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Refurbishment of the Louise Labe Secondary School, France

1 Photo

Figure 1: View of the building from the patio

2 Project summary

Project objectives:
The project is aimed at enlarging the built area and reorganizing spaces in order to unify teaching areas, to refurbish the general aspect of the building, and to correct acoustics, thermal conditions and access for physically handicapped people.

Short project description:
The school is located on a large green site (part of which is classified as of special ecological interest. It was originally made of 2 linear L-shape buildings with concrete façades, like most constructions of the 1950's and 1960's. The new building has the following main features:

- an enlarged block (2 floors) along the main road with a central corridor;
- a central open garden ("patio") around which are distributed the added rooms at the first floor (especially the large workrooms for dress-making) and whose ground floor is used partly as a covered playroom; and
- an extension of the building to connect with the gymnasium.

Stage of construction:
Works were finished in February 2001.

3 Site

France, Lyon, latitude: 45.8°N, longitude: 5°E, altitude: 170 m.
Mean annual temperature: 11.5°C, mean winter temperature: 5.6°C from 1/10 to 20/05, DD = 2528 (base = 18°C).

4 Building description /typology

4.1 Typology / Age

Typology/Age	Pre 1910	1910-1930	1930-1950	1950-1970	1970-
The central corridor school				●	

School grades: Secondary school for technical teaching

4.2 General information

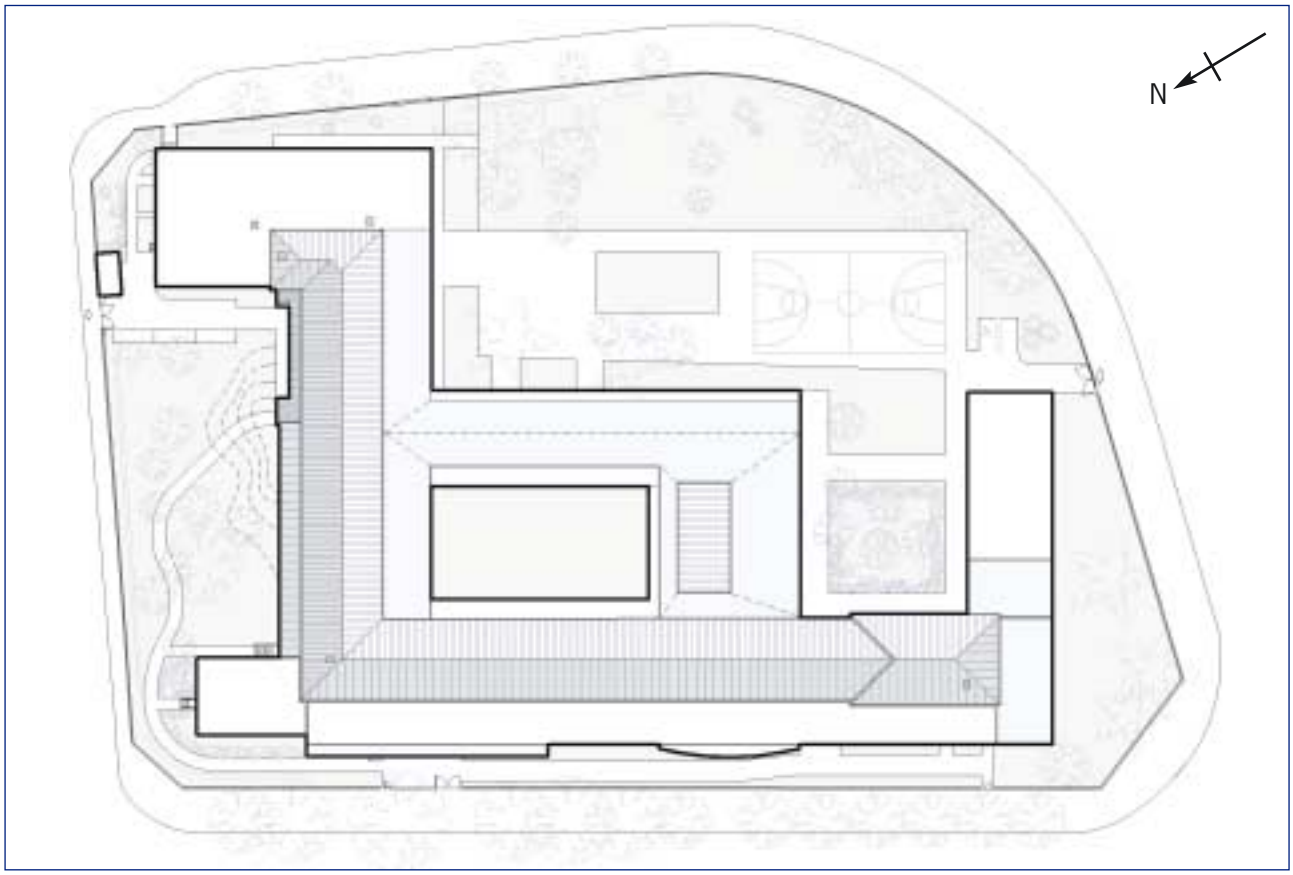
Year of construction: 1953, refurbishment of the heating system in 1987
Year of renovation (as described here): 2000
Total floor area (m^2): area has been extended from 5000 m^2 to 9000 m^2
Number of pupils: max 600

Typical class room:
size (m^2): 60.8 m^2
window/glass areas (m): 17.8 m^2
number of pupils: 30 (24 to 32)

Hours of operation:
Administration 8h per day, 5 days a week (plus a Saturday morning every 2 weeks)
Library : 8 hours per day, 5 days per week
Classrooms: 27 hours per week on 5 days
Kitchen: 9:00 am to 3:00 pm 5 days a week.

4.3 Architectural drawings

Figure 2: Site plan



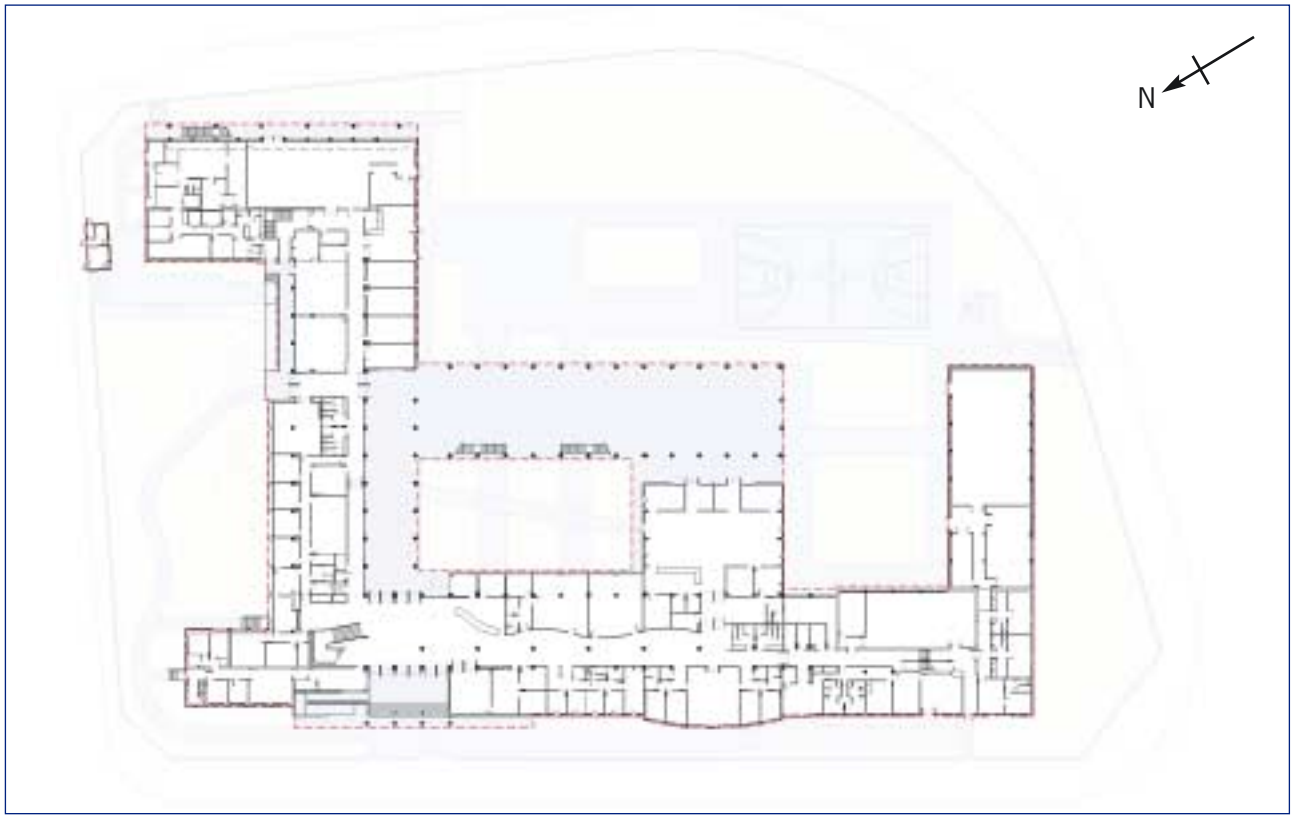


Figure 3: Ground floor plan

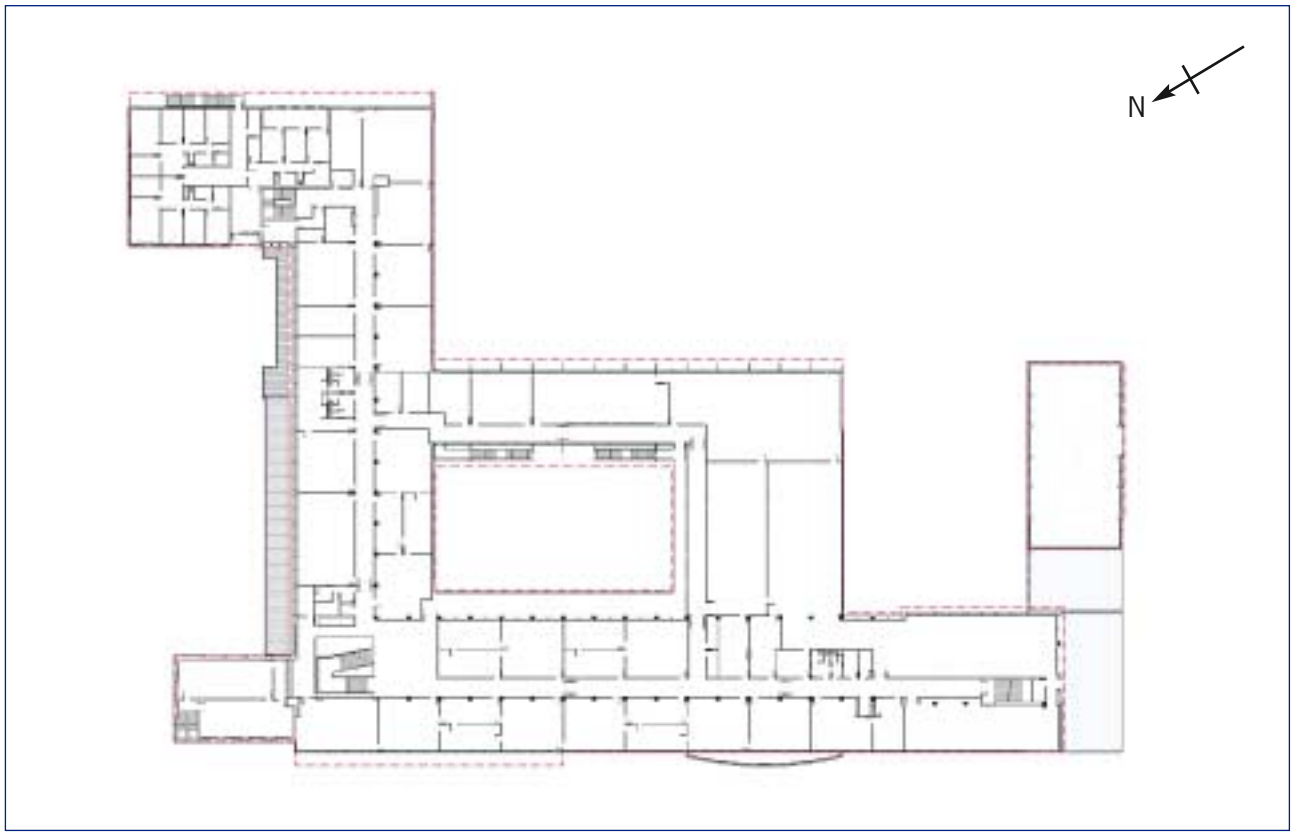


Figure 4: First floor plan

Figure 5: *Right:* Patio before refurbishment
Far right: Patio after refurbishment

5 Previous heating, ventilation, cooling and lighting systems

The heating system was a central hot water distribution system, with radiators and 3 oil-fired boilers. One of the boilers was changed in 1987 as well as the controllers. There was no mechanical ventilation system, air renewal being only by opening windows. The building envelope was in a poor state as it appears on the photograph above. Moreover, new educational programs required a refurbishment of the classrooms, incuding the electrical system and the computer network. The library also was located in an old classroom and suffered from lack of daylight.

6 Retrofit energy saving features

6.1 Energy saving concept

Energy saving was not the main aim of this project but energy conservation for space heating should be achieved thanks to better insulation of the envelope, weather stripping of windows and the increase of daylighting in general and particularly in some rooms (eg the library and circulation spaces).

6.2 Building

Wall insulation is 8 cm glasswool plus 4 cm polyurethane on the lightweight façades and 8 cm polystyrene for masonry walls (U value = 0.47W/m^{2}K or 0.43 W/m^{2}K).
Roof insulation is 20 cm glasswool (U value = 0.39 W/m^{2}K).
Replacement of single-glazed windows by double-glazing (4/12/4) with aluminium frames but low thermal bridges (U value = 4.3 W/m^{2}K).

6.3 Heating

The oil boilers have been replaced by a heat exchanger on the district heating service. Hot water is distributed to the rooms at a variable temperature depending on the zone of the building. Ducts are insulated with 3 cm glasswool. Radiators with thermostatic valves contribute to the heat diffusion at a controlled temperature in the main part of the building. In the entrance hall, heat is by 3 fan assisted convectors inserted into the suspended ceiling. In the library an underfloor system provides the base heating. In the theatre, a displacement ventilation system provides either heating or cooling from an air handling unit.
Domestic hot water for the kitchen and the lavatories is also produced by the heat exchanger through an intermediate storage vessel. A Building Management System is installed to manage heating, ventilation, alarms and maintenance.

6.4 Ventilation

For general teaching classrooms, a minimum ventilation flow is provided by mechanical ventilation. Additional needs are covered by manual opening of the windows. Air inlets are located in the upper part of the windows and air outlets at the opposite wall. Fans run under the control of BMS set according to the hours of occupation.
Mechanical extract ventilation in the lavatories runs continuously. When gas is used inside a teaching laboratory, extract ventilation is provided. In the kitchen, a balanced ventilation system is installed. There is no air treatment to cool, dehumidify or preheat air to the classrooms and the offices. Only the theatre is equipped with an air handling unit (heating/cooling), with large diffusers at the bottom part of the room and ceiling mounted air outlets to extract pollutants.

6.5 Lighting

Natural lighting is largely provided through highly glazed façades (ratio glazings/façade=0.79). Windows are equipped with roller blinds (ground floor) or outdoor screens (first floor) and horizontal solar protection in the form of aluminium fins is installed on east, west and south facades. In the workrooms of the first floor, light-shelves provide lighting from above.
In the classrooms, artificial lighting is provided by ceiling mounted luminaires with fluorescent tubes (4 x 18W), plus blackboard lighting (tubes of 58W). In other rooms and corridors, ceiling inserted spots with compact fluorescent lamps (2x18W): 50 of these are controlled by 5 switches and, 242 in the corridors are controlled with time switches by the BMS.

7 Resulting Energy Savings

From the energy bill, the average energy consumption for years 1995, 1996, 1997 was:

Heating

Oil: 726 hl (722370 kWh) for the space heating and domestic hot water
Natural gas : 148 902 kWh mainly for the kitchen

The average consumption ratio for heating was 174 kWh/m^2.y before refurbishment.

Other uses

Electricity: 120418 kWh (24 kWh/m^2.y)
Natural gas: 7755 kWh
Water: 1717 m^3

Energy consumption after present refurbishment for 2001:

Heating

District heating: 838 000 kWh

The consumption ratio for heating was 93 kWh/m^2.y for the first year after refurbishment.

Other uses

Electricity: 284392 kWh (31 kWh/m^2.y)
Natural gas: 6363 kWh
Water: 1355 m^3

8 User evaluation

Occupant satisfaction regarding the refurbished building was studied with a questionnaire. The surveyed sample included 4 teachers and 24 students, but no administrative staff.
Analysis of the answers shows that:
About indoor air quality, students complain about insufficient ventilation:

In general terms: Sensation of enclosed space for 70% people, 80% feeling dusty
Dry, humid, smelly, etc.: Strong smell sometimes for 50% people
Irritations (eyes, nose, throat, skin): none

About thermal comfort, there is sometimes some problems of low/high temperature probably linked to the control of the heating system:
In general terms, the level of temperature is good for 30% of the occupants, and acceptable for another 40%
Overheating problems for 80% people in the afternoon and 50% in the morning
Coolness feeling for 80% people in the morning

About the quality of daylight and artificial light: Overall satisfaction, less than 30% have quoted that there is sometimes a problem of insufficient lighting of blackboards or annoying glare.

About acoustics: No problems were reported about the equipment, but some dissatisfaction relative to noise insulation between rooms or between rooms and circulation spaces.

The general responses of the surveyed occupants focus on:
General well being: tiredness is quoted as happening often (70%) or sometimes (25%)
Headache: 40% often, 40% sometimes
Difficulty to concentrate: 45% often, 40% sometimes
Eyes irritation or burning: 60% sometimes
Throat irritation or dryness: 50% sometimes
Usually these symptoms are not associated with the school building, except headache and tiredness.

9 Renovation costs

The global cost of this project was 62,3 MF (€9,5 million).

Envelope	*Building works:* €4,700,000
	Windows: €690,000
Systems	*Lighting and electrical appliances:* €600,000
	HVAC: €790,000
	Building Management Systems: €75,000

Approximate increase in cost of project
due to the discovery of asbestos: €37,000.

10 Experiences/Lessons learned

10.1 Impact on indoor climate

Thermal: Regarding the temperature, the set point design temperatures as designed are not fulfilled, especially the set-back temperature seems to be too high in the classrooms and the circulation. The building is largely glass, which improves daylight penetration but causes some discomfort due to summer overheating.

Humidity: The temperature seemed to be too high in the classrooms. This probably reduces the relative humidity, resulting in a relative humidity of 30%, which is too low and could cause discomfort.

IAQ: Problems of strong smells were reported by the people surveyed, and the CO_2 concentration recorded in two rooms showed that levels specified for comfort were exceeded during lessons. This is a result of the mixed ventilation

strategy used in this school (half air change by mechanical ventilation and, half by opening windows). The Building Management System is not fully used and there are not efficient ventilation strategies in the different spaces.

Drafts: In the entrance hall, the supervisors desk is not protected against drafts leading to uncomfortable conditions.

Artificial lighting: Calculation of the electricity consumption due to lighting of circulation spaces during an 8 hour-day and 33 weeks a year gives 11500 kWh, which is about 10% of the total electricity consumption.

10.2 Practical experiences of interest for a broader audience

Good: Landscaping integration of the new project, interior design of spaces.
Bad: No daylighting in the circulation spaces which leads to a significant increase in electricity consumption.
The BMS installation is not completely well operated by users
Solar controls are not effective enough in preventing summertime overheating.

10.3 Resulting design guidance

Occupancy sensors for artificial lighting could be used in the circulation spaces.
To take full advantage of a BMS, the operating staff must be able to read all the indicators of the building facilities, and to adjust and control technical parameters (HVAC). Efficient operation of a BMS requires training according to the user's needs.
Combination of a movable outdoor shading device and an indoor light blind offers best opportunities to control solar gains all year round.

11 General data

11.1 Address of project

Lycée L.Labé
Boulevard Yves Farge
69007 LYON
FRANCE

11.2 Existing or new case study

Project initiation: First project received in December 1997 - Design *completed:* October 1998
Renovation construction completed: September 2000 for classrooms and February 2001 for the restaurant
Monitoring and evaluation completed: March to May 2001

12 Acknowledgements

Builder: Region Rhone Alpes
Architect: P.Boinay
Authors (of this description): V. Richalet, N. Adra, R. Cantin - LASH/ENTPE.

13 References

None provided