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Article

Architecture and Technology in Paimio Sanatorium

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Abstract: Alvar Aalto created innovative architecture in his breakthrough work, Paimio Sanatorium, located in Southwestern Finland and designed between 1928 and 1933. The technological systems in construction, such as the concrete frame, electricity, air conditioning, and lifts, developed rapidly in the interwar period and Aalto drew influences from the culturally radical modernistic discourse around the CIAM organisation and felt that architecture should respond to the demands of the age.

Architecture is an applied form of art, and symbolic expression in architecture is a system with its logic. As a contrast, a building is a technological system and forms a framework within which to solve practical problems. Thus, as a technological system, the building is both material and social, during its construction and after. The theoretical underpinning for the study was the actor-network theory developed since the 1980s by the French sociologist Bruno Latour.

This study clearly showed the importance of a collaborative effort in a building project. The most famous architectural solutions for Paimio Sanatorium, a demanding institutional building project, came into being in circumstances where the architect-innovator, Aalto, managed to create a viable and robust hybrid that merged collective competence with material factors.

Keywords: Alvar Aalto, Modernism, Paimio Sanatorium, Finland, Bruno Latour, actor-network theory, history of technology, history of architecture

1. Introduction

This article discusses the relationship between architecture and technology in Alvar Aalto's breakthrough work, Paimio Sanatorium, located in southwestern Finland and designed between 1928 and 1933. Siegfried Giedion canonised the sizeable institutional building as one of the three most important of the inter-war period.

Architecture is an applied form of art. According to Alan Colquhoun, symbolic expression in architecture is a system with its logic. As a contrast to symbolic expression, a building is a technological system and forms a framework within which to solve practical problems. (Colquhoun 1962) Thus, the building as a technological system is both material and social, not only after its completion but also when it is under construction. Although the ideology of Modernism may have ignored the significance of local culture, buildings are inevitably cultural objects, tied to both time and place.

The technological systems in construction, such as the concrete frame, electricity, air conditioning, and lifts, developed rapidly in the interwar period in Europe, and architects faced new challenges. Aalto drew influences from culturally radical modernistic discourse and felt that architecture should respond to the demands of the age.

The research question eventually became: how did Aalto manage to reconcile international ideology and local building culture in a country where the degree of industrialisation in the building sector was relatively low? It was also interesting to analyse how international discourse translated into practical solutions in Aalto's sanatorium project. Furthermore, in the tradition of architecture, the expressive power of structures is considered part of the overall architectural solution, but how was it with the emerging technological systems – did they become part of tectonic expression along with Modernism?

The theoretical underpinning for the study was the actor-network theory developed since the 1980s by the French sociologist Bruno Latour. The theory assigns a role for both the social and material factors in the evolution of technological systems. Latour co-edited an article with architect Professor Albena Yaneva in 2008, dealing with the problem of buildings looking desperately static. (Latour & Yaneva 2008) Parallel to their pursuits, this study aimed to make visible the movement of architecture, meaning the view of a building as a series of transformations. The actor-network theory served in this work as a theoretical tool to make the chains of events in building Paimio Sanatorium visible. The rich empirical material of this research shed light on the role of parties other than the architect in the design process. As a result, the study also showed how Aalto manoeuvred in this "expanded field" of architecture.

In the Nordic context, the Swedish scholar and architect Lisa Brunnström's research on the impact of the scientific management methods to architecture within the context of factory buildings and cooperative architecture pioneers in shedding light on the interaction between technology and architecture. (Brunnström 1990 and Brunnström 2004) Anne Beim, a Danish scholar, has studied tectonics in architecture and expanded the scope of the architectural meaning assignment. In her view construction technology and practices consciously contribute to the process of architectural meaning assignment if architects treat them consciously. (Beim 2004) In Finland, Professor Pekka Korvenmaa has studied Alvar Aalto's works for the forest industries (Korvenmaa 1998); Licentiate, Art Historian Elina Standertskjöld has researched Alvar Aalto's standard drawings and Americanisation in the Nordics (Standertskjöld 1992a, 1992b & 2010), and PhD, Architect Markku Norvasuo Alvar Aalto's architectural lighting systems. (Norvasuo 2009) The Swedish Professor Claes Caldenby recently emphasised the need to consider architecture and engineering alongside with the humanities and social sciences in the research of construction history, in the Nordic countries.

A large institutional building can only emerge from the interplay between many views and the existing material conditions. The impact of the collective on the architectural solution is particularly interesting in the case of a building that holds a canonised status. When discussing Aalto's buildings, we fail either to see or to understand the input of other designers and specialists. Latour's anthropological approach and analyses provided useful insight into the collective of architecture and construction.

2. Results

2.1 Insight, Knowledge, Skills, and Material in the Reinforced Concrete Frame

Many documents were covering this central building system, varying in quality, which made it easier to understand the different dynamics of relationships affecting the work. Articles written by Aalto revealed the architect's deep engagement in creating the concrete structure, which was a challenge he found inspiring. First, in his role as the leading specialist of the hospital project, Aalto translated the interests of the Building Board to favour a structural designer, with whom he was close, by pleading the merits of using an independent designer instead of allowing the contractor to make the structural calculations, which was a more commonplace practice at that time. As an innovator, Aalto took an active role in the contracting negotiations with the reinforced concrete contractor, even if this tested the boundaries of his integrity. The contract negotiations were merely Latourian trials he had to win.

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Figure 1. The patient wing building site in autumn 1930. The A-wing pillars on the external wall line were cast in situ and protected by a bricklayer. Photographer Alvar Aalto or Aino Marsio-Aalto. Photo No. 50-003-079. AAM.

Aalto and construction designer Emil Henriksson's previous joint projects had been successful, and Aalto had come to rely on Henriksson's expertise, knowledge, and competence as a designer. The professional respect must have been mutual. Henriksson, in turn, was contractor Arvi Ahti's business partner, and they had worked together on many developments in Turku. Henriksson trusted Ahti's knowledge of concrete structures, and Ahti performed to expectation. Moreover, the men were related, which may have been an added motivation to support each other's businesses during the economic recession. To mobilise Latour's set of concepts, Aalto acted as the innovator, the initiating force, who steered the project in the direction of his visions, and who was ready to undergo various trials to achieve his architectural goals, which he had to translate into the goals of the Building Board. Aalto, with his architectural vision, Henriksson, with his understanding of reinforced concrete structures, and Ahti, with his track record as a builder of concrete structures, together with reinforced concrete as the material, formed a secure network that was capable of action. The process was carried out as a joint undertaking by these builders, in good spirit and according to schedule, producing an impressive tectonic outcome for the concrete frame. (Figure 1.)

The Building Board did not debate the fact that the reinforced concrete frame exceeded its budget quite substantially. After all, Aalto's solution, which allowed sunlight to flood deep into the building frame, appealed to the medical experts. He used section drawings as his tool to translate their interests, showing the medical experts how rays of sun reached the farthest corner within the structure. As Aalto had succeeded in first persuading the medical specialist of the superiority of his concrete frame design, the lay members of the Building Board voiced no doubts on this issue. The process was, referring to actor-network theory, a successful translation.

2.2 The Horizontal Health Window

The patient room windows were an essential and salient architectonic feature in the sanatorium and underwent a complete overhaul in the time leading to the final realisation. Besides changing from a steel window to a hybrid window, Aalto also developed the window as a holistic concept, integrally linked with heating, ventilation and the amount of daylight benefitting the patient. He wrote in a publication aimed at Swedish architects in 1932: "The patient room has the following

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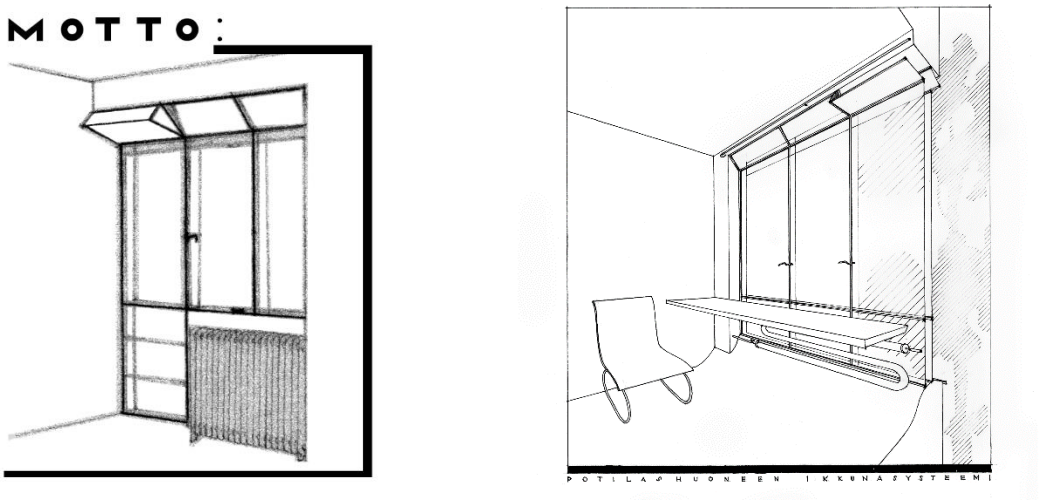
characteristics, among others: morning sun on the patients' beds; afternoon sun on the front part of the room, in front of the window. Double-glazed windows in wood with L-shaped frames, with permanent ventilation through glass panes with vertical openings. Exposure to the sun can be adjusted using external blinds …". (Aalto 1932a)



(**a**) (**b**)

Figure 2. (a) The vignette image of the competition-stage asymmetrical design in 1929 depicts the first version of the patient room window. Detail of drawing No. 50-655, the drawing has been cropped. AAM. (b) One step later in the design process, the standard drawing shows that the bottom edge of the window section was level. The architect also changed the shape of the floor so that it curved upwards near the window. Visually the window reached the floor. Drawing 50-395, the drawing has been cropped. AAM.

Aalto discussed the idea of continuous ventilation, and considering that he was addressing his professional peers, he was probably referring to the then famous wall-sized sliding window for the patient room. With this rhetorical gesture, he wanted to demonstrate his expertise in the overlapping trends in healthcare and architecture. Naturally, the timber-framed window was not designed to be kept continuously open in Finnish weather conditions.

True to his international ideology, as an architect, Aalto was more interested in using industrially produced shallow-profile steel windows than traditional wooden windows. (Figure 2 a.) However, steel windows were more expensive, and Finns needed to import the profiles. At a time of recession, the state regulated imports and favoured local production. In the early stages of the work, the Building Board had agreed on the use of steel windows on the condition that they were Finnish.

For this reason, Aalto never invited tenders from window manufacturers abroad, whose products he had used in his former work. He mobilised the site supervisor to raise the issue of the quality of industrially produced wooden windows and to turn it into a broader question of principle regarding the Finnish timber industry, with the likely ulterior motive of influencing the view of the Building Board on wooden windows. When the final decision was made not to fit the patient rooms with steel windows, owing to their high cost, Aalto developed a new type of wooden window that necessitated the use of some steel profiles for structural reasons. This window was like the traditional ventilation window, known as the "health window," only this time horizontal in orientation.

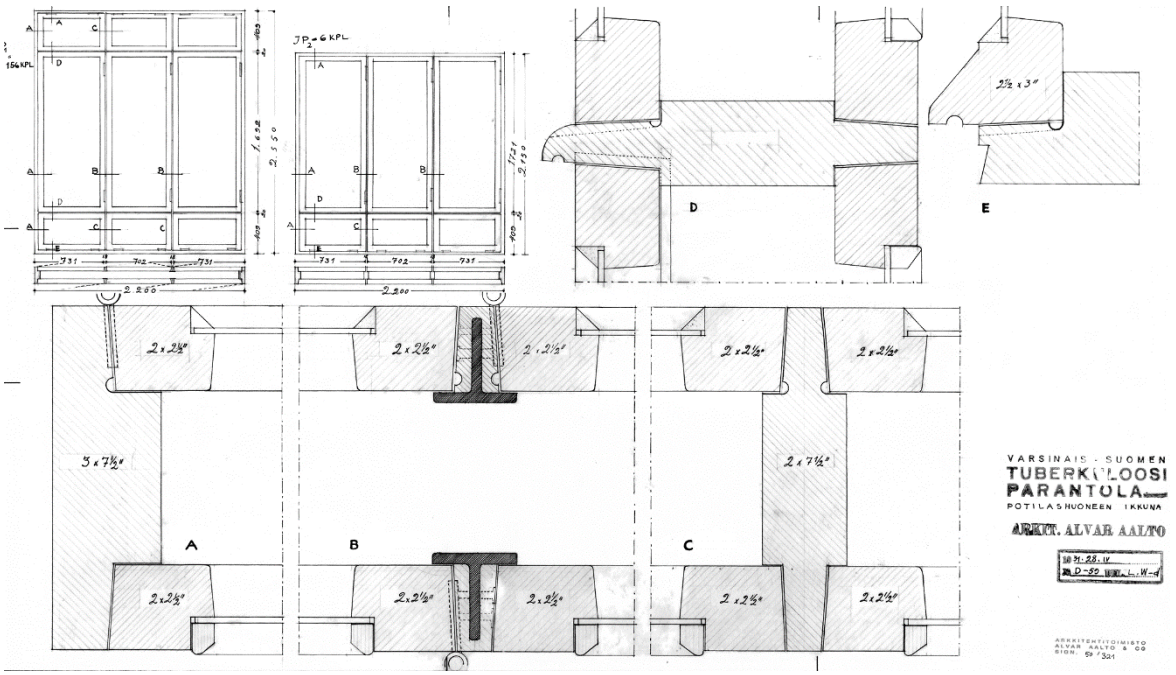


Figure 3. The working drawing shows the realised version of the patient room window. T-profiles supported the two mullions of the middle row of the nine-section window. In the top and bottom rows, the mullion ran through the structure. Drawing No. 50-321. The drawing has been edited. AAM.

The medical specialists of the sanatorium project recommended health windows and architects have used them since the early 19th century in schools, hospitals, and other public buildings. By reiterating this concept and defining his window as a "health window," Aalto managed to translate the opinion of medical experts and win them over to his side. It was a question of cultural classification of window solutions. Aalto's unusual window design required the use of a few steel components, which entitled him to talk about innovation and a hybrid. A material hybrid was, for Aalto, a conceptual victory over a traditional window. Inventing the concept of a hybrid window was a significant achievement for Aalto, who could now postulate his solution to his peers in the media. The professional media was a must-win battle for an architect wanting to position himself as an avant-gardist, which point Beatriz Colomina has discussed in depth in her study of Le Corbusier's media strategy. (Colomina [1994] 1998.)

While the outcome was not ideal from the architect's perspective, it is likely to have been an acceptable compromise. Doctors had requested in their statements after the architectural competition that the unsymmetrical windows were not to reach to floor level for reasons of hygiene. Aalto changed the windows accordingly so that the bottom edge of all window sections was level. (Figure 2 b.) He also changed the shape of the floor so that it curved upwards near the window so that visually, the window reached the floor in the final, realised version. The solution fulfilled the hygienic standards of the doctors, and the architect could preserve an essential design feature. This example is illustrative of how designers work: Aalto reframed the problem and found a new solution, which could combine seemingly contradictory starting points. The example also shows the unpredictability of the evolution of technological solutions – at the beginning of an innovative project, it is impossible to know the outcome in detail. A static artefact, in this case, the patient room window in the finalised building, gives no clues to the process of which they are the result. (Figures 3 and 4.) We need to look profoundly to the process to understand the significance of each system.

Figure 4. The window looks like a traditional double-glazed system but is not. Photo No. 50-003-360. AAM.

2.3 The Integrated design of the patient room

When taking a closer look at the patient room, the overall design comes across as a most harmonious one: all the furnishings were the outcome of holistic thinking, and the technological solutions were implemented with great economy of space while optimising their function. Aalto conceptualised the two-bed patient room as a "minimum apartment." The room was small in size, making space-saving design solutions necessary. Aalto multiplied the available space by adding details of his design, and by approaching the small dwelling as a holistic problem. He also created several standards related to the patient room. However, this harmonious image tells nothing of the process that preceded the result. (Figures 4 and 5.) It might appear that Aalto was commissioned to create the interior design for the patient room, including all its parts. However, this was not the case. (Table 1.)

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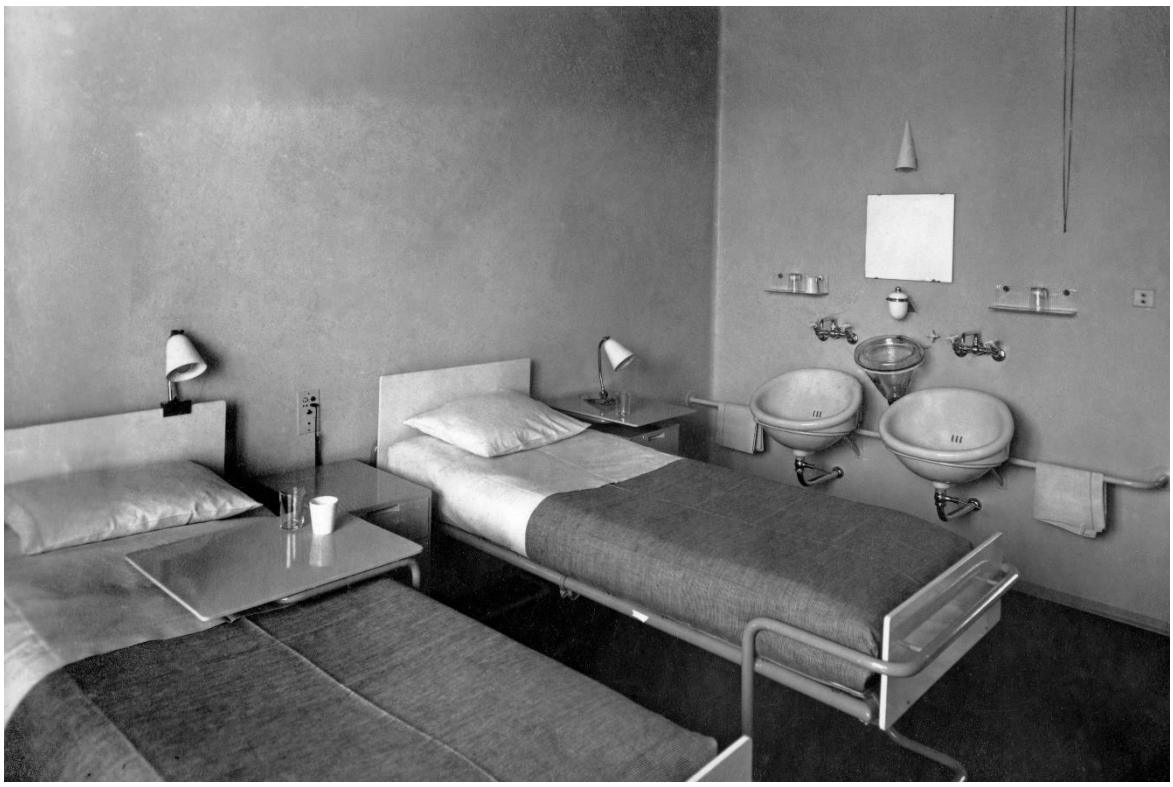

Figure 5. A newly completed patient room is harmonious and designed holistically. Photo No. 50-003-361. AAM.

Table 1. Patient room furnishings

Furniture	Built-in-furniture commissioned from the architect	Loose furniture commissioned from the architect	Loose furniture, purchased standard	Chair purchased standard	Manufacturer
The wardrobes (Figure 6.)			X		Huonekalu- ja rakennustyötehdas[1]
The table	X				Huonekalu- ja rakennustyötehdas[1]
The bedside table & cupboards (Figure 7.)			X		Huonekalu- ja rakennustyötehdas[1]
The bed (Figures 5 and 8.)			X		August Louhen rautasänkytehdas[1]
The chair (Figure 9.)				X	Huonekalu- ja rakennustyötehdas[1]

[1] The two companies, Huonekalu- ja rakennustyötehdas, and August Louhen rautasänkytehdas (The Steel Bed factory of August Louhi), were collaborators among them and with Alvar Aalto already before the Paimio Sanatorium project.

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Figure 6. The wardrobe and the fixed table photographed in the museum room of the sanatorium in 2015. Photo Ark-byroo Architects.

Figure 7. The bedside table and cupboard. Photo Ark-byroo Architects.

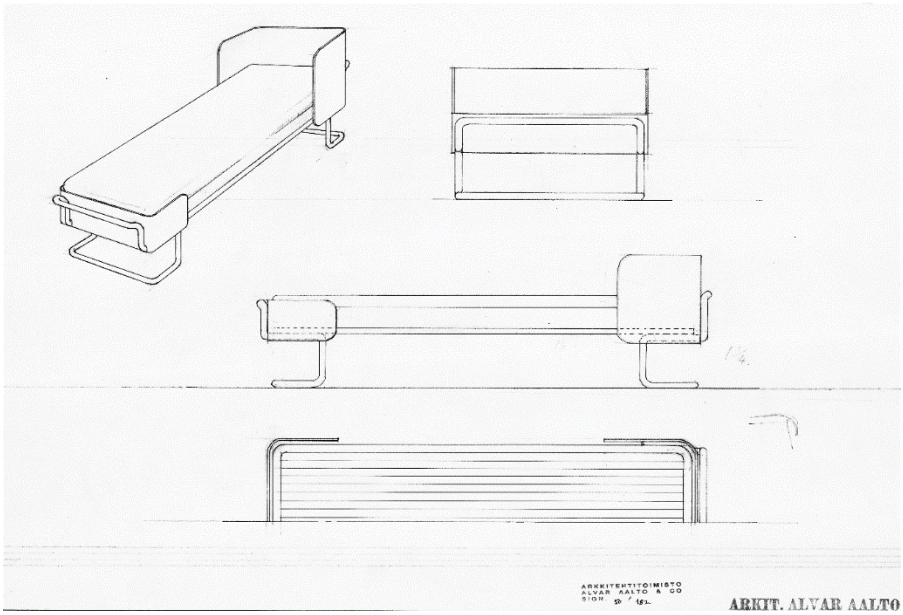

Figure 8. The bed design was more nuanced than the realised version, which is visible in Figure 5 on page 7. Drawing 50-182. AAM.

(**a**) (**b**)

Figure 9. (a) The hybrid chair with steel tube legs and a bent plywood seat is Aalto's design from the late 1920s. Aalto used this Modernist chair with a cantilevered structure in his standard. (Figure 2 b.) Photo No. 105890. AAM. (b) The small, stackable armchair of the patient room was ofmade from wood, which as a local material was cheaper than metal. Photo No. 105931. AAM.

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As the person responsible for purchasing patient room furnishings, Aalto's role in securing the overall furnishing design of the patient room was decisive. He divided the furniture into four categories in the acquisition programme. Only some of these categories were part of the design remit of Aalto's office. From the Building Board's perspective, it was not a question of commissioning an artistically coherent whole. Aalto as a designer was, however, keen to realise the patient room including the tiniest of details. Realizing the holistic design required a great deal of effort from the architect. By manoeuvring the purchasing processes through various trials, he was able to translate the view of the Building Board to support his intentions by always invoking the lowest price. He exercised a great deal of power within the project. As the person responsible for composing the acquisition programme, he knew the rules, and, as a representative of the client organisation, it was part of his role to invite tenders. In addition to this position and the resources of his architectural office, he also formed part of many local collaborative networks, which had taken shape during previous projects. Therefore, for example, the manufacture of the model wardrobes for the patient rooms at Huonekalu- ja Rakennustyötehdas (the Furniture and Building Work Factory) was completed in record time. Aalto showed great creativity in exploiting his social networks and material means. He managed to bring into existence a robust and viable network made up of social and material actors, existing only for the project.

2.4 The Architectural Challenge of the District Infrastructure

The building design and construction preceded many fundamental decisions made concerning district systems, including sewage and electricity. When the time to make these decisions came, no real alternatives existed. The requirements of district systems were not observed in the early stages of the building project, regardless of the background organisations of the Building Board, which included Turku city officials with a wealth of technological expertise, and the State Medical Board, which acted as a specialist organisation in all state-funded hospital projects. Neither the principal designer nor any other stakeholder ever demanded that the installation systems be designed concurrently with the architectural design.

From the perspective of today's building design, it appears unfathomable that the water, sewage, and heating systems, as well as the electrical installations, were designed after the architectural design was complete. The knowledge and skills of different specialists were not at the disposal of the architect until the construction had progressed to execution. The architect was assumed to be able to take the requirements of installation technologies without interacting with specialists in the respective fields, at a time when heating, water, and sewage technologies were still novelties in large, modern institutions. The confidence in the architect's competence was unwavering.

The Building Board had initially requested offers on water, sewage, and heating systems without a reference plan. The poorly prepared first contracting round resulted in no contract. Instead, the Building Board commissioned a plan of the water, sewage, and heating systems from one of the contractors. The second round of tendering based on the plan. The one-year delay in the water, sewage, and heating system contract had a direct impact on the overall schedule of the project. Collaboration between the architect and Radiator, who designed the water, sewage, and heating systems, was fruitful and productive. However, another company, Plumbing Company Onninen, got the contract because it had been carrying out a smaller contract on the site and was therefore familiar with the developer. Cooperation between Aalto and Onninen was not without its difficulties and resulted in excess billing about many details, such as the water traps for the washbasins and spittoons in the patient rooms.

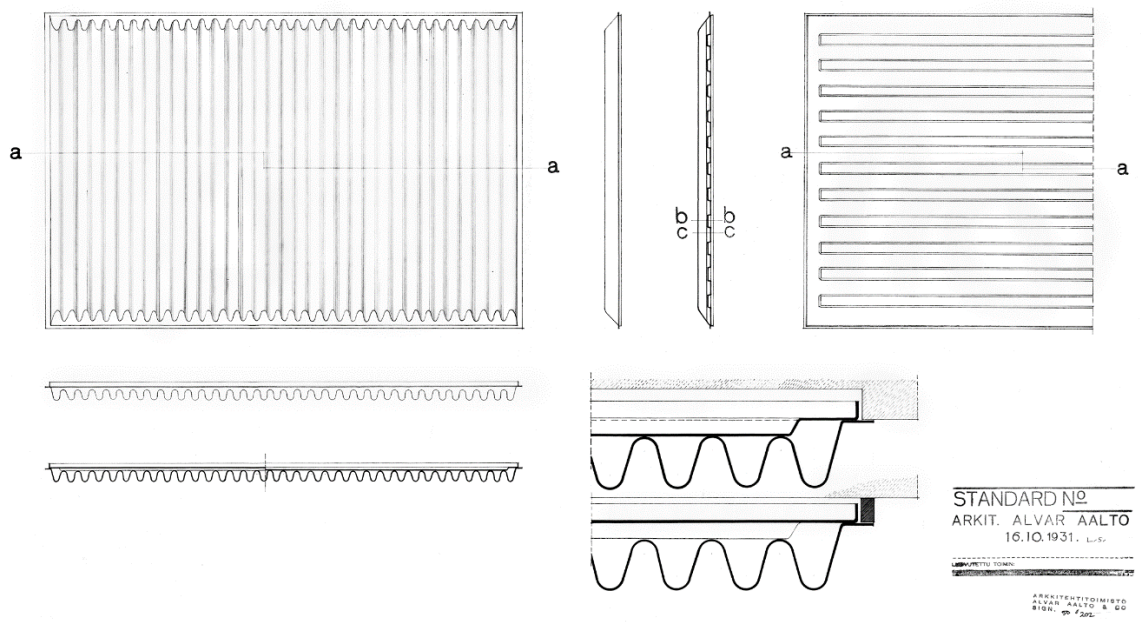

Figure 10. A radiator design by Alvar Aalto proves his interest to look at the technological apparatus and installations more profoundly and understand the way they function. Drawing 50-202. AAM.

Aalto actively attempted to influence the choice of contractors on many occasions. He succeeded in engaging a contractor for the construction of the concrete frame with a quotation that was only fifth cheapest. Aalto failed to choose smart tactic when aiming to exert his influence in the selection of the water, sewage, and heating system contractor. He wanted to continue coop with Radiator, and therefore emphasised the importance of Rayard radiators, which, Radiator had introduced to the project. Contrary to his expectation, the demand did not deter other candidates. Thus, Aalto failed to form the collaborative team he had planned; he lost the trial. It is apparent that the relations between Aalto and Radiator deteriorated because of the decision. Aalto had probably explicitly contacted the owner and director of Radiator, Arthur E. Nikander, who was known as a well-trained pioneering engineer-contractor and had contributed to the design by drawing on his know-how and had trusted in a gentleman's agreement with Aalto regarding the contract.

Aalto's role as an innovator concerning Paimio Sanatorium's district systems, it was variable. When, in Aalto's opinion, the "wrong" water, sewage, and heating piping contractor was selected, the architect seems to have lost interest in developing this area any further. Even the electrical installations, such as high and low-voltage systems, which were abstract and which saw a rapid improvement in the early 1900s, were not of special interest to him. The only exceptions to this were the light fittings and lifts. Another unusual detail is that the ventilation design simply emerged as part of the heating plan. Nobody specifically designed it. Although Aalto wrote in his 1932 article "Bostadsfrågans geografi" (The Geography of the Housing Problem) about the division of Europe into town and country, he had not grasped the character and potential of district systems. (Aalto 1932b) Perhaps he had not personally seen any real examples of the architectural treatment of infrastructure systems. The Latourian hybrids in heating, water, sewage, or electrical systems in the Paimio Sanatorium project were not as successful as they could have been in integrating technological systems into architecture, except for the discontinued collaboration with Radiator and few aspects. However, Aalto was motivated and ideas to develop heating and plumbing apparatus and solutions inside the buildings, which became evident in his initiatives during the Paimio Sanatorium project (see e. g. Figure 10), but he did not manage to be as innovative in a bigger scale.

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3. Discussion

Aalto's modernist discourse was about operating locally. In Paimio Sanatorium, the new social order of modernisation found its architectural manifestation specifically in the patient room. In line with the Fordian ethos, Aalto was conscious of the role of the users of health care services, the patient-consumers, and placed them in his design focus. Therefore, Aalto's creation was socially more radical than other hospitals built in the same period. Aalto designed the patient room around the new patrons of architecture, the ordinary citizens, in an empathetic manner. They could look out of the window while resting on the bed, the light would not be too dazzling, and the radiator installed on the ceiling emitted even comfortable warmth. Aalto treated the patient room as a minimum apartment, which, from the perspective of the discourse, was a highly relevant concept. Rationalist theory or the minimum apartment did not, as such, emphasise the individual experience. Aalto repeated this same room 120 times through the building, but with his original solutions, he created a sense of individuality to enrich the everyday environment.

A detailed inquiry into specific processes produced a wealth of new information about the main building and furnishings of Paimio Sanatorium. Furniture acquisitions revealed the architect's tactics. He favoured certain suppliers because he had previously engaged with them in a long-term collaboration. Aalto's strategy was to launch his furniture into serial production, something that previous research has already suggested but the present study further confirmed that. Aalto aimed to use standardised products for the hospital purchases, and at the same time to design the very standards to be applied, such as the washbasin in the patient room. Standardised products by other manufacturers were available, but they did not pass muster with Aalto. His likely motive was to introduce his designs into serial production, and he found the existing serially produced products, such as the washbasins for the patient rooms, aesthetically unsatisfactory.

The design contracts signed between Aalto and the Building Board did not guarantee that the interiors in general, or even the patient rooms, would be furnished with pieces designed by Aino and Alvar Aalto. The Building Board's decision to select them was not an aesthetic but a pecuniary one. The artistically accomplished designer was not successful merely because of his superior sense of the aesthetic. He succeeded because he knew how to enact and realise his strategy.

The successful furnishing of the patient rooms speaks of the architect's ability to operate in a social context and to direct his actions and even, when necessary, to exceed the limits of his role. In Latour's terms, the question was about translation. The client reached its goal, which was to save costs as much as possible while achieving sufficient quality. For the Building Board of the Paimio Sanatorium project, the end justified the means, so they gave Aalto considerable latitude to manoeuvre, which enabled him to bring in, one contract at a time, his old business partners as suppliers to the hospital project.

The standards, of which several are related to the patient room, can be interpreted through Latour's theory of the locality of scientific knowledge. (Latour 1993) First, Alvar Aalto insisted on including the master drawings, cost calculations, work specification, working drawings and the standard drawings among the working drawings in his design contract. It was somehow necessary for him to establish the concept of the standard to the client, as the concept was, in this context, in all likelihood entirely new for the latter. The architect created many standard drawings in conjunction with the design work for Paimio Sanatorium; a practice that the contract thus legitimised. Aalto's letter to his Swedish friend and colleague Sven Markelius of 1932 revealed that the architect was not paid enough for the design of the hospital in his view. However, the minutes did also reveal that the Federation of Municipalities invested more resources in the interior design of this sanatorium than others of the same period. These anecdotes indicate that Aalto's level of ambition and commitment were far beyond average.

Aalto's intention behind this course of action was to bring an exciting phenomenon into his own designer's studio and under his scrutiny. In this way, he could work it the way he wanted to, and eventually design standards that could enter industrial production. The notions of Aalto's tactics as the chief supervisor of Paimio Sanatorium acquisitions and purchases strengthen this interpretation. Latour's thesis of the locality of knowledge and knowledge management seems to be highly accurate.

According to Latour, the secret of an innovator's success lies in the innovative use of material resources, not in the intellectual superiority of the innovator. Aalto's dominant position and his abilities for networking seem to have been the key to success in furnishing the patient room.

As the example of the patient room window shows, Aalto succeeded in redefining the cultural concept of the window, in this case, the horizontally oriented health window in a patient room. The architectural press was an ideal forum for devising such new meanings. According to Latour, society must be composed, invented, stabilised, maintained and assembled. Society does not explain anything; we must explain society. Various distinctions, as in the case of windows – the definitions of the traditional wooden structure and the modern structural hybrid – served as a source of inspiration for Aalto. Through his texts and designs, Aalto contributed, at a local level, to formulating and maintaining many concepts. To apply Latour's idea: the window of the patient room does not explain anything, as such, but instead, we must explain the window.

It was more natural for Aalto to treat the installation technology – the water, sewage, heating, ventilation, and electrical systems – on the same scale as the patient room, rather than on that of the entire building or district. The resolution of the question of installation systems on the scale of the building or the district created difficulties, mainly because the client assumed that the architect would be able to plan the building-level solutions on his own from the very beginning of the design process, and without input from experts or discussion of the options to hand. In other words, the architect received no specialist support in this area until a later stage of the process. There was no readiness to identify any alternative ways of organising the installation systems until some of the decisions had already been made, thus reducing the remaining options. The installation systems, as distinct systems, were thus developed for the building, without any architectonic treatment based on mutual interaction, except for a few isolated cases of collaboration.

A technological process benefits from inspiring ideas that are tested and subsequently adjusted. The story of Paimio Sanatorium reveals that the water, sewage, and heating pipe systems, alongside the electrical and ventilation installations, were relatively new to Aalto, and he could not manage their design without input from specialists. For this specific reason, it was vital for him to be able to build reliable, capable networks. He had succeeded at the early stages of the construction phase in bringing in some of his trusted partners, but as a consequence lost some of the Building Board's trust.

Latour's observations on descriptions of innovation and the intertwining of forces as events that do not lend themselves to generalised concepts formed a sound basis for choosing a case study as the angle on this topic. Aalto absorbed international influences and applied them in practice in his home country, which was still profoundly agricultural and struggling in the throes of an economic depression. In the case of Paimio Sanatorium, Finland was witnessing the emergence of a new building type (typos); at that time, efforts were made to favour local or at least domestic products and producers; the producer organisation of the building, the architect, and his vision were unique (tectonic), as was the location (topos). The above summary bases on Kenneth Frampton's theory of architecture emerging as a synthesis of these three factors. (Frampton 1996)

Latour's abstract thinking embodies the idea of general symmetry, in which the object is an active entity participating in the construct. According to Latour, the effect is not one-directional. In line with the theme of reciprocity, this study discussed how the current material reality affected the design solution. For example, the Building Board was convinced of the demanding nature of the realisation of the reinforced concrete frame and the imperative of a collaborative process, since it went on to select only the fifth lowest quote. A reinforced concrete building represented new technology, which resulted in more difficult decision-making. However, the Building Board never once questioned the feasibility of the reinforced concrete frame.

The winning competition entry showed that Aalto could take the objectives of the clients, namely the Federation of Municipalities and the State Medical Board, which oversaw the construction work and turning them into action in consensus with his objectives. Aalto was keen to make sure that the press reported the progress of his hospital project in a favourable light. Aalto became a celebrated figure, while the other participants to the project did not actively appear in the publicity, although Aalto mentioned some of them. In a Latourian reading, the collective became visible through its

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innovator, which was enough for the audience. The other actors and the significant input were forgotten. The credit for the success, which was the result of the work by the entire collective, went to Aalto alone. Latour's description of the collective reveals something essential about architecture and is well-suited for the study of architecture, in which the role of the designer is traditionally, and often disturbingly, assigned to a single individual. Anyone familiar with the field will know how necessary it is to view architecture as a collective and an applied undertaking.

Latour's view that a project will never amount to anything if its idea remains pure is also fascinating from the perspective of architecture. A project can only materialise if it is exposed to and intermingles with other elements. Only when the resulting machine or another artefact, in this case, a building, becomes unquestionably established, so that this synthesis is forgotten, can an idea be perceived as "pure." When examining the relationship between architecture and technology, it would be unrealistic to remain exclusively in the domain of ideas.

4. Materials and Methods

Latour urges the researcher to observe the details in view and map out the chain of events. His example directs our attention to what networks reflect of themselves to the outside world. One of the critical issues in the study was to delimit the object of study. According to the definition of technology adopted in the study, the set of objects under scientific inquiry may contain any entities. The anthropological approach enabled the research object itself to direct the researcher to the salient themes of study. By analysing Aalto's writings as well as his drawings, the researcher formed an opinion on which aspects of the design were vital for the architect from the perspective of architectural theory. Besides, the study also tracked the decision-making process of the Building Board and identified many topics that it discussed intensely, and that caused conflict. The study followed these points of disconnect, which Latour has dubbed as trials.

From the perspective of the execution of hospital designs, one of the two archives of vital importance was the archive of the hospital itself. The minutes of the Building Committee and the Building Board are records of decision-making during the building process. Aalto's drawings and photographs from the construction period and of the finished building, as well as his correspondence, are kept in the Aalto archive, which was the second of the two principal sources of information. The archive also contains certain other documents in addition to those produced by the architects, such as engineers' drawings and product catalogues.

The study compiled a robust description of each building component, or technological system from the basis of the minutes of the Building Board and the Building Committee, the written contracts, and the inspection records, in chronological order. The researcher looked more profound to each building part and compared its narration with other source materials, such as drawings, specifications, and the building itself. The minutes revealed, among other things, the intentions of different parties, and answered questions such as who proposed what, whether someone objected to something, whether the administrative bodies altered the plans, in what way the solutions and decisions evolved, and who was entitled to act as the representative of these bodies in different situations.

Architectural drawings and other design documents were grouped into categories to match the focal points in the study, such as the designs relating to the windows. The categories included drawings from the competition phase to working drawings, and from elevation drawings to the smallest details and standard drawings. The researcher arranged the material in chronological order. This method was useful for understanding the development and its challenges. As the next step, the researcher juxtaposed these considerations against the analysis of the minutes and the workshop drawings. Through this method, the study traced which building parts the architect afforded the most design effort and who participated in the process.

5. Conclusions

The study clearly showed the importance of a collaborative effort in an architectural project. Latour refers to strong networks formed by social and material actors that together possess the capacity to act. The more in-depth insight into the prerequisites for successful architecture that the study has provided could be useful today. The most famous architectural solutions for Paimio Sanatorium, a demanding institutional building project, came into being in circumstances where the architect-innovator, Aalto, managed to create a viable and robust hybrid that merged collective competence with material factors. Creating such a context today could lead to successful innovation of the current environments in health care.

Latour's concept of translation offered a framework to understand why the architect justified his design solutions differently to different audiences, such as the medical experts or the professional peers. He needed to understand what motivated each group and interpret the same design differently.

On the historical side, the different electrical, heating, plumbing and air conditioning systems developed very rapidly in the inter-war period, and few had previous experience on them. The disruption of architects' role as master builders had already taken place roughly a century earlier concerning the bearing system along with the use of steel structures and reinforced concrete structures. In the early decades of the 20th century, the pace was just too fast even for an open-minded and skilled young professional like Alvar Aalto, to master all its technological subsystems. Engineers started occupying more mental space in building projects. This study indicates that the break took place in the interwar period, as the architect was on the one hand expected to master all fields of engineering until the contracting stage. The specialists only joined the project during the construction phase, and the design team needed to reconsider many solutions.

Supplementary Materials: The following are available online at https://aaltodoc.aalto.fi/handle/123456789/19607

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References

(Aalto 1932a) Aalto, Alvar. 1932a. Sanatorium i Paimio, Finland (Paimio Sanatorium, Finland). *Byggmästaren* (The Master Builder) No. 14/1932, architecture supplement No. 5, pp. 80–83.

(Aalto 1932b) Aalto, Alvar. 1932b. Bostadsfrågans geografi (Geography of the Housing Problem). *Arkitektur och samhälle, Spektrum* (Architecture and Society, The Spectrum) No. 1/1932, pp. 86–92.

(Beim 2004) Beim, Anne. 2004. *Tectonic Visions in Architecture*. Copenhagen: Kunstakademiets arkitektskoles forlag.

(Brunnström 1990) Brunnström, Lisa. 1990. *Den rationella fabriken* (Rational Factory). Umeå: Dokuma.

(Brunnström 2004) Brunnström, Lisa. 2004. *Det svenska folkhemsbygget.* Om Kooperativa Förbundets arkitektkontor (Building the Swedish Welfare State. Regarding the Swedish Co-operative Union and Wholesales Societies' Architectural Office). Stockholm: Arkitektur förlag.

(Colomina [1994] 1998) Colomina, Beatrix. 1998. *Privacy, and Publicity, Modern Architecture as Mass Media*. 1st pbk. ed. Cambridge: The MIT Press.

(Colquhoun 1962) Colquhoun, Alan. 1962. *Symbolic and Literal Aspects of Technology*. Architectural design, November 1962, pp. 508–509.

(Frampton 1996) Frampton, Kenneth. 1996. *Studies in Tectonic Culture. The Poetics of Construction in Nineteenth and Twentieth Century Architecture*. Second printing. Cambridge: The MIT Press.

(Korvenmaa 1998) Korvenmaa, Pekka. 1998. Aalto and Finnish Industry. In: P. Reed ed. 1998. *Alvar Aalto. Between Humanism and Materialism*. Published on the occasion of the exhibition Alvar Aalto: Between Humanism and Materialism, the Museum of Modern Art, New York, February 19 – May 19, 1998. New York: The Museum of Modern Art, pp. 70–92.

(Latour 1993) Latour, Bruno. 1993. The Pasteurization of France. The first pbk. ed. Cambridge; Massachusetts: Harvard University Press.

(Latour & Yaneva 2008) Latour, Bruno & Yaneva, Albena. 2008. "Give Me a Gun and I Will Make all Buildings Move": An ANT view of Architecture'. Explorations in Architecture: Teaching, Design, Research, ed. by R. Geiser. Basel: Birkhauser, pp. 80–89 <http://www.bruno-latour.fr> [accessed October 29, 2015].

(Norvasuo 2009) Norvasuo, Markku. 2009. *Taivaskattoinen huone. Ylävalon tematiikka Alvar Aallon arkkitehtuurissa 1927–1956.* (A Room with a Sky Ceiling. On Top Lighting in Alvar Aalto's Architecture 1927–1956). PhD thesis Helsinki University of Technology. Land Use Planning and Urban Studies Group Publications. Espoo: Helsinki University of Technology.

(Standertskjöld 1992a) Standertskjöld, Elina. 1992a. Alvar Aalto and standardisation. In: R. Nikula, M-R. Norri and K. Paatero eds. 1992. Acanthus. Helsinki: Museum of Finnish Architecture, pp. 74–88.

(Standertskjöld 1992b) Standertskjöld, E., 1992b. Alvar Aalto's standard drawings 1929–1932. In: R. Nikula, M-R. Norri and K. Paatero eds. 1992. Acanthus. Helsinki: Museum of Finnish Architecture, pp. 89–111.

(Standertskjöld 2010) Standertskjöld, E., 2010. *The Dream of the New World*. Helsinki: Museum of Finnish Architecture.