Vihaistenkari Day Care Centre, Finland

SF2

1 Photo

Figure 1: Vihaistenkari Day Care Centre

2 Project summary

The aim of this study was to develop solutions to the problems and deficiencies encountered in ventilation systems in day care centres. These issues manifest themselves during the maintenance stage of ventilation systems as poor indoor air quality or excessive energy consumption in the building.

In the renovation, the old mechanical exhaust ventilation system was replaced with a mechanical supply and exhaust ventilation system. The most important aim of the renovation work was to improve the quality of the indoor air.

Measurements of indoor air quality and questionnaires to personnel were made both before and after the renovation work.

3 Site

Finland, Raahe; latitude 64,7°N, longitude 24,5°E, altitude 10 m. Mean annual temperature: +1°C, mean winter temperature (December – February): -10°C.

4 Building description /typology

4.1 Typology / Age

Typology/Age	Pre 1910	1910–30	1930–50	1950–70	1970–
The main hall school					●

School grades: kindergarten (0-5 years), pre-school (6 years)

4.2 General information

Year of construction: 1973
Year of expansion: 1982
Year of the renovation of the roof: 1989
Year of renovation (as described here): 2001
Total floor area: 908 m^2
Total volume: 2790 m^3
Number of pupils: about 80 pupils
Number of groups: 4

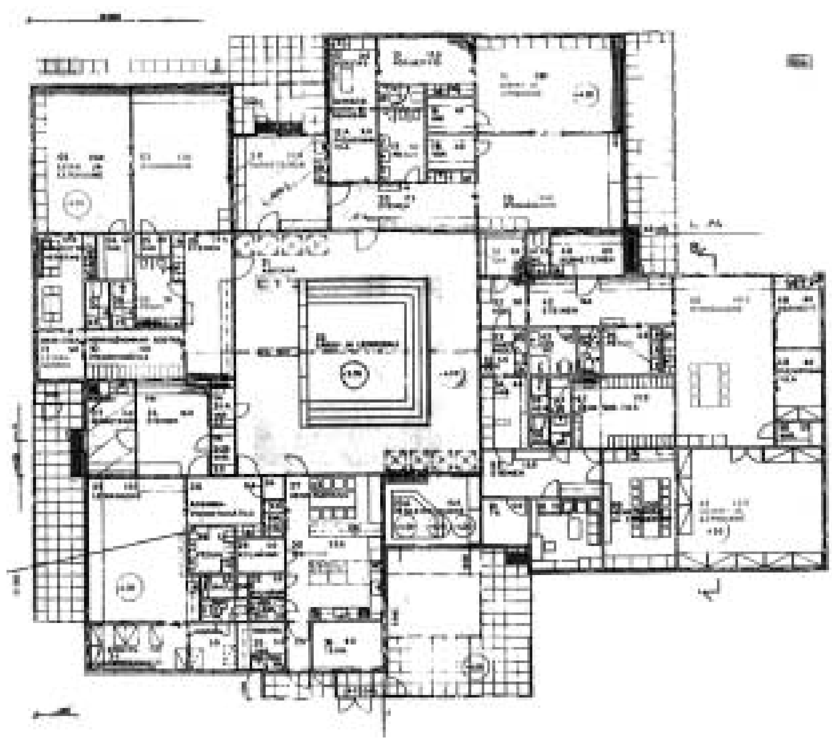
Typical class room
size: 33 to 42 m^2
number of pupils: 15 to 23

Hours of operation:
12 hours per day, 11 months of the year

The year of construction was 1973 and it is a typical example of a nursery schools of it`s era. The building was extended in 1982 and some renovation work was done in 1989. The ventilation system was renovated in 1989. The school type is a main hall school. The building retrofitted was a single storey timber-framed building. The ventilation system was renovated in 2001. The old mechanical ventilation system was replaced with a mechanical supply and exhaust ventilation system. The most important aim of the renovation work was to improve indoor air quality. The case study building was part of a larger multi-building project. No other retrofit measures were carried out during this project. The roof had been renovated in 1989.

4.3 Architectural drawings

Figure 2: Floor plan of the building



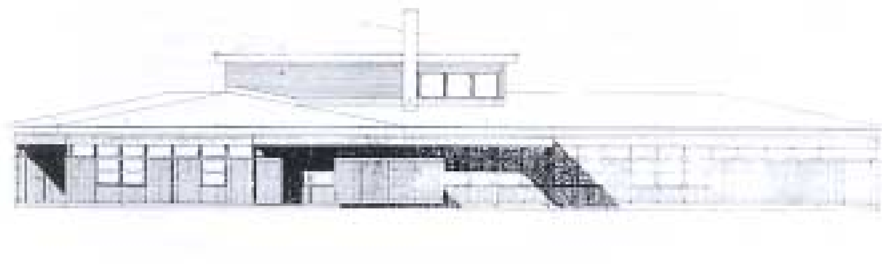


Figure 3: Vihaistenkari Day Care Centre elevation

5 Previous heating, ventilation, cooling and lighting systems

- central heating, radiators
- mechanical exhaust ventilation system

The building is connected to a district heating network. The ventilation system was a mechanical exhaust system. No cooling systems; lighting system was conventional; based on fluorescent tubes. No changes made in heating and lighting systems.

6 Retrofit energy saving features

6.1 Ventilation

- Mechanical supply and exhaust ventilation with heat recovery
- *Pre-heating of ventilation air:* yes
- *Heat recovery:* yes
- No cooling, no humidifiers.
- Air flows of rooms were calculated from guide values of the National Building Code of Finland:
- *Classrooms:* 5 l/s, person (20 persons)

When the outdoor air temperature is lower than –17°C , the air flow rate guide values for individual rooms may be temporarily reduced by no more than 50%, to lower the heating equipment heat output below the design rate (National Building Code of Finland 1987). The possibility to reduce the air flows was not in use in the studied day care centre after the renovation.

Consumption of heating energy

year	MWh	MWh (normalized)
1998	175.2	163.4
1999	168.3	165.8
2000	170.9	187.4
2001	190.2	186.5
2002	203.2	198.7

The heating energy consumption has increased. There are obvious reasons why the amount of heating energy has increased. When the ventilation system was renovated, no other repairs were done. From new, part of the supply air has been coming through leaks and untight areas of external walls. The heat recovery unit actually processes only part of the incoming air.

6.2 Renovation Costs

Not available

7 User evaluation

Questionnaires to teachers before and after the renovation

Percentages of teachers who suffer indoor air problems:

Symptoms	Before	After
Inadequate ventilation in winter, weekly	93 %	36 %
Stuffy air, weekly	87 %	29 %
Inadequate ventilation in summer, weekly	67 %	36 %

According to the results of the questionnaire, teachers and employees are very satisfied with the indoor air quality.

8 Experiences/Lessons learned

These results show that there had been problems before renovation and the main problems have been solved by the ventilation renovation. The indoor air quality has improved. The total energy consumption has increased, anyhow, because the air flow rates have essentially increased, and probably the system is not in balance and the building envelope is leaky (windows). These results show how important it is to design the renovation procedure taking into account all the factors which may affect the results.

One can see that after the ventilation renovation there was no tightening of the building envelope - the consumption of energy has been increased because of improved ventilation and leaks through windows. Probably the limited budget has prevented further measures in connection with the ventilation renovation, the ‘savings’ in other measures are offset by the increasing heating costs.

8.1 Impact on indoor climate

Quality of indoor air in classrooms before and after the renovation:

Measurements	Before	After
Maximum concentration of CO_2 during afternoon nap	1500–1700 ppm	650–750 ppm
Maximum temperature of indoor air	+24°C	+24°C
Increase of temperature during the measurement	1.5–2.5°C	1°C
Maximum of relative humidity of indoor air	34–39%	32–35%

8.2 Practical experiences of interest for a broader audience

Considering the Finnish outdoor climate, in order to guarantee good indoor air quality in classrooms and to reach high energy economy, day care centers in Finland generally, are equipped with mechanical supply and exhaust ventilation which also includes heat recovery from the exhaust air. This has been proven by measurements and questionnaires. There are other alternative design solutions, but in such cases the design and implementation must be carried out very carefully. The generally used ventilation system in Finland in old schools has been natural ventilation. The unsatisfactory IAQ has caused learning problems, and, in the long run, even moisture problems. To improve IAQ, the first step has generally been the change of natural ventilation to mechanical exhaust ventilation systems. This has led to high energy consumption and draft problems. The unheated fresh air flows from the air supply units or cracks, cooling down the structures (floors, windows) causing drafts. To achieve a suitable IAQ and optimum energy efficiency, new types of solution must be studied also. In practice, the communities which finance these improvements have limited resources and also (in some cases) lack expertise. The communities therefore cannot develop alternative design solutions such as natural or hybrid ventilation systems. In this project the objective was to show the level of IAQ and relative energy costs and how to improve them.

The plan must clearly state the number of people that the air flow rate is designed for. This should be communicated to and understood by the day care centre personnel and managers. Calculated surface area-based air flow rates should always be checked by comparing them to person-based air flow rates.

A sufficient ventilation rate should be maintained throughout the year. Based on the results, the quality of indoor air is poor in the children's rooms if the supply and exhaust air flows are only half of the recommended minimum value (currently 2 l/s per m^2 or 5 l/s per person). Hence, the ventilation system should be designed with more scope for variation, ie the supply and exhaust air flows per room should be higher than the minimum if ventilation capacity is halved in cold weather.

In order to achieve successful ventilation and good quality of indoor air, school building owners have to demand more detailed plans and calculations from designers and give them enough time to finish them properly.

Indoor air quality is not necessarily improved by merely increasing air flow. An architect's stipulations for positioning the air distribution can change the way air is distributed and therefore cause cool incoming air to settle in the occupied zone. Also, the effect of the way heat is distributed as well as the effect of the position of windows, lamps and furnishings should be determined to prevent complaints for example about draft or uncomfortable temperature conditions. The architect should also consider the space required by building technology systems.

Goals for the indoor climate of day care centres must be set early in the implementation process of day care centre ventilation so that the required life cycle calculations can be carried out. In the implementation process, additional resources should be reserved for examining alternative solutions, providing guidelines for the client plan and supervising implementation at the site.

When a new building is used, it should be ensured that ventilation functions adequately in all situations that can be anticipated to occur. At the maintenance stage, the functionality of the ventilation system should be checked regularly by measuring the quality and temperature of indoor air and the air flow rates in each room. Also, the ventilation system should be cleaned on a regular basis.

The results of the research were widely communicated via Finnish newspapers and broadcasting companies in August 2002.

8.3 Resulting design guidance

Design, implementation and client instructions for day care centre ventilation were compiled on the basis of observations and results from 19 day care centres studied in the first part of the research. In the second phase of the research compiled instructions were utilised and tested in new day care centres which were under construction as well as in old day care centres which were being renovated.

The guidance book named "Päiväkotien ilmanvaihto" (Ventilation of Day Care Centres) has been sent to all cities in Finland.

9 General data

9.1 Address of project

Vihastenkarinkadun päiväkoti,
Vihastenkarinkatu 19,
FIN-92130 Raahe

9.2 Project dates

Research project: 1999-2002
The first phase: 1999-2001
The second phase: 2000-2002

Measurements and questionnaires before the renovation: spring 2001
Measurements and questionnaires after the renovation: spring 2002

9.3 Date of report / revision no.

22nd January 2003

10 Acknowledgements

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Jalas, J. & Kimari, P. 2002. Päiväkotien ilmanvaihto. Helsinki: TAKE, Serie IAQ F, Report 61. (Ventilation of Day Care Centres)