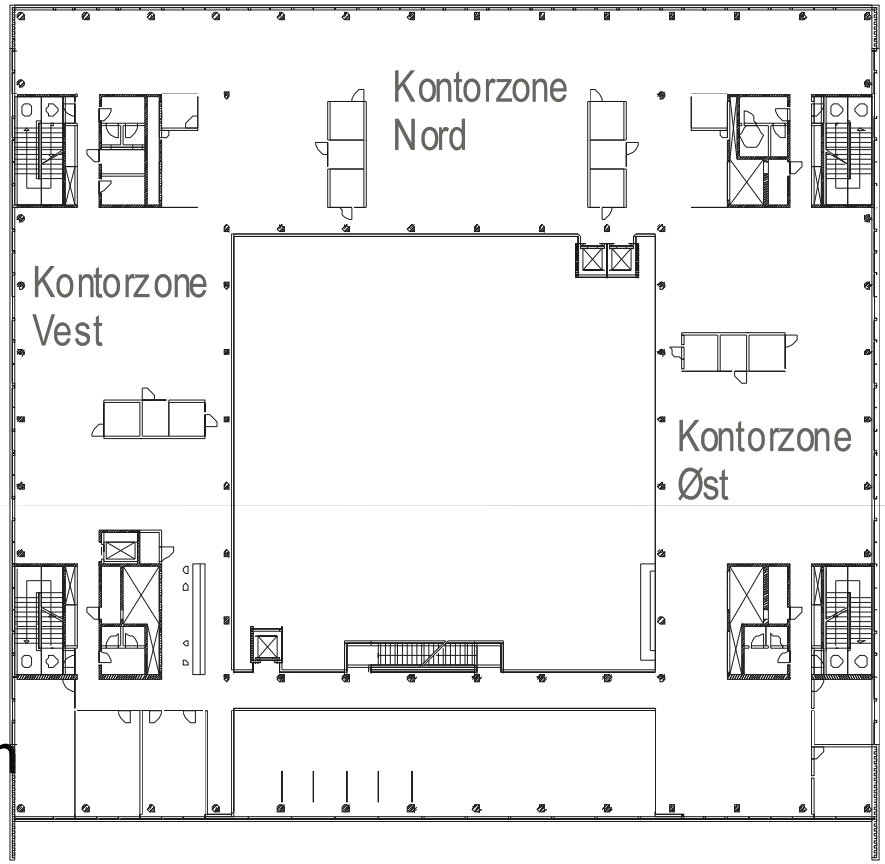
Stack ventilation through atrium

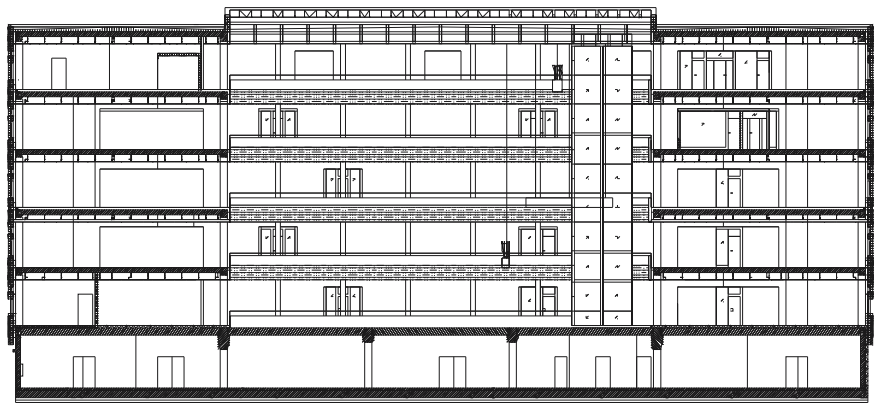


Floorplan

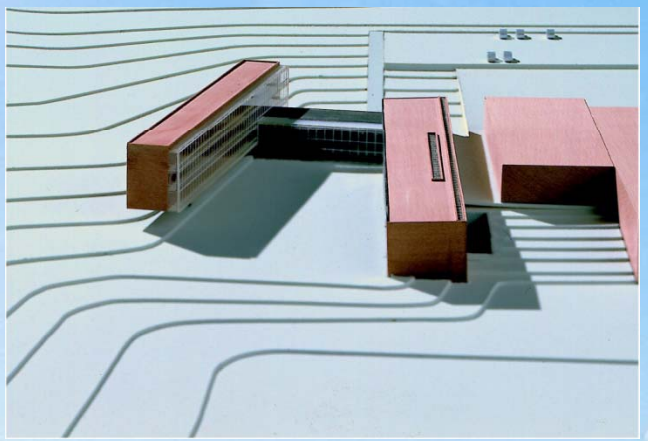
- 3 office zones/floor
- Atrium
- Service room and meeting rooms with mechanical exhaust
- Canteen balanced mechanical ventilation

Etage 3

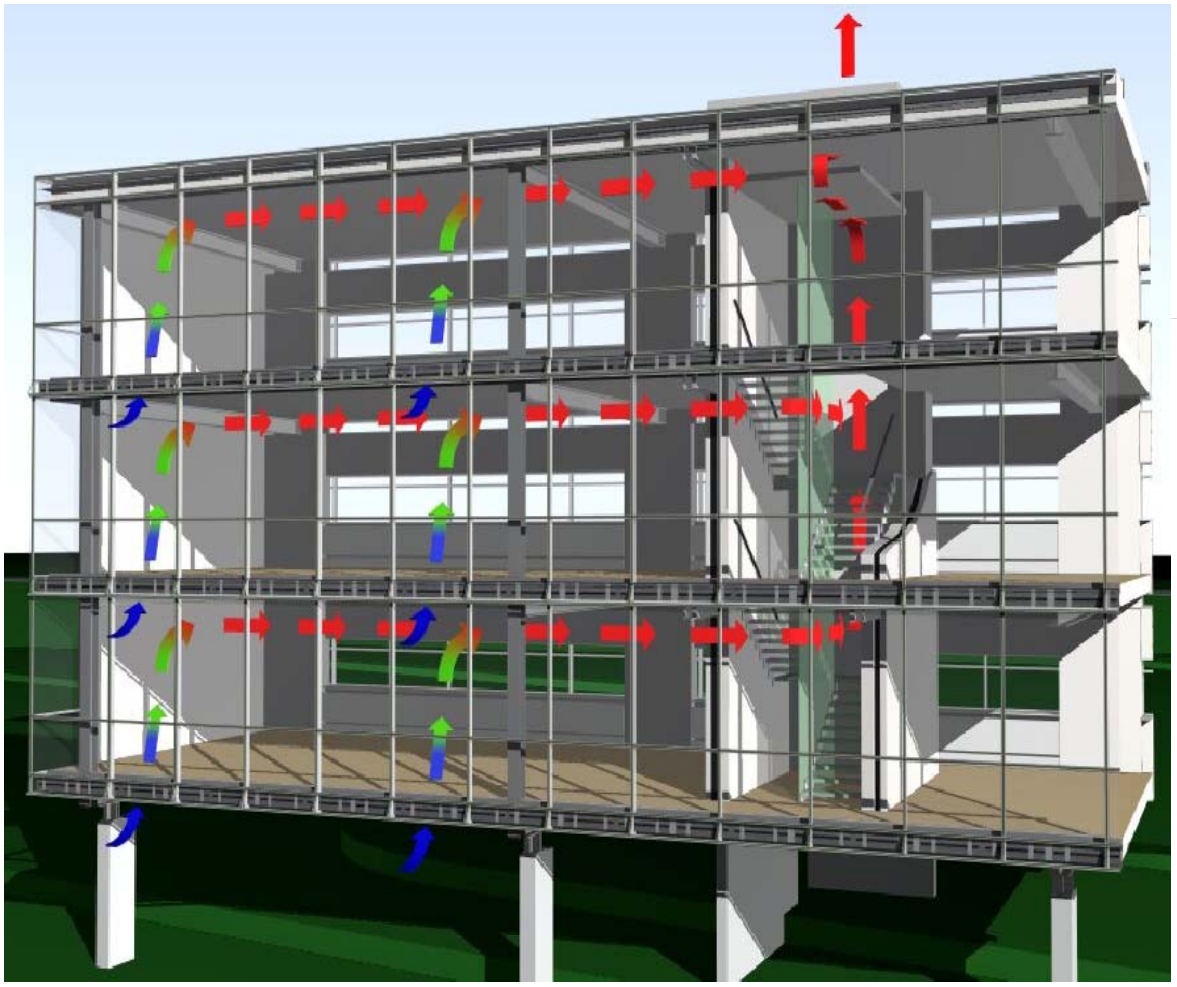


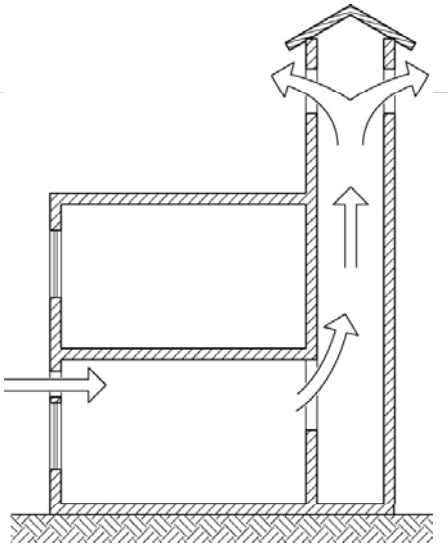


B&O Headquarters, Struer, Denmark



Displacement Ventilation





Stack ventilation with chimney

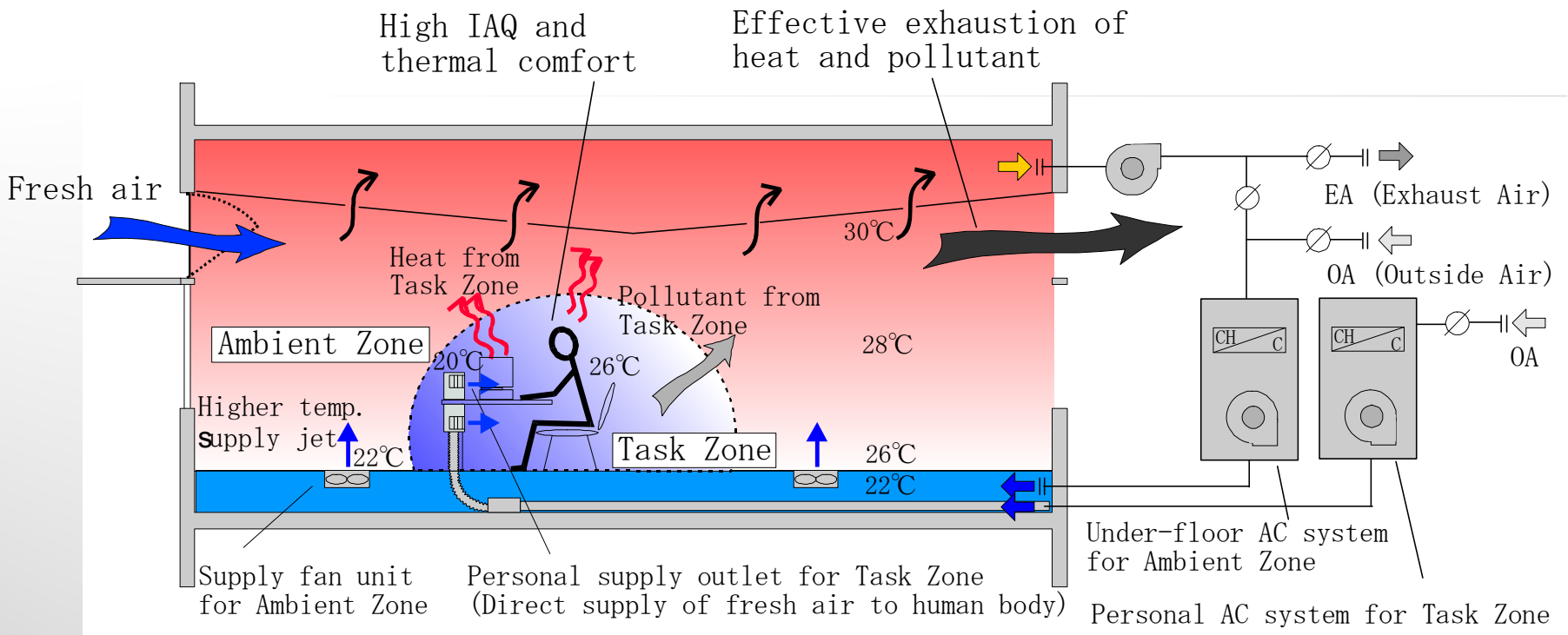
Luftindtag og forvarmning

Air Exhaust System

Institute of Development Economies (JETRO), Chiba, J

Courtesy of:
Dr. Tomoyki Chikamoto, Nikken Sekkei Ltd, Japan

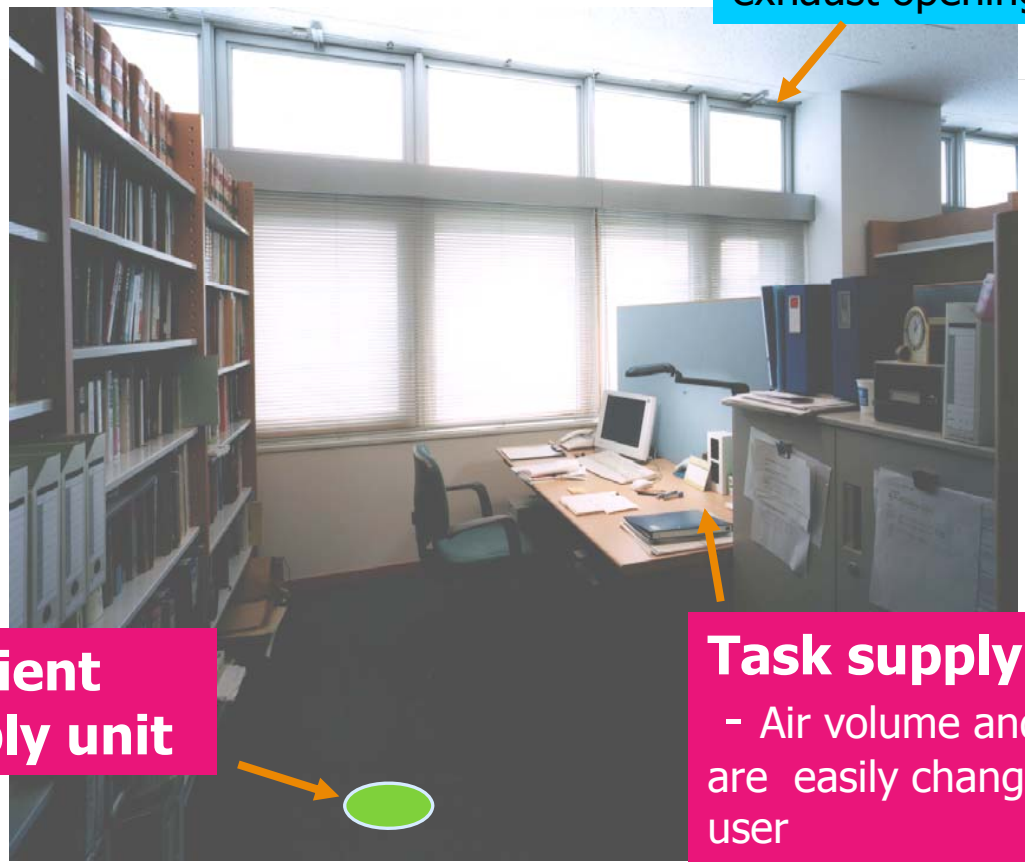
Hybrid Ventilation and Air Conditioning System



Hybrid Ventilation and Air Conditioning System

Automatically controlled window

- This opening is also used for smoke exhaust opening in case of fire

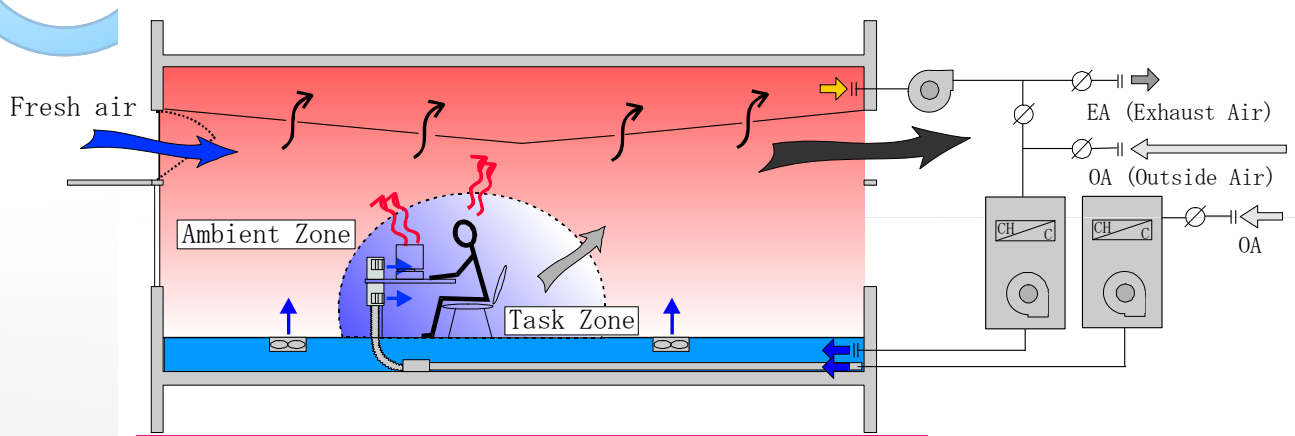


Ambient supply unit

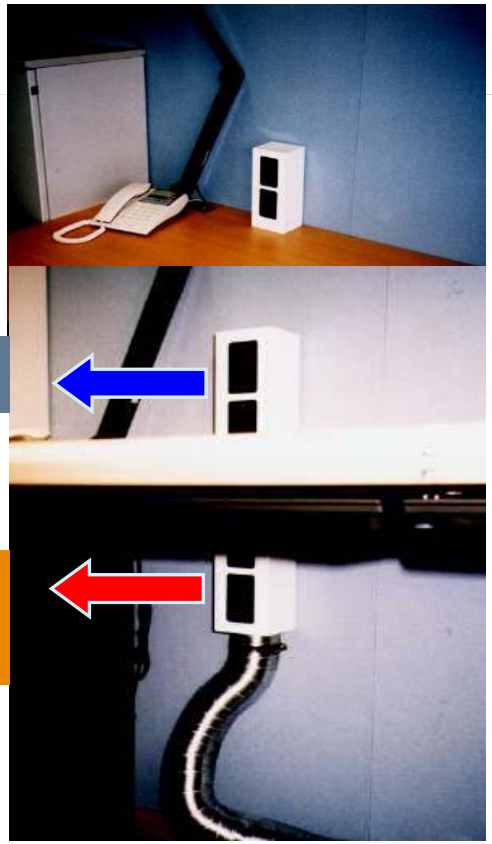
Task supply unit

- Air volume and direction are easily changed by each user

Control of Hybrid Ventilation and Air Conditioning System



Ambient zone is controlled mildly by central BA system for energy saving.
Task zone is controlled by each one's choice for human's comfort.

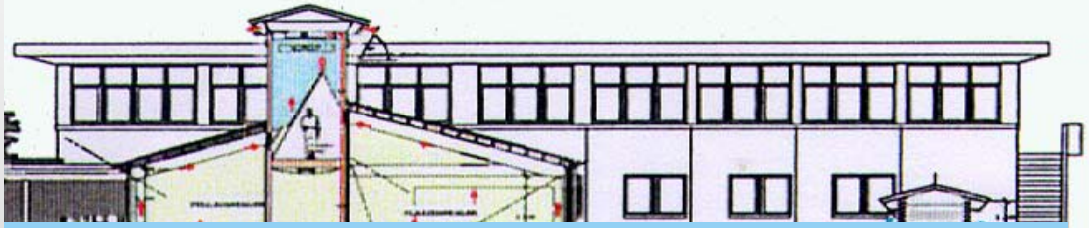


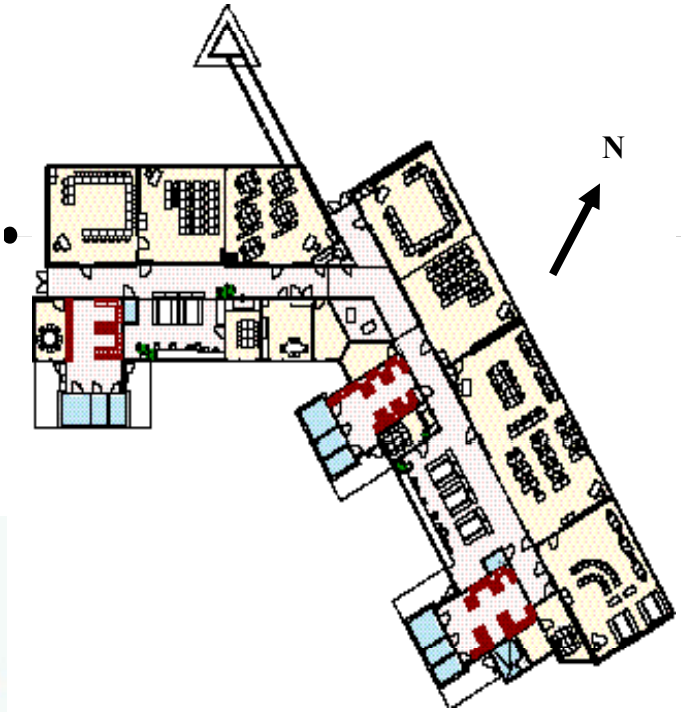
Cool air

Warm air

Air volume and direction are easily changed by each user.
Task supply unit is detachable.

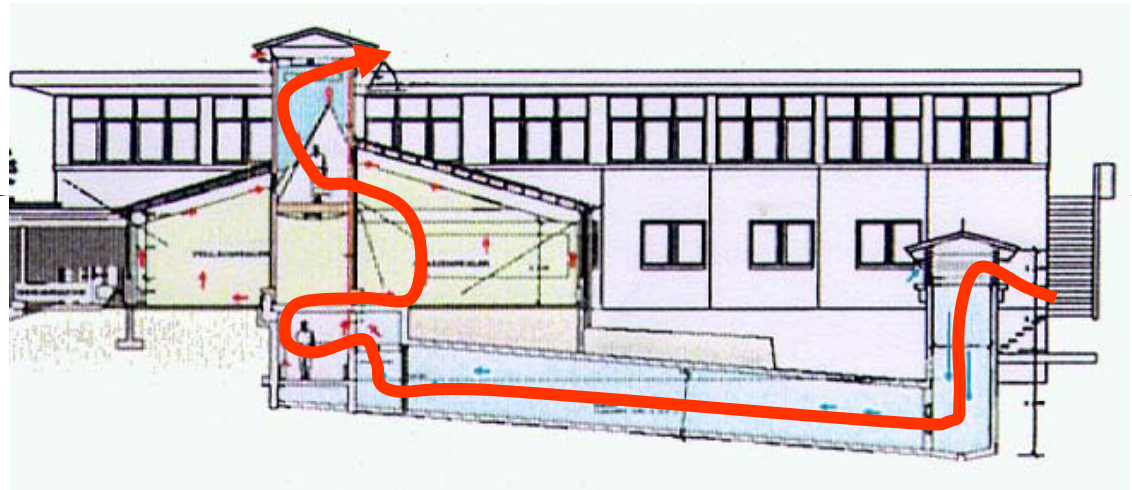
Mediå School, Grong, Norway



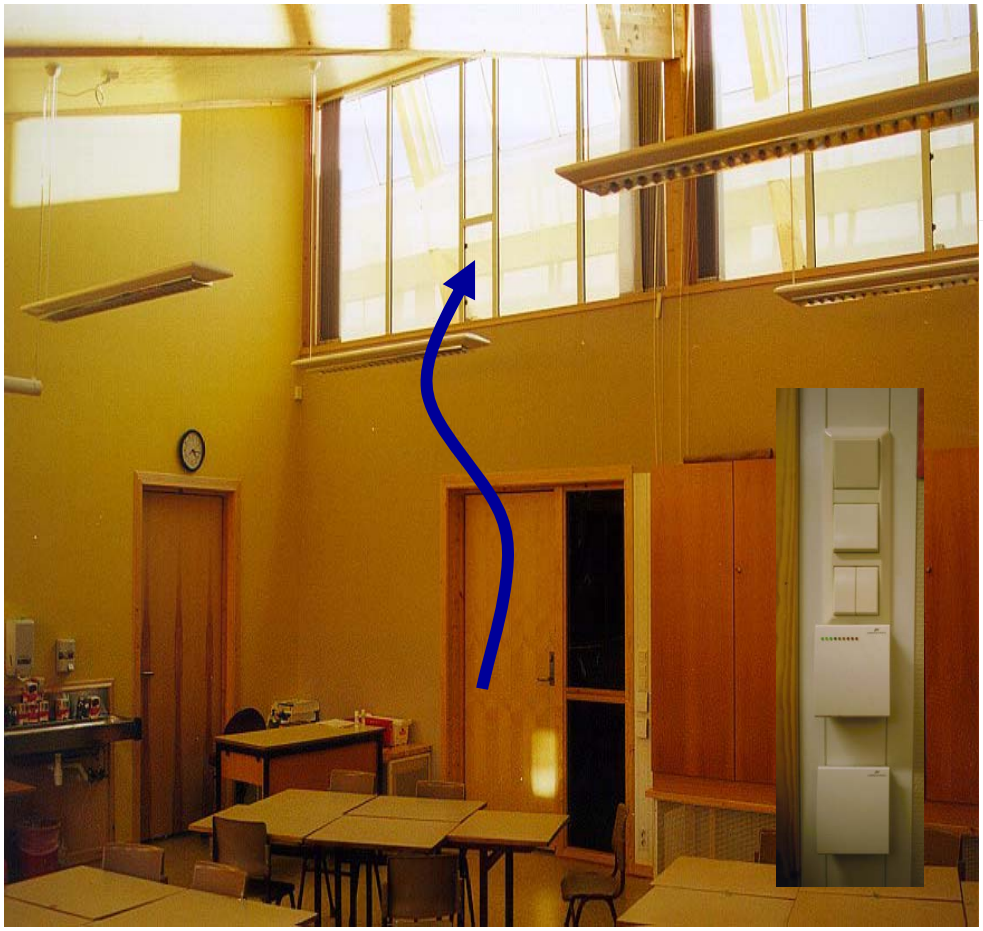


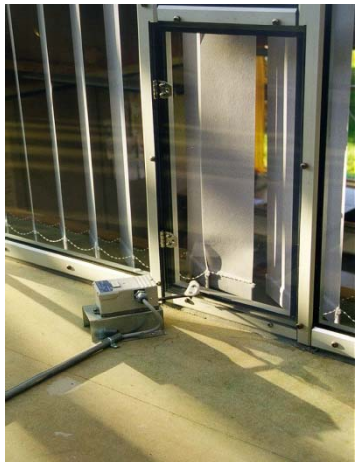
Courtesy of:
Professor Per Olaf Tjelflaat, Norwegian University for Science and Technology, Trondheim, Norway

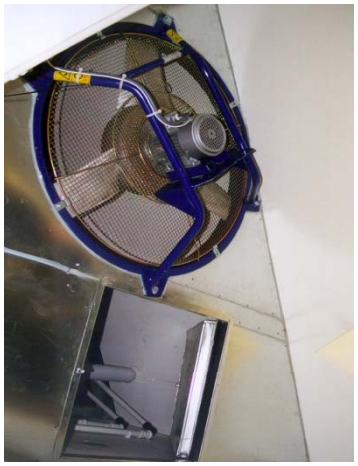
Air Supply System



Air Exhaust System







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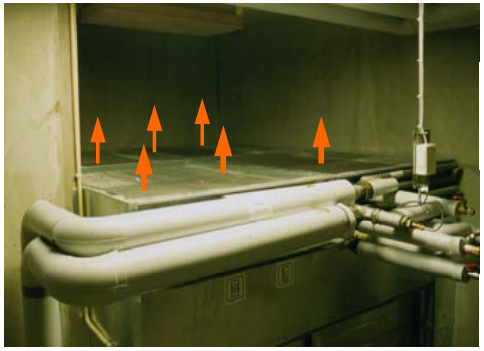

Low Pressure loss in system

- Ventilation supply about 35 pa
  - Filter about 15 pa
  - Heat recovery about 10 pa
  - Heating about 5 pa
- Ventilation exhaust about 20 pa
  - Heat recovery about 12 pa

Total pressure loss winter

about 55 pa

Total pressure loss summer

about 28 pa

Checklist

1. Building Orientation and Location
2. Building Layout
3. Building Constructions
4. Heat- and Contaminant Loads
5. Energy Use
6. Air Distribution Principles, Air Flows and Opening Types
7. Fire Safety
8. Acoustics and Noise (internal and external)
9. Daylight and Lighting Control
10. Security and Safety
11. Indoor Climate (thermal comfort and indoor air quality)
12. Control and operation

Natural Ventilation Applicability

- Issues related to building design
  - Location and orientation
    - Outdoor noise and air quality, sound attenuation, filtration, solar radiation, wind conditions
  - Layout
    - Roomheight, room depth, zoning, plan solution
  - Constructions
    - Facade solution, thermal mass

Natural Ventilation Applicability

- Issues related to building use
  - Heat- and contaminant loads
    - Solar radiation, personload, lighting, office equipment, choice of materials
  - Energy use and thermal comfort
    - Demand control, draught risk, heat recovery, night cooling
  - Air distribution principles
    - Location of inlets and outlets, ventilation efficiency
  - Daylight
    - Facade solution, solar shading, lighting control
  - Fire, noise and safety

Applicability of Natural Ventilation			
Parameters	High	Possible	Requires special solutions
Glasarea in % of facadearea			
External Solar Shading	< 25	25-50	> 50
Internal Solar Shading	< 15	15-25	> 25
Surroundings (shielding, air quality, noise)	Suburb or light traffic load	City area or moderate traffic load	City Centre or heavy traffic load
Roomheight, m	> 3,2	2,7-3,2	< 2,7
Relation between Roomdepth/Roomheight	< 2	2-5	> 5
Activities with High Polution Load	In separate rooms	Partly in separate rooms	Distributed in rooms
Office Type	Cellular offices dominate	Mixed	Open plan offices dominate
Thermal capacity	Exposed thermal mass	Thermal mass	No thermal mass
Internal heatload, W/m^2	< 15	15-25	> 30
m^2 Nettoarea per Person	> 13	8-13	< 8
Criteria for Time of Reverberation	Low	Moderate	High
Is Internal Noise Transport Acceptable?	Yes	Occasionally	No
Are Openings Allowed in Envelope?	Yes, always	Yes, always	Only during occupation
Dress Code	Informal	Formal	Formal
Smoking	Not allowed	Allowed in special rooms	Allowed
Deteriorated IAQ in Periods	Acceptable	Only in short periods under extreme conditions	Not acceptable
Is Draught Acceptable?	In short periods	In short periods	Only in short periods under extreme conditions
Average Air Change Rate in Winter, h^{-1}	< 1	1-2	> 2

Desirable Features

- ”Open” building design (allow for internal air flows)
- Limited room depth
- Increased room heights (thermal and pollution buffer)
- High thermal mass (efficient night ventilation)
- Efficient solar shading (control of external loads)
- Low energy equipment, daylighting and control of efficient artificial lighting (low internal loads)
- Low emitting materials and zoning of activities and equipment (low pollution load)

Characteristics of Efficient Building Integrated Ventilation Solutions

- Reduction of air change rates through emission and demand control
- Heating through a combination of passive (solar radiation, internal loads) and/or active technologies
- Cooling through a combination of natural (outdoor air, ground coupling) and mechanical cooling technologies
- Considerable reduction of pressure loss through utilisation of the building for distribution of air
- Transport of air through a combination of natural and mechanical driving forces
- Utilisation, redistribution, storage and/or reduction of internal heat loads and solar radiation