

NATURAL VENTILATION based on stack effect



All photos and drawings by Livady unless otherwise stated

Juulia Mikkola, Livady Architects

Eesti Vabaõhumuuseum 17.4.2024

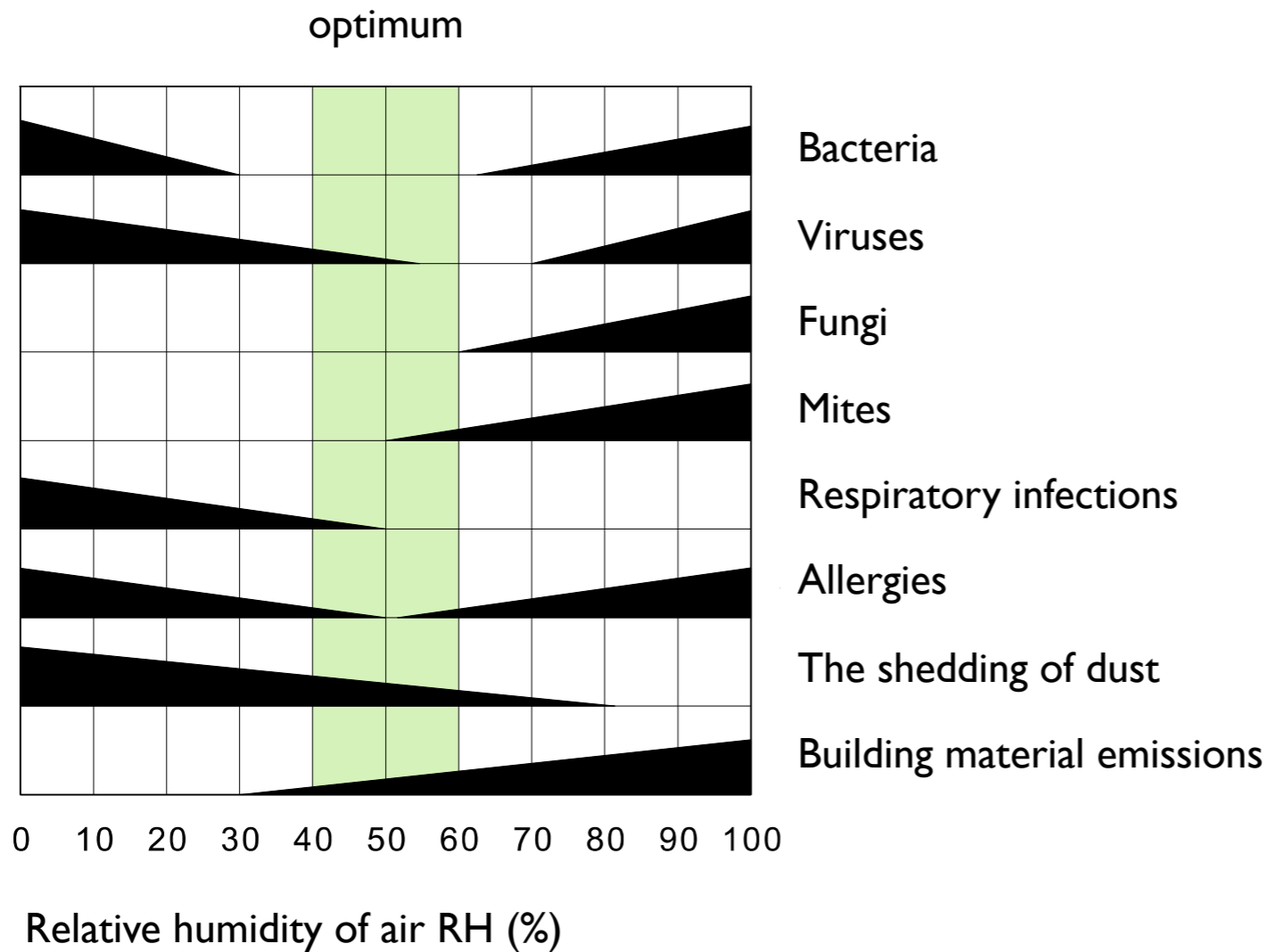
BENEFITS OF NATURAL VENTILATION



- simple and understandable
- requires very little maintenance, very low maintenance costs
- long-lasting and energy-efficient => eco friendly
- passive system, independent of machinery => reliable even during power failures
- ready for use as soon as – or even before – the building is completed, no need to adjust the system
- occupants accept greater variations in indoor conditions because they can adjust ventilation themselves
- adjustability improves comfort and reduces unnecessary energy consumption
- no noise from machinery
- no risk of harmful negative pressure => fewer indoor air problems
- because fine filtration is not possible, the indoor air is rich in microbial flora, which prevents autoimmune diseases
- in residential buildings natural ventilation is easy to design based on experience

THE EFFECT OF INDOOR HUMIDITY

The height of the triangles indicates the magnitude of health hazards at different indoor humidity levels.

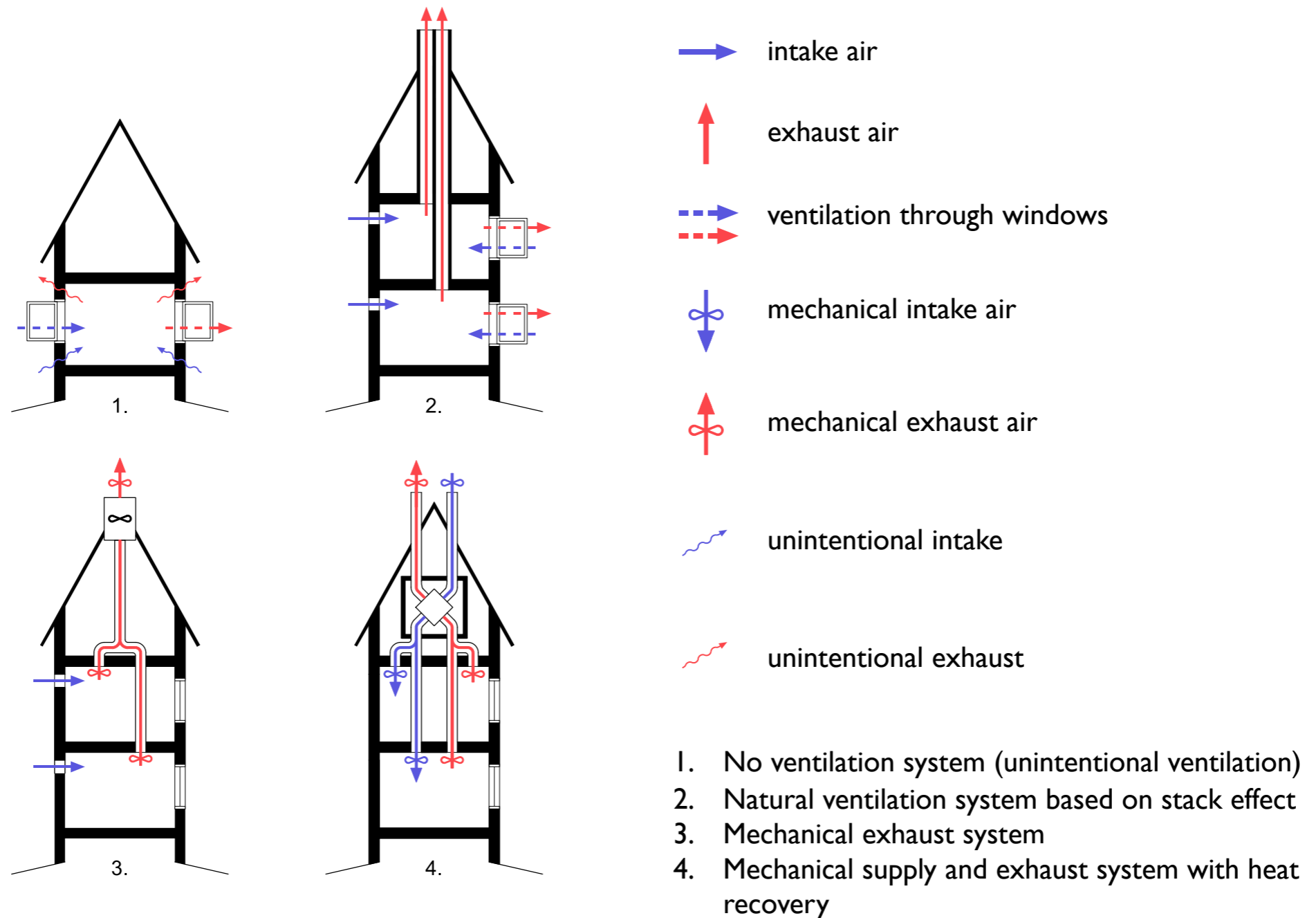


THERMAL COMFORT

RH (%)	How it feels (°C)				
70	20	21	23	24	25
60	19	20	22	23	25
50	19	20	21	22	24
40	18	19	21	22	23
30	18	18	20	21	22
20	17	18	19	20	22
10	17	18	18	20	21
0	16	17	18	19	20
	20	21	22	23	24

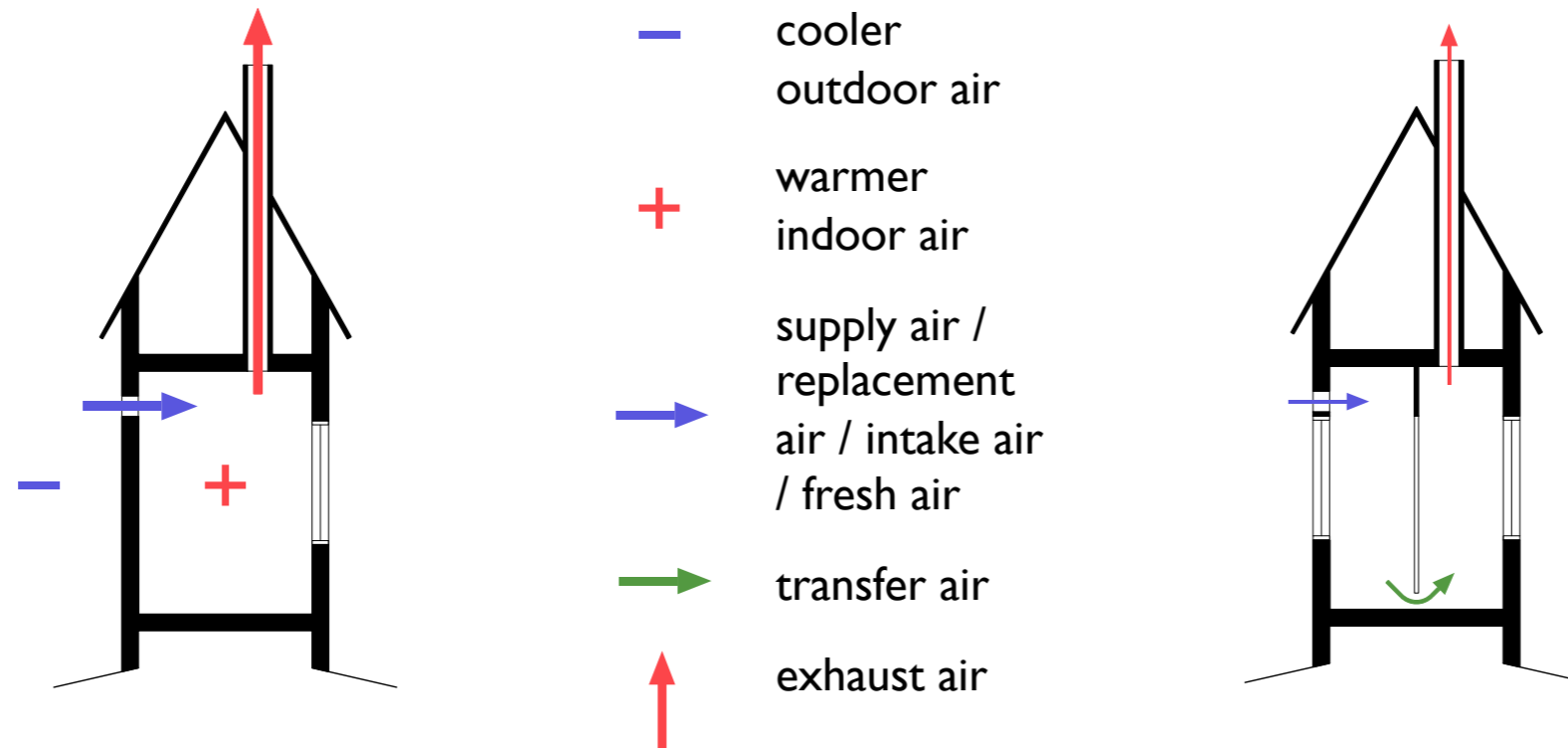
Indoor temperature (°C)

DIFFERENT VENTILATION SYSTEMS



Buildings with no ventilation system at all are often mistaken for naturally ventilated buildings. To be considered as naturally ventilated, the building should have at least one vertical flue, as natural ventilation is based on stack effect.

STACK EFFECT AND DIFFERENT AIRFLOWS



When an exhaust duct is led up from a heated space and an intake air vent is pierced in the external wall, the thermal difference between indoors and outdoors creates a draft in the flue. This causes colder and heavier outdoor air to flow in through the inlet while warmer and lighter indoor air flows out through the flue. If all rooms don't have both supply and exhaust vents, air will also flow from one room to another within the apartment from the inlets to the exhaust vents.

THE EFFECT OF STACK HEIGHT AND HORIZONTAL FLUES

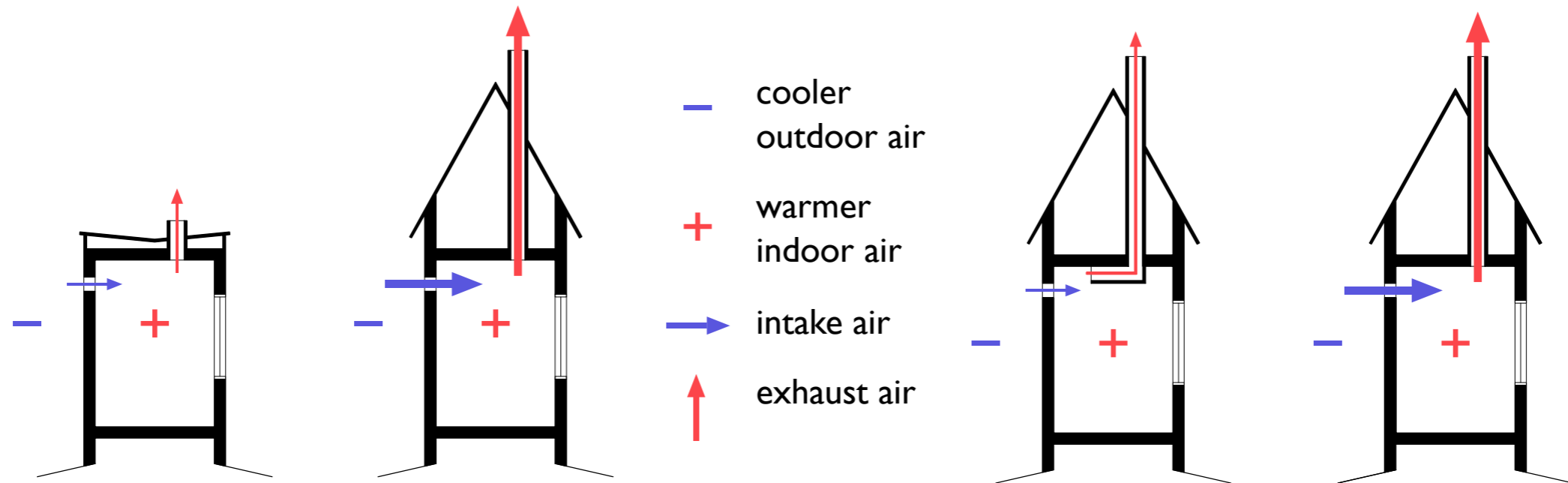


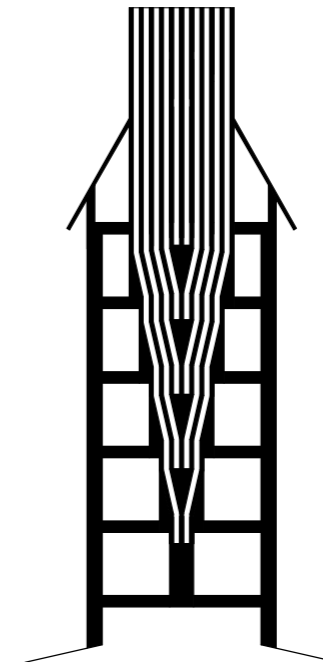
Photo: Kirmo Mikkola

Flues must be

- sufficiently spacious
- high enough
- preferably vertical.

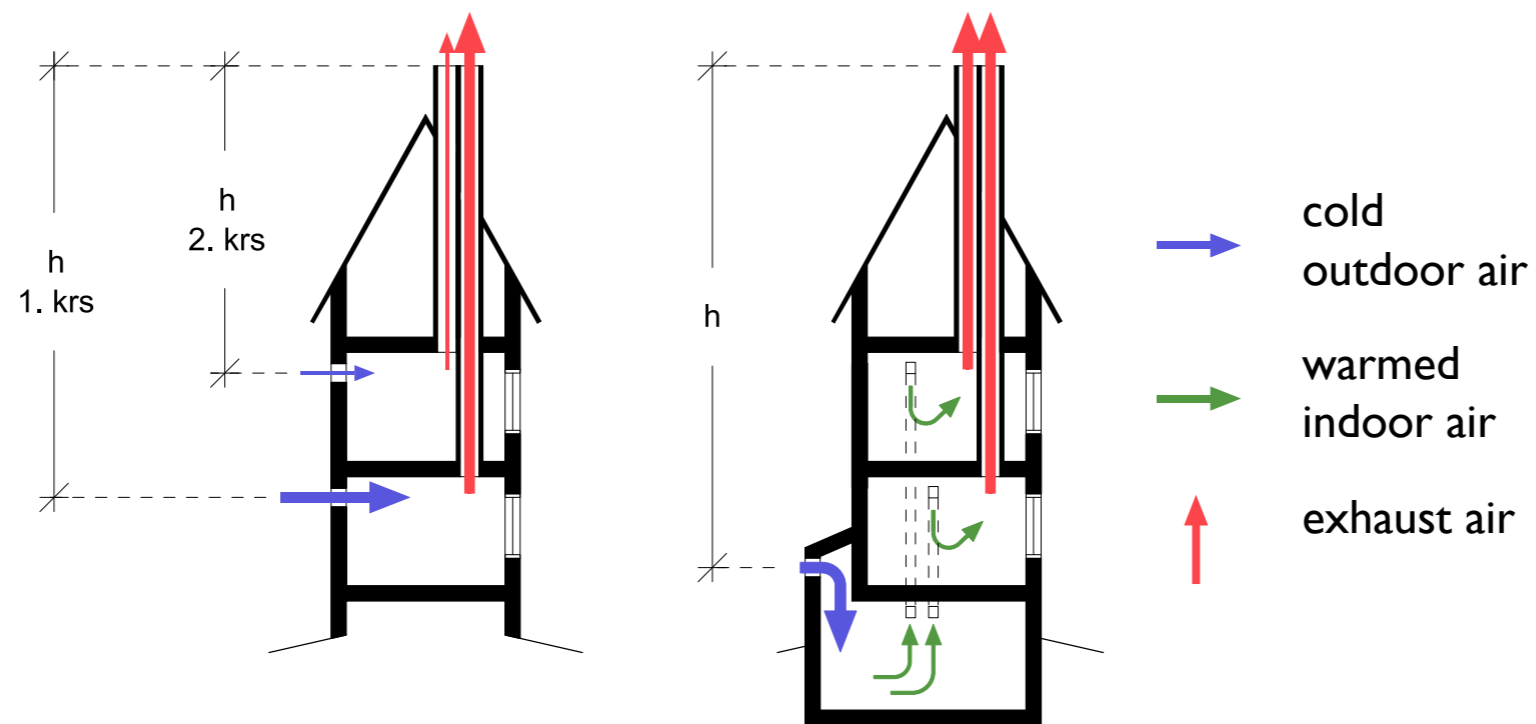
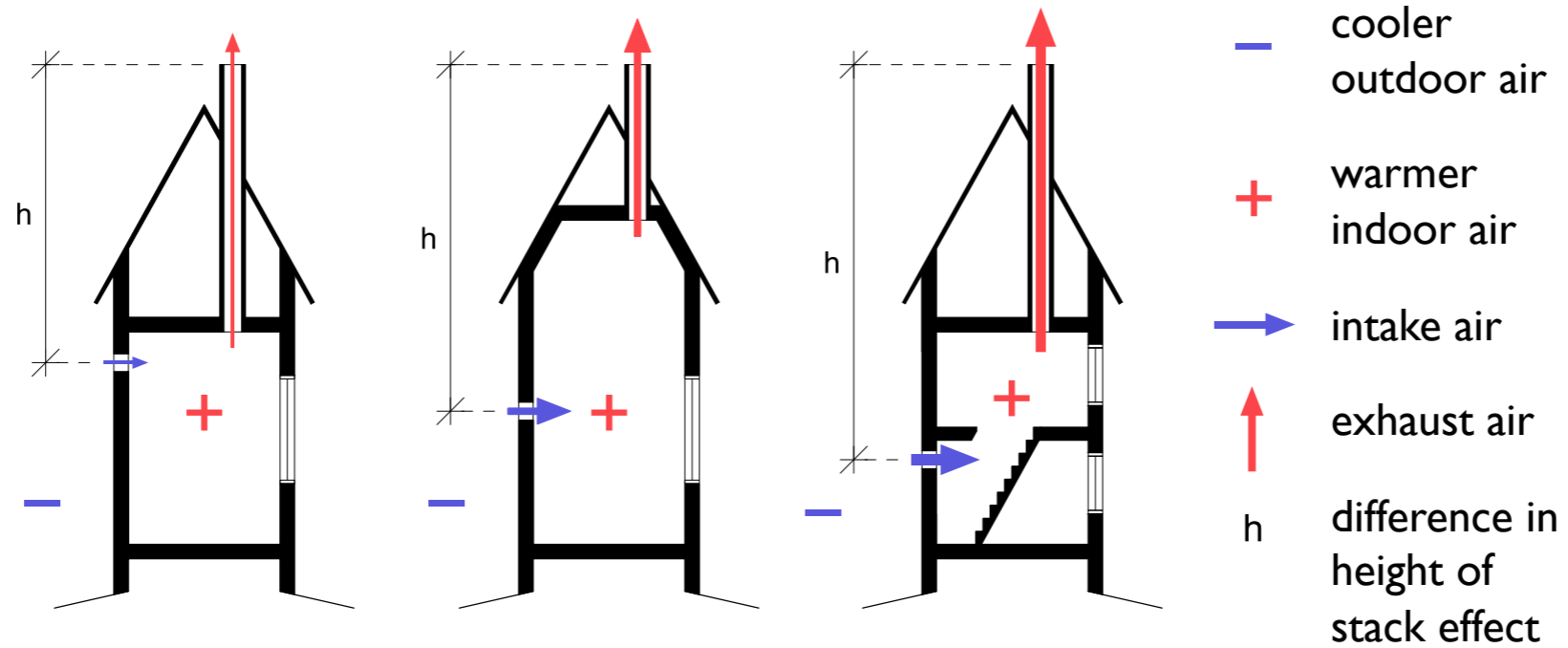
It is advisable to avoid

- horizontal flues
- sharp bends.

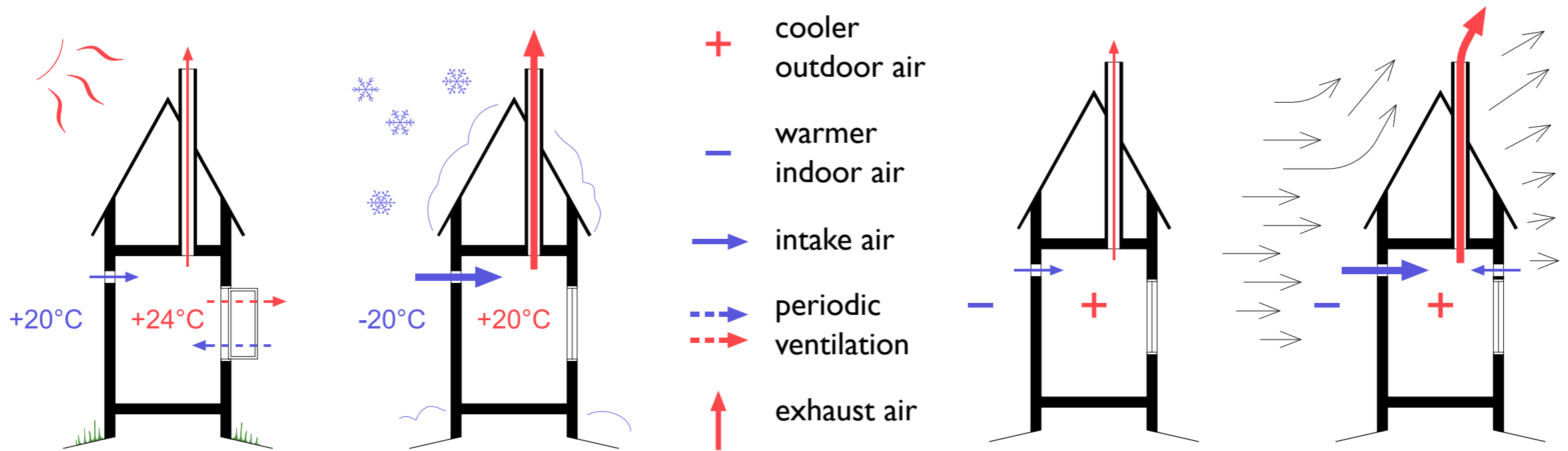


Traditional way of arranging the flues in a multi-storey building

THE DIFFERENCE IN HEIGHT OF STACK EFFECT

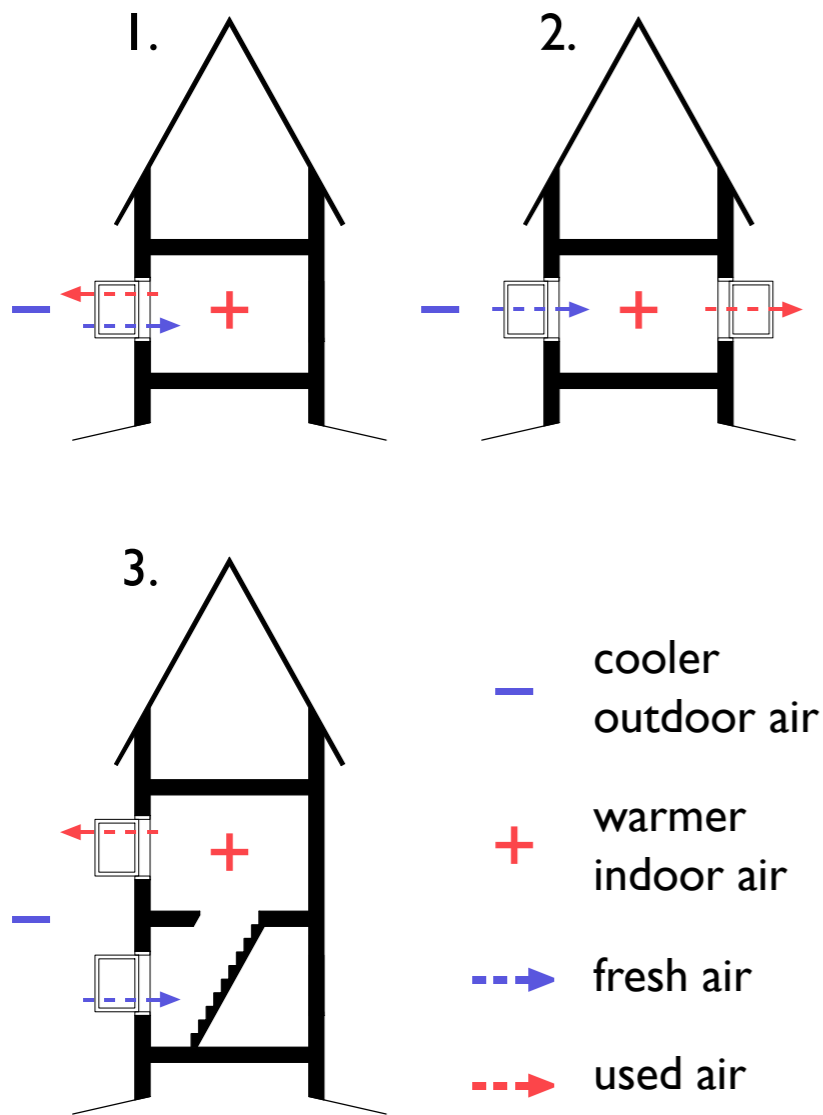


THE EFFECT OF THERMAL DIFFERENCES AND WIND



Both thermal difference and wind enhance air exchange in natural ventilation. The effect of wind is greater on the upper floors of a buildings and lower at ground level. In this way, wind balances the effect of floor height on airflow, for air exchange in calm weather is best in the lowest floors, where the exhaust flues are highest.

VENTILATION THROUGH WINDOWS



Patentti Terveys-Akkuna

Raitis ilma on paras lääke ja sitä saadaan edullisimmin Terveys-Akkunan avulla. — Ilma kiertää yläosan kautta, joten veto on poistettu. — Maksaa ainoastaan **Smk 5:—.**

Saadaan kaikista maamme hyvin varustetuista rakennusainekaupoista sekä

Matti Kyllöseltä,
Helsinki.
Fredrikinkatu 39. Puh. 63 59.

So called health window. Source: Arkitekten 4/1910, Kansalliskirjasto

Fortuska or ventilation pane.



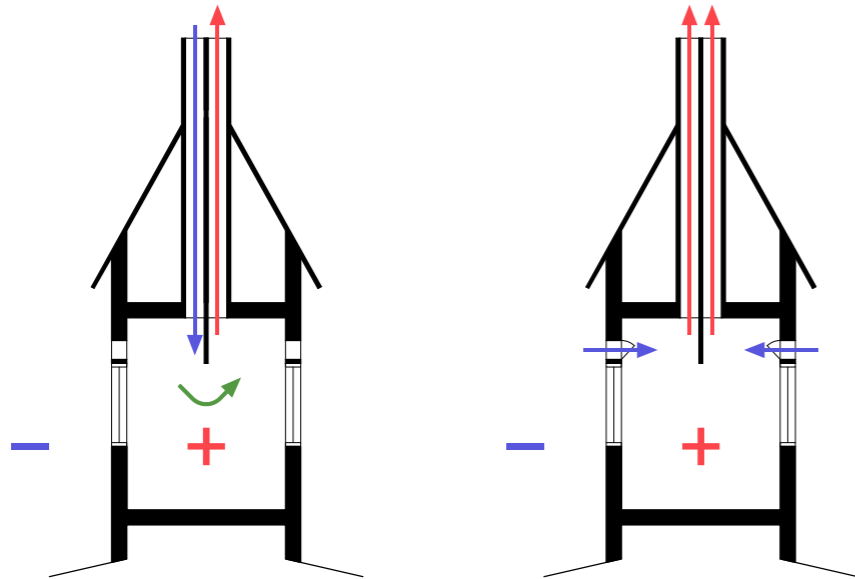
Modernistic fortuska.



IS DOWNDRAUGHT A GOOD REASON FOR MACHINES?

STACK VENTILATION

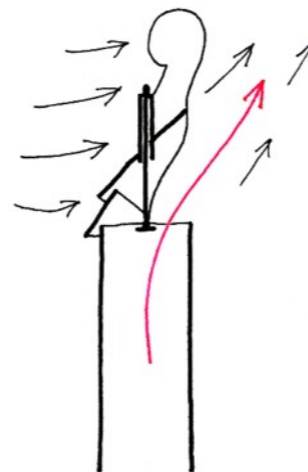
- risk of occasional downdraught that can cause inconvenience



- cooler outdoor air
- + warmer indoor air
- intake air
- transferred air
- ↑ exhaust air

without replacement air with replacement air

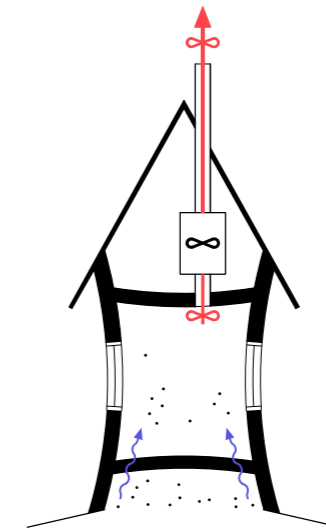
=> no risk



traditional revolving wind cowl: Johnin imuhattu, jonne (meaning 'John's sucking hat')

MECHANICAL EXHAUST

- risk of harmful negative pressure that can cause severe indoor air problems



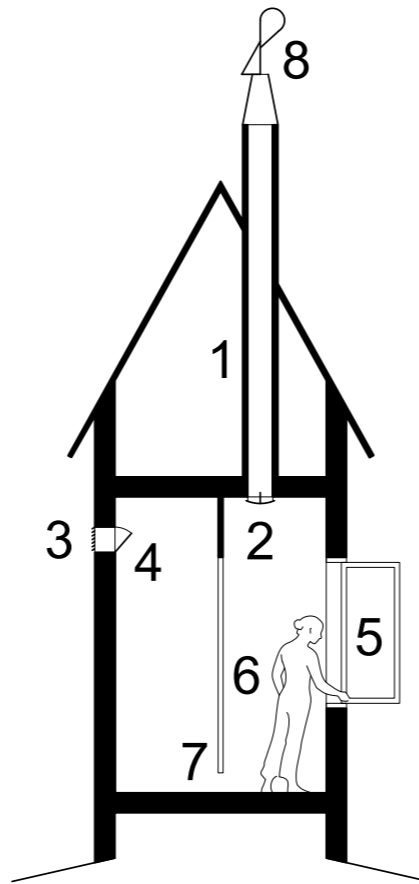
- ↑ mechanical exhaust air
- unintentional intake air

without replacement air

=> risk of indoor air problems

PARTS OF NATURAL VENTILATION SYSTEM

- 1 exhaust flue
- 2 exhaust vent
- 3 air inlet / intake flue with outdoor grille
- 4 intake vent i.e. fresh air vent i.e. replacement air vent
- 5 operable window or ventilation hatch
- 6 occupant who adjusts vents and windows
- 7 door gap or some other opening for transfer air
- 8 wind cowl (not necessary)



Stack of red brick



Outdoor grille



Modern flap vent, Domus Classica



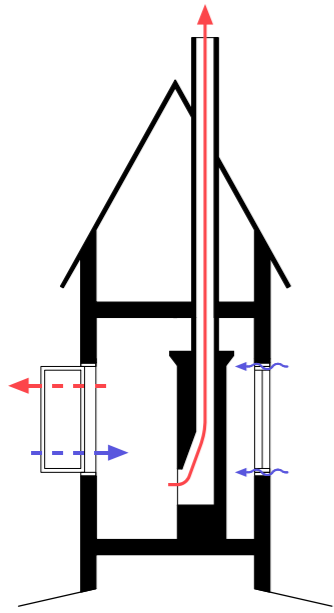
Holes for transfer air



Exhaust vent of cast iron and wind cowl of steel plate, Domus Classica

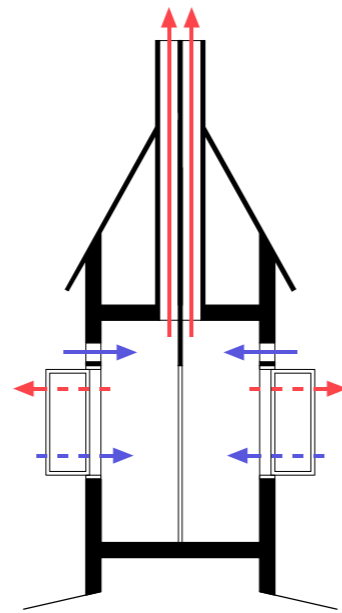


DIFFERENT NATURAL VENTILATION SYSTEMS



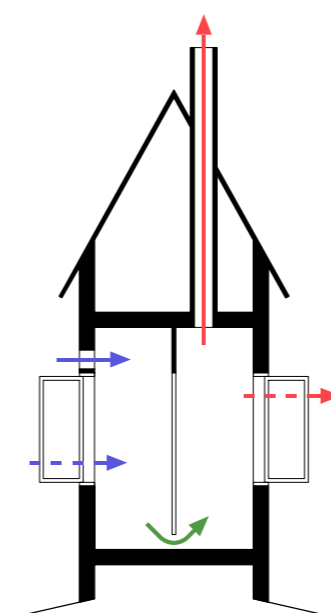
FIREPLACE HEATING AND UNINTENTIONAL INTAKE

Ordinary till the second half of the 19th century



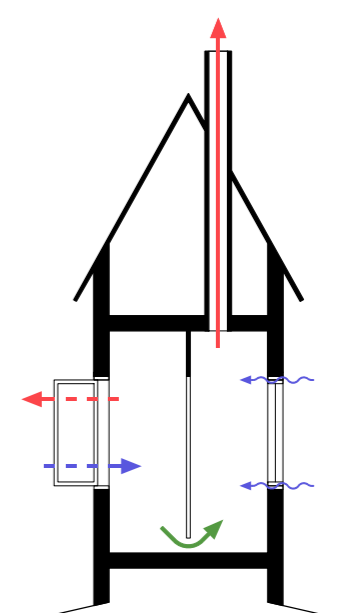
ROOM-BY-ROOM SYSTEM: FLUES AND INTAKES IN EVERY ROOM

Ordinary from the end of 19th century till the 1930's



APARTMENT SPECIFIC SYSTEM WITH OVER-FLOW METHOD

Ordinary from the 1930's till the 1950's



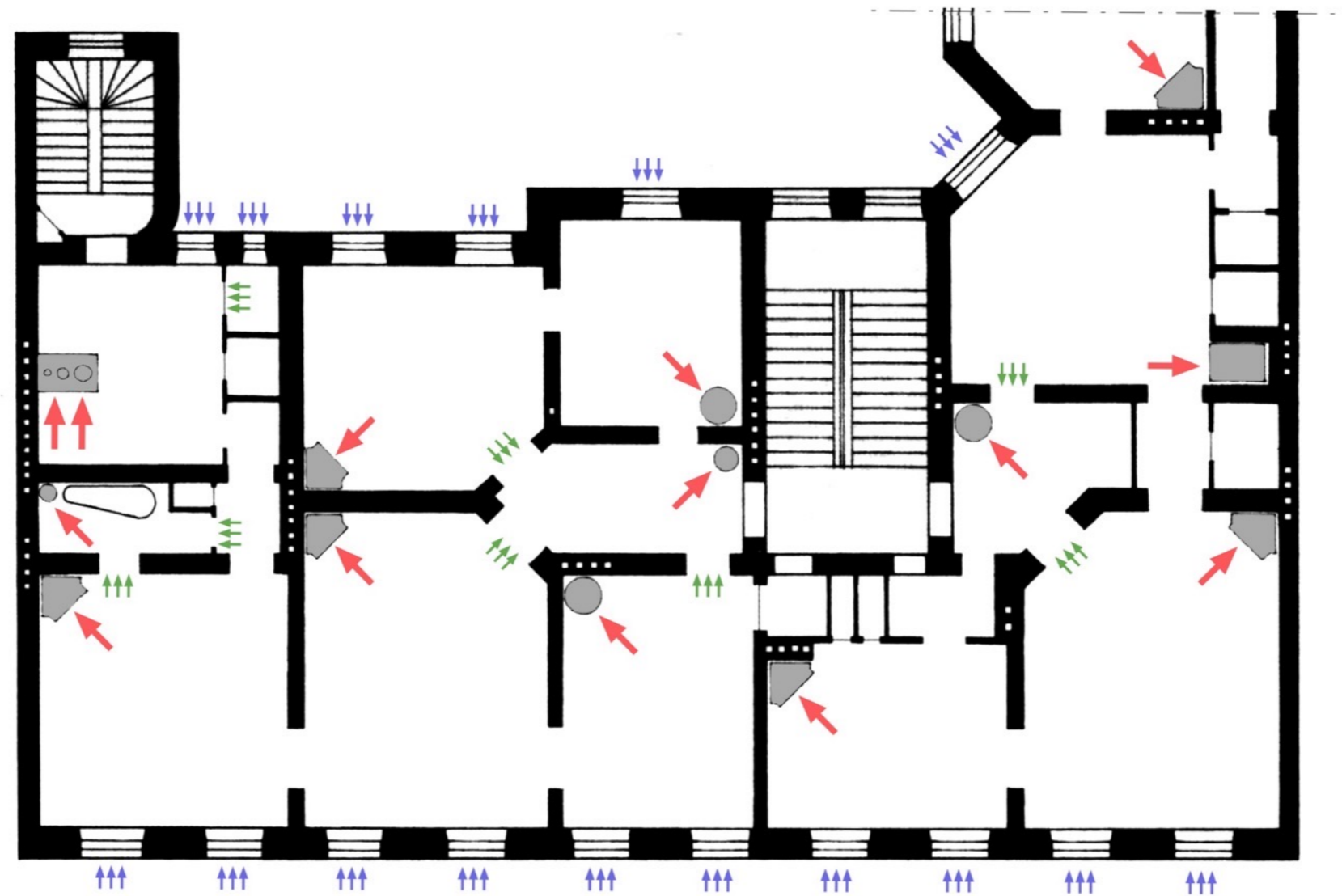
EXHAUST FLUES ONLY IN THE "DIRTY" SPACES (NO INTAKES)





Ordinary from the 1960s onwards



FIREPLACE HEATING AND UNINTENTIONAL INTAKE

Ordinary till the second half of the 19th century, was later also used in summer cottages etc.

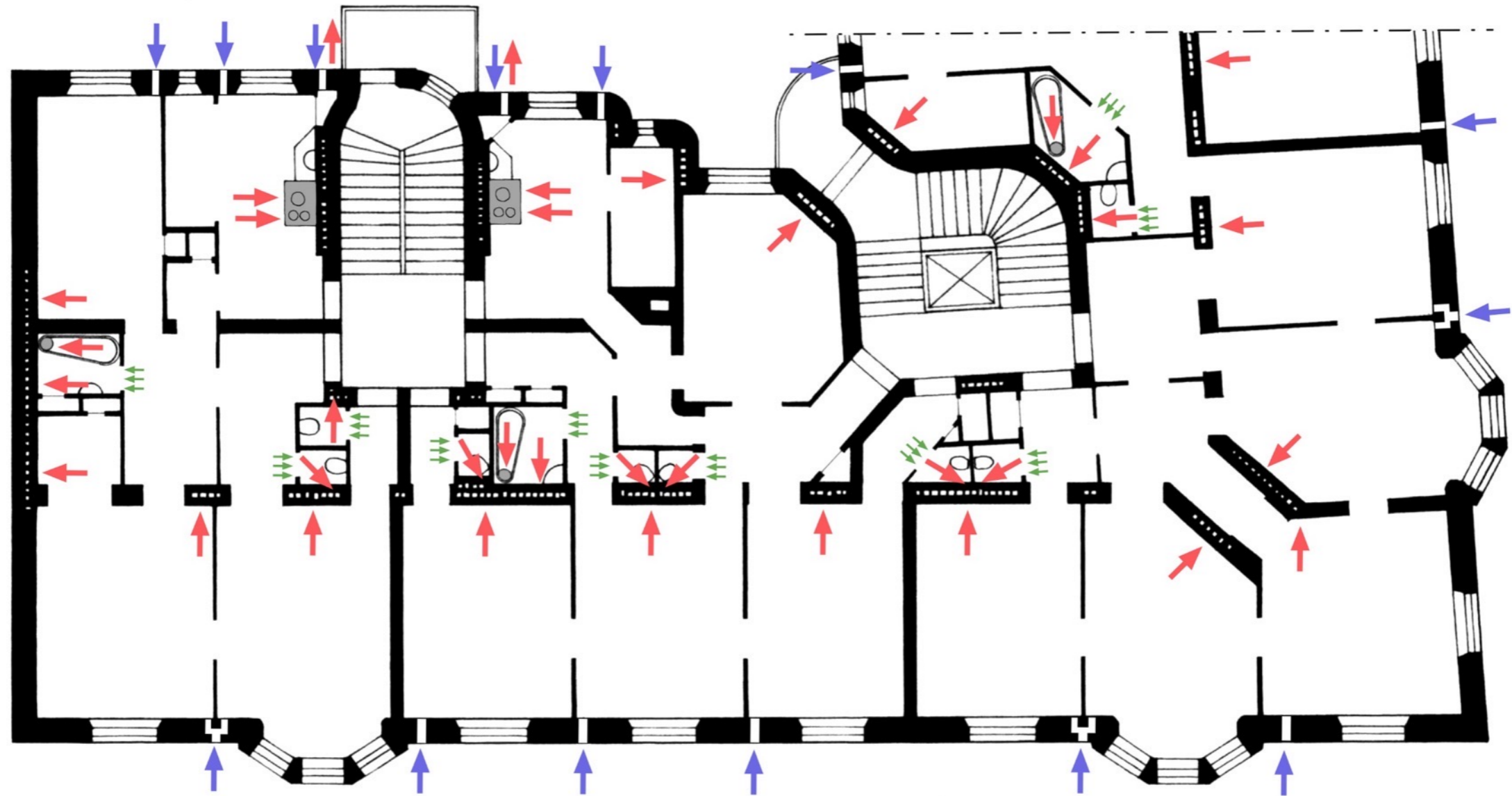


-  unintentional intake air
-  exhaust air
-  unintentional transfer air
-  fireplace

If the windows have modern window seals, there is not enough supply air.

ROOM-BY-ROOM SYSTEM: FLUES AND INTAKES IN EVERY ROOM

Ordinary from the end of 19th century till the 1930's.

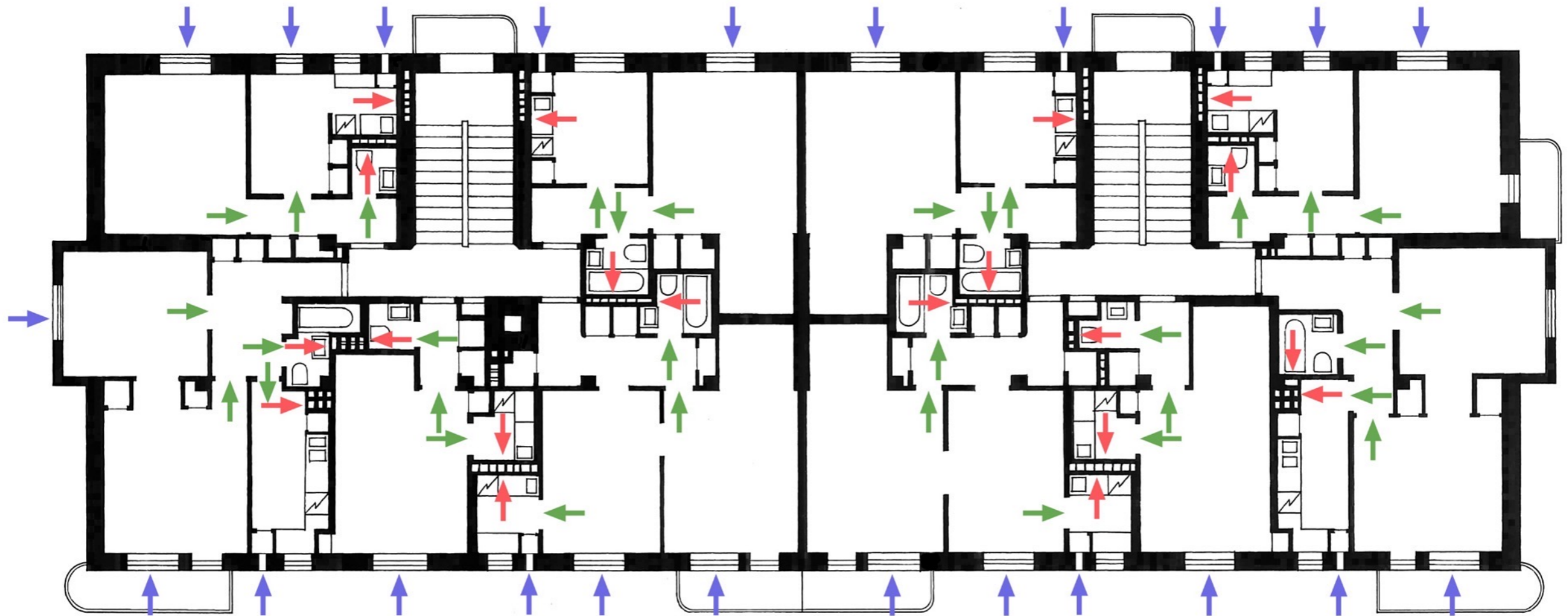


- ➡ intake air
- ➡ exhaust air
- ⇄ unintentional transfer air
- fireplace

The best of systems, though door gaps are often recommended for bathrooms.

APARTMENT SPECIFIC SYSTEM WITH OVERFLOW METHOD

Ordinary from the 1930's till the 1950's



- intake air
- exhaust air
- transfer air

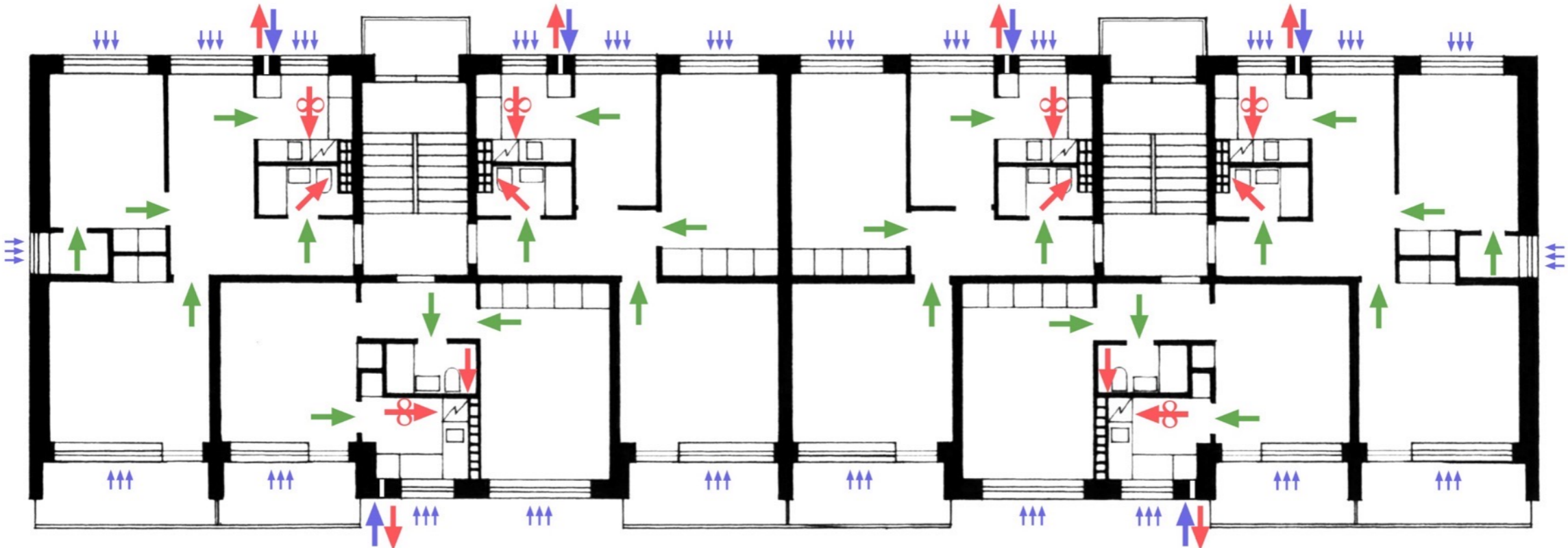
Air is streaming in the “right way”:
from bedrooms and living room to
'dirtier rooms', bathroom and kitchen.






However, ventilation rates can be
insufficient during warm seasons, because
there are not that many flues, and slotted
vents don't let through enough air.

EXHAUST FLUES ONLY IN THE "DIRTY" SPACES (NO INTAKES)

Ordinary from the 1960's onwards

NOTE! Deficient system, requires regular window ventilation.



-  intake air
-  unintentional intake air
-  exhaust air
-  mechanically boosted exhaust air
-  transfer air

Proper intakes should be added!

EXHAUST VENTS



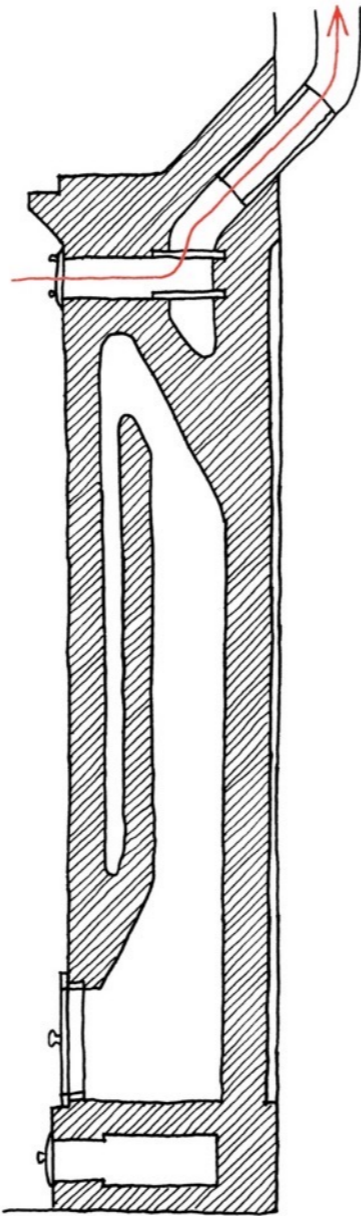
Screen covering an open firebox



Exhaust vent in a masonry stove



Exhaust vent in a masonry stove



The principal of an exhaust vent in a masonry stove with double draught diverters.



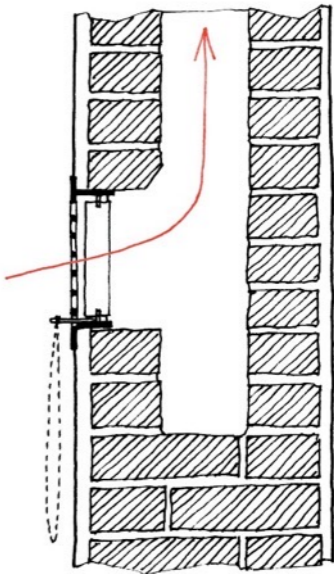
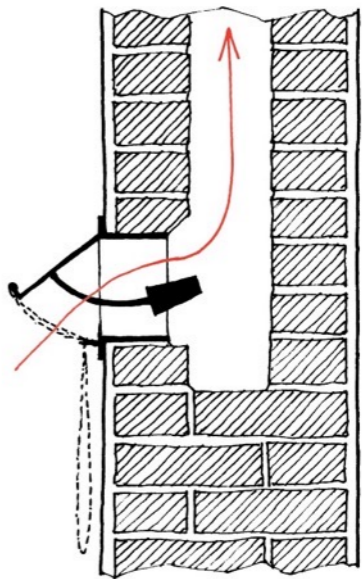
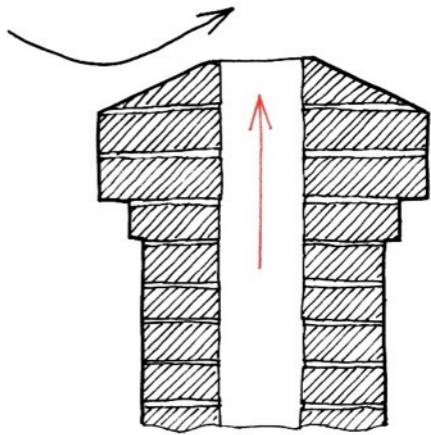
Cooker hood



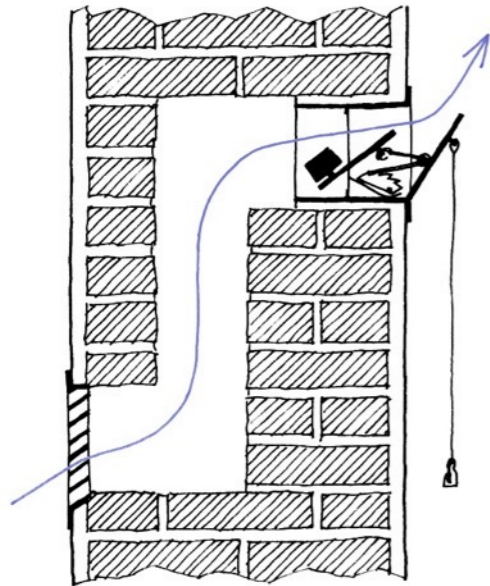
Flap vent for exhaust air



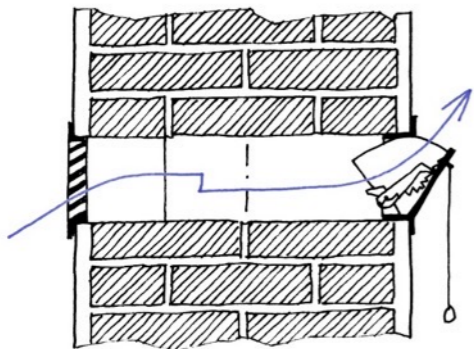
Cast iron vent for exhaust air



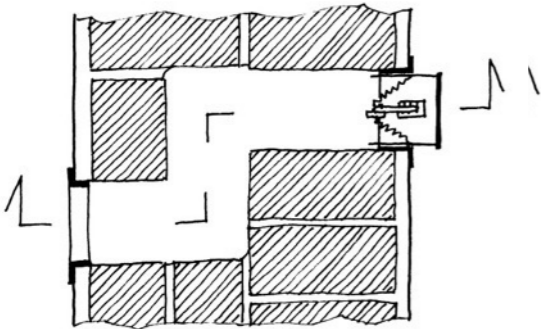
AIR INLETS AND INTAKE VENTS



Z-shaped intake openings



Mesh with rain cover



Intake grille



L-shaped steel pipe



Lid on the inside



Mesh with rain cover



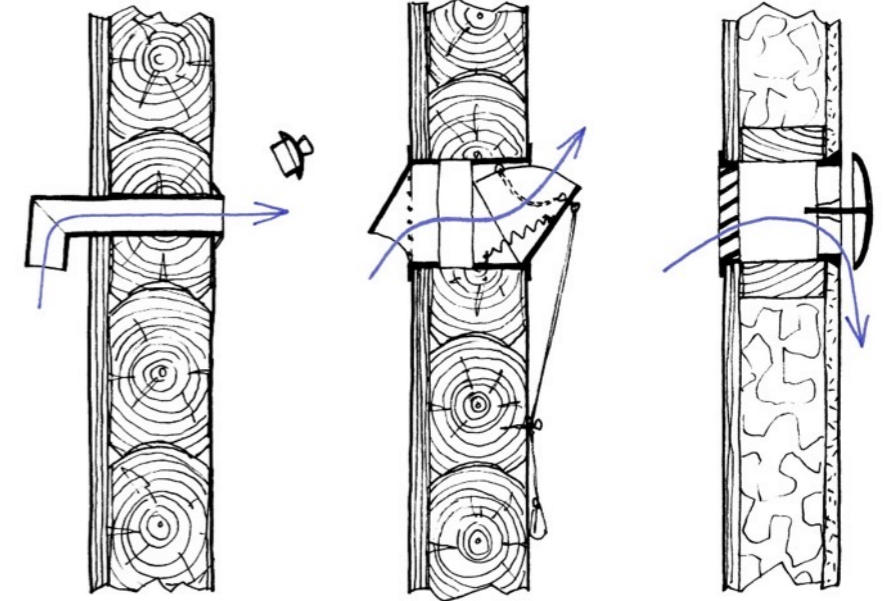
Flap vent



Intake grille



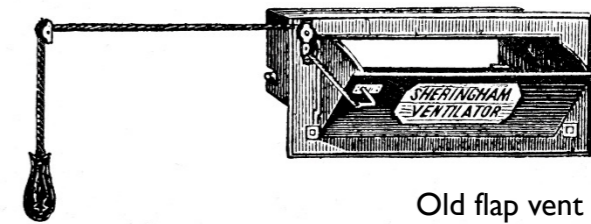
Flap vent



L-shaped steel pipe

Old flap vent

Modern disc vent



Old flap vent

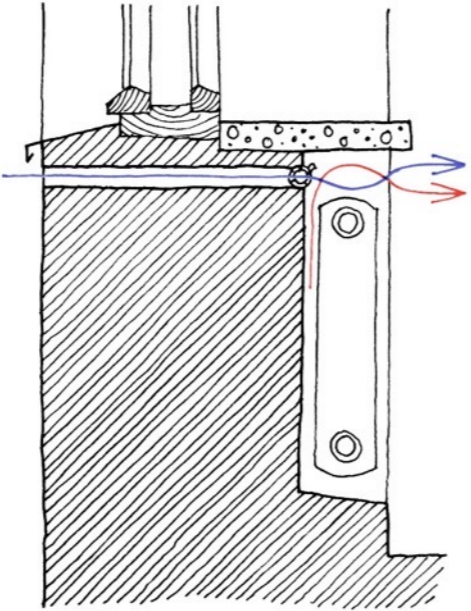


L-shaped steel pipe



Old disc vent

AIR INLETS CONNECTED WITH WINDOWS



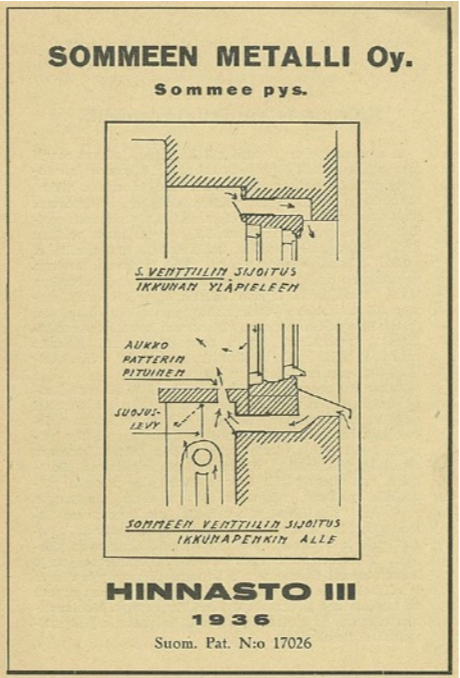
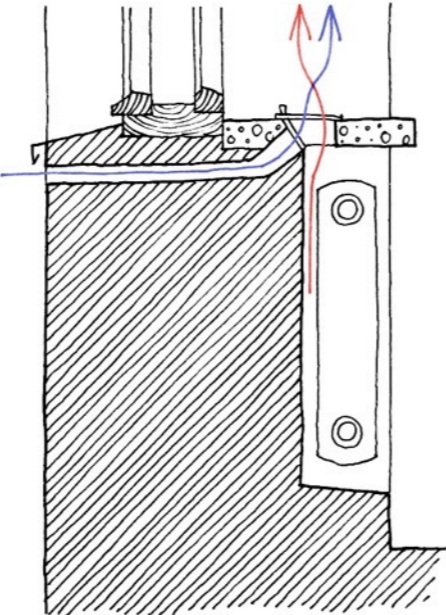
Operating principals



The house of Aino and Alvar Aalto, Riihitie 20



Slotted vent under a window.
Photos: Netta Böök



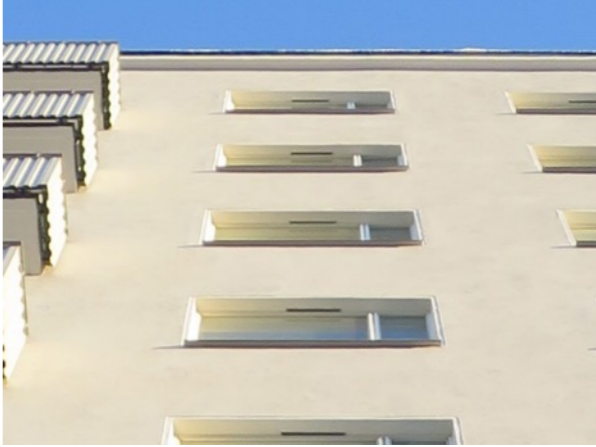
National Library of Finland



Supply air taken in between the panes.
Photos: Anu Laurila



Grille on a window bench



Slotted vents above the windows

NEW EXAMPLES: HOUSE SPAAK



Terraced house of 3 apartments and 450 m²

Helsinki 2016

Avarrus Architects, www.avarrus.fi

Pauli Siponen

Atte Aaltonen

Niilo Ikonen

Photos: Ville Vilppula

NEW EXAMPLES: HELSINGIN MUURARIMESTARI (meaning 'Helsinki Master Mason')



Visualisations: Avarrus Architects

2024

Residential building of 28 apartments

Helsinki

Avarrus Architects, www.avarrus.fi

Pauli Siponen

Niilo Ikonen

Noona Lappalainen

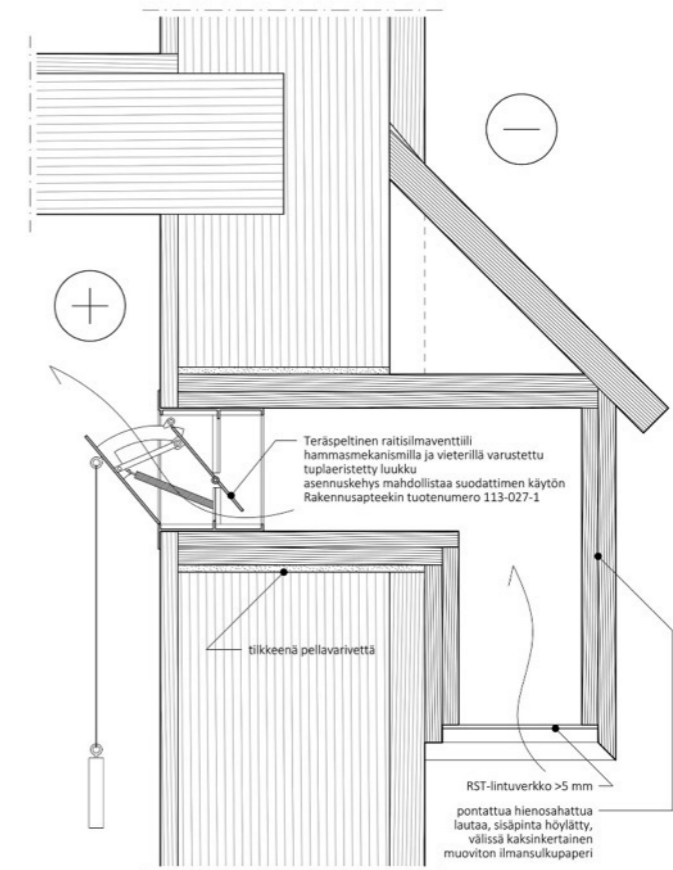
Atte Aaltonen

Erno Laakso

Iida Siponmaa



NEW EXAMPLES: HUOPALAHDEN ASUINKASARMI (meaning 'Huopalahti Residential Barracks')



Terraced house of 4 apartments
and 446 m²

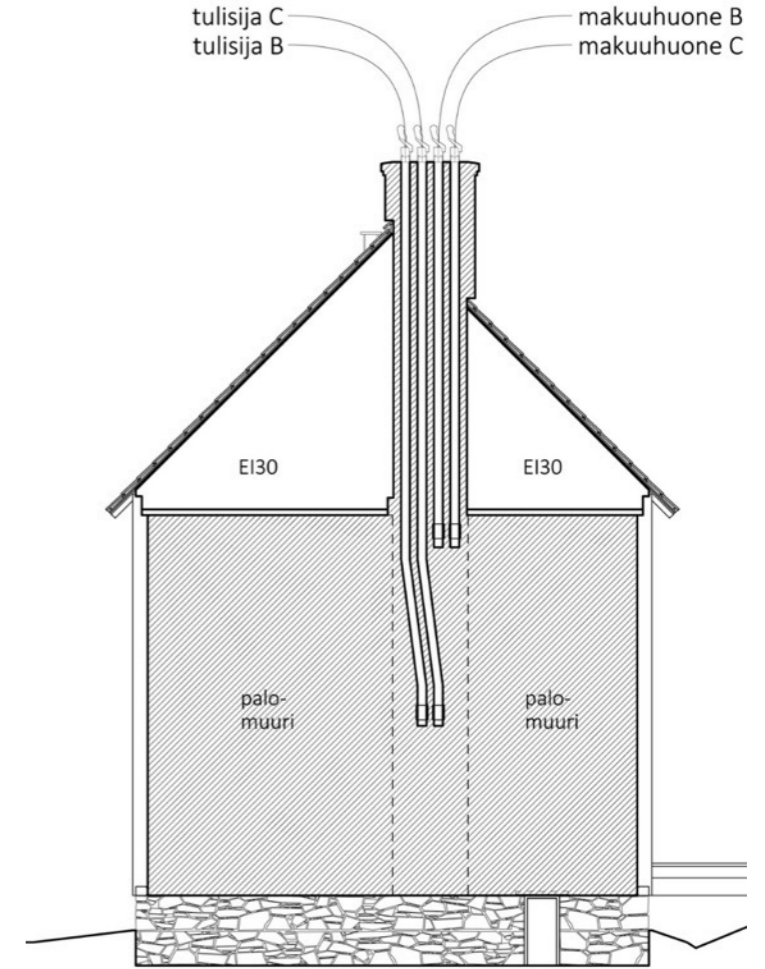
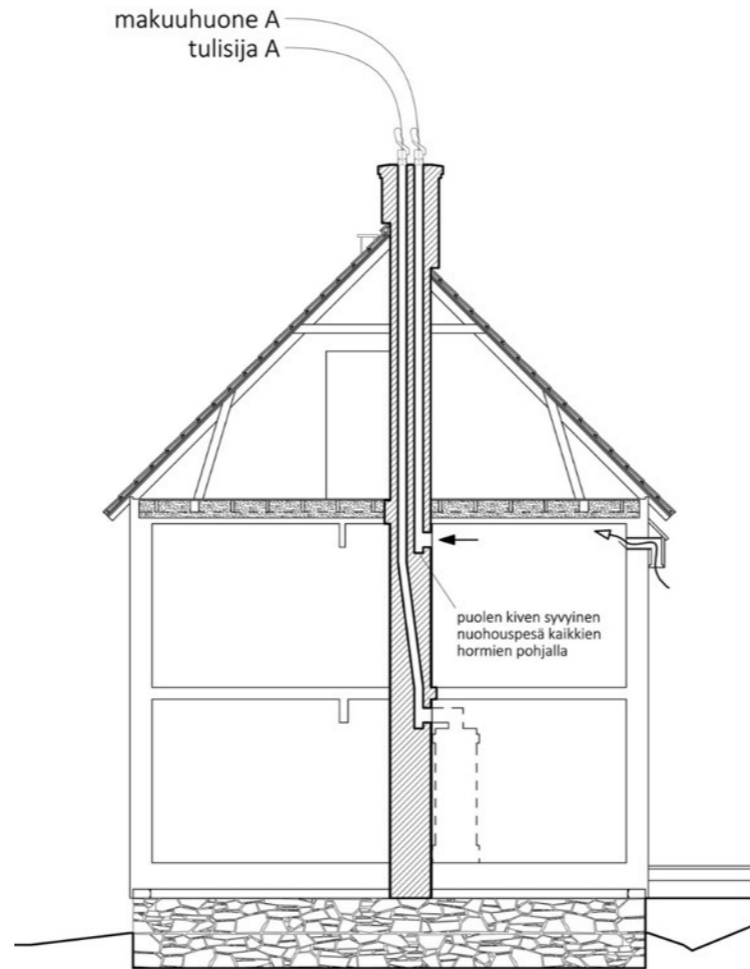
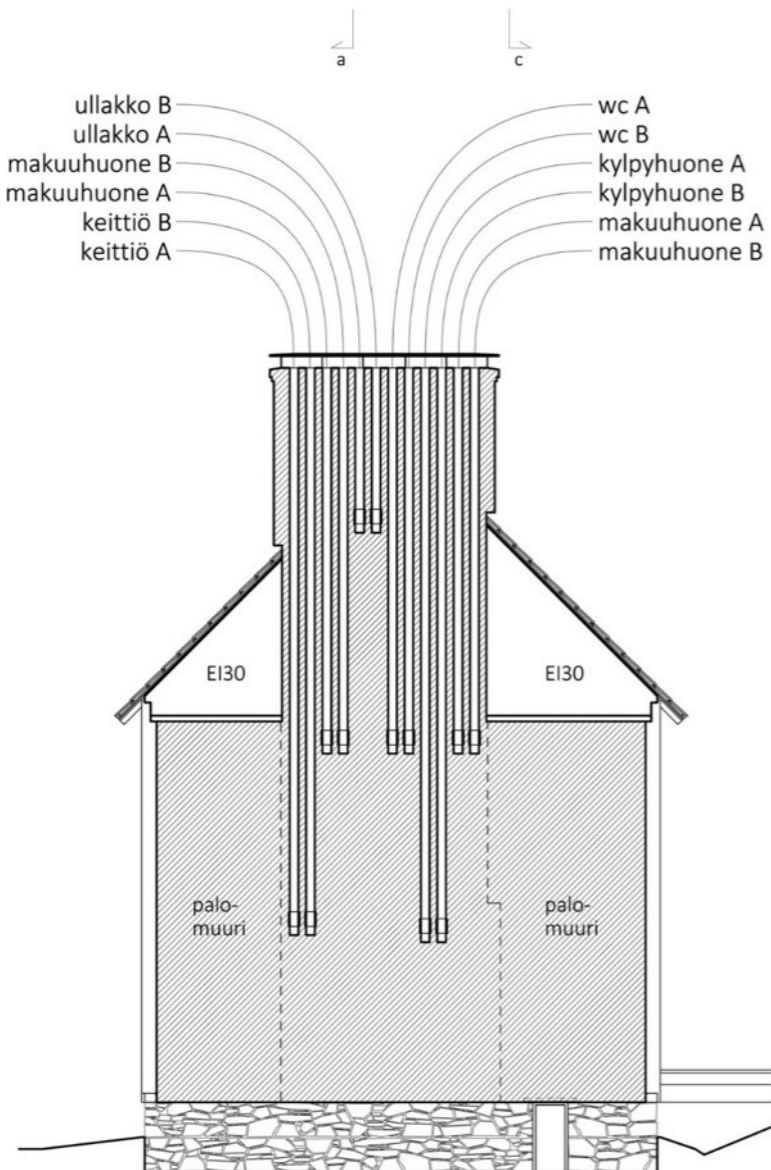
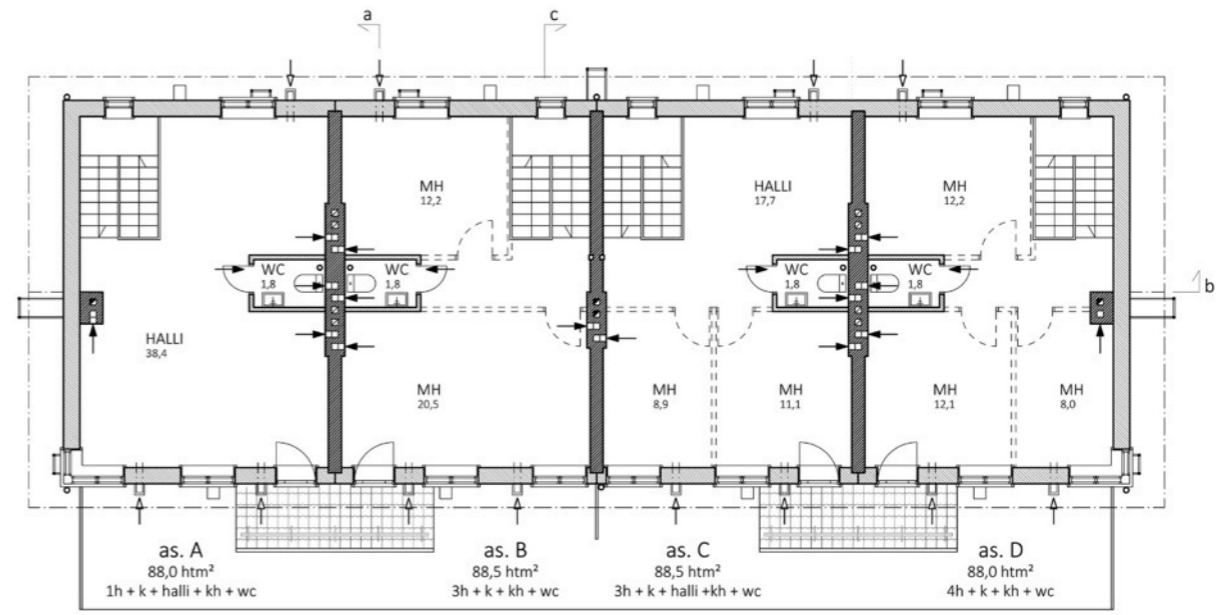
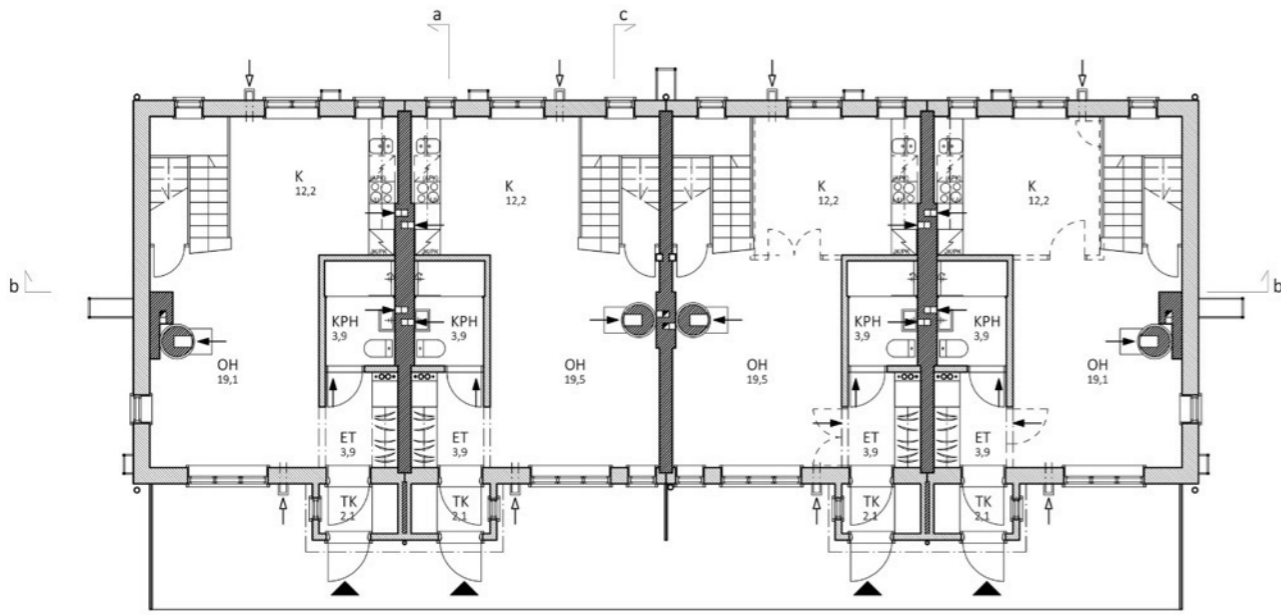
Helsinki 2024

Livady Architects, www.livady.fi

Juulia Mikkola

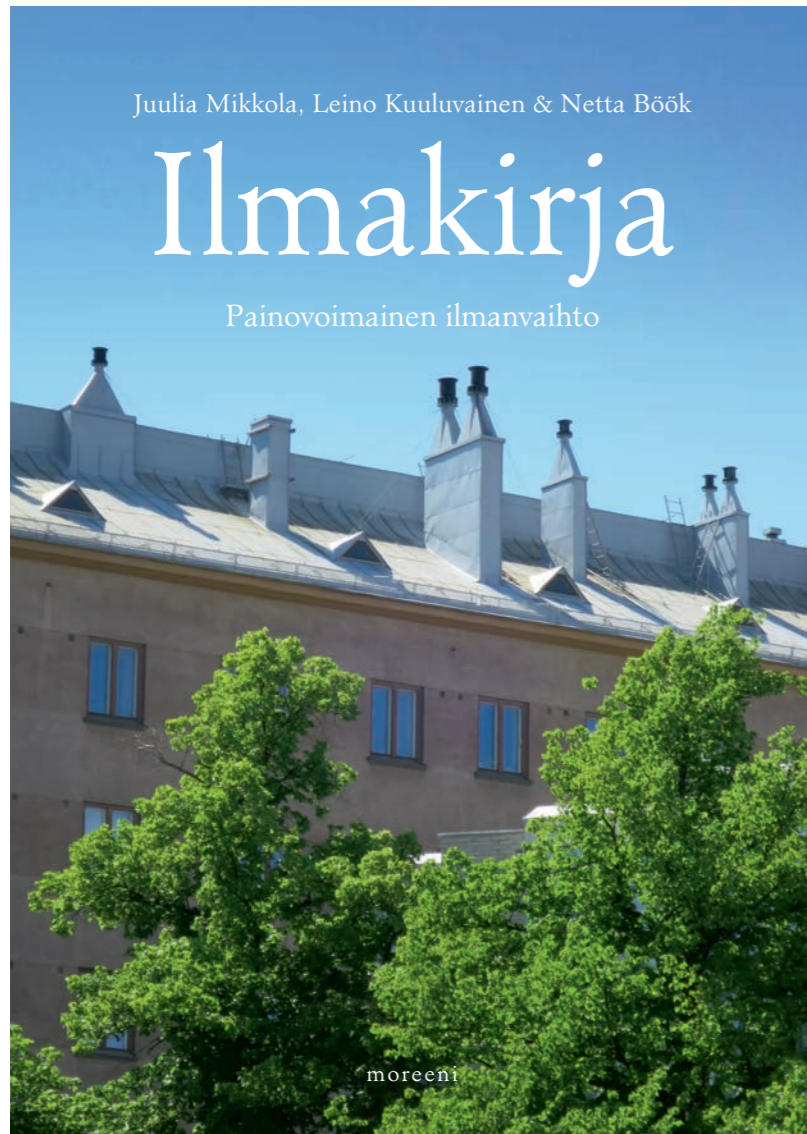
Lars-Erik Mattila

www.livady.fi





MORE INFORMATION ON NATURAL VENTILATION – IN FINNISH



<https://www.domusclassica.fi/sisustus-ja-lahjaideat/ilmakirja-painovoimainen-ilmanvaihto-juulia-mikkola-leino-kuuluvainen-ja-net/p/949-064-17/>

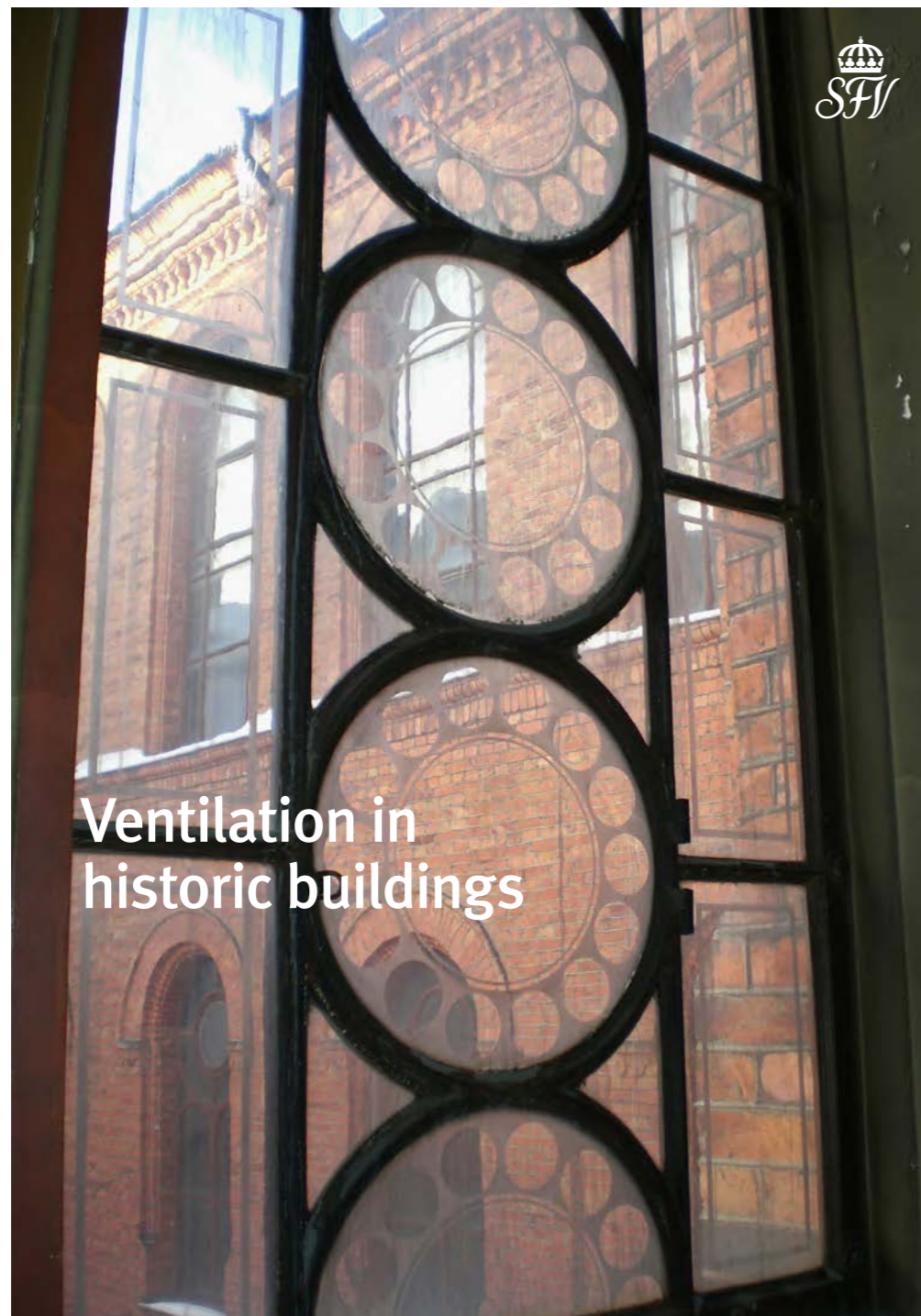


<https://ym.fi/rakentamismaaraykset>
Rakentamismääräykset
Terveellisyys
Muut materiaalit
Painovoimainen ilmanvaihto -opas



<https://www.korjaustaito.fi/fi/korjauskortit/painovoimainen-ilmanvaihto-1>

MORE INFORMATION ON NATURAL VENTILATION – IN ENGLISH OR SWEDISH



NATIONAL PROPERTY BOARD SWEDEN



STATENS FASTIGHETSVERK

<https://www.sfv.se/media/ky4ngp1e/sfv-ventilation-in-historic-buildings-2009.pdf>

<https://www.sfv.se/media/asgfhuc0/sfv-ventilation-i-aldre-byggnader-2009.pdf>