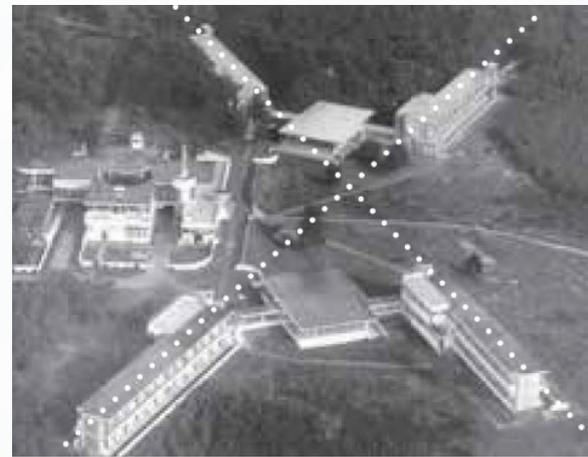


# ULTRAVIOLET ASPECTS OF ZONNESTRAAL

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*A look to the outside of the newly renovated sanatorium. The new glass specifications are in line with the original thoughts of glass quality and the importance of UV light in the treatment of tuberculosis. Aerial view of the two treatment sections (top).*

Modernist architects need to expand their definition of rationalism. They need to analyze more of the qualities intrinsic to the architecture they design. Architects need to consider not only architecture's visible colors—program, economy, technology, hygiene, site—but also its invisible “ultraviolet band”

Alvar Aalto, “Rationalism and Man” (1935)

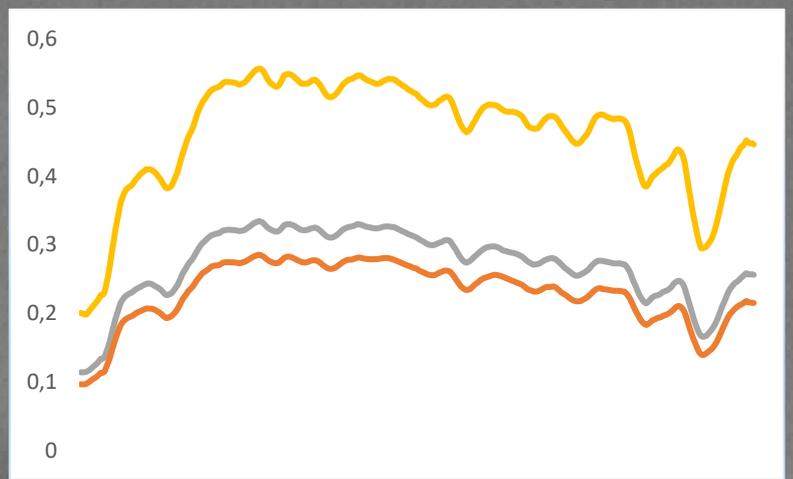
**Architecture is visible, concrete shapes, physical spaces, envelopes, surfaces and materials, but architecture is also much more than that. This article will look a little closer at the invisible - and often overlooked - aspects of architecture, giving a slightly larger picture of the architecture. The article is based on the Zonnestraal Sanatorium. The article describes the thoughts and knowledge that formed the basis for the development of the modern health architecture in the inter-war period, 1925-1945. An architecture based on light, air and openness. The Zonnestraal Sanatorium is particularly interesting because it inspired the very early modernist architects in Northern Europe, such as Alvar Aalto, and led to several of these invisible, “ultraviolet” principles being implemented in the early, modernist buildings in Northern Europe, such as The Paimio Sanatorium.**

After World War II, these thoughts and this knowledge is lost, due to vaccines and antibiotics, in what is often referred to as The Antibiotic Age. The fact that architecture from 1945 and up until now loses its health aspects and healing role, is not only seen in the closing of sanatoriums like the Zonnestraal, but also in new, more technological hospitals emerging in this post-war period. In architecture, which demonstrates less understanding of the importance of light to health, less understanding of the importance of direct sunlight and less understanding of the quality of daylight and air. Conditions, which the sanatoriums and hospitals of the 20s and 30's originally were built on. This article links knowledge from the past and the present together, in order to describe and put into perspective the invisible - and often overlooked - aspects of architecture, and puts into practice this forgotten knowledge in the new hospitals today, e.g. in a rotatable 1:1 model of a future patient room at The New Psychiatric Centre, Bispebjerg in Denmark.

### **Natural Light and Natural Air in Natural Surroundings**

The Zonnestraal sanatorium was designed by Jan Duiker in 1925 and completed in 1931. The sanatorium was built for the Dutch diamond workers' union, DWW, which through collection and resale of production parts from the production of diamonds such as diamond dust and copper, acquired a site in Hilversum outside Amsterdam and later collected funds for building the construction. The sanatorium was part of the treatment of union members, as well as their families when they become ill from tuberculosis, etc.

When first diagnosed, tuberculosis required rapid treatment, and often patients immediately were separated from their families and brought to the sanatorium for treatment outside the city to avoid further infection. The sanatorium is located just outside Amsterdam, located in natural surroundings, with a forest and highland to the north and an elongated, flat-heath landscape to the south. A landscape carefully selected in order to provide optimal frames for light, air and openness, with direct access to sunlight from the south all year and clean, purified air from the wooded slopes north of the sanatorium. The treatment was inspired by Auguste Rollier's Luft und Liege-Kur from Davos, where natural elements, such as clean air and UV-light from the sun were parts of the treatment. Inspired by Niels R. Finsen and his pioneering work on UV light, heliotherapy was practiced here, with light being dosed according to the individual's susceptibility to UV-light, and depending on the variations caused by the seasons. Here, patients were exposed to sunlight for up to 4 hours a day in winter and 2 hours a day during the summer. First, legs and arms were exposed and then gradually the torso and other more vulnerable part of the body.



*The special glass provides a complete clear shadow- and color rendering in all rooms, together with the Zonnestraal Sanatorium's design with retracted columns and curtain-wall glass facades, completely dissolves the boundary between inside and outside. Single-layered low-iron glass (yellow) transmitting UVB light has been replaced in many hospitals today with 2 layered (grey) and 3-layered (red) energy glass, reducing the natural daylight spectrum and no longer transmitting UVB light and providing vitamin D.*

Actually, these sanatoriums originally were named *sanitariums*, which stems from the word *sanitas*, meaning healthy living in a healthy, natural environment. Isolated from the cities, with light and fresh air as the most important part of the treatment, a non-medical recovery from illness was practiced here. However, along with more and better medical treatment, the word sanitarium later is replaced by the word *sanatorium*, stemming from the more active form of the word *sanare*, which means treating. At the sanatoriums a more active, improved medical treatment played a leading role.

The Zonnestraal Sanatorium originally was built as a temporary construction and the developer strongly emphasized that the construction would only be of a temporary nature - with an expected lifecycle of approx. 30 years - until a an efficient medical cure against tuberculosis was found. The funds collected only could fund half of the planned construction, and the initially four symmetrical sections, were reduced to only two symmetrical sections, each consisting of two bed wards with 25 single-bedrooms. The sanatorium housed a total of 100 - 120 patients divided into 100 single bedrooms as well as an adjacent, smaller round pavilion building. All single-bedrooms had full glass facades, primarily oriented towards the sun (SE and SW). Originally, the idea was that the four sections of the sanatorium should accommodate men, women and children. However, the two built bed wards accommodated male patients only.

For the individual patients, the course of treatment was long and lasted up to 1 or 2 years. For many patients, the Zonnestraal Sanatorium therefore became a part of their lives. Here they found friends and some patients even were employed at the sanatorium as assistants after recovery. The course of treatment was supplemented by physical activity throughout the course of a week for each patient. Through workplaces, they could work and maintain their working skills, thus re-entering the labor market once healthy again. At the same time, this workflow helped reducing hospitalization costs by reducing the cost of the individual hospitalization through production, an important part of the overall economic operation of the sanatorium. Another non-visible aspect of the Zonnestraal Sanatorium - in addition to its physical location and orientation due to the elements of sunlight and clean air - was this possibility of physical activity and rehabilitation during hospitalization.

### **Construction and Building Physique**

With a depth of only 3 m, each bedroom was bathed in sunlight from morning to evening. A basic idea that later inspires Alvar Aalto to do the same at the Paimio Sanatorium in Turku. A basic idea that, in practice, is attributable to sunlight and sunlight optimization, together with the fact that concrete items over 3 m span must harden for longer periods of time than items under 3 m, to increase the free unsupported strength of the material. A faster and more efficient construction process thus enables the building body to become slim and optimize the daylight amount at the same time in relation to the facade of the building. With a height of 4 m and a maximum depth of 3 m, the design of the sanatorium appears almost like a slim, white ship stranded on the edge between the flat hilly landscape south and the sloping forest hill north of the sanatorium. Open railings in steel, painted only in a light blue sky-colored shade, contribute to the open maritime appearance while contributing to the light and air flowing unimpeded through the railing, cleansing the air of the patients who all were encouraged to practice sunbathing on the open-air terraces. A principle which Alvar Aalto later uses in Paimio Sanatorium, after his visit to the Zonnestraal Sanatorium in 1927.



*Zonnestraal Sanatorium before renovation (left), and as it originally looked in the 1930s (right). Both forest and horticulture gradually covered several of the buildings, and the sanatorium was allowed to gradually decay from 1945 to the 1990s.*

### **Ultraviolet Light and Hygiene**

At the Zonnestraal Sanatorium sunlight is seen as the most important purifier and first line of defense against bacteria. The findings of the antiseptic effect of UV-light on tuberculosis bacteria also applied for all bacterial types, and affected the architecture fundamentally in the interwar period. At The Zonnestraal Sanatorium, Jan Duiker's architecture in itself was cleansing and hygienic. This extra ultraviolet, hygienic aspect becomes a hallmark of Modernism and a welcome rationale for the Modernist style that soon will occupy the whole world; The international style. For the same reason, it is also referred to as the hygienic style. In this period, a bathtub is emphasized as a product, which is both beautiful and hygienic, and hygiene almost becomes beautiful in itself. The fight against redundant ornamentations results in completely pure, often geometrical, euclidean shapes. With light considered as the only ornamentation in otherwise perfectly uniform, white and clean surfaces, bathed in light at the same time, purified by the sun's antiseptic UVB-light.

### **... And Vitamin D**

In the years up to his death, Dr. Niels Finsen shows an interest in the beneficial health aspects and disease preventing effects of sunlight. Among others, he believes to have found that the light has a yet unprecedented, positive effect on the human immune system. Niels Finsen's empirical observations indicate that the chemical UV light actually is beneficial to the health. However, when the Finsen dies in 1904, the world still does not know about the existence of vitamin D - it will be discovered two decades later, in 1922.

The discovery of vitamin D leads to a renewed focus on sunlight and new health movements all over Europe. In 1926, a such new health movement, the New Health Society, emerges in England. The purpose of the movement is to share the importance of sunlight and air, including new knowledge about the importance of UV light and vitamin D for health. Here Dr. Belfrage e.g. promotes more focus on high transmittance glass, and low-iron glass like Vita-glass in the following way:

*It has been proved that they (ultraviolet rays) have a stimulating effect on general growth, power of resistance to disease, and on the richness of the blood... Yet ordinary window glass was quite un-transparent to these health giving ultra-violet rays<sup>1</sup>*

It is this discovery of vitamin D, together with the hygienic movement, that creates the very foundation of the Zonnestraal Sanatorium. Vitamin D however is in fact not vitamin at all, it is a so-called steroid hormone. That is, a substance which the body - contrary to vitamins – actually can form itself: UVB light from the sun transforms 7-dehydrocholesterol in the skin, and this so-called inactive vitamin D, is then turned into active vitamin D<sub>3</sub>, 1,25 (OH) D via liver and kidneys. The formation of vitamin D<sub>3</sub> thus is neither a result of the sunlight alone, nor for that sake of the body alone, but the result of a complex interaction between the body and the physical environment.

The discovery of vitamin D and, in particular, the discovery of what the lack of sunshine and vitamin D can cause on the human body, has since been supplemented with more and more knowledge. Today, new scientific studies confirm Niels Finsen's discoveries about the importance of UV light for our health and well-being. Researchers today have discovered that the immune system is actually completely dependent on vitamin D in order to work. The so-called killer cells (T-cells) which the immune system uses to fight bacteria, viruses and cancer simply can't work without vitamin D.

In this context it is remarkable to see to what extent the discovery of vitamin D in 1922, actually affected the entire architecture of Jan Duiker's generation and The Zonnestraal Sanatorium in 1925. Just as it is remarkable and thoughtful to see how little the discovery of vitamin D characterizes state of the art hospital-architects and architecture today. Today, hospitals are being built with patient rooms facing away from the sun, and with building depths five times deeper than The Zonnestraal Sanatorium. Single-layer and 2-layered low-iron glass is also being replaced with 3-layered energy glass, reducing the natural daylight and completely blocking the transmission of UVB light – literally an ultraviolet element of the sanatoriums in the past. Where sunlight in the pre-antibiotic age was considered to be the first line of defense against bacteria, it is now increasingly becoming the last line of defense at today's hospitals, where antibiotics, such as vancomycin are controlling infections and bacteria. However, infections pose a major problem and amounts to high healthcare costs e.g. to hospital acquired infections, which today represents a major health problem. In Denmark, it is estimated that approx. 8-10% of all bed days in hospitals are caused by hospital infections, corresponding to approx. 400.000 bed days annually in Denmark.

Also other factors point out that the age of antibiotics perhaps may be over. According to the WHO, there is a global crisis in antibiotics, and we see more MDR bacteria, and unfortunately less new medical responses, in the form of effective vaccines against these bacteria and the diseases they cause. In this regard, the time is right for restoring the importance of the healthy interwar architecture and study the physical framework and environment as an additional, ultraviolet factor for the overall disease prevention and promoter of general health and recovery - according to researchers<sup>2</sup>, several correlations between lack of vitamin D and the general health conditions are found in the population.

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<sup>1</sup> Carter S. *Rise and shine - Sunlight, Technology and Health*, p. 68. Berg, 2007.

<sup>2</sup> Lotte Husemoen, Research Center in Prevention and Health at The Capital Region, Denmark



*Paimio Sanatorium by Alvar Aalto (1927) originally was inspired by The Zonnestraal Sanatorium. Alvar Aalto also uses low-iron glass, natural ventilation, together with a slender building shape and an open-air terrace as important architectural elements.*

*When we have adjusted for other factors, people with very low level of vitamin D in the blood have 65 percent greater risk of developing diabetes than those who have a high level of vitamin D in the body.*

### **Tomorrow's Architecture**

All in all, the role of architecture may be redefined and rediscovered, as an important element in the healthcare and prevention of disease, if these correlations are applied in case studies. Instead of today's airtight houses with fully mechanically ventilation, hospitals with natural daylight, natural ventilation and natural settings might be reintroduced as thoughtful ideas, with doctors of today worked together with architects of today, in the planning of the built environment of tomorrow.

To quote Alvar Aalto, after finishing The Paimio Sanatorium in Finland: "The rationalist working method does not go deep enough and also must encompass psychological requirements, such as neurophysiology and the general physiological properties of human beings". "My aim," he continued "is to show that real rationalism means dealing with all questions related to the object. . . . [The architect must] take a rational attitude also to demands that are often dismissed as vague issues of individual taste, but are shown by more detailed analysis to be derived partly from neurophysiology, and partly from psychology." Once architects adopt such

an approach, he continued “we will have extended the rationalist working method enough to make it easier to prevent inhuman results.” Rationalism “should be extended to the psychological domain,” he insisted. “Only one book has not yet been published in the world; The Physiological Home.” Aalto’s close relationship with Lászlò Moholy-Nagy opened up his interest in experimental psychology and work with the “psychobiological” experience of man, an experience, which for Moholy-Nagy meant a person’s fundamental, intersubjective relationship with space, time, and light<sup>3</sup>.



*Past and presents architecture represented at New Psychiatry Bispebjerg. NID-Group<sup>4</sup> in Copenhagen has created a rotatable model of a single bedroom, here light, air and indoor environment is tested reintroducing ideas of low-iron glass and natural ventilation as important elements in tomorrow’s hospital architecture.*

<sup>3</sup> See also the article “Towards a Solar Architecture”, 2017.

<sup>4</sup> Klaus Martiny and Carlo Volf in New Interventions in Depression, NID-Group.