The Equitable Building – The Genesis of Modern Air Conditioned Buildings

David Arnold,
Troup Bywaters +Anders

Summary

The Equitable Building, which opened on 1 January 1948, in Portland, Oregon, was the first of a new architectural form. Technically and aesthetically it was radically different from any previous structure. It was a fully air conditioned building, clad with sheer aluminium curtain walling and huge expanses of sea green tinted sealed glass. It was fully electric with heat pumps providing heating and cooling from underground aquifers. The architect was Pietro Belluschi, an Italian immigrant who originally trained as an engineer and the mechanical engineer was J. Donald Kroecker, a highly respected local engineer. The genesis for the building was a wartime project in one of the leading architectural magazines. The editor invited a number of leading architects to produce designs for a range of different projects that might be built once wartime building restrictions were lifted. Belluschi produced a design that subsequently formed the basis for the Equitable Building. Kroecker designed an innovative system that was energy efficient and took advantage of the local geology and availability of hydro electric power. Nothing like this had ever been built before and it became the model for more famous buildings such as the United Nations Building, Lever House and perhaps even Mies van der Roe's Seagram Building.

Background

Air conditioning, although increasing in popularity in office buildings during the 1930s, had not made any real impact on the form and appearance of buildings. This was to change almost immediately after the Second World War which practically halted construction and design of new buildings throughout the western world. The Equitable Building, which opened on 1 January 1948, in Portland, Oregon, was the first of a new architectural form. Technically and aesthetically it was radically different from any previous structure. It was a fully air conditioned building clad with sheer aluminium curtain walling, the double-glazed windows were huge expanses of sea green tinted sealed glass, the planning grid was completely modular for flexibility, electrical and communications trunking was distributed in the ceiling void with the same modular flexibility for cellular offices and, the building was fully electric with heat pumps providing heating and cooling from underground aquifers. Nothing like this had ever

been built before and it became the model for more famous buildings such as the United Nations Building, Lever House and perhaps even Mies van der Roe's Seagram Building.

The Client

The architect was Pietro Belluschi, an Italian immigrant who originally trained as an engineer. He had first worked indirectly for the Equitable Company in 1929 when he designed a new headquarters building for an associate company the Commonwealth Trust and Title Company. The client was represented by a lawyer called Ralph Cake who was also a member of the Board of the Equitable Company. He was determined the new building should be a technological marvel, one of the most notable efficient and progressive buildings in the country, equipped with the most advanced mechanical equipment available anywhere (1). Unfortunately the Crash of 1929 intervened and the building was never started. When the economy improved in the late 1930s, Cake talked again about erecting a new headquarters building in Portland. However when World War II broke out a moratorium was placed on the construction of all new civilian buildings.

The Forum Project

In the absence of new projects during the WWll moratorium on civilian buildings, one of the leading architectural magazines, Architectural Forum, ran a special issue speculating about post war trends called "New Buildings for 194X" (2). The editor, Howard Myers, invited a number of leading architects including Louis Kahn, William Lescaze, Mies van der Rohe and the lesser known, Pietro Belluschi, to produce designs for a range of different projects that might be built in a medium sized town, once wartime building restrictions were lifted. Myers 'stipulated that the architects' design "show an advanced but not stratospheric" approach to planning construction and equipment and that they draw upon technology that was currently available but not yet in common use."

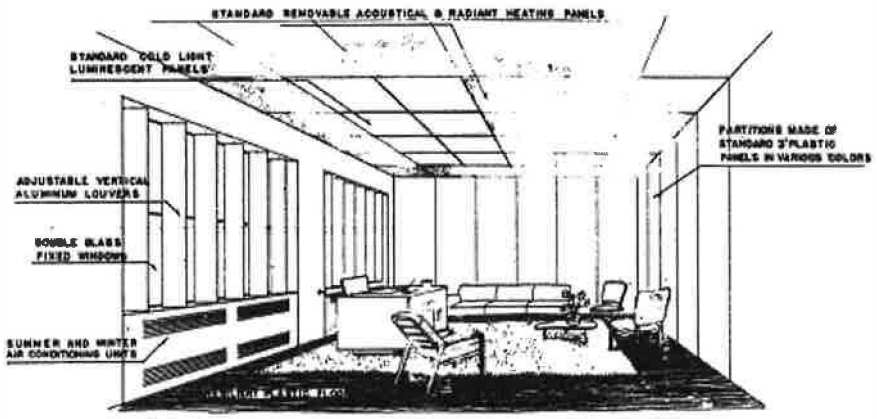

Figure 1.From Belluschi's 1943 Design Study for an Office Building in 194X(Ref. 3)

Belluschi was selected by Myers to produce a design for an office building. He wrote "Our assumptions were affected by the peculiar circumstances found in our north-west region - cheap power and a tremendously expanded production of light metals for war use, which will beg for utilisation after the emergency." (3) It appears that Belluschi had met the head of the hydro-electric power station that supplied power to the Kaiser Aluminum Company. The company were deeply involved in constructing aircraft for the war effort and he recognised there would be a surplus production capacity after the war.

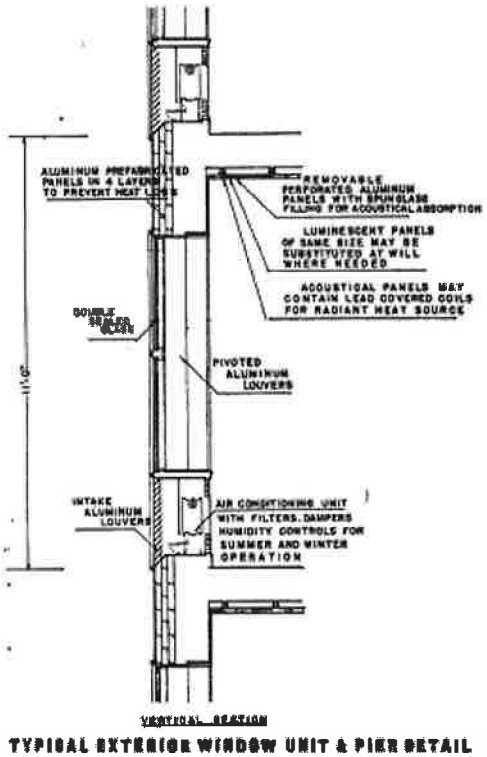

Figure 2.Detail from Belluschi's 1943 Design Study for an Office Building in 194X (Ref. 3)

He intended using aluminium extensively, as, cladding, wall-panel frames, external air-inlets, internal louvre-blinds, as trays for ceiling tiles and even as a structural frame. Some idea of the extent of the use of aluminium can be seen from the cross section of his design, figure 1. It also shows his proposals for maintaining internal comfort, with unit air conditioners, individual local air inlets, and radiant heating panels in the ceiling. The large double sealed glass windows have pivoted aluminium louvres on the inside.

The Equitable Building

Belluschi had the opportunity to put his ideas into practice before the War had even finished. The Equitable Savings and Loan Association intended building a new headquarters building in Portland. Ralph Cake came to Belluschi with the proposal to build a new scheme in the closing months of the war. Cake was also a lawyer, and someone who relished challenges and the excitement of new technology (1).

Whilst superficially the design for the Equitable was similar to the Forum project Belluschi introduced a number of significant changes that impacted the internal environment as much as the appearance.

Figure 3. Front Elevation - The Equitable Building (From ref. 4)

The building was heralded by the Architectural Forum (4) as the first and long overdue "crystal and metal tower" and one of its most spectacular aspects is "its huge areas of sea green glass." The glass was sealed double glazing with the outer pane heat absorbing glass providing a 40% reduction in solar transmission. Belluschi had satisfied himself that the solar treated glazing would not only reduce the solar heat load but also reduce sky glare to the point where blinds or shades, included in the Forum Project, would not be needed for comfort. Apparently, some of the tenants expressed alarm at the lack of shading, but after several months of satisfactory conditions few of them had installed blinds (4).

The Mechanical Systems

Belluschi selected a local man, J. Donald Kroeker, as the mechanical engineer, and he was as innovative as the architect. Few modern air conditioned buildings had been constructed at the time but he accompanied Belluschi to inspect two examples, the Johnson Wax Administration Building in Racine, Wisconsin and the Federal Reserve Bank in Milwaukee. The Johnson's Wax Building, designed by Frank Lloyd Wright, was one of the few buildings that was air conditioned and had sealed glazing. Kroecker did not follow the example of Johnson's Wax which has large central air handling plants in the infamous nostrils on the roof.

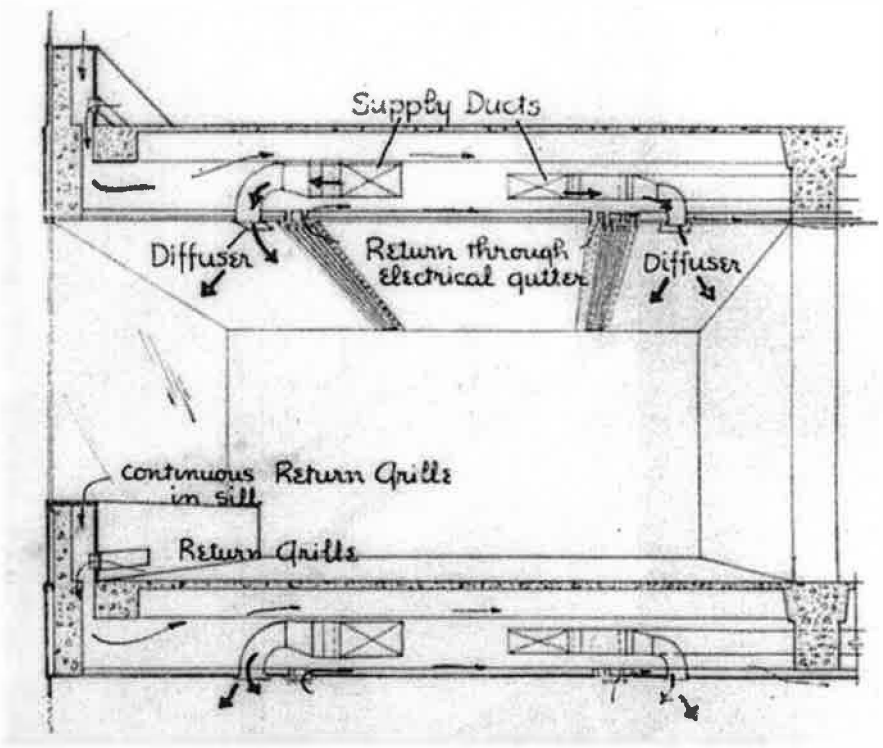

Figure 4. Diagrammatic Section of Typical Office Showing AC Principle (from Ref. 4)

Instead, and different to the Forum Project, Kroecker used floor by floor air handling units and located them in the stair tower at the back of the building. The units could supply full fresh air for flushing and economy or operate on recirculation. Supply ducts from each unit were distributed through the ceiling void and divided into four external and internal zones, with four air outlets to each office module. This allowed zone control and further sub-divisions of air supply to offices. The supply air was introduced through the ceiling grilles and exhaust air could return either through a gutter next to the electrical cable duct or through grilles at low level via the ceiling void in the floor below. Clearly fire separation was not considered.

The heating and cooling was provided from underground wells via heat pumps and the systems were fully automatic including changeover of the heat pump. Cake, the client's representative, had heard about heat pumps but thought they had only been used abroad (1). This led Kroecker to find a reverse-cycle heating and cooling system using alternate wells in use in Zurich, Switzerland. He was an active member of ASHRAE and was probably also aware of projects in the US. There were several homes using heat pumps, but Doolittle had described the Edison building which was heated and cooled by electricity power in 1931 (5) and Sporn and McLenengan described an office building in close by Salem heated and cooled by well water in 1935 (6). However, nothing had been attempted on the scale of the Equitable Building.

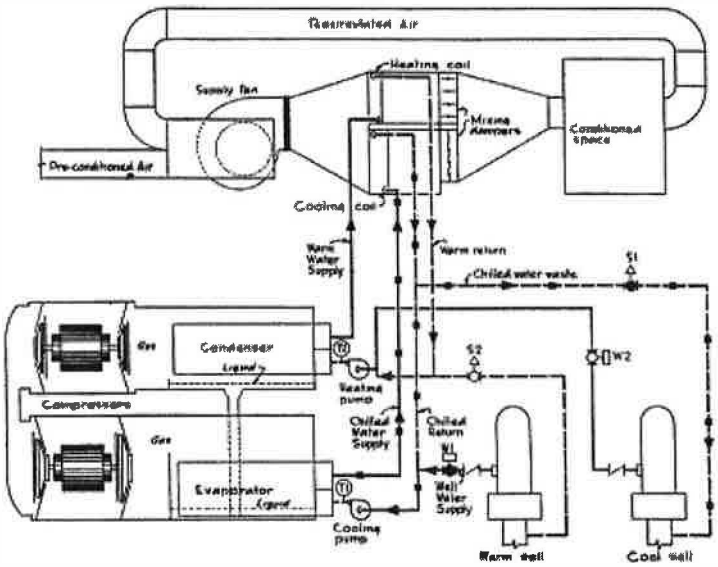

Figure 5. Diagrammatic Arrangement of Heat Pump Circuit (from Ref. 7)

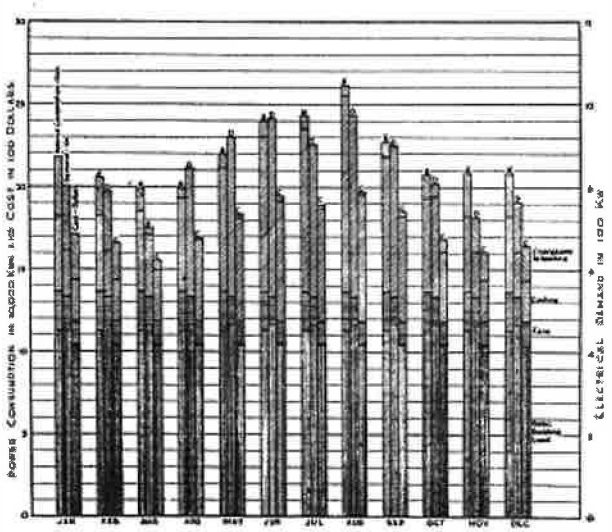

Figure 6. Kroecker' s analysis of running costs (from Ref. 7)

Kroecker carried out a detailed analysis, based on daily records of temperature for 1940, estimating the performance energy use and cost of the heat pump. The analysis was published in the ASHVE Transactions of February 1948 (7) and the results were published in June of the following year (8). Kroecker predicted an energy power use by the compressors and all pumps of 1,121,800 kWh, the measured use corrected for external temperatures was 1,060,900 kWh. The building and systems have gone through many changes in the past 50 years but still operate fundamentally the same. The energy use (1) is currently 62,800 Btu/ft^2/annum (196 kWh/m^2/annum) compared with a (US) DOE target of 108,000 Btu/ft^2/annum (341 kWh/m^2/annum).

Discussion

The building, now called the Commonwealth Building, is the prototype modern "fully air conditioned building" as we now use the term. But why was the building air-conditioned in the first place? The climate in Portland is very similar to the south of England and air conditioned buildings were few and far between even in the US. Was it driven by Belluschi's desire to be innovative? Was it the client's wish to have everything that represented the latest technological marvel? Most probably it was a combination of the two. It appears that Belluschi convinced himself that air conditioning would eliminate the need for sun louvers included in the design for the Forum project.

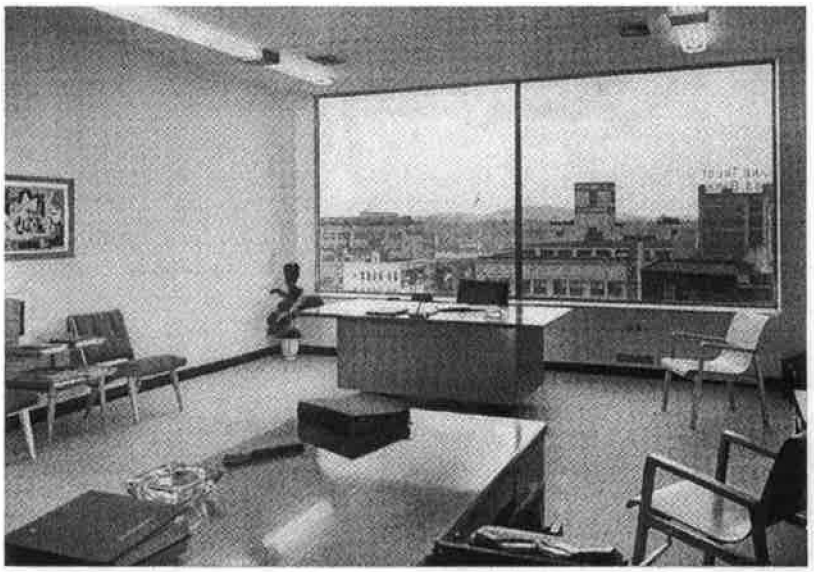

Figure 7. Interior view of office and window

To a certain extent these questions are irrelevant because the choice of heat pump cooling and heating is an almost ideal solution in the location. The availability of hydro-electric power, the benign climate and local geology with underground aquifers combine to a near perfect solution for this location.

Unfortunately, this may have been an unfortunate precedent in energy and environmental terms, the concept was replicated in totally different climates without the availability of renewable energy sources and entirely different geology. The result was the proliferation of clones of this building but many were built without any consideration of the local climate or availability of energy and they could be seen as using profligate amounts of energy and failing to provide comfort for the occupants (9,10). Nevertheless, this building, and its heating and cooling systems, have withstood the test of time and demonstrate the results of careful analysis and design coupled with an appreciation of local climate and resources.

References

(1) Clausen, Meredith "Belluschi and the Equitable Building in History", Journal of the Society of Architectural Historians, Vol. L No. 2, June 1991, pp109-129

(2) Anon, "New Buildings for 194X " Architectural Forum, May 1943,

(3) Belluschi, Pietro, "New Buildings for 194X - Office Building" Architectural Forum, May 1943, pp 108

(4) Anon. "Equitable Builds a Leader" Architectural Forum, Sept. 1948

(5) Doolittle, H. 1931. Edison building heated and cooled by electricity power. Power 74 (Sept. 8) pp 348 – 351.

(6) Sporn, Philip and McLenegan,, D.W. "An All Electric Heating, Cooling and Air Conditioning System" ASHVE Trans. June 1935, pp 307-326.

(7) Kroecker, J. Donald, and Chewning, Ray C., "A Heat Pump in an Office Building" ASHVE Trans. February 1948. pp 221-238.

(8) Kroecker, J. Donald, Chewning, Ray C. and Graham, Charles E., "Heat Pump Results in Equitable Building" ASHVE Trans. June 1949. pp 345-362.

(9) Sterling, E and T.S. and McIntyre, D. " New Health Hazards in Sealed Buildings" AIA Journal April 1983

(10) Hatten, M.J., and Morrison, B.M., "The Commonwealth Building: Groundbreaking History with a Groundwater Heat Pump" ASHRAE Journal July 1995