Ordrup School

Improving high-level learning environment with automatically controlled roof windows

Ordrup School

Gentofte, Denmark

Facts

Ordrup School is a state school located in the municipality of Gentofte, approximately 10 kilometres north of the Danish capital of Copenhagen.

Ordrup School provides primary school education from first to ninth grade. The school also offers vocational courses for advanced students aiming for a career in medicine or biotech.

Before renovation

The Challenge

Poor air quality impaired learning.

A popular educational institution, Ordrup School, has been expanded with new buildings several times. However, until recently, the working environment for high-level students did not match the academic ambitions. Then former head master of Ordrup School, Jan Hansen, was regularly presented with complaints from users of the third-floor classrooms.

"Teachers and students alike complained about headaches and weariness. When you are in such a state, you aren't very productive - and you are certainly not very teachable," says Jan Hansen.

One of the employees experiencing the poor indoor climate was Michael Svensson. A teacher of geography and politics, he was forced to come up with his own solutions to the problems:
"Sometimes I simply asked the pupils to leave the classroom for a while," Svensson recalls, elaborating:
"When a large group of teenagers are sitting in a stuffy room, the result is best described by quoting Nirvana: it smells like teen spirit. And it was annoying."
Poor air quality was one part of the problem.

Another, just as impairing according to Svensson, was the temperature variations caused by irregular ventilation through the windows:
"Some pupils complained it was too hot, while others were freezing. The teaching was interrupted by the indoor climate," Michael Svensson says. He felt that the poor air quality was weakening his ambitions to teach complicated issues:
"The pupils quickly lost their concentration. I myself got tired too. It is difficult to explain the power distribution of parliamentary systems, when everyone is weary."

Before renovation

A Solution

Natural ventilation with automatically controlled windows

As the indoor climate problems on the third floor became increasingly impossible to ignore, then former head master Jan Hansen looked to the municipality for help. At first, they considered installing a mechanical ventilation system.

"But it turned out to be very expensive," Jan Hansen recalls.
Then they came up with the idea of contacting VELUX Denmark.
"Partly because we heard they had made a good job of rebuilding a school in a northern municipality," Jan Hansen says.

Accompanied by municipality officials, he visited the VELUX architects.

"During our dialogue with them, the idea of a natural ventilation solution took shape. It made much more sense than mechanical ventilation. Additionally, it provided us with the opportunity to enlarge some of the windows, thereby improving the light conditions in the classrooms and allowing for a better view of the surroundings," Jan Hansen says.
In February 2015, the municipality decided to embark on a rebuilding with natural ventilation.

The chosen solution included:
Installation of 27 VELUX Integra roof windows, distributed between five classrooms and a hall.
Control pads in each of the classrooms.
Enlargement of around half of the windows, creating a small glass area beneath the roof window.
Installation of platforms with backrests in the sills of the enlarged windows.

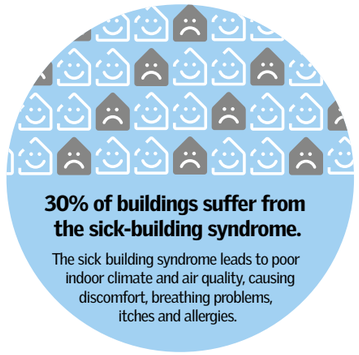
Learning environment

Improved concentration and new opportunities

Complaints of headaches and weariness were the main reasons for the rebuilding of Ordrup School's third floor. With the implementation of automatically controlled windows, the factors causing the problems have been eliminated:
"The result is very satisfying. We see improvements in temperature and CO_2 levels, and consequently a good learning environment," says municipality engineer Tine R. Jensen says. She was construction supervisor of the rebuilding.

For the pupils and teachers using the third floor, the poor indoor climate has been replaced with a feeling of general well-being:
"The air feels better now, and you don't get that damp sensation anymore," teacher Michael Svensson says, adding that the pupils have felt the benefits of the improved indoor climate too:
"In my experience, they are more calm and relaxed now."

The pupils themselves emphasise the time-saving factor of automatic ventilation. Previously, they spent a lot of time opening and closing the windows manually:
"Now, you only need to raise your hand to ask the teacher to activate the windows," 8th grader Sigrid says.



30% of buildings suffer from the sick-building syndrome.

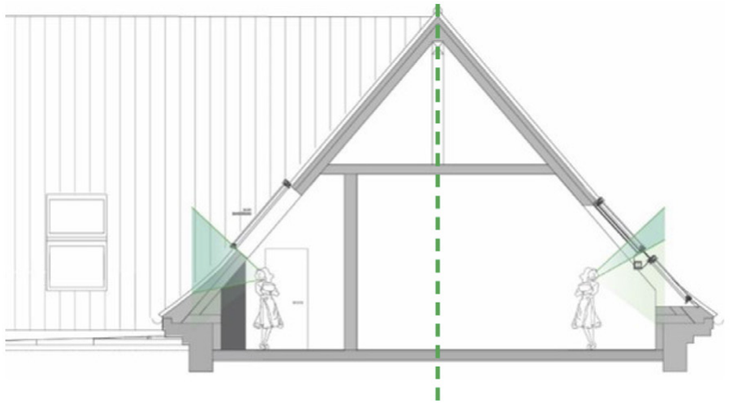
The sick building syndrome leads to poor indoor climate and air quality, causing discomfort, breathing problems, itches and allergies.

Old rooms, new feeling

Improving the indoor space quality encompassed addressing the access to a clear view, as the windows were originally located too high. The roof windows were therefore lowered , improving the connection with outdoor views, and allowing the windows to be used as escape exits as required by the Danish building law.

As part of the rebuilding, around every second window has been enlarged and equipped with a small bench beneath. 8th grade pupil Rebecca enjoys sitting by the window when she is doing school work or having a break between lessons: Overall, it is just a very good initiative," Rebecca says, while teacher Michael Svensson uses the windowsills in a new way:

"Sometimes, during lessons, I sit there and take my shoes off. Then I place my feet on the wall. That makes teaching more informal. School is already quite rigorous, so sometimes, I believe you need to do something out of the box."



Comparing old roof windows (left) with new VELUX roof windows (right)

Indoor climate

A good indoor environment that is controlled by generous daylight levels and fresh air from outside is a key to having healthy schools, and improving the children's learning ability.

Many studies have shown that poor air quality reduces mental performance, while good air quality improves it. Pupils thus learn faster and work more accurately when fresh air is supplied.
Increasing the window opening areas to suit the number of pupils and the floor area is essential to ensure an efficient natural ventilation system.

To ensure a well performing natural ventilation system for a classroom, the ratio of the window opening area to the floor area and number of pupils is a key design parameter. As much opening area as possible should be achieved.

The ventilation performance of a typical classroom in Odrup School has been studied using the number of hours when CO_2 level exceeds the recommended level of 1,000 ppm.

Parts per million (ppm) is the common way of expressing dilute concentrations of substances such as CO_2 in the air. CO_2 is a good indicator of the indoor air quality in classrooms, where the pupils and their activities are the main source of pollution. Outdoor air contains approximately 400 ppm.

Breathing generates CO_2, so the indoor CO_2 concentration will always be at least 400 ppm and usually higher. An indoor CO_2 level lower than or equal to 1,000 ppm indicates a good indoor air quality in most situations.

The graph on page 12 shows the number of hours with CO_2 levels below 1,200 ppm obtained for two classrooms that are highlighted in the left plan. It shows an improvement for 96% of the year for classroom one, and 100% in classroom two.

When the CO_2 level reaches the first setpoint, the window is fully opened until the next setpoint is reached.

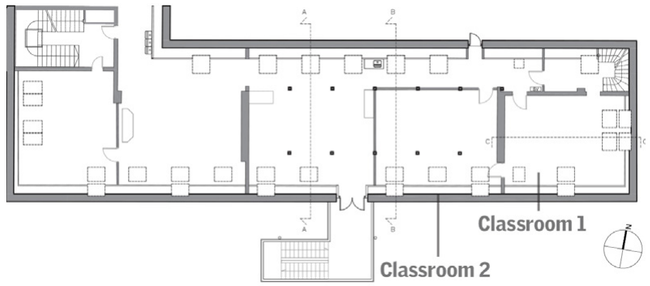
A separate monitoring system used for collecting indoor air quality and thermal comfort data is installed in each individual classroom so that VELUX experts can follow, learn and adjust the system based on short- and long-term results. Teachers and students can also use this directly in learning programmes by simply analysing the measurements on tablets or smartphones and creating simple diagrams of monthly or annual results. They can observe and analyse data about indoor and outdoor air temperatures, CO_2 levels, humidity and noise levels.

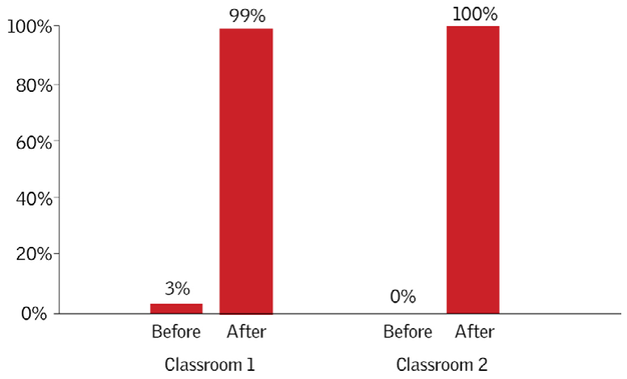
Improving the fresh air provision using VELUX products also affected the indoor thermal comfort levels in the classrooms.

2-4 airings a day is all it takes to achieve optimum indoor air quality.

Fresh air

Demand-controlled natural ventilation in the classrooms was achieved by installing VELUX roof windows that are automatically controlled by control pads and CO_2 sensors in each classroom. The roof windows open automatically and close again when minimum CO_2 set point is achieved or if it rains. In the event of rain and high CO_2 levels, fresh air is supplied through the flap in the upper part of the roof windows. This solution allows very high indoor air quality to be achieved and ventilation to be adjusted according to the number of students and their activity.





Percentage number of hours with acceptable CO_2 levels (below 1,200 ppm).

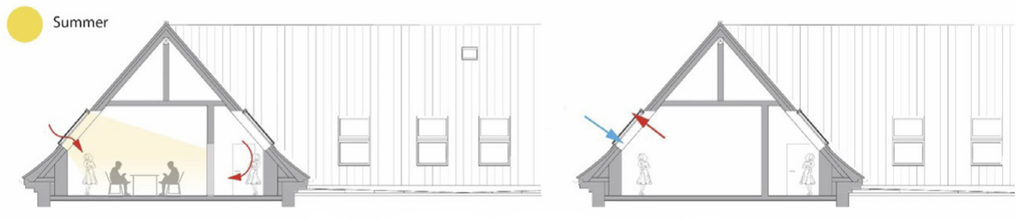
Thermal comfort

Improving the thermal comfort level in the classrooms was also important, as it was poor in the existing building.

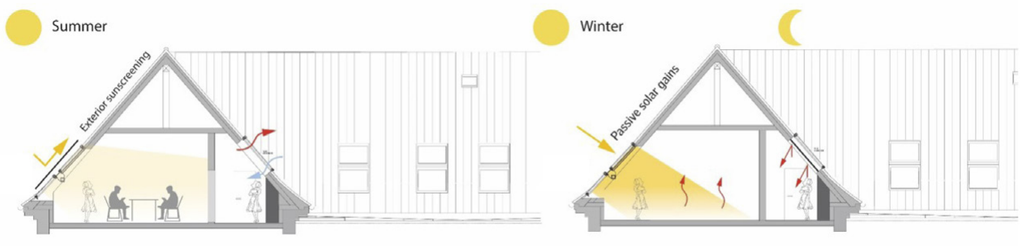
In the summer, there were overheating problems due to insufficient ventilation, difficulties with operating awning blinds and no possibility for night cooling.

By using VELUX products, automatically controlled exterior sunscreening would help to prevent excessive solar heat gains in the summer. Manual control of interior blinds would also provide the possibility of adjusting daylight levels according to the needs of teacher and pupils. Moreover, automatically controlled ventilation contributes to decreasing the temperature and also allows night cooling.

In winter on the other hand, automatically controlled interior sunscreening would help minimise heat losses at night, and larger glazing surface would allow higher passive solar gains during the day.

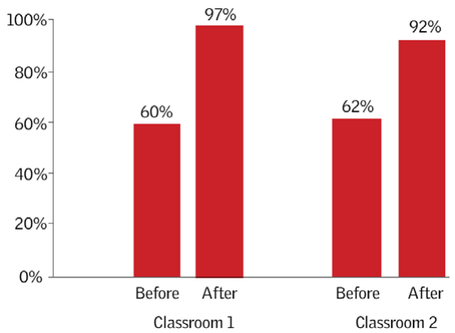


Existing classroom before using VELUX products

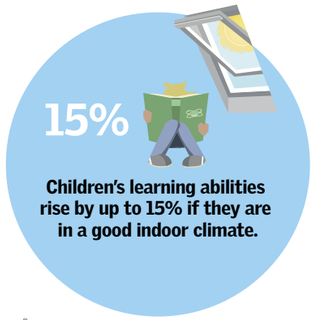


Using VELUX products improved the thermal comfort in classrooms during both summer and winter

Simulations for thermal comfort levels were made both for the existing building and for the proposed changes. The graph on the right shows the total percentage of hours that is within the acceptable comfort levels for the whole year for the two classrooms. Installing the roof windows shows an improvement in the indoor thermal comfort in both classrooms.



Daylight factor



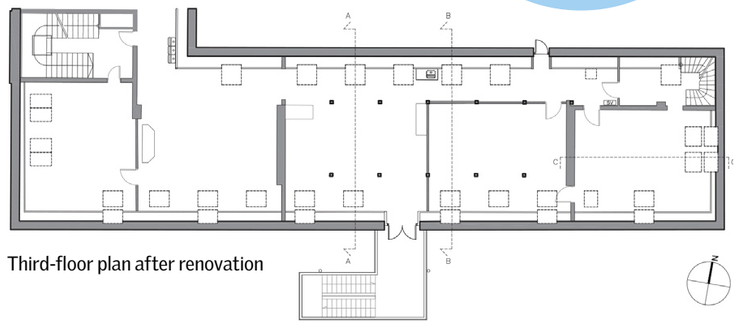
Daylight is essential for our circadian rhythm, has a positive impact on our well-being and performance, and provides pupils and teachers with a better learning environment. Studies have shown that good daylight provision in a space increases children's learning ability and wakefulness during the day.

In addition, optimised and controlled use of daylight reduces the need for artificial lighting and provides useful solar gains during the winter period. Accordingly, implementing the intelligent use of daylight and shading devices can significantly help to reduce a building's energy consumption.

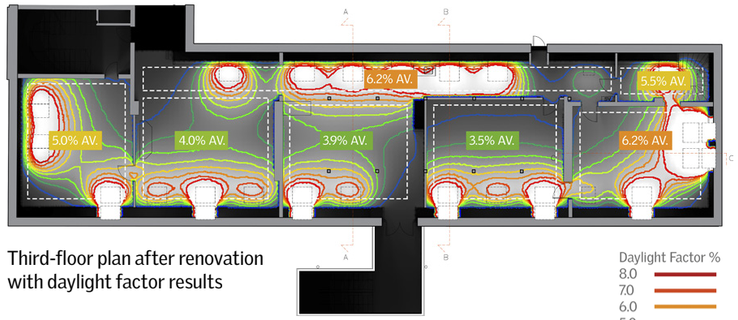
The decision on the number and type of VELUX products to be installed was, in this case, dependent on the simulations of indoor climate and thermal comfort, as they were the primary concerns. But daylight provision was also simulated and then compared with acceptable thresholds. The daylighting performance of Odrup School was evaluated using the daylight factor (DF) as performance indicator.

The daylight factor is a common and easy-to-use parameter for the available daylight in a room. It expresses the percentage of daylight available inside on a work surface compared to the amount of daylight available outside the building under known overcast sky conditions. An average DF below 2% generally makes a room look dull and electric lighting is likely to be frequently used, whereas an interior will look substantially daylit when the average DF is above 5%.

The figure on the right shows the daylight levels in the school, thus portraying the impact of the installed roof windows on the final design. The average daylight factor in the classrooms range between 3.5% and 6.2%, which is considered a good range.



Third-floor plan after renovation



Third-floor plan after renovation with daylight factor results

Simulations were made by the VELUX Daylight Visualizer 2, a software tool dedicated to daylighting design and analysis. For more details and download, visit http://viz.velux.com.

Installation phase of the roof windows

VELUX Products

used in Ordrup School

VELUX INTEGRA® roof windows

If you want ultimate comfort, VELUX INTEGRA® is the answer. This innovative system of remote controlled windows, blinds and shutters lets you open and close with just one touch of the control pad. VELUX INTEGRA® is the ultimate choice for fresh air and better indoor comfort.

Exterior sunscreening
- electrically operated awning blinds

Offer great heat protection, view out and light in due to the transparent cloth.

Model MML.

Interior sunscreening
- electrically operated blackout blinds

Elegantly designed VELUX blinds for easy control offer a lightproof seal for total darkness at any time. Ideal when you need complete daylight control.

Model DML

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