

## The importance of introducing the study of original technical devices in the 20th century architectural heritage, for a well-reasoned conservation approach

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### ABSTRACT

One of the main characteristics of the twentieth century buildings is the integration of more or less complex technical devices during the architectural design. Those devices: heating ventilation, water systems, became obsolete quicker than the other parts of the buildings as the structure or the facades. This condition makes more complex the archaeological knowledge for the conservation, because often the technical devices in use or in place, when the renovation of the building is planned, had nothing to do

with the original systems. All those different successive technical devices installed interfere or even contradict the interpretation of the original design. A well-reasoned restoration should introduce the study of the technical devices (throughout archaeological tracks and archives, backward and forward) with the other historical researches on the buildings of the 20th century architectural heritage; especially when those systems influenced the comfort and its perception. We will show the importance of the approach through those cases: the Aalto's Viipuri's library, the Le Corbusier's 'Cité de Refuge'.

The different cases presented come from different type of research or professional opportunities. I visited the Aalto's Viipuri Library when, in September 2003, a seminar of Docomomo Technology occurred there<sup>1</sup>. And last year, I had the opportunity to assess the heating and ventilation system of the 'Cité de Refuge', for the architect in charge of the forthcoming restoration<sup>2</sup>. With those two different cases, I want to show the importance of applying the history of building thermal performances to history of architecture, especially for restorations<sup>3</sup>.

### THE RADIANT ROOF OF THE VIIPURI LIBRARY

The municipal library of the city of Viipuri was built in 1933-35 by Alvar Aalto after a competition in 1927. After WWII and the annexation of the city by the Soviet Union,

and bombing, the building stayed abandoned and opened during ten years. In 1955-1961, the architect A. M. Shver rebuilt the library, with a result criticised by Aalto itself. A new restoration program started in 1991, a joined initiative by the Finish Ministry of Environment, Aalto architects and the Russian Authorities with original archives available. One of the most remarkable restorations was the roof skylights in 2002.

The architect Alfred Roth, a close friend of Alvar Aalto, published about the library in his book 'The New Architecture' in 1939. He provided many technical details: 'The following rooms are heated by ceiling panels: loan department, reading room, periodical room, newspaper room, children's library and entrance hall. The other rooms, including the lecture room, are heated by ordinary radiators' (ideal standard "Classic" radiators).<sup>4</sup> According to Roth the engineer C. Rosenqvist was in charged of the

heating and ventilation systems. Radiant heating from above was indeed appropriate for the building's function, since the walls are covered with bookshelves and cannot be equipped with radiators<sup>5</sup>. At the time of the building's construction, radiant heating was recommended by thermal engineers for places where people did exert any physical activities, such as libraries, even if this advice was theoretical in the thirties when such systems were infrequent<sup>6</sup>. On the basement plans, one can see a heating chamber with three boilers and another room with three pumps, as well as a large storage for coal and a chimney in the corner of the reading room's terrace. The unusual thickness of the external walls (75 cm) permitted insulation (without more details) and the passage of ventilation conduits (glazed stoneware pipes) and rainwater downpipes. The plans show two kinds of ventilation ducts: small round ones for fresh air coming from the roof, and larger rectangular ones for the air coming from the ventilation plant. The openings of these last conduits are visible on the pictures of the reading and the periodical room at the upper level of the external walls. A freehand sketch reproduced, in the Getty Foundation Report, illustrates the circulation of the fresh air from the vent at the upper level of the walls to other registers not shown on original pictures but that may have been inserted into the bookshelves<sup>7</sup>. We do not know if the air was lightly heated in the basement before circulation although radiant heating was sufficient to maintain comfort with fresh air<sup>8</sup>.

### **THE DESTRUCTION AND RENOVATIONS**

No particular information exists about the destruction of the heating and ventilating systems. As the foundations are intact and the inner and outer brick walls slightly were only slightly damaged, it is possible to imagine that this system was still present: forty percent of the concrete roof was destroyed and it is possible that the pipes inside were damaged. The transcription of a discussion between A. M. Shver, T. V. Svetelnikova and Finnish Committee for the Restoration of the Viipuri Library in April 2002, gave some information on the condition of the heating system 'I don't see much of a problem regarding heating. Of course, all the pattern was taken down and all pipes in the ceiling were partly repaired. Anyway, they were installed where Aalto had them, according to the pattern of his pipes. Plaster was taken down<sup>9</sup>'. During this meeting, A. M. Shver pointed out that the heating room was still functioning in the sixties. Today, the building is connected to the district heating network that probably cause the

current inefficiency by an inadequate quantity of hours of heating production or a shortcoming of power delivered. The Getty Report traces the different restorations and the renovation of the heating and hot water system during 1999-2000 with heating pipes in the ceiling<sup>10</sup>.

### **HEATING AND CONSTRUCTION OF SENSATIONS**

Aalto's idea that natural light and warmth should come from above the seats of readers is seductive, and even sensual, just like the feeling of the sun on the skin. The heating in the ceiling was certainly supposed to keep in salubrious conditions the chink space inside the double slab roof, and prevent condensation on skylights, a kind of 'active' insulation of the roof. Radiant heating is an obvious reference to the Roman hypocaust systems with their warm floors and ventilated walls<sup>11</sup>. Aalto's sensualist design not only featured the radiance of light but also the radiance of heat coming from the same source, the ceiling. The library users were thus bathed in light and warmth.

In this case, it was especially important to restore the original system, in order to preserve the feeling of radiant heat as well as the comfort.

### **AN ELABORATED HEATING SYSTEM FOR A SOCIAL UTOPIA**

The Salvation Army's 'City of Refuge', built in Paris in 1933 by Le Corbusier, materialized a social utopia<sup>12</sup>. Conceived as an airtight controlled environment, this building introduced into a socially aware context the technological systems found in upscale programs such as luxury hotels and cruise ships.

Le Corbusier wanted to implement two theories he developed at that time: the 'neutralizing wall' (a double-glazed façade with an air cavity that can be heated or cooled) and the 'exact breathing' (a purified circulating air system at constant temperature), in what was planned to be a 'factory for well-being'<sup>13</sup>. The 'neutralizing wall' was never truly considered for this project, the architect replaced it by a single curtain wall, one the first built in Europe. On the other hand, he maintained a reduced version of the 'exact breathing' system. The logic of these systems remained mostly coherent in spite of the budgetary cuts. This unique envelope sheltered various functions, such as a childcare center, individual rooms, and dormitories, linked by a very efficient circulation. The idea of multi-purpose buildings, that he will develop later in his work, found here one of its first expressions. At the lower levels, the succession of low volumes, the porch, the

rotunda, and the annexes, are articulated along the sequence of entry, spanning the passage between interior and exterior. They contrasted with the vertical mass of the dormitories.

### THE HEATING SYSTEM

In 1931, several companies: Leroy, Sulzer, Tunzini, Zaniroli, Castiaux, explored solutions for the central heating and cooling systems<sup>14</sup>. Construction having already begun by this date so the location and size of the service spaces were already fixed, including that of the two chimney flues and of the six ventilation ducts. Sulzer, Leroy and Tunzini proposed four different solutions, from traditional radiator heating to complete air conditioning systems<sup>15</sup>. The architect and the client chose at first Zaniroli and Castiaux<sup>16</sup>, and finally selected Castiaux, probably because the simplified system it proposed, at 470.000 francs, was the least expensive.<sup>17</sup> After Castiaux faced financial difficulties, the 'Compagnie de Chauffage par le Vide', or CCV, took over the project. It implemented a sensible solution that privileged mixed heating: a vacuum-driven, low pressure steam circuit fed cast iron radiators directly and, indirectly, forced air heaters. Although known in France, vacuum-driven low pressure steam heating, common in tall buildings in the United States, was rarely used<sup>18</sup>. Mechanical hot air heating deployed at the Salvation Army was unusual in French residential buildings, although one did find it in factories<sup>19</sup>. Le Corbusier's idea of heating his building with warm air at a constant temperature in order to minimize cold drafts also originated in France. He, apparently, followed the recommendations of the marquis de Chabannes who, in his first book on heating of 1815, stressed 'the purification of the air, the prevention of dampness, the equality of temperature and suppression of draughts of air'<sup>20</sup>.

At the City of Refuge, eight steam heating circuits were planned but only four were implemented. Three oilburning boilers, a vacuum pump, and hot water tanks occupied the basement. The fresh air coming from the roof, after being filtered, was distributed by forced air heaters into the rooms. The larger spaces in the building (the dormitories, the dining room, the hallways, the meeting room) were also heated by forced air heaters. The blowers were located either inside the space to be heated or underneath the floor with registers, as was the case in the circular entrance pavillon, the hall at the pilotis level, the meeting room, and the elderly women dormitory. The staircase was heated by two blowers placed on the first

floor. The individual rooms for mothers and their children and the childcare centre were heated by blowers located at both ends of the corridors. The ducts were inserted into a counterceiling along the corridors and registers were placed in the wall above the door in the rooms. The forced air heaters, well adapted to large rooms were also used for small bedrooms, where the heating could be perceived as 'magic', with a dematerialised comfort unusual for poor guests. The offices, apartments, the room for supervisors, the room dedicated to the princess of Polignac (the principal donor) were equipped with standard cast iron radiators heated directly by steam. Most of these small spaces had opening windows.<sup>21</sup> The heating system seemed to function properly, even if the Salvation Army thought the consumption of oil and electricity was too important. Most of the issues, however, occurred during the Summer.

### THE PROBLEMS

In the summer, blowers disconnected from the heating system provided ventilation. Rooms were thus given fresh air, although Le Corbusier feared that the Salvation Army saved electricity by shutting down the blowers. It remains unclear how the air circulated in the large spaces, such as the dormitories. On floors 3 to 6, the individual rooms serviced by a corridor were ventilated by registers above the doors, creating a slight overpressure. The air left the room underneath the door to the corridor and exited the building through grilles set in the breast walls of the small courtyards. This system was apparently not sufficient. In the childcare centre on the 5<sup>th</sup> floor which, unlike the dormitories, operated during the day, the temperature could rise to 33°C. The replacement of the air conditioning system by forced air ventilation may have made sense financially but certainly did not technically.

### THE TRANSFORMATIONS

In 1950-52, Le Corbusier offered to repair the façade destroyed by the bombing, and designed a new façade where he experimented with concrete sunshades or 'brise-soleil' that he developed notably in India. The frames were replaced by wooden windows with a small operable piece and a masonry sill. Disheartened by the choice of the façade colours made by the Salvation Army, Le Corbusier resigned from his consulting position in 1952. Slightly modified during the 1975 renovation, the wooden frames were replaced by aluminium in 1988, and the sills were covered with aluminium sheets.

The original heating plant and the distribution networks have been totally destroyed at an unknown date. The implementation of the current radiator system, with visible pipes circulating vertically close to the concrete columns, negated the architectural qualities of the building. Since 1994, the City of Refuge is heated by the Parisian district heating system (CPCU) using low pressure steam. Despite the destructions, it is still possible to find significant traces of the ventilation ducts around the building such as filled-up floors openings, grilles, and registers<sup>22</sup>. Those traces confirm that the original system was close to the technical specifications and the few changes described in the letters exchanged between the architect and the CCV. They point to a captivating history of technical innovation.

## IN CONCLUSION

A better understanding of the innovative qualities of the original thermal conception of the City of Refuge will not only enhance our understanding of Le Corbusier as a master of Modern Architecture but also make apparent the necessity of a sensitive restoration of this important work to make available to future generations the architect's utopian vision. The archaeological tracks of air registers and some pipes will be preserved, and I hope that the understanding of the original system will be deciding for the new technical decisions concerning the heating and ventilation.

In Viipuri, the importance to restore the original heating system to preserve the feeling of radiant heating, allow a real understanding of the sensual architect goals.

Through those two cases, both innovative but very different, it is possible to touch the importance of studying the history of building thermal performances for restoration. My conviction is that the conservation should not only concern the visible aspect of architecture but also the conception of the environment and its control, especially if it was a determinant aspect of the design what is often the case for part the twentieth Century heritage.

## NOTES

1. Gallo Emmanuelle, 'Thermal comfort in the Viipuri library', Construction for sensations, Docomomo ISC/T, 2004, Copenhagen, p. 100-105.
2. Study done with Vanessa Fernandez for the glass façade, for François Chatillon, ACMH. Also on the same topic: Gallo Emmanuelle, Fernandez Vanessa, 'A Factory for Well-being', Innovation in the Heating System and the Curtain-

- Wall in Le Corbusier's Salvation Army 'City of refuge', Paris 1933, Living in Urban Modernity, Docomomo 11<sup>th</sup> conference, 2010, Mexico City
3. General context: Gallo Emmanuelle, 'Modern Movement Architecture and Heating Innovations in France 1900-1939', Climate and Building Physics in the Modern Movement, Preservation technology, dossier 9, Docomomo International, 2006, p. 91-96. Gallo Emmanuelle, 'Modernismo, arquitectura y calefacción. Innovaciones en Francia, 1900-1939', Revista de Edificación, n° 36-37, 2007, Pamplona, p. 118-124
4. Roth Alfred, The New Architecture, 1930-1940, Engelarch, Zurich, 1939, 238 p.
5. From the nineteenth century, libraries were often heated by hot air (safer but without propulsion), what is not as comfortable as radiant heating with fresh air
6. Missenard André, 'Convection et rayonnement', Architecture d'Aujourd'hui, mai 1935, p. 36. This number was dedicated to heating and ventilation. This author, graduated in Polytechnic School, won the famous German Rietschel price in 1938 for this works on ambient temperature.
7. Project Preparation Work for the Conservation of the Alvar Aalto's Library in Vyborg, The Getty Grant Program Report, The Finnish Committee for the restoration of Viipuri Library, 2001, p. 50.
8. With still air, the ambient temperature is proportional to the sum of the air temperature and the average of radiant temperatures
9. Shver Aleksandr Mihailovitsh, Svetelnikova Tatiana Vladimirovna, Finnish Committee for the Restoration of the Viipuri Library, Reskalenko Kristi, Roberts Liisa, 'Alvar Aalto Library Vyborg', 24 April 2002 Russia', Verlag der Buchhandlung Walter König, Köln, 2003.
10. Getty Report, p. 4.
11. Hypocausts were well known in the nineteenth-century, because of archaeological excavations and publications. Alvar Aalto may have learned about these systems because on his frequent trips to in Southern Italy (Capri), and through the central heating literature referring often to the roman period.
12. The first study on the topic is: Taylor Brian Brice, Le Corbusier, the City of Refuge Paris 1929-1933, University of Chicago Press, Chicago, 1987
13. Justin Godart (Fondation Le Corbusier J1-20-20)
14. Technical specifications and plans describing the different projects are stored in Le Corbusier Fondation
15. Those three firms were very well known at that time, there were member of the Union Chamber of heating system manufacturers. In this last, very detailed proposal, the firm hoped to place a heating and cooling source in the basement, to filter the air coming from the roof, and to dispatch the warmed or cooled air throughout the building using ducts. Air conditioning was rare in France before the war, and the attention given to the proposal reveals the firm's determination to implement its system.

16. Zaniroli worked previously for the Salvation Army on a female shelter in Paris, and Castiaux was in charged of the heating of the Pessac Le Corbusier's housing estate
17. By contrast, for their air conditioning systems, Sulzer had asked for 1.640.000 francs, Leroy 1.250.000 francs and Tunzini 978.000 francs. As B. B. Taylor pointed out in his study on the building, these figures were out of proportion with the building budget that oscillated between 4 and 5 million francs (Taylor, B. B., *Le Corbusier, the City of Refuge Paris 1929-1933*, University of Chicago Press, Chicago, 1987, p. 96).
18. Missenard André, *Chauffage et ventilation* (handwritten), 1932, 166 p. (Archives AICVF). Charlent Charles, Bourcier Lucien, *La pratique du chauffage central*, Garnier Frères, 1928, p. 219-220
19. The Glass House by Pierre Chareau (1883-1950) in Paris (1928-1931) used also a mechanical hot air heating system, a direct one. Le Corbusier was often visiting the construction site
20. Chabannes Jean-Baptiste marquis de, *Explanations of a new method for warming and purifying the air in private houses and public buildings*, Schulze & Dean, London, 1815, p. 5-8
21. B. B. Taylor, on the contrary, claims that all rooms equipped with radiators had opening windows
22. Successives visits to the archives and the building allowed to find those traces

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