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Aalto's ideas on air-conditioning - how Finland became a "Fanland"?

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Alvar Aalto was interested in technical aspects of architecture: especially lighting, but also heating, acoustics, solar orientation and air conditioning. Alvar Aalto's career was extraordinary long and his commissions exceptionally diversified. During that long period of time from 1920s to 1970s many aspects of life changed: state and the socio-political situation, lifestyle, state capital and citizen's personal wealth. Thus, in the 20th C also the people's insistence for convenient and easy life widely led to implementation of technical innovations in buildings such as central heating, warm water and sewage systems, full mechanical air conditioning and vast use of electricity.

Introduction

This study is focusing on the development of mechanical air conditioning in Finland from 1920s to 1960s, mostly through two cases of Alvar Aalto Vyborg Library (1927-1935) and National Pensions Institute (1953-1957). These buildings were heated and ventilated with two world famous systems, which later came to be characteristic for Modern Movement architecture also in Finland. The Library in Vyborg was heated with Crittall radiant ceiling heating system. The National Pensions Institute in Helsinki was mechanically ventilated with Carrier Weathermaster high velocity air conditioning system with fan coil units.

Mechanical and electrical services in buildings are a small and important piece of the history of technology. Today, in 2010s, nearly 100 per cent of new buildings in Finland are equipped with mechanical ventilation and heat recovery systems, public buildings also with cooling. This study is focusing on the early days of air conditioning on the time period, which was the start for Finland to became a "Fanland".

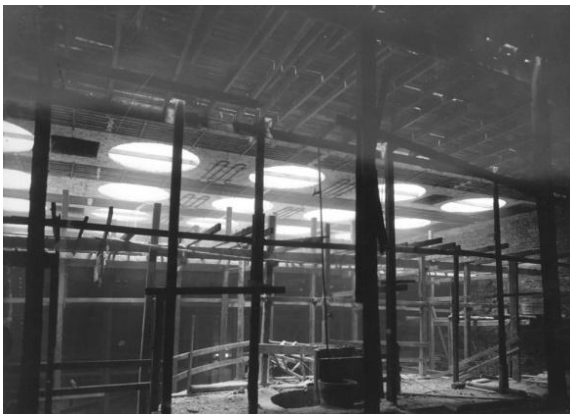
Aalto's architecture has been studied and published extensively, therefore, literature review computed as a method of research. In conservation plans and reports of Aalto's buildings, mechanical and electrical services have been taken notice. Original letters, documents and drawings by Aalto are located in magnificent archives by Alvar Aalto Foundation and Museum in Jyväskylä and in Helsinki – I hope I would have been able to utilize those original resources more.

Vyborg Library 1927-1935

Vyborg Library 1935. Sun shades over the windows. In addition to mechanical and electrical systems in his architecture, Aalto used also traditional passive methods to control the indoor climate. Photo: Alvar Aalto Museum.

A new City Library to Vyborg was completed in 1935 following the architectural competition win in 1927. Vyborg Library[1] was a pioneer building in Finland in employing modern technical innovations for indoor air quality such as radiant panel-heating and mechanical ventilation, but Aalto used also traditional Finnish technical services, opening windows and central heating radiators. Alvar Aalto was assisted by young engineers in their thirties Torsten Kranck (born 1896) in electricity installations and Carl Rudolf Rosenqvist (born 1899) in heating and air conditioning services.[2]

First Crittall -ceiling heating systems in Finland 1935



Radiant ceiling heating coils by Crittall, 1935. Photo: Alvar Aalto Museum.

In 1935, two buildings were heated by famous ceiling heating called Crittall "radiant panel-heating": the Library in Vyborg and the dwelling house for architect S. Kuhlefelt in Väinämöisenkatu 29, Helsinki. [3] Engineer Carl Rudolf Rosenqvist had just returned from a study tour to Middle Europe and England, and recommended ceiling heating to Aalto due to its functional benefits: all walls in the library and collection rooms could be left free for book shelves.[4] Judging from Rosenqvist's article published by the Society of Master Builders in Finland, engineer Rosenqvist had visited Richard Crittall & Co building sites in Paris and London.[5] According to the system of Crittall radiant panel-heating, coiled pipe circuits were fixed into the concrete surface of lower ceiling, embedded into plaster and heated with warm water.

In lecture room, Aalto relied on the more traditional way for central heating in Finland accommodating the radiators under the windows.[6] Radiators enabled the design of the undulating ribbed ceiling which was so distinctive to Aalto's architecture. In addition, radiators prevented draught, heat loss and condensation.[7]

"Central warm air airing"

Vyborg Library interior. Grills for supply and exhaust ventilation dissipate into the smooth walls. Photo Seija Linnanmäki 2010.

Vyborg Library was also one of the first buildings in Finland furnished with mechanical exhaust and supply ventilation.[8] Pipes were conducted in outer walls which were exceptionally thick two and half bricks 750 mm. Aalto used to call outer walls as a ventilation network. There were 6 different types of pipes and ducts embedded into the walls: supply and exhaust air, rainwater from the roof, heating pipes for the radiant panel-heating, water pipes and electricity. Most of these structural and behavioural details of the Library have come to knowledge only in last decade during the intensive restoration project.[9] Embedding the ducts and pipes into the walls enabled the smooth and elegant architecture.

Fresh supply air ran in relatively small, round ceramic tilepipes, from cellar upwards near the Crittall heated ceiling. Engineer Rosenqvist called it "central warm air airing", so probably supply air was slightly preheated in cellar heating chamber. Exhaust ducts for foul air ran in rectangular "holes" starting from the middle of the wall ending up to the roof, built by the bricklayers inside the brickwork.[10] Rain water downpipes were from cast iron, running downwards from the flat roof water traps.[11] Ventilation and heating methods constrained the architectural design, because air and water could only be conducted in windowless parts of outer walls. Edward Ford drew an analogy between the ceiling *"grid perforated by cones"* to other technical services in the Library: *"The roof is dematerialized by the light... the wall is eroded by air"* [12]

In 1930s when Vyborg Library by Aalto was under construction, also other public buildings were provided by HVAC systems, for example the Parliament House by Jukka Sirén completed in 1932 had a complete system on its own time.

Restaurant Savoy, interior by Aino and Alvar Aalto 1936 was one of the first mechanical ventilation systems in Finland. In the restaurant, fresh air distribution was supplied from the ceiling, through combined lighting and ventilation devices specially designed for Savoy by Aaltos. Mechanical ventilation system was constructed by German Company Rudolf Otto Meyer from Hamburg. [13] In Savoy, HVAC works were inspected by engineer Carl Rudolf Rosenqvist.[14]

A little bit earlier might have been Oy Lasipalatsi Ab [Glass Palace], Helsinki by Viljo Revell et al in 1934-35. [15] Also in Glass Palace, the German Wiessner "climate system" distributed fresh air to the movie theatre over the ceiling lights, where as exhaust ventilation was connected to the ducts under the seats. Air handling plant in the cellar was able to filter, humidify and heat the air, and it could be adjusted and metered from the theatre hall.

First regulations for air conditioning came as late as in 1955, when Building Codes for the heating and ventilation equipment design were published by the Technical Society on Heating and Water pipes.[16] Before that, German norms and design models were adapted.[17]

National Pensions Institute, Helsinki 1953-1957

National Pensions Institute 1953-1957. Photo: Alvar Aalto Museum.

Office room with Carrier Weathermaster fan coil unit under the window sill. Original system is restored and still in use. Photo Seija Linnanmäki 2012.

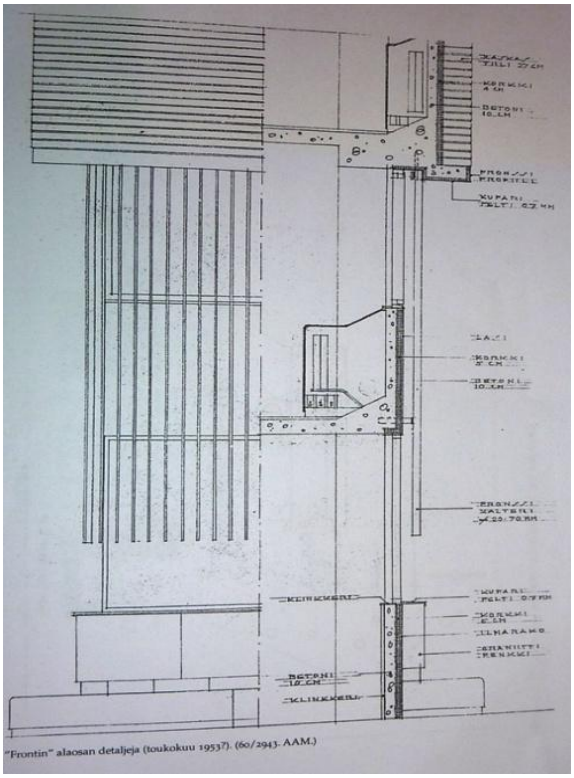
Another case on Aalto's innovative approach on technical systems to look closer, is the National Pensions Institute, Helsinki, built in 1953-1957,[18] one of the Docomomo architectural masterpieces of Finnish Modernism. In National Pensions Institute Aalto used many experimental structural and technical systems, here I will present two of them, architecturally designed radiant ceiling heating as well as one of the first fully air-conditioning systems in Finland, world famous Carrier Weathermaster system.

Carrier Weathermaster system in Finland

Carrier Weathermaster systems – how it works. High velocity systems was manufactured at the State Aircraft Factory in Tampere by an American license by Carrier Corporation. Advertisement published in Arkkitehti 1954.

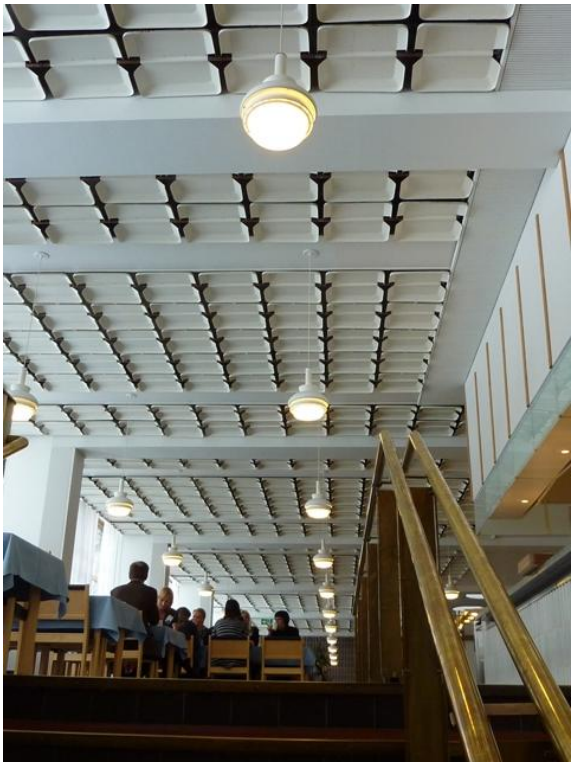
The State Aircraft Factory in Tampere[19] Linnavuori started to manufacture fans in 1945, mostly for industrial use.[20] Probably, the first ventilation commissions for comfort and convenience in dwellings and offices were Voimatalo [Power House] Imatran Voima Headquarters by Aarne Ervi 1949-50 and Palace Industry Centre by Viljo Revell et al in 1949-1952.[21] I suppose, that actual devices for Voimatalo and Palace might have been ordered from US because the State Aircraft Factory made an licence agreement with Carrier Company not until 1953. Therefore, National Pensions Institute is likely to have domestic produced Carrier Weathermaster "made in Finland".

World famous American Willis Carrier, known as a Father of air conditioning,[22] had two variations for mechanical ventilation. The first one, so called "all-air" system, was mostly used in those installations, which were constructed before the World War II. Carrier Weathermaster system installed in National Pensions Institute was the second type, exploiting "fan coil units"[23] being actually the first system for full air-conditioning. Carrier patented the installation system in 1940.[24] Carrier Weathermaster high-velocity induction units were installed for example in United Nations Building in New York 1952.[25]



Drawing in section of a wall construction for office rooms in the National Pensions Institute 1953-1957. Photo: Alvar Aalto Museum.

In National Pensions Institute Carrier air conditioning ducts and pipes were installed from March 1955 to March 1956.[26] Carrier devices under the window sills were covered by purpose designed sheet aluminium casing, painted white. Aluminium casing had air grills both upwards and to the room. Carrier used high velocity air to reduce the duct sizes. Heating and cooling energy was transported in the building by water, which has bigger thermal capacity than air. In 1957 when National Pensions Institute was completed, Carrier Weathermaster high velocity air conditioning was advertised to be installed in many public and commercial buildings also in Finland.[27]



Ceiling heating in lunch room at the National Pensions Institute was purpose designed by Aalto. Photo Seija Linnanmäki 2012.

Ceiling heating in National Pensions Institute was specially designed in the Lunch room, where the suspended ceiling is not a common false ceiling but a heating device as well. Concave shaped white aluminium plates were manufactured by Sohlberg Oy and fixed straight to the heating pipes working in the same time as an architectural ceiling covering and a heating device.[28]

Concave shaped, white aluminium plates were manufactured by Oy Sohlberg Ab in Finland. Photo Seija Linnanmäki 2012.

Early history of air conditioning

"The weather is always pleasant in Westinghouse Fanland. Current from lighting circuit for the fan costs only ¼ $ an hour." The invention of small electric motors in the end of 19th Century was the start for the mechanical ventilation, however expensive due to the high costs of electricity. Today nearly 100 % of new buildings in Finland are mechanically ventilated with contless fans, and despite all energy saving efforts, each reparation will increase the electricity consumption. Picture published by Sigfried Giedion1947 in Mechanization Takes Command - a contribution to anonymous history, USA.

Few words about early history of ventilation and air conditioning. As far as is commonly known, first mechanical supply and exhaust ventilation in Finland was constructed for the Surgical Hospital in Helsinki in 1880s, following an engineering competition wan by German Engineer Rudolf Otto Meyer. Fans in Surgical Hospital were steam powered. Most public new buildings in Helsinki were ventilated mechanically already in the end of 19t Century.

Nevertheless, the actual creator for mechanical ventilation was the introduction of small electric motors. Michael Faraday invented electric motor already in 1831, but he was not interested in practical solutions. Not until 1886, Nikolai Tesla invented an alternating current motor. First applied to run a small fan, it was easy to trade in hot and humid climate of the Southern States in US.[29]

In Finland, first indoor lighting was introduced in Tampere Finlayson Cotton Mill by engineer Carl von Nottbeck in March 1882, direct from Edison's workshops where he had worked. Finland was electrified relatively early considering our remote geographical location in Europe, [30] however, it was not until 1919 when the first electric fan is said to be constructed in Finland.[31] Electricity generating plants, especially big Imatrankoski water power plant and the national grid 1929 made electricity available. In America 1920s was a decade for fully air conditioned public buildings, theatres and department stores, the word air conditioning was launched and a special building type for offices was created.

Architectural appearance of air conditioning

Radiant surface heating in ceiling or floor was appreciated by Modern architects because it provided an undisturbed connection between interior and exterior, without any window sills or radiators.

False ceilings, being so characteristic to Modern architecture, developed in close conjunction with mechanical and electrical installations. Especially air conditioning with all ducts and pipes wanted to be hidden. False ceilings gave the architects an opportunity to design plain and unassuming interiors which complemented the architecture. [32]

Traditional ways to protect humans from extremes of the climate in Finland were relatively well developed. Double glazed, opening light windows were common already in 18th Century and efficient wood burning stoves took care of heating and ventilation. Occasionally, on warm days in summer time, opening windows and passive measures such as sun shades, were sufficient to control the indoor air. Also in 20th Century buildings, first in the beginning, windows provided both daylight and ventilation and fenestration defined the width and depth of the building. Electricity in the form of air conditioning and artificial lighting released architects to design deep open plans in Modern Movement buildings.

Air conditioning is not only a matter of interiors, but is has a certain visibility in exteriors and urban town scape. Technical components contribute to the architecture in interiors as well as in exteriors for example Alvar Aalto's chimneys in Paimio Sanatorium 1928-33 and in the street corner of National Pensions Institute. In Sähkötalo 1973 [Helsinki City Electricity House] the pyramid shape raised roofline conceals an air handling plant. [33]

Alvar Aalto was one of the first architects in Finland to integrate mechanical and electrical systems into Finnish architecture in 1930s. Nevertheless, technical innovations and reshaping were not absolute values for Alvar Aalto, but he humanly searched out for opportunities to provide his clients as well behaving premises as possible. He was not the first one to try new innovations, but put his heart into careful design and search for elegant and functional solutions, in close co-operation with his engineering designers.

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1
2 To be short I use the name Vyborg Library, however the official name today is The Central City Alvar Aalto Library.
Tekniska Föreningens i Finland avdelning för värme- och sanitetsteknik samt Värme- och sanitetstekniska föreningen i Finland, *Fornt och nytt i uppvärmning och vattenförsörjning. Historisk återblick på värme- och sanitetsteknikens utveckling i Finland*, Helsingfors, 1947.
3 In 1935 there were actually two first Crittall-methods in Finland: Vyborg Library and architect S Kuhlefelt's house in Väinämöisenkatu 29, Helsinki. C. Rosenqvist, *Rakennustaito* 12/1936, Helsinki, 1936, p. 196.
4 C. Rosenqvist, Letter to Alvar Aalto in Documentation of Vyborg Library in *Alvar Aalto Foundation archives*, Helsinki, 7.3.1934.
5 C. Rosenqvist, 'Crittall-lämmitysjärjestelmä', in *Rakennustaito* 12/1936, Helsinki, pp. 196-199. Rosenqvist also gave a lecture of Crittal system in the annual meeting of the Society of Heating and Water Installation Technologists [Värme- och Vattenledningstekniker Klubben] in 1934. Tekniska Föreningens i Finland, op. cit., p. 301.
6 J. Saarto, 'Lämpö- ja vesijohtolaitteet sekä niiden hoito nykyaikaisissa asuinrakennuksissa', in *Rakennustaito* 5/1936, Helsinki, pp. 81-86.
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12 Ford, op. cit., pp 122-127.

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17 Mäkiö, op. cit.

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25 United Nations Building 1952. Le Corbusier, architect Wallace K Harrison director of planning board.

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