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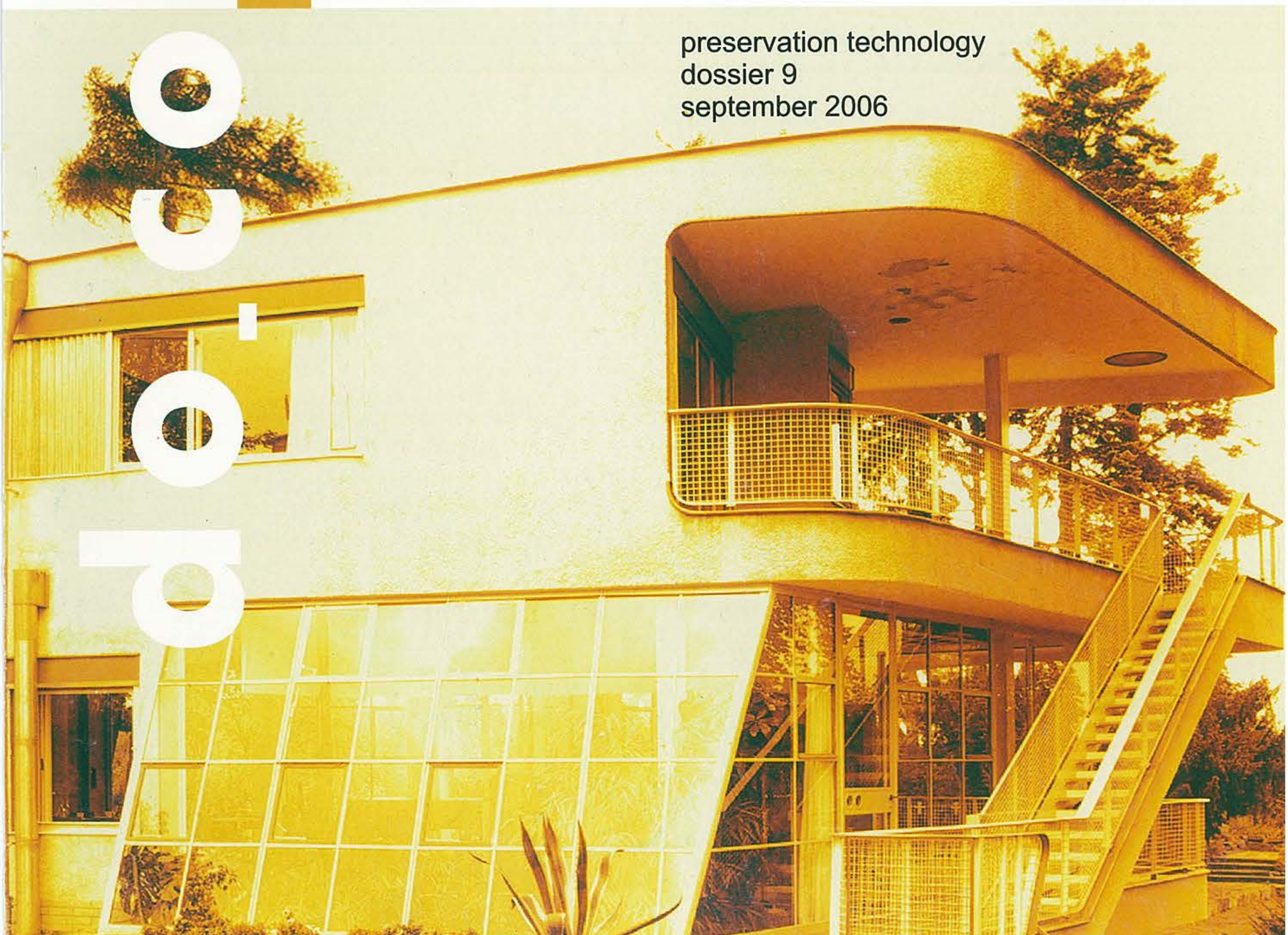
Climate and Building Physics in the Modern Movement

preservation technology
dossier 9
september 2006



Colophon

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Climate and Building Physics in the Modern Movement
proceedings of the 9th International DOCOMOMO Technology Seminar
June 24/25 2005, House Schminke, Löbau, Germany

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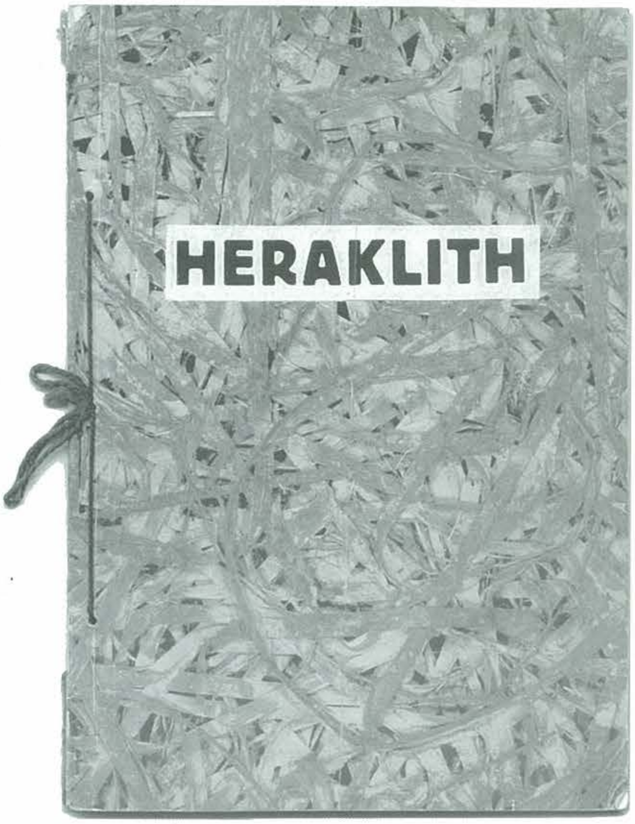

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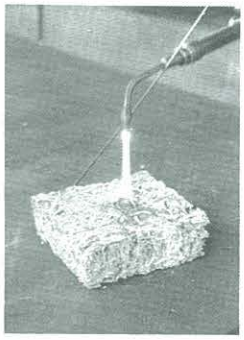

Die Eisenteile im weißglühenden Zustand.

Das geschmolzene Eisen.

Schmelzen von Nägeln mittels Sauerstoffgebläses auf einem Stück Heraklith.

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in cooperation with the Hochschule Zittau/Görlitz (FH), Technische Universität Braunschweig and the Royal Danish Academy of Fine Arts, Copenhagen.

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School of Architecture

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WÜSTENROT STIFTUNG

Contents


Haus Schminke by Hans Scharoun 1931-1933
Photo Jos Tomlow

Preface

Modern Movement pioneers considered structural design mainly as a matter of geometry.

In *Towards a New Architecture* (1923) Le Corbusier wrote:
"Architecture is the masterly, correct and magnificent play of masses brought together in light ..."

However, climatic conditions and a range of problems with moisture and insulation in completed buildings, obliged modern movement architects to take an interest in the then emergent discipline of Building Science. This process was paralleled by conservative criticism on modern movement building praxis, which included the "flat roof discussion".

The Schminke House by Hans Scharoun (1931-1933) in Löbau, Saxony, a building of advanced and sophisticated performance of Building Physics, has been the location for this seminar. We traced the development of the then still young Building Physics discipline in the modern movement architecture and its attitude towards climate, focussing on the period between 1920 and 1940. Experts in building science, technical and architectural history, building restoration and monument preservation authorities as well as architectural teachers explained and discussed this innovative theme with topics such as:

heat insulation / transmission / k-value
experiment houses / new materials
sun orientation in different climates
glassed surfaces, thin walls
air conditioning / heating systems
flat roofs / terraces

In spite of the apparent retrospective historic view of the seminar, its inherent goal is sustainable development of the cultural ressources, embodied in the modern movement architecture still existent.

A seminar tour in the Saxon region was arranged, which visited modern movement buildings outstanding for the behavior and performance of their internal environments. The tour included industrialized timber building by Konrad Wachsmann in Niesky, a vocational school complex and the theatre in Zittau. The embedding of this meeting in an intact landscape and the charming Schminke House and garden guaranteed a friendly atmosphere, unforgettable for the participants.

One may summarize already now about this seminar, where people from eleven climates and countries met that the validity of building science as a vantage point of architecture historiography was established firmly.

The seminar *Climate and Building Physics in the Modern Movement* was organized on June 24 and 25, 2005 by DOCOMOMO International Specialist Committee - Technology in cooperation with the Hochschule Zittau/Görlitz (FH), Technische Universität Braunschweig and the Royal Danish Academy of Fine Arts, Copenhagen. The DOCOMOMO international staff in Paris and Rome was helpful in promoting the seminar worldwide, under the 49 working parties and it is us a privilege to be part of this organisation. Prof. Dr.-Ing. habil. Rainer Hampel and Prof. Dr. oec. Joachim Zielbauer, rector and vice rector science of Hochschule Zittau/Görlitz (FH), supported by Prof. Dr.-Ing. habil. Reinhard Schwerter, dean of the building department, enabled the seminar dossier to be published. Both the seminar and this seminar dossier would not have been accomplished without the financial support by the Wüstenrot-Stiftung, Ludwigsburg. This foundation shows a remarkable profound scientifical attitude in supporting the modern movement heritage.

Jos Tomlow and Ola Wedebrunn

Introduction

Building Science as Reflected in Modern Movement Literature

by Jos Tomlow

"One could take the activity of a nation's population in the field of health and hygiene as a measure for its potential to play a grand role in cultural history"[1] Max von Pettenkofer in 1873

"A great deal of important publications on health engineering does not reach architects, since these are only available as a special issue of scientific periodicals."[2] Richard Schachner in 1926

"A famous architect reached such a level of enthusiasm (...) that he asserted: "In the future one will build in the far North exactly as along the Mediterranean Sea". In a few years his demand has been fulfilled; Architecture has suffered such a defeat, that she will recover only very slowly. Had this been just an aesthetic mistake, then it would probably not have been fatal to a similar degree. But Nature – in this case the climate – will not withhold its revenge, for the fact that she has been so badly ignored."[3] Bruno Taut in 1936

Building Science – *Bauphysik*, in German – can be regarded as a neglected aspect in the historiography of Modern Movement architecture. On the one hand the innovative side of MoMo design includes the introduction of features like flat roofs, thin walls, increased glass surfaces orienting towards the sun or *brise-soleil* in hot regions, and new materials – all of them highly related with Building Science and its problems – but on the other hand the technical questions raising from these features are hardly analysed by art critics or others.[4]

But even inside the Building Science discipline, interest in its history is rare, with appreciable exceptions like Helmut Künzel and Klaus W. Usemann.[5]

In order to be able to discuss Building Science and its relationship with the Modern Movement, the author wants to take a strict historical viewpoint. Along original publications from the MoMo period – for methodological reasons with occasional references to earlier writings – the role of Building Science will be analysed. Another viewpoint could be to critizise Modern Movement architecture by confronting it with present Building Science knowledge – as often instantly happens when Building Science engineers discuss Modern Movement buildings – but up to now this approach tends, at least from my experience, to be confused by ideologically founded statements like "Hans, single glass is energetically not political correct" and prejudices on comfort standards in historical context like "Walter, an art studio should be cosy warm all over".

What is *Bauphysik* (Building Science)?

Definition *Bauphysik*: "The physical basics of building technology which analyses building materials and systems, especially in the field of transmission of heat, sound, humidity and air."[6] Another definition, more aiming at the goal of the discipline is: "*Bauklimatik* describes principles and methods which are effective to control the climate in the interior and its near surroundings in such a way, that they can be used properly (function safeguarding), as well as that the building's structure may be protected against impermissible attacks by the climate (self-safeguarding)."[7]

The word *Bauphysik* is rather young.[8] Before 1950 one would hardly find it used. Methodologically, this contribution includes into the analysis key-terms with a similar content: Building Science, Building Physics, Building Systems, *Bauklimatik*, *Stadthygiene*, and connected disciplines which deal with energy, heating, cooling, ventilation, sanitary equipment, insulation material. By tradition, its actors are similarly termed: *Bauphysiker, Bauklimatiker, Bauphysikingenieur, Bauhygieniker, Gesundheitsingenieur, Bauchemiker.* The word *Bautenschutz* (preservation of structures) describes accurately the goal of Building Science in the design process.

The present study takes a viewpoint which strongly relies on German – less Dutch – literature, inspired by the important role of Germany as a centre of early international Modern Movement architecture and because of the high scientifical level of German Universities from which *Bauphysik* could profit. However, of major importance for the development of *Bauphysik* are specific international contributions by individuals like Bugge and Syrkus. Beside these, a range of institutions in France (on heating, sanitary equipment), America (on air-conditioning, industrialized building) and England (on air pollution) shows that outside of Germany aspects of Building Science were in development as well. A balanced depiction of the whole development of Building Science would pass the restrictions of the actual contribution.

Heat transmission

A key notion which helps to controle temperature in buildings is the so called k-value (now generally described in Europe with U-value in W/m²h°C) or heat transmission value (*Wärmedurchgangszahl*). The k-value is defined by: "Energy loss – in W/m²K – of 1° C (or 1° K = Kelvin) through a 1 m² wall or ceiling part during one hour". Its importance for *Bauphysik* cannot be overestimated, since it is one of the rare quantitative criteria for building quality. A low k-value implies that heat insulation properties are good, which not only means that energy may be saved for heating, but also – generally spoken and provided that there is enough air ventilation – that one feels comfortable in the room in question with a small heating effort. Heat transmission was already analysed from a mathematical point of view by J.B.J. Fourier in early 19th C.[9] Fourier's complicated formulas were simplified by the French physicist J.C.E. Péclet.[10] He was also one of the first to measure heat transmission by experiment. Péclet's k-values – derivated with methodological errors – were quoted frequently in literature until 1920, when more reliable values were established by institutional research.

The problem of used air

An important issue of Building Science is the interior air quality, and the problem of a proper ventilation degree. In halls where many people are assembled fresh air will be consumed quickly.[11] Already at an early stage, medical doctors observed that breathing air in a room will be polluted when not refreshed. Whereas a range of phenomena are unhealthy in used air, a measurable factor should be found, to enable the establishment of a general ventilation standard. The hygienist Max von Pettenkofer discovered that CO_2 (carbonic acid) as part of the outgoing breath is the most important factor of used air. He found a way of measuring the CO_2 quantity in air as indicator of air pollution. One result of Pettenkofer's experiments was that the question of proper ventilation became considered in the architectural design process, advocated especially for public buildings such as schools.

Heating and ventilation systems

Around 1885 the international heating industry was able to present a broad variety of products, and Germany had reached a high scientifical standard, even in comparison with France or England, which underwent her academic development much earlier. In this fruitful situation a key figure of Building Science could gain decisive power. Hermann Rietschel, son of the Dresden sculpturer Ernst Rietschel, combined strong commercial activity with scientific research and an elaborative networking on everything concerning heating and ventilation. His biographer, Usemann, portrays a person who is absorbed by the idea of establishing a heating and ventilation discipline of high standard, safe and in fair competition.[12]

Among the merits of Rietschel, one can recall his efforts for optimizing heating and ventilation systems by meticulous research, both experimental and theoretical, for reducing the danger of accidents and increasing fire protection. He fought against low prices on the open market, hiding bad job. His aim was a general standardization of all components in the heating process. One gets the impression that Rietschel was decisive of the development of the heating and ventilation branch, indeed even dominating it, a fact which may have discouraged the search for alternative systems. As an indictation of this statement one may quote Rietschel in a report on ventilation in schools (1886): "The air quality in all class rooms turned out to be most defective. Almost without effect were the channel systems, installed for ventilation in class rooms in older times. These showed far too narrow dimensions and can only be interpreted as an effort to remedy objective deficiencies, which went wrong."[13]

I consider Rietschel's words in its generalistic authoritative way of expression as dangerous, because ventilation systems in Rietschel's time turned out full of errors and hard to handle by unskilled persons – as Rietschel himself states – whereas the criticized ventilation channels were developed following a rational concept, which could possibly be improved technically. In the late 19th C. hygienists and architects had estabilished the channel system in walls, on the presumption that used air would leave the room through the vertical channels in walls by chimney effect, when fresh air was led through opened windows. The channels reached into the open attic space, where the used air was concentrated into air outlets, decoratively set along the ridge of the roof.[14]

Rietschel's vision included the idea that heating and ventilation – his proper working field – were integrated in a range of disciplines concerned with human well-being and comfort in buildings. He was one of the organisers of a hygiene exhibition in Berlin (*Hygiene-Ausstellung Berlin*) in 1883, a commercial fair combined with conferences on technical developments in household equipment which were influential in housing culture.[15]

For the present paper Rietschel's contribution to Building Science is especially important because of his scientific work as one of the world's first professors for ventilation and heating (1885) at the *Königliche Technische Hochschule* in Berlin.[16] In 1886 Rietschel established a university laboratory for experimental research on heating and ventilation equipment.[17] The work done here was decisive for later developments and many inventions in equipment, and measuring devices for temperature, pressure and other factors followed. As a result Rietschel wrote a handbook with data and rules for the design of heating and ventilation equipment.[18]

Another influential German writer on *Bauphysik* is Friedrich Wilhelm Hermann Fischer, who was a teacher on heating and ventilation technology at the *Technische Hochschule* in Hannover. In the famous serial *Handbuch der Architektur* he published basic knowledge on both heat transmission and ventilation.[19] His contribution is eminently important because it focuses directly on readers within the architectural branch.

Heating plants and insulation industry

When in Rietschel we met a mechanical engineer who started as a producer of heating systems for buildings, technicians dealing with big energy plants were also influential on the development of Building Science. High energy costs required a tight control on heat loss of such engines and the structures surrounding them. Users of insulation materials, for instance in energy plants and in steam driven engines, were very keen to compare insulation materials. The rather small and specific group of industrialists producing insulation material took itself the initiative to increase research on insulation materials. In 1918, after years of preparation, the *Forschungsheim für Wärmewirtschaft* near München was established by Prof. Oskar C.W.H. Knoblauch.[20] This private institution – with academic connections – became a recognised source for data on Building Science, including k-values. Instantly after the announcement of the first results of the *Forschungsheim* laboratory, an interesting public discussion started between Rietschel's follower Prof. Brabbée and Dr. Wierz from Berlin and the München group around Prof. Knoblauch (Cammerer, Hencky and Schachner). They observed differences between the results of theoretically found k-values and measured values in experiment. One agrees that the moisture in building material has a negative impact since it increases heat transmission.[21] Without doubt competition was sensed between the older prestigeous Berlin laboratory – after more than 20 years with numerous experiments – and the München laboratory.[22] On the other hand the discussions in publications were fruitful and increased the scientific level.

Building physicist networks

Remarkable international networks emerged.[23] The first successor of Rietschel in Berlin was Karl Brabbée (1879-after 1949), an Austrian engineer who had been involved in research on air ventilation of then very innovative rail-way tunnels. After World War I Brabbée decided to go to America and he became the founding director of a research institute, the American Radiator Company (1924), Brabbée Laboratorium in Yonkers, NY, and the Research Institute for Heating and Ventilation of Columbia University NY (1927). Another successor of Rietschel was Heinrich Gröber (1880-1949), who had been an assistant of Knoblauch in München.[24]

Building codes as distributors of Building Science knowledge

Next to this short overview of scientific development, one may also detect in building practice itself and its conditions positive factors for an increased awareness of Building Science. Since long ago municipal *Bauordnungen* (building codes) existed in Europe.[25] An important issue was fire protection which around 1500 led to the directive to plaster half-timbered houses in cities, and later to the prohibition of such structures in wood. For the same reason the typical gable houses, with roof ridges leading toward the street, were forbidden and the ridge had to be turned parallel to the street. But also other issues were discussed, such as minimal heights for lodges, execution rules for chimneys and air supply avoiding smoke pollution by CO in the interior, minimal dimensions of inner courtyards, restrictions of lodging in cellars because of bad daylight and moisturous conditions. Gradually, important knowledge of young Building Science was incorporated in these building codes.[26]

The persons responsible for the building codes found in late 19th C. inspiration in city planning congresses, and progressive political forces demanded increased social and medical care for the working classes and the deprived.[27] Because of big cholera epidemics (Berlin 1831/1832, 1,426 killed; München 1854, 3,000; Hamburg 1892, 8,605) and epidemics which grew from concentrating people (barracks, prisons, boarding schools) steadily the notion developed that general hygienic standards should be improved. Main publications by the founders of communism, Karl Marx (*Das Kapital*, Band. 1: *Der Produktionsprozeß des Kapitals*, 1867) and Friedrich Engels (*Die Lage der arbeitenden Klasse in England*, 1845), contain similar descriptions of unhealthy housing conditions, especially for the poor, quoting profusely from medical reports, journal articles, and sociological literature. Another famous writer, the art critic and philosopher John Ruskin, observed keenly changes in the climate of England – like a yearly reduction of sun hours – caused by the process of industrialisation.[28]

These publications, typical of the 19th C., connect activities for political reform with proposals for technical improvement, both reflected in numerous book titles.[29] Apart from any political consideration, these publications show important historic information on Building Physics, absent in other historical sources.

Standardization and norming

In Germany the *Reichsgründung* (state founding) of 1871 was part of an increased tendency toward centralisation, similarly strong as the French and European developments during and after the Napoleonic era, and with an impact on all levels. Whereas the building codes were rather independent from the state law and developed by the cities over a long period, standardization became a big issue in Germany in general.

Standardization as a means for rational working methods and in the terms of quality control was favoured in intellectual circles like the architects' organisation *Werkbund* (Behrens, Muthesius) and – somewhat later – by the *Bauhaus* staff (Gropius, Hannes Meyer, Mies van der Rohe), as well as in the academic and technical world. One result of the tendency toward standardizaton was the German Norm (DIN: *Deutsche Industrie Norm*), which was founded 1917 by the German industry. In 1927 3000 norms had been issued.[30] Some of the data needed for these norms were delivered by research institutes like those mentioned.

To inform the general public about the aim of standardization and to discuss its implementation under experts were main reasons for building fairs. Networking of architects with the industry, university and municipal authorities can be read from the lecture programs and exhibition themes.[31]

In contrast, the four first CIAM meetings (*Congrès Internationaux d'Architecture Moderne*) were not yet focusing on technical matters, let alone on Building Science, as implied by the singularity of Syrkus' lecture at the CIAM 1934 session, to be discussed below.[32]

Building Science at the start of the Modern Movement and its – small – role in architectural training

If we presume that around 1918 a good part of Building Science was known in academic circles, one may ask how this knowledge could then reach MoMo building practice. A first difficulty turned out to be that early literature was less attractive for architects or building firms, since these reports, books and reviews were specializing in energy plants and heating industry. They were often narrowly academic or fragmentary. The ample use of mathematics in such literature did not attract architects as readers, like Richard Schachner – an architect himself – notices in his book on health engineering.[33] There were, however, also general comprehensible articles on Building Science. As examples may be mentioned the periodical *"Gesundheitsingenieur – Zeitschrift für die gesamte Stadthygiene"*, edited in Berlin, and the *Handbuch der Architektur.*[34] Very rich in information are also Wasmuth, G. (Hg.), L.Adler, G.Kowalczyk, *Wasmuths Lexikon der Baukunst – A bis Z*. Bd. 1-4, Berlin 1929-1932, Wasmuth, G. (Hg.), B.Schwan, H.Zechlin, *Wasmuths Lexikon der Baukunst – Fünfter Band Nachtrag A bis Z*. Berlin 1937.[35]

From the 1920s and 1930s few German books on Building Science written for architects existed and none of them gave a complete overview of the discipline.[36] Richard Schachner and engineer Richard Flügge include in their books design rules for houses to improve the Building Physics behaviour, within a traditional building typology of pitched roofs. It would be interesting to know whether architects took up these interesting proposals.[37]

An increasing amount of architectural departments at universities in Germany founded specialised institutes for Building Sciences and the new discipline was integrated gradually in the study plan of architects. Of special interest for the present contribution is the *Bauhaus*, as a major source of MoMo architectural training.

Christian Wolsdorff has investigated the architectural school types in Germany of the MoMo period and its public debate. He concludes that a central problem of architectural training in the universities is the abstract teaching system, depending on a narrow disciplinary point of view, in an old-fashioned rigid atmosphere. In line with this observation is a certain lack of contacts between Building Science laboratories and the architects or architectural students till 1930 as a conclusion of the present study. As a good teaching model was considered a preparation of the architectural study in a university or an academy by passing the *Baugewerkeschule* (vocational school) – founded in the early 19th C. on behalf of building authorities – where one learned a handicraft and building practice. Stuttgart University was one of the first (1918) to include a practice period, within the study, following the recommendations of Theodor Fischer. At least in this respect (practice versus mere academic training) *Bauhaus* teaching included the training on art and a few building-related handicrafts, in this way bringing the young students in direct contact with materials and thus – on a practical level – with general physics.[38] Especially after the start of the *Architekturabteilung* (architectural department) at the *Bauhaus Dessau* under Hannes Meyer in April 1927 students were trained in projects to be realised, containing design, experiment and building practice. As a rare example of a certain interest in Building Science one can read in the semester plan of the *Bauhaus Dessau*, 1926/1927, about singular lectures on applied thermodynamics and installations in the 4th semester.[39]

How diverse the architectural trainings of the MoMo architects themselves were, may be illustrated by the following listing: *Regierungs-Baumeister* (state building master, Bruno Taut); architectural study at a technical university (Ludwig Hilberseimer, Jan Duiker, Johannes Bernardus van Loghem), cancelled studies with no degree (Walter Gropius); vocational school for watch engraving (Le Corbusier); son of a building contractor, without special training (Ludwig Mies van der Rohe); a mix of vocational handicraft school, school for drawing teacher, some university courses (Jacobus Johannes Pieter Oud); trained by his father in furniture making (Gerrit Rietveld), some theatre school, some teaching by a painter, autodidact (Theo van Doesburg).[40]

The *Bauhaus* education had, generally speaking, less training in basic theoretical knowledge of physics than the architectural departments of universities. In comparison with the young *Bauhaus*, the university institutions (like in Berlin, Dresden, München, Hannover and Stuttgart) could rely on a much longer history of scientific research, documented in adequate libraries and often related to experimental research in laboratories. On the other hand, in the *Bauhaus* education and its building activities a lot of experience on material behaviour and daylight design – to name only two aspects – was gained from first hand, not only from the masters' creative education, but also resulting from the cooperation with numerous building firms and city authorities, not to mention the constant international contacts.

At the *Bauhaus* Dessau at least the scientific treatment of natural light became integrated in the architectural design by Hannes Meyer. In comparison to the more liberal Gropius and Mies van der Rohe, Hannes Meyer belonged to the political left side (communist) and, like some others he went to the Soviet Union to help it building up. His architectural theory, derived from a general utopist vision on society, included all parts of live: "Building is social, technical, economical, psychological organisation".[41] This theoretical open framework led Hannes Meyer to his interest in Building Physics.[42]

Advertisement and product information contributes to Building Science

For this study about many aspects of new materials and building systems no official books were found, whereas information about historical developments could be traced in articles and advertisement publications. Often this *grey literature* lacks author names and a proper dating. Of special interest – also for Building Science – are those on roof paper, insulation, (steel) windows and glass, stucco and tiles as well as installations.[43]

Imminently valuable are both books by the Rasch brothers *Wie bauen?* (How to build? 1927/1928) since they connect firm information to specific *Weissenhofsiedlung* houses, including photos of the building site.[44]

MoMo architects promoting building science

Some personalities were influential in bringing Building Physics into MoMo Architecture. They were practicing architects themselves, like Syrkus from Poland and Van Loghem from the Netherlands, or they defined their own Building Science research based on existing architecture like Bugge from Norway.

To start with the architectural engineer Andreas Bugge, he became a professor at the technical university in Trondhjem, Norway. His work in the Building Science field, together with laboratory engineer Leif J. Hanssen, is based on the one hand on experimental research (1920-1927), consisting of a series of experimental houses of identical shape and climate exposure and on the other hand on field research of construction methods for houses. On an extensive research trip in the USA (1926), Bugge documented carefully structural solutions for small houses and compared them with European building practice. After the American trip he included a range of new wall systems in his experimental buildings, so that in the end he had 53 wall systems represented. His results for the k-value (U-value) were used internationally and published in German and Norwegian.[45]

In the case of Szymon Syrkus (1893-1964) we may speak of a contribution to Building Science by a first range MoMo architect. Syrkus – in many activities assisted by his wife Helena Syrkus (1900-1982) – was the Polish representative in CIAM and active in several architectural reviews and organisations. Whereas many MoMo architects in Poland in those years tended to an aesthetic dispute in connection with Polish excellent graphic design and painting, Syrkus – and those around him – oriented towards a clear functionalist interpretation.[46] His lecture on exterior walls for the CIAM IV (1933) was published in Holland as: Syrkus, S, *De buitenmuur – ondervindingen van de laatste jaren*, in: *De 8 en opbouw*, juni 1934.

With this contribution by Syrkus, the problematic side of simplistic white cubic design – in the sense of a vulgarization of Le Corbusier's early work – was clearly stated: Only when Building Physics would become an important issue for designing architects, thus the immanent conclusion, modern architecture could develop.[47]

In Holland MoMo architects from Rotterdam and Amsterdam merged their clubs in *De 8 en opbouw* with a review of the same name (1932-1943, reprint 1985-1989). Authors were for example the architects Jan Duiker, Koen Limperg, Johannes Bernardus van Loghem. Particularly interesting is Jan Duiker who, despite his early death in 1935, can be considered as a singular architectural talent by his work. Duiker's restless search to improve the technical level sometimes met borders. Typical of his austere attitude is his comment on the perception of interiors in winter as being quite cold, due to single plane glass surface in steel window frames: "The open-air school and outdoor working activate the skin and reduce the need for calories for the human body".[48] Thus he argues that those who sense subjectively the low temperatures as problematic are affected by a sociologically based weakness. Although correct as an observation, this was of course not a satisfying answer for mass housing, let alone for shelter of the ill or the elderly.

Duiker, with a building science engineer by the name of De Ridder, developed a heating system, based on ceiling heating with hot air. In the case of *Hotel Gooiland* (1934), Hilversum, the main air channel was put along the south façade, which was kept thin, in order to make use of passive sun energy. Also in this case, which is conceptually very near to the so-called "ecological architecture", rooting from energy saving in our times, Duiker's idea lacked the view of the total energy transmission, since at night and during cloudy winter days, the thin channel wall would cause energy loss. Only together with a control system, which starts certain devices – when needed – automatically or by hand, his idea would have been complete.[49] The heating system of Duiker/de Ridder was used in private houses as well, for example in a studio house by and for F. Hausbrand in Blaricum, 1934/1935.[50]

A fourth personality involved with Building Science is the authoritative Dutch architect Van Loghem.[51] Somewhat older than many MoMo colleagues, he was a renown writer with a critical view. His interest in the Building Science matter rooted partly in the fact that he had built – like other MoMo architects – in the Soviet Union (West Siberia). He recounts in his book *Acoustisch en thermisch bouwen voor de praktijk* (acoustical and thermal building in practice 1936) his discussions with Szymon Syrkus on construction for severe cold climates. In his Dutch buildings too Van Loghem came up against problems in the field of Building Science, as in the case of the huge sliding doors of steel and glass for a public bath, which he resolved in a clear way.[52] Another relevant design by Van Loghem in this respect is the housing complex "Betondorp" near Amsterdam (1922-1924) for which he developed a wall system of poured concrete between light concrete prefabricated elements (pumice).[53] His acoustical interests were relevant for his entry to the design competition for the Soviet Palace competition (1932).

MoMo architects promoting building according to the prevailing climate

In the eyes of many, the Modern Movement became fashionable for its generalistic formal vocabulary ("white, cubic"), seemingly applicable all over the world, but others never forgot their roots, neither the climate, nor their own building traditions which had coped with conditions of the climate in spite of reduced technical aid. These architects, whom one can call the *Organic Modern Movement*, had great relevance for the development of Building Physics.[54] In international respect one can observe a sophisticated MoMo and CIAM dispute between Northern Europe, with German architects like Walter Gropius and Ludwig Mies van der Rohe as spokesmen, and Southern Europe, the Mediterranean region, with Le Corbusier as the leading figure, together with Josep Lluís Sert from Barcelona. Joaquín Medina Warmburg has analyzed profoundly architectural contacts and mutual influences between Germany and Spain in the early 1930s, finding proof of these different views. The "German" position, under *Bauhaus* influence, would focus especially on functional and sociological analysis in its methods, and building dwellings for the masses became a main goal. The "Mediterranean" position, on the other hand, saw the Modern Movement from an aesthetic or philosophical point of view, as an evolution of the archaic honest way of life, which yet had survived on islands like Mallorca. Sert, for example, presents holiday houses for Ibiza using thick walls and a shaded terrace in front of glassed surfaces, being published next to the image of a humble farm house with similar characteristics.[55] The Mediterranean position seems to be still important now from the point of view of conservation policy: Whereas in Germany and Holland public debates ran between "conservatives" and "progressives", with the preservation of a "pitched-roof heritage" as seemingly the most important issue, MoMo architects in Southern Europe openly admired the old, whether as a house concept, a village structure, a building tradition like the Catalan vault or even in the shape of simple handcraft items like a peasant chair. A well documented example of a problematic design from the climatological viewpoint is the Hartung-Bergmann House on Menorca from 1933, as admitted frankly and with self-irony by the architect Hans Hartung. Problematic were the glass areas, which in winter were exposed to cold north winds, and other aspects.[56]

An elaboration of the Mediterranean position was achieved by the Catalan born architect Antonio Bonet Castellana (1913-1989). Bonet went to Latin America, as did many other civil war refugees. Trained by the masters Le Corbusier and Sert to respond theoretically to new professional conditions, Bonet and others who worked in Argentina founded the *Grupo Austral* and formulated a manifesto called *Voluntad y Acción* (Will and Action), published in the review *Nuestra Arquitectura*, in June 1939. In eleven points *Voluntad y Acción* discusses the necessity of inspiration from modern plastic arts and Surrealism in addition to a functionalist architectural training which, in its present form, was criticized as being too academic. Explicitly the *Grupo Austral* puts itself in the tradition not only of masters like Lloyd Wright, Gaudí, Eiffel, Perret and Le Corbusier but also in rural building tradition. Thus they established a reforming attitude towards architecture, fostering organic forms next to cubic and with respect for nature and physical laws. In this theoretically prosperous period a specific project arose, in which many of the formulated goals could be manifested: the coastal living resort Punta Ballena in Uruguay (1945). In an explicit natural surrounding the Casa Berlingieri (1946-1947) got barrel vault shapes, inspired by the Catalan vault. Bonet was assisted for the engineering part by the Montevidean engineer Eladio Dieste (1917-2000), who thus invented his *Céramica Armada* concept. Dieste would later build international renown brick shells in Uruguay and Spain.[57] The concern – and disconcern – for climate practiced by MoMo architects may be seen best in regions with extreme climatic conditions. See the contribution by Griselda Pinheiro Klüppel for the case of Brazil[58] and Ivan Nevzgodin for Siberia.

All this does not mean that in Germany the *Organic Moderns* were not represented. As examples may figure Bruno Taut and Hans Scharoun. Whereas Bruno Taut published a lot, showing his mature ability to combine a huge building practice with creative writing on functional architecture, Hans Scharoun is less important by his publications of the first MoMo period and more relevant by some exemplary buildings.[59] Graupner and Lobers explained how carefull, in terms of Building Science, the Haus Schminke (1933) in Löbau was conceived by Hans Scharoun.[60]

In his book on Japan Bruno Taut displays incredible powers of observation of social life and its technical necessities in a foreign culture.[61] With their wise attitude, personalities like Scharoun and Taut achieved a practical understanding of building, still with a fresh experimental approach, bypassing the abstract positions of some colleagues. To the problem of flat roofs, Bruno Taut had adopted a traditional detail as his own solution, which avoided the typical hidden gutters behind an attica of the 'white cube' building type. His roofs, for example in the *Hufeisensiedlung* in Britz, Berlin, tend to slope in a pronounced small angle (approx. 5°) to one side, with the gutter cantilevering in front of one façade. The other sides show walls ending in an attic, crowned by exposed bricks. Thus a certain abstract overall shape remains.

To the author this last category of architects shows, that sometimes Building Science may be sufficiently regarded when "things are allowed to happen in a simple way". This list of MoMo architects with a major relevance for Building Science is in no way complete. It would be interesting to hear about other developers of Building Science.

Where to put heat insulation in the wall?

From a Building Science point of view the question of where to put insulation is rather important, since the insulation position influences the walls' performance. Some ignored the question and one "solved" the problem by adding somewhere a thin layer of (costly) insulation material. In most early MoMo technical literature – like *Wie bauen?* by the Rasch brothers – wall insulation and its quantitative calculation with the heat transmission value (k-value) was a matter of simply adding the values of the different material layers. They relied on advertisement texts of the insulation firms, instead of reports of the more independent laboratories.[62]

Later on writers express reasons why they put the insulation inside or outside or in the centre of the wall, but their reasoning seems to lack an independent judgment, based on all factors. Only a very few examples are shown here, but the author suggests that more competent research than his should follow in the near future. Richard Schachner proposes to put the costly insulation material on the wall's <u>inside</u> in order to get a warming-up effect shortly after heating starts. Please note that individual stoves were common and central heating still rare.[63] Based on experimental research on the effect of interrupted heating periods Schachner is sceptical of the accumulation of heat in the walls with <u>exterior</u> insulation, and he argues that the accumulated heat in the walls dissipates quickly, after the interruption of heating. Ed. Jobst Siedler argues similarly, showing that a smaller amount of heating is needed in the case of a thin brick wall with interior insulation, compared to a thicker wall without insulation with the same total heat transmission.[64]

Although Walter Gropius was eager to connect his theories with practice, his experimental attitude sometimes led to technical mistakes. In his steel house for the *Weissenhofsiedlung* 1927 the walls of 157 mm thickness, consisted from outside to inside of *Eternit* board (pressed asbestos), air, cork board, air, *Celotex* board (a bagasse-based material). Hans Spiegel discusses Gropius' steel house and finds quite critical remarks, from the viewpoint of Building Science. Like Syrkus, he designed buildings with a steel frame and wrote two handbooks on this difficult theme. Theoretically, the described wall gives a good insulation that equals a 160 cm brick wall (10 times thicker than the initial wall!) but – argues Spiegel – in reality some factors will turn out negative. Since the 80 mm thick cork board elements were held between the steel posts, in front of the steel structure no cork insulation exists. Thus, the insulation level was substantially reduced. In both air cavities, each 30 mm wide, Spiegel expects moisture introduction in the long term. Even with the best workmanship in the montage process, a perfect closing of joints between the elements will be prevented by different thermal expansion of the various materials. A third point of discussion is the lack of acoustic insulation, for which Spiegel suggests a more flexible montage of the interior boarding.[65] However, contrary to what one would think after this criticism by Spiegel, Gropius had been eager to get professional help for this design as Jan Molema pointed out to me. In *Bau und Wohnung*, the official book of the 1927 *Weissenhofsiedlung*, Gropius refers on pp. 62-67 for the Building Science calculations to a report of the *wärmeschutz-wissenschaftliche Abteilung des Rheinhold-werkes Stuttgart* (heat-insulation scientific department of the Rheinhold firm, a producer of insulation material). This may serve as an example of prominent MoMo design of 1927 with a medium level of analysis in the Building Science field. Walter Gropius and Konrad Wachsmann will later succeed in the USA with prefabricated houses of plywood sandwich elements (General Panel System) in a different climate.

However, in theory and practice many further problems occur, such as condensation and insufficient thermal accumulation. Only after a proper analysis and calculation of the insulation layers, could a wall with new materials and in innovative building systems be designed and detailed properly. The climatic conditions on the building site should of course also be considered. Rudolf Stegemann, author of a technical handbook, published by the *Deutsche Ausschuss für wirtschaftliches bauen e.V.*, an organisation that defined standards for building systems, expresses in 1928 the need for new knowledge on heat transmission and he refers explicitly to the work by Knoblauch c.s. in München from whom he expects improved data in the future.[66]

In the more specific literature, like the writings by Flügge and Siedler, the main factors of Building Science are described, even when still a systematic approach for a Building Science design methodology seems to be absent.[67]

As an excellent publication – anticipating post-war standards of Building Physics – can be considered Limperg's description of a Belgian MoMo house of 1931 in Auderghem, Belgium, by Louis Herman de Koninck.[68] De Koninck had recognised that a flat-roof terrace could cause condensation on the ceiling of the living room below the terrace. He made a full calculation of the nine material layers, considering moving air on the top and standing air below the ceiling, in which he proves that without insulation condensation would occur with an exterior temperature of -1° C. With an insulation layer in the central zone of the concrete structure condensation could be expected by exterior temperatures below -15° C, which in Belgium is very rare. Expertise in Building Physics showed Koen Limperg in his book: Limperg, K., thermotechnische dienst der warmtestichting, *Naar warmer woningen*. Amsterdam 1936.

Conservative criticism of MoMo architecture and Building Science: The *Kochenhof-Siedlung* case

Conservative criticism of the Modern Movement often found a start in observations related to Building Science aspects. Most clearly one can see this in the flat-roof discussion, which led to (international) inquiries and publications by Walter Gropius and, on the conservative side, by Paul Schultze-Naumburg.[69] The *Kochenhof Siedlung* conflict may serve as a dramatic example of an architectural dispute between conservatives and progressives. In the course of the famous *Weissenhofsiedlung* in Stuttgart, which met with a very controversial reception among architects, the conservative Paul Schmitthenner proposed another settlement, *am Kochenhof*. The reasons were to enlarge the engagement of Stuttgart' architects and further ideological grounds, formulating an answer to the left and liberally dominated *Weissenhofsiedlung*. This project did not continue. A new initiative was taken in 1932 by Bodo Rasch and Richard Döcker to proceed with a second experimental settlement on the *Kochenhof* site in Stuttgart. Their idea was to make all houses in wood, as modern prototypes, and this would open new markets for the German wood industry, which after the 1929 stock-exchange crash was in a general financial crisis. The project within a growing conservative atmosphere both in Stuttgart and Germany as a whole was hindered by negative publication on the *Weissenhofsiedlung* houses.[70] The discussion focused on the difficult building site, which was much less attractive than the sweeping wide *Weissenhofsiedlung* site.

Stuttgart's most prominent architect, the gifted Paul Bonatz, who had been rejected for contribution to the *Weissenhofsiedlung* gave a negative report on the initial *Kochenhof* settlement's design. And early 1933 – shortly after the start of Hitler's dictatorship – the full project was taken over by the conservatives. Under the direction of Schmitthenner and the city planner Heinz Wetzel all progressives (among them Konrad Wachsmann, Hugo Häring, Adolf Gustav Schneck and the Swiss office Werner Max Moser & Rudolf Steiger) and their designs were kicked out of the project. The built *Kochenhof* settlement stayed to the concept of wooden houses without references to the MoMo initiative.[71]

Now to the Building Science aspect. Apart from the somewhat ugly way in which the project could emerge, the *Kochenhof* settlement showed one "progressive" feature, not included in the five year older Weissenhof settlement: All architects, among them of course

Schmitthenner and Bonatz had to bring a structural solution in wood, according to certain defined standards in acoustic and thermal insulation. The whole building process was controlled with institutional help of the Stuttgart University.[72] A second interesting observation is that the complex may be considered rather modern looking, not in the experimental way of the *Weissenhofsiedlung* but still with a certain freshness. This observation was expressed similarly by Van Loghem in a review in 1933.[73] My conclusion is that since 1927 – when the MoMo development had reached its first top – five years of discussions and experience had brought to the architectural world a basic respect for the technical side and that Building Science in general was on its way to become mature.

In Germany after 1933, building practice went in a conservative direction.[74] Yet, both from MoMo trained writers – like Ernst Neufert – and from others appeared publications with relevance for Building Science in the period till 1945.[75]

Conclusions

Let us try to draw some first conclusions from this study, enriched substantially by the discussions during and after the seminar.

1. The scientific discipline *Bauphysik* or Building Science after World War I was in many aspects ready for implementation in practice. However, its dissemination among architects was rare till 1930, not least because the theoreticians of Building Science stayed isolated in the academic world and their books were difficult to apprehend for architects.
2. The laboratories on heating and ventilation did incredibly important work and provided a solid base for later publications on Building Physics, even still valid in many aspects now.
3. The CIAM and other international organizations gave initially technical matters, including Building Science, a low priority compared to aesthetics, design methodology and social housing. This hesitant attitude may be interpreted to have caused negative influence on the Modern Movement architecture and on its reception.
4. The *Bauhaus* (training), at least as far as the daylight aspect and use of sun incidence are concerned, took part in the development of Building Science.
5. Architects and architectural writers trained at technical universities – Aachen, Berlin, München, Stuttgart, Delft (NL) – seem to have integrated the Building Science in their work to a higher degree than those trained elsewhere. This was decisive for the increased Building Science level in the 1930s.
6. The *Werkbundsiedlung* at the *Weissenhof* 1927 was an incredibly important statement for a modern life style. The material and technical side of this open-minded experiment, initiated by Mies van der Rohe, was an integral part of its presentation. However, at the same time some of these designs showed insufficient methodology in respect to Building Science.
7. In the dispute between conservatives and the Modern Movement, at least in the case of the Stuttgart *Kochenhof-Siedlung* 1933, the conservative side showed a progressive attitude towards Building Science. Decisive was the advice of established academic laboratories in the building process.
8. The experience of international cooperation by Western architects in the Soviet Union led to inspiration for the development of Building Science.
9. The integration of the climate factor has always been a major design theme within the Modern Movement, although not all participated in this design concept.

Epilogue and Acknowledgement

At the closing session of the present seminar, Jan Molema proposed to include the Catalan architect Antoni Gaudí (1852-1926) in the Modern Movement. I would like to reverse the question: Do not look for Modern Movement architects, but explore architecture in general on the basis of Building Science analysis! The impact of such an approach may be astounding to the architectural world.

The Dutch born author wishes to thank all the people who contributed to this study which started some 20 years ago. In this period he worked at Frei Otto's *Institut für leichte Flächentragwerke*, (IL) Stuttgart University, on special research into the history of construction, and since 1995 at the Hochschule Zittau/Görlitz FH, in Zittau, as Professor for Art and Architectural History.[76]

Notes

[1] "Man könnte die Tätigkeit eines Volkes in gesundheitlicher oder hygienischer Richtung geradezu als einen Maßstab gebrauchen für die Größe seiner Fähigkeiten in der Kulturgeschichte eine Rolle zu spielen." Translation by JT. Cited in Usemann 1993, p. 38

[2] *Vorwort* in Schachner 1926.

[3] "Ein bekannter Architekt ging in seiner Begeisterung für einen solchen platten Internationalismus so weit, daß er die These verkündete: "In der Zukunft wird man im hohen Norden genau ebenso bauen wie am Mittelländischen Meer!" In wenigen Jahren hat sich seine Forderung erfüllt; die Architektur hat eine so schwere Niederlage erlitten, daß sie sich nur sehr langsam davon erholen kann. Wäre es nur ein ästhetischer Irrtum gewesen, so wäre es vielleicht noch nicht einmal so schlimm. Aber die Natur, in diesem Fall das Klima, wird mit ihrer Rache dafür, daß sie so sträflich vernachlässigt wurde, nicht lange auf sich warten lassen." Translation by JT. Bruno Taut: *Architekturlehre* (1936), cited from: Medina Warmburg 2005, p. 392.

[4] Exceptions are: Graupner, K., Lobers, F. *Bauklimatische Aspekte, Heizungs- und Lüftungskonzept.* In: Burkhardt 2001, pp. 120-135. Schaal 1990. Almodóvar Melendo 2004.

[5] Künzel 2002, with analyses of the laboratory history, and very substantial on heating and ventilation. Usemann 1993.

[6] Source: Meyers Grosses Taschenlexikon, 1998.

[7] Source: *Petzold* 2000.

[8] An early book title containing the word Bauphysik is: Kleber, K. *Bauentwurfslehre, Band 1 – Bauphysik, VEB Verlag für Bauwesen, Berlin (GDR), 1961.*

[9] French Mathematician Fourier, Jean Baptiste Joseph (1768-1830); Fourier 1822

[10] French Physicist Péclet, Jean Claude Eugène (1793-1857). Péclet 1828, 3. edition 1861. Usemann 1993.
[11] von Pettenkofer, Max (1818-1901); Pettenkofer 1858. Fischer 1908. Usemann 1993. See also: Degen 1869.
[12] Machine engineer Rietschel, Hermann Immanuel (1847-1914). 1870, with Rudolf Henneberg (1845-1909), start of the firm Rietschel & Henneberg, Berlin, on heating, ventilation, gas and plumbing systems. Rietschel 1893. Usemann 1993.
[13] "Die Luftbeschaffenheit sämtlicher Hörsäle hat sich als eine in hohem Grade mangelhafte erwiesen. Nahezu wirkungslos zeigten sich übrigens die in den Lehrräumen aus älteren Zeit vorhandenen, für Lüftungszwecke bestimmte Kanäle. Diese wiesen viel zu geringe Querschnitte auf und können nur als ein verunglückter Versuch zur Abhülfe unzweifelhafter Übelstände angesehen werden." Translation by JT. Usemann 1993, p. 174, Rietschel 1886. A French example of a report on school hygiene is: Guillaume 1874.
[14] As Henning Löber explained to me, this type of ventilation channels provoked the pollution of the attic space with pathogen bacteria which could spread easily throughout the whole building. Also they turned out to be dangerous in terms of fire protection. A description of the ventilation channel system – including modernised variations with closed channels in the attic space and cleansing doors – in: Schachner 1926, pp. 53-64
[15] The following may illustrate the strong self-discipline of the organisors of the hygiene exhibition. The exhibition was initially planned for the year 1882, but shortly before opening the pavilion burnt down, together with most of the exhibition samples. Within one year an improved pavilion was built and filled with more displays than originally intended, and the 1883 exhibition became a full success.
[16] Fischer from Hannover started even in 1876. At the *Dresdner Polytechnische Schule*, Wilhelm August Roth 1833-1892, Professor for Hygiene, gave a course on Hygiene since 1873. At the *Polytechnical School* in Copenhagen a city engineer of Copenhagen Ludvig August Colding, started 1885 a professorship for Heating and Air Conditioning with a research institute later named: *Laboratoriet for Varme- og Klimatechnik*. The *Thermotechnische Dienst* of the *Warmtestichting* in Utrecht, Holland, founded around 1926, is another research institute of insulation and heating equipment. Its director was engineer F. G. Unger. This laboratory was part of Utrecht University, under the responsibility of Leonard Salomon Ornstein, professor for experimental physics.
[17] *Prüfungsstation für Heizungs- und Lüftungsanlagen, Versuchsstation für Heizungs- und Lüftungseinrichtungen*, 1886, belonging to the Berlin Technical University.
[18] Rietschel 1893.
[19] Civil engineer Friedrich Wilhelm Hermann (or Hermann) Fischer (1840-1915). Professor for *Heizungs- und Lüftungstechnik* at the *Technische Hochschule* Hannover since 1876. Fischer 1908. Usemann 1993.
[20] Forschungsheim für Wärmewirtschaft, later: Forschungsinstitut für Wärmeschutz München e.V. FIW. Please see the more fundamental contribution by Roland Gellert and Horst Zehendner in this publication.
[21] This matter will be the topic of a discussion in Dutch MoMo literature of the 1930s (Limperg/Van Loghem) concerning traditional double wall masonry with a cavity, which, when ventilated profusely, will loose its insulation properties when the cavity air is saturated with moisture.
[22] It was not allowed to expand the Berlin laboratory because the ministerial authority had been informed about the planning of the München laboratory. Usemann 1993.
[23] Inside the Modern Movement networking is common. Observe the connections between Bugge, Syrkus, Limperg, Van Loghem, Siedler and their occasional citing of each other.
[24] Gröber 1921.
[25] Already in ancient Greece was the building of cities restricted by rules. The city of Augsburg seems to possess the oldest building code of Germany, published in 1155. Amsterdam got a *brandkeur* (fire code) as early as 1400, and its first *bouwkeur* (building code) dates 1531/1532. See: Meischke, R. a.o., *Huizen in Nederland – Amsterdam.* Zwolle 1995, pp. 15, 26.
[26] Some examples of German building codes and related literature: n.a., *Ortsbauordnung für die Stadt Zittau. Beilage zu Nr. 74 der Zittauer Nachrichten und Anzeiger.* Dresden 1908; Busse, C., *Bürgerliche Baukunde und Baupolizei – Leitfaden für den Unterricht an Baugewerkeschulen und verwandten technischen Lehranstalten.* Leipzig, Berlin 1919; Heilmann, G., K. Weinisch (Hg.), *Die Bayrische Bauordnung vom 17. Februar 1901 – abgeändert durch Vorschriften vom 3. August 1910 und 10. Juli 1918.* München, Berlin, Leipzig 1924; Berger, O. (Baudirektor), *Die Bauordnung vom 20. Mai 1926 und andere baurechtliche Bestimmungen für Breslau.* Breslau 1929.
[27] In the city of Zittau (Saxony) a medical doctor by the name of Brauer criticized the old defense wall system and its moat in 1831 for being unhealthy. His comments were instrumental in its destruction and the building of a "Ringstrasse". See: Brauer 1831, pp. 202-205, Original text by Brauer cited in Dudeck 2000, p. 40.
[28] Kemp 1987. p. 383f.
[29] n.a., *Die Wohnungsnoth der ärmeren Klassen in deutschen Großstädten und Vorschläge zu deren Abhülfe – Gutachten und Berichte.* Leipzig 1886. Sachs, S., *Der verbesserte Pise-Bau – Ein Beitrag zur Vervollkommnung des Staatshaushaltes.* Berlin 1822. Tappe, W., *Darstellung einer neuen äußerst wenig Holz erfordernden und höchstfeuersicheren Bauart – Heft 1 – 1818, 2 – 1819, 3 – 1820, 4 – 1821, 5 – 1821, 6 – 1821, 7 – 1822, 8 – 1823.* Essen 1818-1923. Teichmann, F., *Feuersnoth- und Hülfs-Buch über Entstehung und Beträchtlichkeit der Feuerbrünste, ... Unterstützung der Abgebrannten, ... nebst Anhang über Volksveredlung und Wohlfahrt.* Leipzig 1831.
[30] In 1946 was founded the "International Standardisation Organization" ISO in Geneva, Switzerland, in which the DIN was integrated in 1951.
[31] Gräff 1928. Kurz 1928. Lüdecke 1924. n.a., *Offizieller Führer durch die internationale Baufachausstellung mit Sonderausstellungen Leipzig 1913 und durch Leipzig und Umgebung mit einem Plan von Leipzig.* Leipzig 1913. n.a., *Programm Deutsche Bauausstellung Berlin 1931 – Vom 9.5. – 9.8.1931 auf dem Ausstellungsgelände am Kaiserdamm.* Berlin 1931. n.a., *Deutsche Bauausstellung Berlin 1931 – Amtlicher Katalog und Führer.* Berlin 1931. Riezler 1924.
[32] Gropius 1930. Giedion 1931. One may find a more general scope, including technical demands, in the

inofficial report of CIAM IV of 1933: *La charte d'Athènes / Le Corbusier*. Paris, 1943, which was edited by Le Corbusier.

[33] See: *Vorwort* in Schachner 1926. Schachner was a professor at the *Techische Hochschule München*.

[34] The serial *Handbuch der Architektur*, founded by Dr. phil. Dr.-Ing. Eduard Schmitt in Darmstadt, was probably the world's biggest architectural publication project and internationaly esteemed. Within a systematic structure occurs a complete scientific information on the building process. In 1921 it contained 64 volumes with 23 supplement volumes.

[35] Wasmuth 1929-1932, Wasmuth 1937. Please note the obvious ideological change in the supplement volume of 1937, conceptually in line with the conservative dictature (enforced conformity). As an example one can compare the statements on the Stuttgart *Weissenhofsiedlung* in both publications and, in the illustration material, an optical change from a pluralist architecture including MoMo examples to Nazi architecture.

[36] Bugge 1924. Cammerer 1928 and more specific for architects: Cammerer 1936, Flügge.1927. Gröber 1921. Schachner 1926. In post-war Germany the book: Kleber 1961, as well as earlier Cords-Parchim, *Technische Bauhygiene*, Leipzig 1953, restart the discipline in the German Democratic Republic with a more systematic approach. In the Netherlands the first known books on Building Physics are Limperg 1936 and Van Loghem 1936. A German example on acoustics: Michel 1921.

[37] See also the contribution by Roland Gellert and Horst Zehendner.

[38] Wolsdorff 1997, pp. 81-93. At *Bauhaus Weimar* certain technical fields were covered by other architectural schools.

[39] Original terms: *wärmelehre, installation*; *spezialausbildung unter bevorzugung der theorie*; *einzelvorträge*. Source: Probst, H. Schädlich, C. Band 2 1986, p. 187. Please note the modern writing without capital letters.

[40] See also Wolsdorff 1997, p. 81.

[41] Kraus 1988, pp. 279-284.

[42] About Hannes Meyer's – and Bruno Taut's – contribution to Building Physics see: Cabeza-Lainez 2005 and Nerdinger 1989.

[43] Bodenbender, H.G., *Sicherheitsglas / Verbundglas / Panzerglas / Hartglas / Kunstdrahtglas*. Berlin 1933. Düwer, D., W. Friedrich. *Die Feuersicherheit des Pappdaches und sein Verhalten bei Bränden*. Halle approx. 1931. Emperger, F. (Begründer), A.Kleinlogel (Schriftleiter), *Beton und Eisen – Internationales Organ für Betonbau*. Berlin 1925. Falian, C. (Hg.), *Vedag-Buch 1936 (Dachpappe)*. Berlin 1936. Feldhaus, F. M., K. Siegfried, *Das blaue Badewannenbuch – Vom Holzzuber zur Metallbadewanne*. Schwarzenberg 1932. Kalff, Ir. L. C., *Kunstlicht und Architektur – Philips' technische Bibliothek*. Eindhoven 1943. Keller, E. (Hg.), *Ascona Bau-Buch. Zürich 1934. Lade, K., A. Winkler, Putz – Stuck – Rabitz – Ein Handbuch für das Gewerbe*. Stuttgart 1936. Lange, B., J.Schäfer, H.Malchow, F.Kramer, Th.Temme u.a., *Mitteilungen aus der Dachpappen-Industrie 1938*. Berlin 1938. n.a., *Auswahl ausgeführter Heraklithbauten – Erzeugerfirma und Patentinhaberin von Heraklith*: Österr. Amerik. Magnesit AG Radenthein, Kärnten, Graz (after 1926). n.a., *Nordische Blockhäuser Christoph & Unmack AG Abt. Holzbau Niesky Oberlausitz (Niederschlesien) Katalog XIV*. Niesky 1926. n.a., *Wohnbauten aus Holz – nach dem Montage-System "Nilbo" – Firmenkatalog mit Bauzeichnungen*. Basel 1944. n.a., *Schwarzwälder Dauer-Holzhausbau Bauweise: System Schmelzle – Ernst Schmelzle, Mitteltal, Sägewerk und Holzhausbau*. Tübingen. approx. 1934. Riepert (Hg.), *Der Kleinwohnungsbau und die Betonbauweisen – Zement-Verarbeitung Heft 15*. Charlottenburg 1926. Schönberg, A., *Die Pappdächer – Erfahrungen über Haltbarkeit und Werth*. Dresden 1857. Schubert, E. R., *Warum Ziegelbau? – Eine Antwort aus Geschichte und Leistung der Ziegelindustrie – Sammlung von Werbebüchern für die Ziegelindustrie in Einzelbänden Band I*. Berlin 1926. Stegemann, R. (Hg.) u.a., *Vom wirtschaftlichen Bauen "Holz- oder Massivdecken im Wohnungsbau – eine Wirtschaftsfrage*. Dresden 1928. Stelzer, R., *Der praktische Platten- und Fliesenleger – Handbuch für das gesamte Platten- und Fliesen-Gewerbe*. Berlin 1938. A Dutch example of grey literature is: Timmer, J., *De beschuttende functie van glasramen*. Amsterdam n.d.

[44] Rasch 1927, Rasch 1928. An appreciation in: Tomlow 1998, pp. 158-162. See also: Behrens 1927, Roth 1927, Stegemann 1941.

[45] Bugge 1924; Bugge 1927. A reference about Bugge's contact with MoMo architects is a handwritten signed dedication to Martin Wagner, city planner in Berlin: *An Herrn Stadtbaurat Martin Wagner ergebenst vom Verfasser. Trondhjem 20/2.´30 Andr. Bugge*. as discovered in the book owned by the author. See also the contribution by Ola Wedebrunn.

[46] See Jadwiga Urbanik's and Wessel de Jonge's contribution as well as De Jonge 1992, and Tomlow 1998. Plans and excellent reproduced photographs of Dr. N. house (1932) and of the Sanatorium of Dr. B. (1931) in Warsaw, both designed by the Syrkus' couple with Stanisław Hempel, in: Sartoris, A., *Gli elementi dell' architettura funzionale*, Milano 1941, pp. 717-722.

[47] In the pre-war time the CIAM organisation prolonged its interest in building physics. At CIAM V in Paris 1937 Dr. (Pierre?) Winter, a medical doctor, spoke of the hygienic point of view. According to a Dutch reportage Dr. Winter declared himself ready to direct an information centre for CIAM related architects with questions about hygiene. The central theme of CIAM V was: *Wohnung und Erholung* (living and leisure). See B.M., *Indrukken van het 5e congres van de C.I.A.M. te Parijs*. In: *De 8 en opbouw*, 17. juli 1937, No 14, p. 134.

[48] "De openluchtschool en arbeid in de buitenlucht verhoogen de activiteit van de huid en hebben een verlagenden invloed op het aantal calorieën, waaraan het lichaam behoefte heeft." Translation by JT. Duiker, J., *De Nieuwe Zakelijkheid in zomer en winter*. In: *De 8 en opbouw* 1932, p. 143.

[49] Duiker, J., *Stralingsverwarming en ventlatiesysteem*, In: *De 8 en opbouw,* 10 october. 1936, no, 20/21, special issue on Grand Hotel Gooiland, p. 256. See also the contribution by Wessel de Jonge.

[50] See description "centr. verw. syst. Ir. Duiker" and plans in: *De 8 en opbouw*, 16. october 1937, p. 190. The initial more purist modern house design with a mild sloping roof, was rejected by the *Welzijnscommisie, Centrale Schoonheidscommissie voor het Gooi* (welfare authorities) and the adding of a pitched roof was forced in

order to meet the "landscape character". *De 8 en opbouw*, 25. januari 1936, No. 2, p. 17,18. Kind remark by Jan Molema.

[51] Johannes Bernardus van Loghem (1881-1940). He had studied architecture (*bouwkundig ingenieur*) at the *Delftse Hogeschool* (*Delft University*). Van Loghem 1936. See also Nevzgodin 2004.

[52] Sportfondsenbad Frederikspark 14 Haarlem, 1933-1934. Destroyed.

[53] See Loghem 1939, 199-208. See also the contribution by Wessel de Jonge.

[54] Tomlow *Gaudí* 2003.

[55] Medina Warmburg 2005 p. 364, 365. A similar description of the *Neue Sachlichkeit* position by Dutch and German architects – supported by Swiss and Czechoslovak architects – is expressed by Le Corbusier in 1929 in *The Studio Yearbook*, and quoted in: Molema 1996, p. 17, 18.

[56] See Medina Warmburg 2005, pp. 392-396. Examples of German MoMo architects with positive historical references in their writings are for example Heinz and Bodo Rasch, Bruno Taut, Konrad Wachsmann.

[57] See: Tomlow 1999/2001, Tomlow 2001, with further literature.

[58] A complete recent analysis of the Brazilian *brise-soleil* system can be found in: Almodóvar Melendo 2004. Kind information by José María Cabezza.

[59] Some major publications by Bruno Taut are: Taut 1926. Taut 1927, (reprint Berlin 1995)

[60] Graupner 2001.

[61] See: Taut 1937/1997.

[62] Rasch 1927; Rasch 1928. See also: Tomlow 1998.

[63] Schachner 1926, p. 410.

[64] Siedler 1932, p. 251, illustration 415.

[65] See Spiegel 1929, pp. 130-133. Gropius' steel house in the Weissenhofsiedlung has been demolished.

[66] Stegemann 1928 p. 16. In the *Deutsche Ausschuss für wirtschaftliches bauen e.V.,* with an office in Leipzig, conservative architects like Paul Schmitthenner and Hugo Keuerleber as well as progressive architects like Ernst May from Frankfurt and ed. Jobst Siedler were members, and they probably met here "on a rather neutral territory", together with building scientists like Knoblauch.

[67] Flügge 1927. Siedler 1932.

[68] House for the garden architect Jean Caneel Claes. See Limperg, K., *Woonhuis te Auderghem* and *Een plat- of een hellend dak?* In: *De 8 en opbouw* 26 mei 1933, pp. 91-102. An interesting discussion follows with architect Albert Boeken in *De 8 en opbouw* 10 juni 1933 and 24 juni 1933. Boeken refers to Swedish experiments on heat transmission possibly meaning the Norwegian tests by Bugge.

[69] See in this publication the contribution by Anke Zalivako. The many-facetted personality of the publicist Schultze-Naumburg (1869-1949), usually writing in a seemingly reasonable objective tone, should not be reduced historically to his perhaps positive cultural impact on conservation policy by his publication serial *Kulturarbeiten* (1901-1917). He fostered strongly the racist ideology *Blut und Boden* (blood and soil) by Richard Walther Darré (1895-1953). Already in 1928 Schultze-Naumburg wrote *Kunst und Rasse*, a book on which relies the traveling exhibition *Entartete Kunst* 1937-1940 illustrating the harsch rejection of modern art by the national socialist party.

[70] In the Dutch – and Swiss – MoMo press these discussions were followed and openly commented until the II World War. It is quite amusing to read how K.L. Sijmons, after a visit to the *Weissenhofsiedlung* in 1935 rectifies some conservative statements by the review *Deutsche Bauhütte* which should prove the impossibility of living there. Sijmons reveals that the small Le Corbusier house since six years was used by Prof. Hermann Reiher, the director of the *Anstalt für Schall- und Wärmetechnik*, which is the institute of the *Technische Hochschule Stuttgart* responsible for Building Physics. What can underline more competently the fact that MoMo houses have a certain comfort? See: Sijmons, K.L., *Rectificatie*. In *De 8 en opbouw*. Nr. 3, 1935, p. 31, 32. Another article, dealing with the political power of publishers, is by the German theoretician Adolf Behne who chose to publish in Holland, since in Germany it would probably have been prohibited: *Een architect marcheert naar Rome (boekbespreking)*. In: De *8 en opbouw*, 1933, 4 februari, Nr.3, p. 22, 23. In this critique of Karl Willy Straub's *Die Architektur im dritten Reich*, published by the young Akademischer Verlag Dr. Fritz Wedekind Co. in Stuttgart in 1932 (?), Behne contests the fact that the publisher, who contributed so much to spreading the idea of the Modern Movement whith his publications, now simply turned to the other side of the political spectrum.

[71] See: Kirsch 1987. Magnago Lampugnani 1992, pp. 267-281. Schmidt, D.W. Exhibition, *Wohnhausprojekte für die geplante Werkbundsiedlung "Deutsches Holz" in Stuttgart 1932-1933*. Stuttgart University, 2004.

[72] Reiher 1933, pp. 6-8. About Schmitthenner's early project garden city *Staaken* in Berlin (1914-1917) and an appraisal of his architectural position, see: Kiem 1992. Karl Kiem's statement, following Schmitthenner's position that pitched roofs are preferable to flat roofs for housing settlements seems to me too general.

[73] Van Loghem, J.B., *Duitsche Houtbouw*. In: *De 8 en opbouw*, 27 november 1933, pp. 211-216.

[74] Some political aspects of MoMo and the Nazi regime are analysed in: Nerdinger 1993.

[75] Büning 1940. Gretsch 1940. Hess 1943. Neufert 1936. Schäfer 1937.

[76] See also: Tomlow. 1998, pp. 158-162.

Literature on Building Physics and related fields

*The literature mentioned below is part of the private library of Jos Tomlow in Zittau, Germany, with the exception of books marked with *.*

Ahnert, R., K.H.Krause, *Typische Baukonstruktionen von 1860 bis 1960 – zur Beurteilung der vorhandenen Bausubstanz – Stützen, Treppen, Balkone und Erker, Bogen, Fußböden, Dachdeckungen* and *– Gründungen, Wände, Decken, Dachtragwerke.* Berlin 1996

Almodóvar Melendo, J,M, *Le Corbusier y el Moviemiento Moderno en Brasil. La adaptación ambiental y cultural de la arquitectura europea. Revista de historia y Teoría de la Arquitectura.* Número 5. Sevilla 2004.*

Autorenkollektiv, *Gesundheitsingenieur Zeitschrift für die gesamte Stadthygiene,* Jg. 56, Berlin 1933

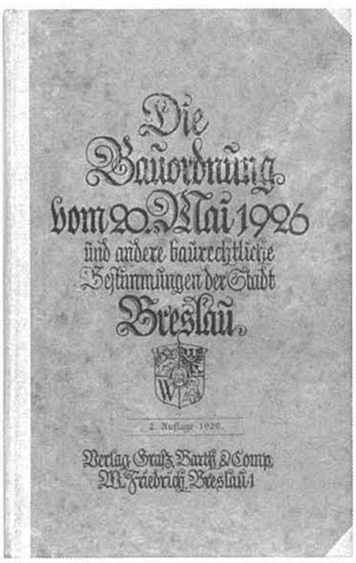
Banham, R., *Das gebaute Atlantis – Amerikanische Industriebauten und die Frühe Moderne in Europa.* Basel 1990

Bargmann, H., *Historische Bautabellen – Normen und Konstruktionshinweise 1870-1960.* Düsseldorf 1993

Behrens,P., V. Bourgeois, R. Döcker, J. Frank, W. Gropius, *Bau und Wohnung.* Stuttgart 1927

Bellmann (Bearb.), *Das sächsische Baugesetz – Neufassung vom 1. März 1948 – Gesetz über den Verkehr mit Grundstücken vom 1.Juli 1949.* Dresden 1949

Berger, O. (Baudirektor), *Die Bauordnung vom 20. Mai 1926 und andere baurechtliche Bestimmungen für Breslau.* Breslau 1929



Block, F., F. Schumacher, A. Gellhorn, F. Paulsen u.a., *Probleme des Bauens.* Potsdam 1928

Bodenbender, H.G., *Sicherheitsglas – Verbundglas/Panzerglas/Hartglas/Kunstdrahtglas.* Berlin 1933

Böhm, R., *Das Gasglühlicht – seine Geschichte, Herstellung und Anwendung – ein Handbuch für die Beleuchtungsindustrie.* Leipzig 1905

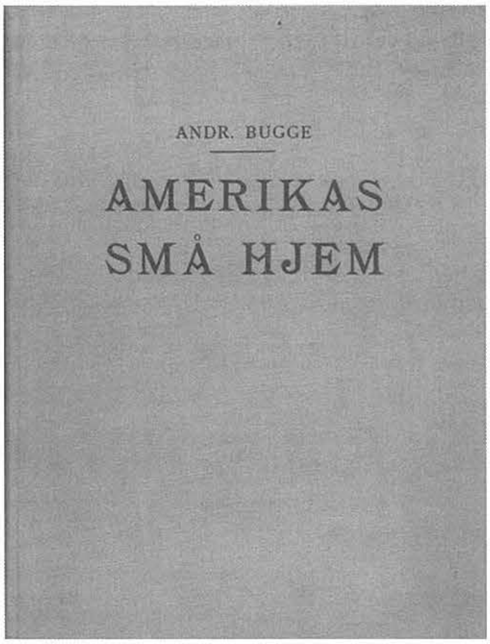
Braun, I., O. Zucker, W. Baune, W. Matuschke, *Ein Industriebau – Von der Fundierung bis zur Vollendung.* Berlin 1927

Brauer, Dr., *Bemerkungen über die innern Umgebungen Zittaus.* In: *Just's Communalblatt*, Zittau 1831, pp. 202 – 205*

Büning, W., Prof. Peters (Vorwort), *Die neue Bauanatomie – Einführung in den Wohnbau.* Berlin 1940

Bugge, A., *Ergebnisse von Versuchen für den Bau warmer und billiger Wohnungen.* Alf Kolflaath, Beiträge zur Wärmebedarfsberechnung. Üb. Frhr. H. Grote. Berlin 1924*

Bugge, A., *Amerikas små hjem, deres planlegning, konstruksjon og utførelse* (Norwegian: American small houses – Planing, Stucture, Building). Oslo 1927



An Herrn Stadtbaurat Martin Wagner ergebenst vom Verfasser. Trondhjem 20/2. 30
Andr. Bugge

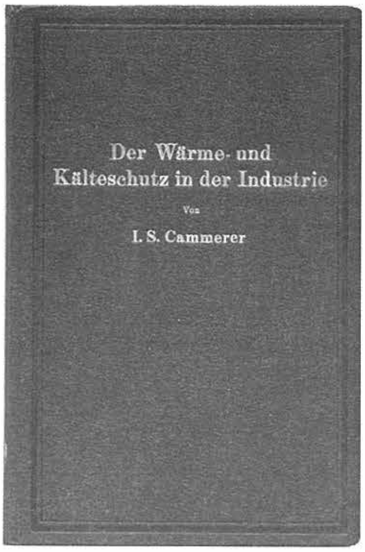
Burchard, C., *Gutes und Böses in der Wohnung in Bild und Gegenbild – Grundlagen für neues Wohnen.* Leipzig/Berlin 1933

Burkhardt, B. (ed.), *Scharoun. Haus Schminke, Die Geschichte einer Instandsetzung*, Stuttgart 2001

Busse, C., *Bürgerliche Baukunde und Baupolizei - Leitfaden für den Unterricht an Baugewerkeschulen und verwandten technischen Lehranstalten.* Leipzig, Berlin 1919

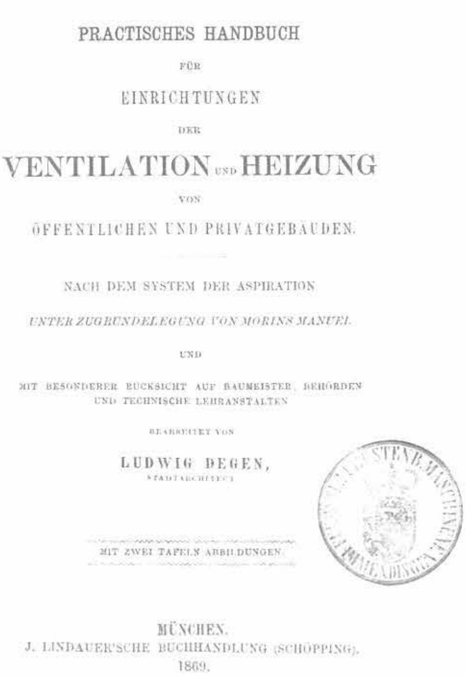
Cabeza-Lainez, J. a.o., *Architectural Simulation for Sustainability.* In: *Proceedings 2005 World Sustainable Building Conference*, Tokyo 2005*

Cammerer, J.S., *Der Wärme- und Kälteschutz in der Industrie*, Berlin 1928



Cammerer, J.S., *Konstruktive Grundlagen der Wärme- und Kälteschutz im Wohn- und Industriebau*, Berlin 1936*

Degen, L. (Bearb.), *Practisches Handbuch für Einrichtungen der Ventilation und Heizung von öffentlichen und Privatgebäuden – Nach dem System der Aspiration*. München 1869



PRACTISCHES HANDBUCH
FÜR
EINRICHTUNGEN
DER
VENTILATION UND HEIZUNG
VON
ÖFFENTLICHEN UND PRIVATGEBÄUDEN.

NACH DEM SYSTEM DER ASPIRATION
UNTER ZUGRUNDELEGUNG VON MORINS MANUEL
UND
MIT BESONDERER RUCKSICHT AUF BAUMEISTER, BEHÖRDEN
UND TECHNISCHE LEHRANSTALTEN
BEARBEITET VON
LUDWIG DEGEN,

MIT ZWEI TAFELN ABBILDUNGEN.

MÜNCHEN.
J. LINDAUER'SCHE BUCHHANDLUNG (SCHÖPPING).
1869.

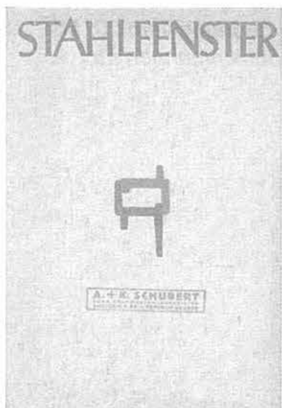
De Jonge, W. CIAM inquiry on functional outer walls – A proposal for an international DOCOMOMO research program on Modern Movement technology. (Typescript) Paper for the Second International DOCOMOMO Conference 16-18.09.1992 Bauhaus Dessau

Döcker, R., *Terrassentyp – Krankenhaus – Erholungsheim – Hotel – Bürohaus ... und die Stadt.* Stuttgart 1929

Dorn, J.F., *Praktische Anleitung zur Ausführung der neuen flachen Dachdeckung – Anlegen künstlicher Fußwege etc.* Berlin 1838

Dudeck, V., J. Tomlow, J. *Der Zittauer Ring – phantsievoller Städtebau des 19. Jahrhunderts – Kunstwerk Stadt*, Wissenschaftliche Berichte Hochschule Zittau/Görlitz (FH), Sonderheft 61.2000, Nr. 1752, hrsg. v. D. Reichel, Görlitz, Zittau 2000

Dürr, H. R., *Das Stahlfenster in der Bauwirtschaft – Eine Betrachtung seiner Entwicklung, Ausführungsarten und Eigenschaften.* Berlin 1940.

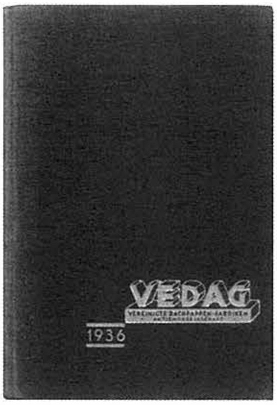


Düwer, D., W. Friedrich. *Die Feuersicherheit des Pappdaches und sein Verhalten bei Bränden.* Halle um 1931

Eckstein, B., D.W.Schmidt, C.Nielsen, J.Urbanik, A.Denk, *Auf dem Weg zum Neuen Wohnen – Die Werkbundsiedlung Breslau 1929. Basel, Boston.* Berlin 1996

Emperger, F. (Begründer), A.Kleinlogel (Schriftleiter), *Beton und Eisen – Internationales Organ für Betonbau.* Berlin 1925

Falian, C. (Hg.), *Vedag-Buch 1936 (Dachpappe).* Berlin 1936



Feldhaus, F. M., K. Siegfried, *Das blaue Badewannenbuch – Vom Holzzuber zur Metallbadewanne.* Schwarzenberg 1932

Fischer, F., Fischer, H., Kohlrausch, W., Schmitt, E, *Die Hochbaukonstruktionen – Anlagen zur Versorgung der Gebäude mit Licht und Luft, Wärme und Wasser. Handbuch der Architektur – 3. Teil, 4. Band, 3. Auflage.* Leipzig 1908.

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HOCHBAUKONSTRUKTIONEN.
DES
HANDBUCHES DER ARCHITEKTUR
DRITTER TEIL.
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Anlagen zur Verſorgung der Gebäude mit Licht und Luft, Wärme und Waſſer.
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Heizung und Lüftung der Räume.
Waſſerverſorgung der Gebäude.
Von
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Profeſſor an der Univerſität in Göttingen,
Dr.-Ing. Hermann Fiſcher und Dr. Wilhelm Kohlrauſch,
Geh. Regierungsräte und Profeſſoren an der Techniſchen Hochſchule in Hannover,
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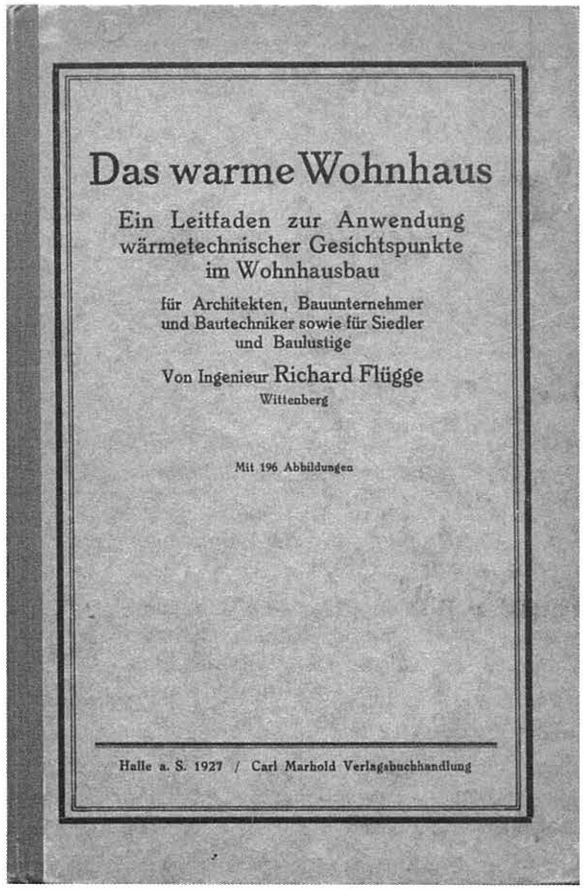
ALFRED KRÖNER VERLAG.
1908.

Flügge, R., *Das warme Wohnhaus – Ein Leitfaden zur Anwendung wärmestechnischer Gesichtspunkte im Wohnungsbau.* Halle a. S. 1927



Fourier, J.B.J., *Théorie analytique de la chaleur.* Paris 1822*

Gaudí und die organische Moderne am Beispiel Scharouns. Ein Symposium im Haus Schminke, Löbau am 18.10.2002, Bearb.v. J. Tomlow, Wissenschaftliche Berichte Hochschule Zittau/Görlitz (FH), Sonderheft 76.2003, Nr. 1978-1983, hrsg. v. R. Hampel, Zittau 2003

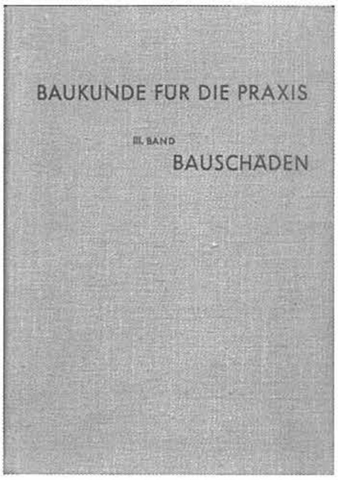
Giedion, S., Böhm, Kaufmann, Le Corbusier a.o., *Rationelle Bebauungsweisen – Ergebnisse des 3. Internationalen Kongresses für Neues Bauen (Brüssel, November 1930).* Frankfurt am Main 1931

Ginsburger, R., *Frankreich – Die Entwicklung der neuen Ideen nach Konstruktion und Form – Neues Bauen in der Welt.* Wien 1930

Gräff, W. (Hg.), *Innenräume – Räume und Inneneinrichtungsgegenstände aus der Werkbundausstellung „Die Wohnung" insbesondere aus den Bauten der städtischen Weißenhofsiedlung.* Stuttgart 1928

Graupner, K., Lobers, F. *Bauklimatische Aspekte, Heizungs- und Lüftungskonzept.* In: *Scharoun. Haus Schminke, Die Geschichte einer Instandsetzung*, ed. by B. Burkhardt, Stuttgart 2001, pp. 120-135

Gretsch (Leiter Bauberatung), *Baukunde für die Praxis III. Band Bauschäden*. Stuttgart 1940



Grobler, J., J.von Gruner, D.A.Klein, F.L.Kurowski u.a., *Das Eigenheim – Bau von Ein- und Mehrfamilienhäusern* ... Leipzig 1932

Gröber, H., *Die Grundgesetze der Wärmeleitung und des Wärmeüberganges*, n.p. 1921*

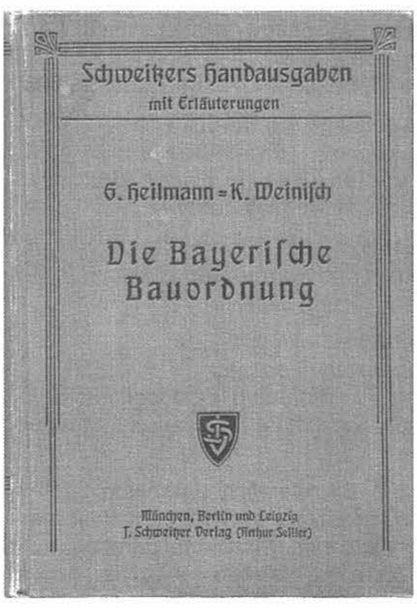
Gropius, W., S. Giedion, E. May, Le Corbusier, H. Schmidt a.o., *Die Wohnung für das Existenzminimum – Auf Grund der Ergebnisse des II. Internationalen Kongresses für Neues Bauen*. Frankfurt am Main 1930

Guillaume, L., *Hygiene de écoles. Conditions architecturales et economiques*. Paris 1874*

Harbers, G., *Das Kleinhaus – seine Konstruktion und Einrichtung*. München 1930

Hawranek, A., *Der Stahlskelettbau – mit Berücksichtigung der Hoch- und Turmhäuser*. Berlin und Wien 1931

Heilmann, G., K. Weinisch (Hg.), *Die Bayrische Bauordnung vom 17. Februar 1901 – abgeändert durch Vorschriften vom 3. August 1910 und 10. Juli 1918*. München, Berlin, Leipzig 1924



Heinicke, E., *Die Flachbauwohnung für das Existenzminimum – Der wirtschaftliche Baubetrieb, Band 5*. Berlin 1931

Hencky, K., *Der Wärmeschutz von Gebäuden – Mitteilung aus dem Forschungsheim für Wärmewirtschaft*. In: *Bayerische Industrie- und Gewerbeblatt*, Nr. 7/8, 1919

Hencky, K., *Nachtrag zum Aufsatz "Der Wärmeschutz von Gebäuden"*. In: (Sonderdruck) *Bayerische Industrie- und Gewerbeblatt*, 1919

Hess, F., H. Hoffmann, *Konstruktion und Form im Bauen*. Stuttgart 1943

Hirdina, H. (Hg.), *Neues Bauen Neues Gestalten – Das neue Frankfurt – Eine Zeitschrift zwischen 1926 und 1933 (Auszüge)*. Dresden 1991

Hoffmann, H.(Bearb.), *Neue Villen – 124 grosse und kleine Einfamilienhäuser – von 84 deutschen und ausländischen Architekten in Ansichten, Grundrissen und Beschreibungen nebst einem Gartenanhang*. Stuttgart 1929

Hoh-Slodczyk, C., *Scharoun und Natur*. In: *Gaudí und die organische Moderne am Beispiel Scharouns. Ein Symposium im Haus Schminke, Löbau am 18.10.2002*, Wissenschaftliche Berichte Hochschule Zittau/Görlitz (FH), Sonderheft 76.2003, Nr. 1978-1983, hrsg. v. R. Hampel, Zittau 2003, pp.17-22

Jaeger, R., *Neue Werkkunst – Architektenmonographien der zwanziger Jahre – Mit einer Basis-Bibliographie deutschsprachiger Architekturpublikationen 1918-1933*. Berlin 1998

Junghanns, K., *Das Haus fur Alle – Zur Geschichte der Vorfertigung in Deutschland*. Berlin 1994

Kalff, Ir. L. C., *Kunstlicht und Architektur – Philips' technische Bibliothek*. Eindhoven 1943 (Dutch 1941)

Keller, E. (Hg.), *Ascona Bau-Buch*. Zürich 1934

Kiem, K.: *Die Gartenstadt Staaken als Prototyp der modernen Deutschen Siedlung.* In: *Moderne Architektur in Dezutschland 1900 bis 1950 – Reform und Tradition*, Stuttgart 1992, pp. 133-149

Kirsch, K., G. Kirsch (Zeichnungen), *Die Weißenhofsiedlung – Werkbund-Ausstellung „Die Wohnung" – Stuttgart 1927.* Stuttgart 1987

Kleber, K. *Bauentwurfslehre, Band 1 – Bauphysik, VEB Verlag für Bauwesen, Berlin (GDR), 1961*

Kleinlogel, A., *Winterarbeiten im Beton- und Eisenbetonbau.* Berlin 1932

Knoblauch, O., *Die wissenschaftlichen Grundlagen des Wärmeschutzes.* In: *Bayerische Industrie- und Gewerbeblatt*, nr. 7/8, 1919

Knoblauch, O., H. Reiher, H. Knoblauch, *Bericht über die wärme- und schalltechnischen Untersuchungen in der Versuchssiedlung München.* In: *Reichsforschungs-gesellschaft für Wirtschaftlichkeit im Bau- und Wohnungswesen e.V.* Bericht Nr. 1, August 1930*

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Bericht über die wärme- und schalltechnischen Untersuchungen in der Versuchssiedlung München.

Von Osc. Knoblauch, Herm. Reiher und Helm. Knoblauch.

Vorwort.

Nachdem die in der Versuchssiedlung des Bayerischen Post- und Telegraphenverbandes durchgeführten wärme- und schalltechnischen Prüfungen im Winter 1929/30 bis zu einem gewissen Abschluß durchgeführt worden sind, veröffentlichen wir nachfolgend den vom Laboratorium für technische Physik der Technischen Hochschule in München eingesandten Bericht als Ergänzung unseres Sonderheftes Nr. 5.

Da die Bauwirtschaft sich heute in ständig steigendem Maße für die wärme- und schallschutztechnischen Maßnahmen interessiert, glauben wir ein größeres Interesse der Öffentlichkeit für den nachfolgenden Bericht voraussetzen zu können. Es wäre für die Weiterarbeit auf dem Gebiet der Reichsforschungsgesellschaft erwünscht, wenn die Bauwelt nicht nur die erzielten Ergebnisse verwertet, sondern auch ihrerseits Anregungen auf diesem Gebiet erbringen könnte und kritisch zu den behandelten Dingen Stellung nehmen würde.

Reichsforschungsgesellschaft.

Kolbe, E., *Die wichtigsten Decken und Wände der Gegenwart mit Berücksichtigung ihrer nutzbaren Eigenschaften ... durch den Bergbau unterminiertem Gelände.* Oberhausen /Rhein 1905

Koppe, J. u. R., *Ausgeführte und geplante Krieger-Heimstätten – Mit Ratschlägen aus der Praxis. Anhang: Sparsame Bauweise für Kleinwohnungsbau.* Halle 1919

Kraus, S., bauen ist ein biologischer vorgang - Hannes Meyer, In: Herzogenrath, W. (ed.), S. Kraus, bauhaus utopien - Arbeiten auf Papier, Stuttgart 1988, p. 279-284

Kreuter, F., *Praktisches Handbuch der Drainage – Anleitung zur Trockenlegung nasser und kalter Gründe.* Wien 1854

Künzel, H., *Bauphysik – Geschichte und Geschichten*, Stuttgart 2002

Kürvers, K., *Entschlüsselung eines Bildes – Das Landhaus Schminke von Hans Scharoun (Dissertation).* Berlin 1996

Kurz, O.O., *Was wir wollen – Anregungen, Wünsche von Architekten, Hausfrauen, Technikern für den Wohnungsbau zur Ausstellung „Heim und Technik"* München 1928. München 1928

Kutzner, E., *Ein neuzeitlicher Großbau von der Fundierung bis zur Vollendung – Erläutert am Beispiel des gemeinsam mit Prof. F.Becker erbauten Palasthotel Mannheimer Hof.* Stuttgart 1930

Lade, K., A. Winkler, *Putz – Stuck – Rabitz – Ein Handbuch für das Gewerbe.* Stuttgart 1936

Lange, B., J.Schäfer, H.Malchow, u.a., *Mitteilungen aus der Dachpappen-Industrie 1938.* Berlin 1938

(Le Corbusier) *La charte d'Athènes / Le Corbusier.* Paris 1943

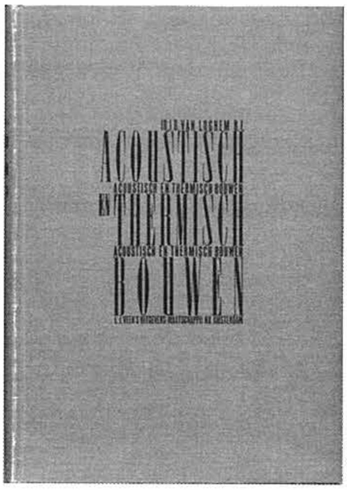
Limperg, K., *Woonhuis te Auderghem* and *Een plat- of een hellend dak?* In: *De 8 en opbouw* 26 mei 1933, pp. 91-102

Limperg, K., thermotechnische dienst der warmtestichting, *Naar warmer woningen.* Amsterdam 1936

Lindner, W., *Bauten der Technik – ihre Form und Wirkung – Werkanlagen.* Berlin 1927

Loghem, J.B. van, *Duitsche Houtbouw.* In: *De 8 en opbouw*, 27 November 1933, pp. 211-216.

Loghem, J.B. van, *Accoustisch en thermisch bouwen voor de praktijk.* Amsterdam 1936



Loghem, J.B. van, *De gedifferentieerde wand in warmtetechnisch, geluidtechnisch en economisch opzicht.* In: De 8 en opbouw, 2 september Nr. 17/18, 1939, 199-208.

Lotz, W. (Hg.), E.R.Haberfeld, G. Laue, W. Riezler u.a., *Licht und Beleuchtung – Lichttechnische Fragen unter Berücksichtigung der Bedürfnisse der Architektur.* Berlin 1928

Lübbert, W., *Rationeller Wohnungsbau – Typ/Norm.* Berlin 1926

Lüdecke, G., W.Meyer, H.Grage, E.Engelmann u.a., *Das Bauwelt-Haus – Wohnungen mit eingebautem Hausrat – 21 Arbeiten aus einem Wettbewerb der „Bauwelt“.* Berlin 1924

Magnago Lampugnani, V. *Vom >Block< zur Kochenhofsiedlung.* In: *Moderne Architektur in Deutschland 1900 bis 1950 – Reform und Tradition.* Stuttgart 1992, pp. 267-281.

Medina Warmburg, J., *Projizierte Moderne, Deutschsprachige Architekten und Städtebauer in Spanien (1918-1936).* Frankfurt am Main, 2005

Michel, E., *Hörsamkeit großer Räume.* Braunschweig 1921

Molema, J.,*The New Movement in the Netherlands 1924-1936*, Rotterdam 1996

Molema, J., *Streven naar schoonheid. De Amsterdamse Openluchtschool van Jan Duiker.* In: *Amstelodamum* 90-6 (2003), 91-1 (2004)

Muthesius, H., *Wie baue ich mein Haus? – Berufserfahrung und Ratschläge eines Architekten.* München 1925

Neuffert, E., G. Hassenpflug, *Bau-Entwurfslehre – Handbuch für den Baufachmann, Lehrenden und Lernenden.* Berlin 1936

Nägele, H:; Bodo Rasch u.a., *info bau 83 – Weissenhof 1927-87 – Zeitschrift.* Stuttgart 1983

Nerdinger, W., M. Koch, H.-J. Wittwer u.a., *Hannes Meyer 1889-1954 Architekt Urbanist Lehrer.* Berlin 1989

Nerdinger, W. (Ed.), *Bauhaus-Moderne im Nationalsozialismus - Zwischen Anbiederung und Verfolgung.* München 1993

Nicolaise, D. (Hg.), *Das andere Bauhaus – Otto Bartning und die Staatliche Bauhochschule Weimar 1926-1930.* Berlin 1997

Nöthling, E., *Die Baustofflehre (Das Handbuch des Bautechnikers Band XIII) Die natürlichen und künstlichen Bausteine, Bauhölzer und Metalle, sowie Verbindungs-, Neben- und Hilfsbaustoffe.* Leipzig 1904

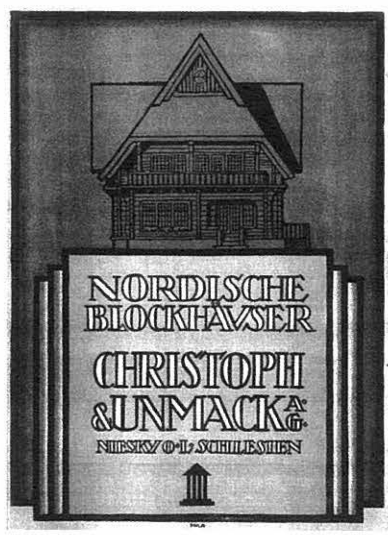
Nevzgodin, I., *Het nieuwe bouwen in West-Siberië: architectuur en stedenbouw in de jaren 1920-1940*, Thesis PhD, Delft 2004

n.a., *Offizieller Führer durch die internationale Baufachausstellung mit Sonderausstellungen Leipzig 1913 und durch Leipzig und Umgebung mit einem Plan von Leipzig.* Leipzig 1913

n.a., *Deutsche Bauausstellung Berlin 1931 – Amtlicher Katalog und Führer.* Berlin 1931

n.a., *Programm Deutsche Bauausstellung Berlin 1931 – Vom 9.5. – 9.8.1931 auf dem Ausstellungsgelände am Kaiserdamm.* Berlin 1931

n.a., *Nordische Blockhäuser Christoph & Unmack AG Abt. Holzbau Niesky Oberlausitz (Niederschlesien) Katalog XIV.* Niesky 1926



n.a., *Auswahl ausgeführter Heraklithbauten – Erzeugerfirma und Patentinhaberin von Heraklith: Österr.Amerik.Magnesit AG Radenthein, Kärnten.* Graz nach 1926

n.a., *Wohnbauten aus Holz – nach dem Montage-System „Nilbo“ – Firmenkatalog mit Bauzeichnungen.* Basel 1944

n.a., *Schwarzwälder Dauer-Holzhausbau Bauweise: System Schmelzle – Ernst Schmelzle, Mitteltal, Sägewerk und Holzhausbau.* Tübingen um 1934

n.a., *Technische Vorschriften für Bauleistungen – DIN Taschenbuch 3 – Deutsche Industrie Norm 1962-1985.* Berlin 1926

n.a., *Ortsbauordnung für die Stadt Zittau. Beilage zu Nr. 74 der Zittauer Nachrichten und Anzeiger.* Dresden 1908

n.a., *Die Wohnungsnoth der ärmeren Klassen in deutschen Großstädten und Vorschläge zu deren Abhülfe – Gutachten und Berichte.* Leipzig 1886

Péclet, J.C.E., *Traité de la chaleur considerée dans ses applications.* Paris 1828, 3. edition 1861*

Pettenkofer, M. von, *Ueber den Luftwechsel in Wohngebäuden*, München 1858*

Pitz, H., W. Brenne, P. Portoghesi, J. Posener, *Die Bauwerke und Kunstdenkmäler von Berlin – Siedlung Onkel Tom – Einfamilienreihenhäuser 1929 – Architekt: Bruno Taut.* Berlin 1998

Petzold, K., *Bauklimatik für Architekten: Vorlesung Grundlagen der Bauklimatik I.* Dresden 2000*

Pöthig, O., *Das Problem der deutschen Dachform im Einzel- und Städtebau und die neuen Dachkonstruktionen.* Berlin 1911

Probst, H. C. Schädlich, *Walter Gropius, Band 1: Der Architekt und Theoretiker, Werkverzeichnis Teil 1.* VEB Verlag für Bauwesen Berlin 1986

Probst, H., C. Schädlich:, *Walter Gropius, Band 2: Der Architekt und Pädagoge, Werkverzeichnis Teil 2.* VEB Verlag für Bauwesen Berlin GDR 1986

Rappold, O., *Der Bau der Wolkenkratzer – Kurze Darstellung auf Grund einer Studienreise für Ingenieure und Architekten.* München, Berlin 1913

Rasch, H. u. B., *Wie bauen? Bau und Einrichtung der Werkbundsiedlung am Weißenhof in Stuttgart 1927.* Stuttgart 1927

Rasch, H. u. B., *Wie bauen? Materialien und Konstruktionen für industrielle Produktion – Jahres-Ausgabe 1928.* Stuttgart 1928

Reiher, H. *Wärme- und schalltechische Untersuchungen.* In: Schmitthenner, P. *Die Holzsiedlung am Kochenhof – Ausstellung Deutsches Holz für Hausbau und Wohnung.* Stuttgart 1933, pp. 6-8

Riepert (Hg.), *Der Kleinwohnungsbau und die Betonbauweisen – Zement-Verarbeitung Heft 15.* Charlottenburg 1926

Rietschel, H., *Lüftung und Heizung von Schulen. Ergebnisse im amtlichen Auftrage ausgeführter Untersuchungen, sowie Vorschläge über Wahl, Anordnung und Ausführung von Lüftungs- und Heizungsanlagen für Schulen.* Berlin1886*

Rietschel, H., *Leitfaden zum Berechnen und Entwerfen von Lüftungs- und Heizungsanlagen*, Berlin 1893, 1. edition*

Leitfaden zum Berechnen und Entwerfen

von

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Auf Anregung
Seiner Excellenz des Herrn Ministers der öffentlichen Arbeiten
verfasst
von
H. Rietschel

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II.
Tabellen und Tafeln.

Berlin.
Verlag von Julius Springer.
1894.

Riezler, W., W. Pleiderer, *Die Form ohne Ornament – Werkbundausstellung 1924.* Stuttgart, Berlin, Leipzig 1924

Roth, A., H. Hildebrandt, *Zwei Wohnhäuser von Le Corbusier und Pierre Jeanneret*. Stuttgart 1927 (Stuttgart 1991)

Sachs, S., *Der verbesserte Pise-Bau – Ein Beitrag zur Vervollkommnung des Staatshaushaltes*. Berlin 1822

Sartoris, A. *Gli elementi dell' architettura funzionale*, Milano 1941

Schachner, R., *Gesundheitstechnik im Hausbau*, München 1926

Schaal, R., S. Pfister, G. Scheibler (Hg.), *Bautechnik I – Zum Rohbau – Baukonstruktion der Moderne aus heutiger Sicht.* Basel, Boston, Berlin 1990

Schaal, R., S. Pfister, G. Scheibler (Hg.), *Bautechnik II – Zum Ausbau – Baukonstruktion der Moderne aus heutiger Sicht.* Basel, Boston, Berlin 1990

Schaal, R., S. Pfister, G. Scheibler (Hg.), *Siedlungen - Baukonstruktion der Moderne aus heutiger Sicht.* Basel, Boston, Berlin 1990

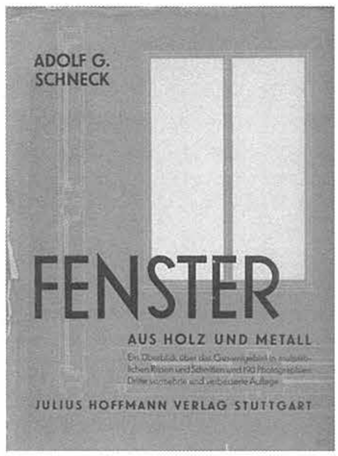
Schönberg, A., *Die Pappdächer – Erfahrungen über Haltbarkeit und Werth.* Dresden 1857

Sigrist, A., *Das Buch vom Bauen – Wohnungsnot – Neue Technik – Neue Baukunst – Städtebau.* Berlin 1930

Schäfer, P. (Red.), *Finanzierung* des Wohnungsbaues der minderbemittelten Klassen. Frankfurt am Main 1937

Schmidt, C. A. (Hg.), *Schweizer Holzbau*. Zürich 1936

Schneck, A. G., *Fenster aus Holz und Metall – Konstruktion und Maueranschlag*. Stuttgart 1938



Schneegans, A., P. Kick, *Geschäfts- und Warenhäuser, Messpaläste, Banken – Handbuch der Architektur – 4. Teil: Entwerfen, ... Anlage und Einrichtung der Gebäude, 2. Halbband: Gebäude für die Zwecke des Wohnens, des Handels und Verkehrs, 2. Heft*. Leipzig 1923

Schrader, F., *Praktische Preisermittlung sämtlicher Hochbauarbeiten*. Berlin 1925

Schubert, A., E. Schmitt (Hg.), *Handbuch der Architektur – Entwerfen, Anlage und Einrichtung der Gebäude, 4. Teil 3. Halbband – Gebäude für die Zwecke der Landwirtschaft und der Lebensmittelversorgung, Heft 1.* Leipzig 1913

Schubert, E. R., *Warum Ziegelbau? – Eine Antwort aus Geschichte und Leistung der Ziegelindustrie – Sammlung von Werbebüchern für die Ziegelindustrie in Einzelbänden Band I*. Berlin 1926

Schüle, Prof., *Autographie der Vorlesung über Technologie der Baumaterialien*. Zürich 1913

Schultze-Naumburg, P., *Flaches oder geneigtes Dach? Mit einer Rundfrage an deutsche Architekten und deren Antworten*. Berlin 1927

Schulze, K. W., *Der Stahl-Skelettbau – Geschäfts- und Hochhäuser*. Stuttgart 1928

Schulze, K. W., *Glas in der Architektur der Gegenwart.* Stuttgart 1929

Schuster, F., *Ein eingerichtetes Siedlungshaus – Broschüre Reihe der Kleinen Baubücher 2. Heft.* Stuttgart around 1926

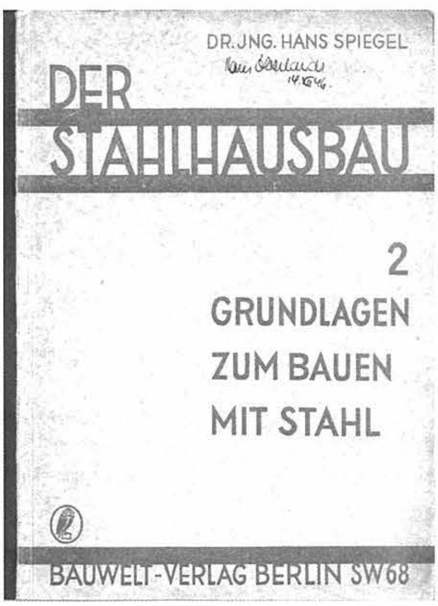
Schuster, F., *Ein Möbelbuch – Ein Beitrag zum Problem des zeitgemäßen Möbels.* Stuttgart 1932

Seeßelber, F. (Hg.), *Das flache Dach im Heimatbilde – als kulturelles und wirtschaftliches Problem gefasst und im Auftrage der Hauptstelle für Bau- und Kunstberatung* ...Berlin vor 1914

Siedler, E. J., *Lehre vom neuen Bauen – Ein Handbuch der Baustoffe und Bauweisen.* Berlin 1932

Spiegel, H, *Der Stahlhausbau –Wohnbauten aus Stahl 1.* Berlin 1929

Spiegel, H., *Der Stahlhausbau 2. Grundlagen zum Bauen mit Stahl.* Berlin 1930



Stegemann, R. (Hg.), *Das große Baustoff-Lexikon – Handwörterbuch der gesamten Baustoffkunde.* Stuttgart, Berlin 1941

Stegemann, R. (ed.) a.o., *Vom wirtschaftlichen Bauen. Holz- oder Massivdecken im Wohnungsbau – eine Wirtschaftsfrage.* Dresden 1928

Stelzer, R., *Der praktische Platten- und Fliesenleger – Handbuch für das gesamte Platten- und Fliesen-Gewerbe.* Berlin 1938

Stolper, H., E. Wiemken, O. Graf u.a., *Bauen in Holz – Blockbau, Fachwerk, Plattenbau und Hallenbau.* Stuttgart 1933

Syrkus, S, *De buitenmuur – ondervindingen van de laatste jaren.* In: *De 8 en opbouw,* 23 juni 1934, pp. 105-111

Tappe, W., *Darstellung einer neuen äußerst wenig Holz erfordernden und höchstfeuersicheren Bauart – Heft 1 – 1818, 2 – 1819, 3 – 1820, 4 – 1821, 5 – 1821, 6 – 1821, 7 – 1822, 8 – 1823.* Essen 1818-1923

Taut, B., *Die neue Wohnung – Die Frau als Schöpferin.* Leipzig 1926

Taut, B., *Ein Wohnhaus.* Stuttgart 1927, (reprint Berlin 1995)

Taut, B., *BAUEN. Der neue Wohnbau.* Berlin 1927

Taut, B., Hg. Manfred Speidel, *Das japanische Haus und sein Leben* (German edition of *Houses and People of Japan*, Tokyo 1937). Berlin 1997

Teichmann, F., *Feuersnoth- und Hülfs-Buch über Entstehung und Beträchtlichkei der Feuerbrünste, ... Unterstützung der Abgebrannten, ... nebst Anhang über Volksveredlung und Wohlfahrt.* Leipzig 1831

Timmer, J., *De beschuttende functie van glasramen.* Amsterdam n.d.

Tomlow, J., *Sources of Momo Technology - „Wie bauen?" (1927/1928) and the Dutch results of a CIAM inquiry „functional exterior walls" (1939).* In: *Conference Proceedings V.International DOCOMOMO conference Vision and Reality – Social Aspects of Architecture and Urban Planning in the Modern Movement, Stockholm 16.-18.9.1998*, pp. 158-162

Tomlow, J., *Konrad Wachsmann's use of log building traditions in Modern Architecture, Proceedings International Seminar Wood and Modern Movement, Helsinki University of Technology, 3.6.-4.6.1999, Preservation technology DOCOMOMO-Dossier 4*, August 2000, pp. 46-53

Tomlow, J., *Notes on a Bibliography of Literature on MoMo Technology: A Case Study of Publications in German Language 1920-1940.* In: *DOCOMOMO Journal* 22, May 2000, pp. 10-12

Tomlow, J., *La bóveda tabicada a la catalana y el naciemento de la „cerámica armada" en Uruguay*, in: Huerta, S.(Ed.), *Las Bóvedas de Guastavino en América*, Instituto Juan de Herrera, Madrid 1999/2001, pp. 241-251

Tomlow, J. *Eladio Dieste und das katalanische Gewölbe*, in: *Eladio Dieste – Form und Konstruktion*, ed. R. Barthel, TU München, München 2001, pp. 9-14

Tomlow, J. (Bearb.), *Gaudí und die organische Moderne am Beispiel Scharouns. Ein Symposium im Haus Schminke, Löbau am 18.10.2002*, Wissenschaftliche Berichte Hochschule Zittau/Görlitz (FH), Sonderheft 76.2003, Nr. 1978-1983, ed. R. Hampel, Zittau 2003

Usemann, K., *Entwicklung von Heizung- und Lüftungstechnik zur Wissenschaft. Hermann Rietschel, Leben und Werk.* München, Wien 1993*

Völckers, O., *Wohnbaufibel – für Anfänger und solche, die glauben es nicht mehr zu sein.* Stuttgart 1932

Wachsmann, K., *Holzhausbau – Technik und Gestaltung.* Berlin 1930 (reprint mit Beiträgen von C.&M. Grüning, C.Sumi, Basel/Berlin 1995)

Wachsmann, K., *Wendepunkt im Bauen.* Wiesbaden 1959, (reprint mit Beitrag von O. Patzelt Dresden/Wiesbaden 1989)

Wasmuth, G. (Hg.), L.Adler, G.Kowalczyk, *Wasmuths Lexikon der Baukunst – A bis Z.* Bd. 1-4, Berlin 1929-1932

Wasmuth, G. (Hg.), B.Schwan, H.Zechlin, *Wasmuths Lexikon der Baukunst – Fünfter Band Nachtrag A bis Z.* Berlin 1937

Zalivako, A., *Zur Erhaltung der Bauten der 1920er Jahre im Vergleich Bundesrepublik Deutschland – Russische Föderation (Moskau) unter besonderer Berücksichtigung der baukonstruktiven Voraussetzungen: Probleme, Erfahrungen, Perspektiven.* (Dissertation TU Berlin), Berlin 2003

The Unbearable Lightness of Building

The 'Functionally Differentiated Outer Wall' and the Preservation of Modern Movement Buildings

by Wessel de Jonge

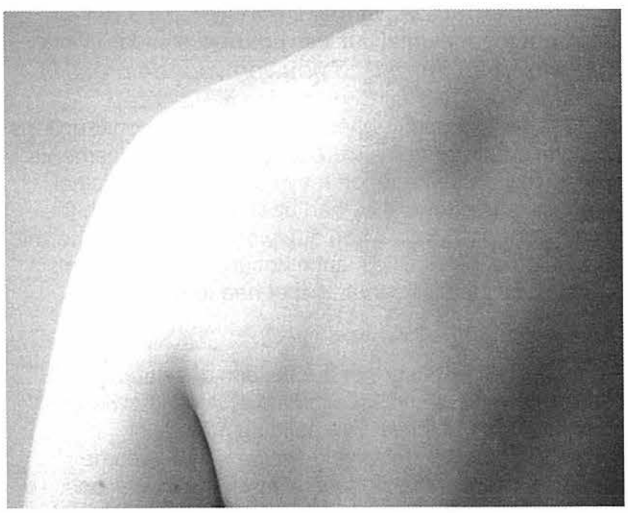
Conservation and adaptive re-use

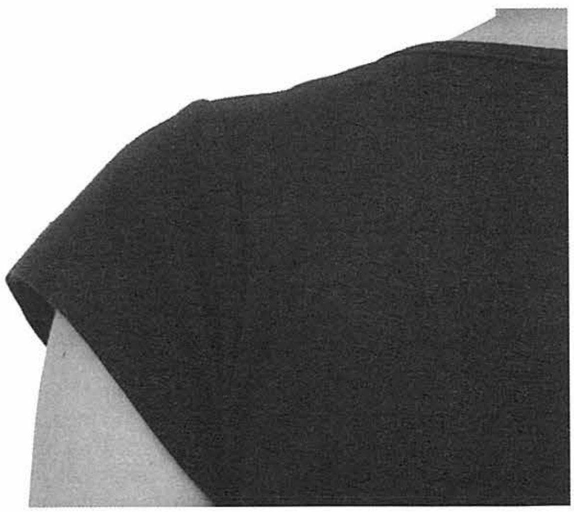
Building physics are increasingly recognised as essential to architectural conservation and to the proper stewardship of our built heritage. This is partly due to the technical minimalism and vulnerability of most of the Modern Movement buildings that, in many countries, have recently entered into the realm of architectural conservation. Conservationists and restoration architects seem to share a growing understanding that knowledge of building physics is instrumental in the further development of the professions. On the other hand, very little research has been performed on the historic development of knowledge of and standards in building physics as yet. Good knowledge of building physics may appear to be key in the evolution of preservation and adaptive re-use as a field of research and practice with increasing economical, environmental and cultural relevance.

However the conservation of recent architectural heritage may seem a relatively limited niche in our present economy it is obvious that soon, the building industry in many Western countries will be largely engaged with old buildings rather then new ones. In our densely populated territories urban expansion is more and more restricted in order to curb urban sprawl. Planners, property developers, investors, housing corporations and other decision-makers are therefore increasingly interested in the redevelopment of vacated buildings, former industrial complexes and obsolete infra-structural sites. The challenge must be to recognise this as an unprecedented opportunity to sustainable development in economical, environmental, social as well as cultural terms, rather than a mere financial necessity.
As a consequence, we are not just talking about a recognised selection of listed buildings or historic townscapes but about the mainstream of architectural production of the past century. We will have to deal primarily with the buildings of post-war Modernism, as well as a more limited number of pre-war Modern Movement structures, simply because these make up a main part of our building stock. Given the particular social and cultural meaning of 20th Century architectural heritage, and the minimalist character of many of these structures on the other hand, this poses a range of challenges to the professions.

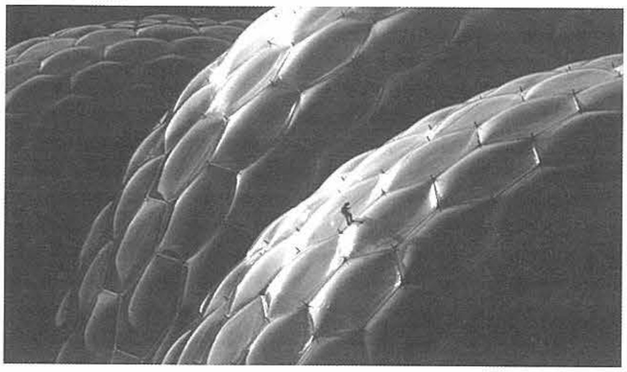
The skin

As human beings, the parable of a building's envelope as a 'skin' appeals to us, as it helps us to understand the balance between technical performance requirements and representative qualities in terms of aesthetics and cultural value. This parallels just as well our appreciation of clothing – the dress as a second skin. The outer shell of our buildings, as the envelope of our shelter, may be seen as our third skin. The architects of the Modern Movement were already appreciative of some of these similarities in relationship to the design of the outer shell of their buildings, particularly regarding the idea of the breathing envelope and the insulating effect of captured air in cellular structures.[1]
The interactivity of our skin often inspires present day architectural façade design, as can be seen in the many





The parable of a building's envelope as a 'skin' helps us to understand the balance between technical performance and aesthetical and cultural value. This explains as well our appreciation of clothing as our second skin. Photo: Wessel de Jonge architects.



The outer shell of our buildings may be considered as our third skin. The magnificent roof structure of the Eden Project environmental centre in Cornwall (UK), designed by Nicolas Grimshaw 2001. Photo: unknown.

recent buildings that involve a so-called 'active envelope', which is typically a ventilated double glass-skin façade. As we will see, some remarkable adaptations of existing buildings followed a similar concept, with the addition of a secondary skin.

Of course, building physics has to do with much more than just the performance of façades, roofs and other components of the outer shell of buildings. In terms of urban planning, which may greatly affect the performance of our buildings, building physics involves such aspects as sun and shade, traffic noise and pollution, building heights and the effects of air currents that may be caused by them. Orientation towards the sun and overall energy performance and ventilation are essential elements at the level of the buildings as a whole. Going down to the level of building parts, like façades, roofs and floors, we are dealing with hygro-thermal aspects, energy performance, ventilation and daylight access, solar gain, noise control and so on. In terms of interior spaces, some of these aspects come together again in the overall interior climate, daylight levels, lighting and room acoustics. The performance levels of the interior spaces and buildings as a whole are not only defined by the physical performance of building parts and components, but also closely linked to the building's service systems (installations). When building new – but even more when adapting an existing structure – it is essential to understand the balance between these two.

Given the efforts of the architects that belonged to the Modern Movement to move away from stylistic superficiality, as the functional lay out and structure of buildings was much more essential to them, we may be hesitant to value the architectural quality of their buildings merely by their outer shell. Even so, the fundamental architectural qualities, which are typically strongly related to the rationale of their buildings, can mostly be well understood from the façades. If we want to preserve the cultural value of such buildings, and apart from other essential architectural particularities, it means we must capture the essential features of the façades.
Yet in case of adaptive re-use of buildings and their upgrading to present standards, it is also the façade where most changes are typically required. To a lesser degree this applies as well to flat roofs, particularly if these are fitted as a part of the architectural and functional concept, for instance to serve as terraces, solariums or roof gardens.

Inevitably, in case of conservation and adaptive re-use, and without disregard for the other aspects of building physics, we have to reconsider the building parts that make up the skin of such buildings very carefully, and most particularly the façades. This requires a profound understanding of building physics, both in terms of knowledge standards at the time, as well as present state-of-the-art design technology.

DEVELOPMENT OF BUILDING PHYSICS IN THE NETHERLANDS 1925-1940

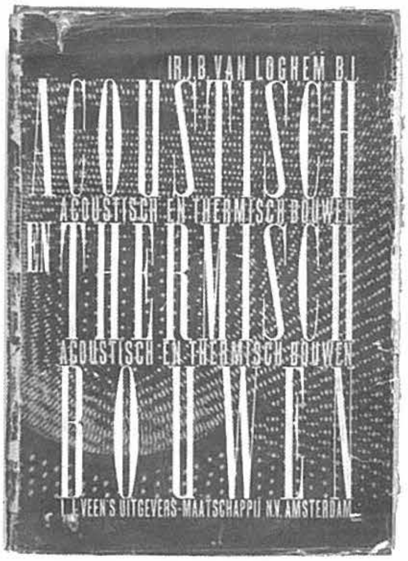
Building physics and architectural concept

In my way of working, the architectural and structural analysis of the buildings themselves has grown to be prominent. The aim of such - often extensive - research is to obtain a comprehensive understanding of a building's rationale before actually touching it. The most complicated issue to assess is how these architects themselves saw the performance of their buildings in terms of building physics in relationship to the climatisation systems they devised.

In the 1920s and 30s the pioneering construction and climate concepts of these 'modern' engineers and architects have been persistently criticised by their more conservative colleagues. In retrospect, one may conclude that their criticism was mostly not based on a profound understanding of building physics, at that time a still young discipline. On the other hand, the engineers that were engaged in new developments in building physics were dedicated to deepen their knowledge and to diversify their fields of research and, at the same time, to develop tools that would facilitate the integration of their knowledge in building practice.

Unfortunately, research on the historic development of building physics has so far remained very limited, and we have to rely largely on period magazines and some handbooks. As far as The Netherlands are concerned, the first two handbooks on building physics were only published in 1936, which is rather late as the architectural avantgarde in Holland came to the fore already in the early 1920s. These were Koen Limperg's *Naar warmer woningen* (Towards Warmer Dwellings) and J.B. van Loghem's fundamental but less practical standard work *Acoustisch en thermisch bouwen voor de praktijk* (Acoustic and Thermal Construction in Practice).
In some cases, mostly when innovative new constructions or climatisation systems were proposed, advertisements or technical documentation may be found in municipal archives. Sometimes they had been handed in with the construction drawings when applying for a building permit. Mainly in the larger cities, such documentation was also collected by the civil servants that had to review applications.

To get a broader picture of the historic development of building physics, the dissemination of such knowledge, and the variety of innovative building materials, components and construction systems that became available, it is worthwhile to study period publications. To this end, I have made an inventory of the complete set of volumes of the periodical *De 8 en Opbouw*, that has been



Acoustisch en Thermisch Bouwen voor de praktijk by J.B. van Loghem of 1936 was one of the first handbooks on building physics in The Netherlands. Collection: Wessel de Jonge architects.

published between 1932-1943 (reprint Amsterdam 1985-1989). This review has been a main source for the architects of the Modern Movement in The Netherlands, that was generally referred to as 'Het Nieuwe Bouwen'. Johannes (Jan) Duiker (1890-1935), the architect of the famed Sanatorium 'Zonnestraal' in Hilversum of 1928-31 and a main spokesman for the Dutch architectural avantgarde, was a leading editor from the founding of the magazine in 1932 until his death in 1935. Other main authors on technical issues included Koen Limperg, Johannes Bernardus (Han) van Loghem, Albert Boeken, Charles Jean-François Karsten, Ben Merkelbach and Jan Piet Kloos, all noted modern architects in their own right, as well as the heating engineer Jan Jacobus de Ridder.

Modern technology

In terms of building physics the most interesting publication of *De 8 en Opbouw* has no doubt been the 'functional outer walls' edition, that was published in early September 1939. Apart from a series of key articles, it included the entry of the Netherlands' CIAM group to the 1939 international CIAM inquiry of the same name, which had been conceived by Helena and Szymon Syrkus and Carl Hubacher.[2] As we will see, this was certainly not the first time that aspects of building physics were addressed but by far the most comprehensive and international overview and analysis of the state of affairs.

In his preface to the edition, the chief-inspector for Public Health of the Netherlands Ministry for Public Housing, the engineer Van der Kaa, underlines the importance of the development of new construction methods and materials, in order to improve the thermal qualities of dwellings and the acoustic performance of residential buildings.
Cornelis (Cor) van Eesteren, at that time the president of CIAM, opens his introductory essay with an observation that the 'modern construction methods and the building materials of today make it possible to meet any contemporary building programme. Yet, on the other hand, they make the requirements made to our buildings increasingly versatile and sophisticated.' He identifies the interaction between programme and technical possibilities as a main influence on architecture, and the essence of buildings. Van Eesteren analyses that the programmes for public buildings already include technical requirements to such an extent, that the application of modern constructions is considered the only proper way, and are therefore accepted for those buildings. But he concludes that soon, this will affect social housing construction inevitably, regardless of the type of dwellings, as the requirements already set for social housing are so specific, that the use of 'modern' technology will remain the only solution. At the time, not many dwellings had been constructed according to these technological principles. He suggests that, although the necessity of functional requirements for dwellings is generally appreciated, ultimately the practical consequences thereof are not commonly accepted yet.

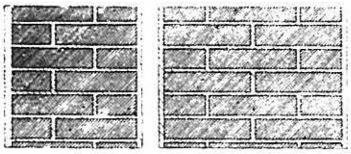
Experimental dwellings

The construction of experimental housing projects is promoted to prove the practical advantages of 'modern' constructions. Some tests had already been set up. Rather than full scale dwellings, the experimental 'dwellings' of the Norwegian University of Technology of 1919-1928 concern simple shacks with four walls and a roof, just to record measured data.[3] *Betondorp*, built near Amsterdam between 1923 and 1928, involves a range of construction systems with various types of light concrete that were primarily tested in an effort to cut down construction costs. In the 1939 edition of *De 8 en Opbouw*, after more than a decade, Van Loghem evaluates these experiments, this time within the perspective of functional outer walls though including aspects of workmanship, labour conditions and construction economy.[4] The majority of such experiments however, were to be found in Germany, mainly initiated by the Deutsche Werkbund, like the 1927 Weissenhof Estate in Stuttgart and the 1929 *WUWA* Estate in Breslau, today Wroclaw, in Poland. Remarkably, Josef Frank decided to deny the importance of such technological innovation for small scale housing in his manifest for the Viennese *Werkbundsiedlung* of 1932.[5] In Poland the architects of the *Praesens* group, including the Syrkus' couple, tested various combinations of materials in a series of small buildings around 1930 that clearly demonstrated the development of new approaches in the construction of outer walls (façades). In the following decade, such approaches became more evident in other countries as well.[6]

The authors of the inquiry propose to set up further series of test sites in much more countries and regions, to get a better picture of local circumstances and possibilities, mainly to acquire experience regarding the degree to which additional insulation benefits the thermal performance of dwellings. Van Eesteren strongly supports this idea and regrets that only so few experiments have been done in Holland: 'From the answers (...) the necessity to gather practical experience concerning functional outer walls can clearly be understood. With respect to functional floor constructions, partitions and many other important parts of dwellings, studies can be performed at the same time. The issue of Social Housing could be tremendously advanced by the construction of these experimental dwellings.'
Evidently Van der Kaa, from whom this may be expected, and Van Eesteren agreed that the essence of 'modern' technology lies in the benefits for social housing. The

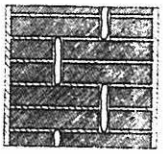
fragebogen : „funktionell differenzierte aussenwand"
beilage no. 2: beispiel einer entwicklungstabelle der schichtenwand

1. ausgangspunkt: vollziegelmauer dicke verschieden je nach dem klima.



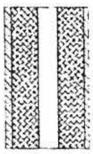
aussenputz 2 cm
vollziegel 38 cm resp. 52
innenputz 1,5 cm

2. warschau
43 cm dicke vollziegelwand, in der die wärmebrücken der mörtelfugen mit pappe unterbrochen sind, wirkt wärmetechnisch gleich wie eine 55 cm dicke vollziegelwand.



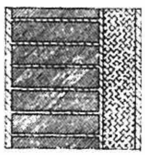
aussenputz 2 cm
vollziegel 13 en 27 cm
pappfuge 3 cm
innenputz 1,5 cm

3. basel - stahlskelett
bimsbetonwand: wärme-isolierung -und-accumulierung nicht genau differenziert.



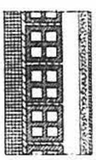
aussenputz 2 cm
bimsplatten 8 cm
luftraum 6 cm
bimsplatten 8 cm
innenputz 1,5 cm

4. warchau - eisenbetonskelett
wand aus ziegeln u. zellenbetonplatten: isolierungsschicht nach innen, akkumulierungsschicht nach aussen verlegt.



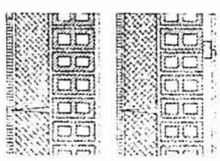
aussenputz 2 cm
vollziegel 27 cm
zellenbeton 10 cm
innenputz 1,5 cm

5. paris - stahlskelett
dasselbe prinzip in bezug auf die anordnung der akkumulierungsschicht (backstein) und der isolierungsschicht (heraklith), aussen-u. innenputz durch verkleidungsplatten ersetzt.



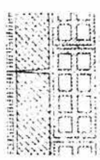
kunststein 5 cm
mörtelfuge 1 cm
hohlsteine 11 cm
luftraum 5 cm
heraklith 3 cm
verkleidung 0,5 cm

6. warchau - stahlskelett
weitere durchbildung der wand 4: zellenbetonplatten als wärmeisolierung nach aussen, wärmeakkumulierungsschicht aus backstein nach innen versetzt, (die zellenbetonplatten werden in der fabrik mit ihrer verkleidung aus natursandstein versehen). auf der windanfallseite celotex auf latten.



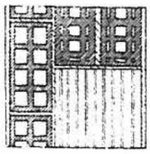
natursandsteinplatten 2,5 cm
cementmörtel mit dichtungszusatz 1 cm
zellenbeton 10 cm
mörtelfuge 1 cm
hohlziegel 6 x 13 x 27 cm
innenputz 1,5 cm
auf windanfallseite celotex auf lattung 3,6 cm

7. warschau-stahlskelett.
zur verminderung der fugenzahl und möglichkeit der anordnung versetzter fugen wurden hohlziegelblöcke von vierfachem normalformat verwendet.
das prinzip der anordnung der schichten bleibt dasselbe.



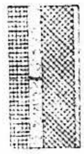
natursandsteinplatten 2,5 cm
zementmörtel mit dichtungszusatz 1 cm
zellenbeton 10 cm
mörtelfuge 1 cm
hohlziegelblock 27 x 13 x 27 cm

8. warschau.
dasselbe prinzip in backsteinmaterial: isolationsschicht aus dünnwandigen hohlziegelblöcken an der aussenseite, akkumulationsschicht aus dickwandigentragenden hohlziegelblöcken von gleichem format fugen versetzt.



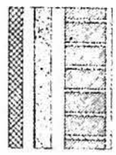
aussenputz 2 cm
dünwandige ziegelhohlblöcke 27 x 13 x 27 cm
mörtelfuge 1 cm
dickwandige ziegelhohlblöcke 27 x 13 x 27 cm
innenputz 1,5 cm

9. zürich - komposit skelett.
das prinzip der wände 6, 7 u. 8 ist in diesem beispiel durch anwendung stark differenzierter materialien weitergeführt: als isolation dient kork, als akkumulation kiesbeton, als aussenverkleidung kunststeinplatten.



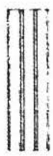
kunststein 6 cm
korkplatten 4 cm
betonbrüstung 10 cm
innenputz 1,5 cm

10. warschau
die luftschicht wirkt als körperschallisolierung, gleichzeitig trennt sie die organische isolierplatte von der event. feuchtigkeit der zementmörtelplatten und des mauerwerks.



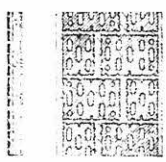
zementmörtelplatten 4 cm
luftschicht 4 cm
holzfaserplatten (muroblock) 5 cm
luftschicht 4 cm
vollziegelsteine 6 x 13 x 27 cm
innenputz 1,5 cm

11. berlin - holz skelett.
beispiel einer serienweise nergestellten und trocken montierten aussenwand.



kupferwellblech 0,05 cm
1 lage asbestbitumenpappe
1 lage aluminiumfolie
2 lagen aluminiumfolie
2 lagen asbestbitumenpappe mit
1 lage aluminiumfolie dazwischen
2 lagen asbestbitumenpappe mit
1 lage aluminiumfolie dazwischen
1 lage aluminiumfolie
1 lage asbestbitumenpappe
aluminium innenblech

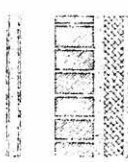
12. zürich.
differenzierung d. wände je nach der lage im hause: südbrüstung in zusammenhang mit der fensterkonstruktion gebracht. (auf wärmeakkumulierung wird bewusst verzichtet) nordwand normale artsübliche hohlziegelwand.



südbrüstung:
eternit 0,3 cm
luft 0,7 cm
kork 0,8 cm
sperrplatte 1,3 cm

nordwand:
aussenputz 2 cm
ziegelhohlblöcke 30 cm
innenputz 1,5 cm

13. basel.
dasselbe prinzip in anderer ausführung.



südbrüstung:
pressinsulite 0,6 cm
korkplatte 3 cm
pressinsulite 0,6 cm

nordwand:
ziegelsteine 6 x 12 x 25 cm
kork 3 cm
tuffplatten 6 cm
innenputz 1,5 cm

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A page of the CIAM inquiry on functionally differentiated outer walls, as published in 'De 8 en Opbouw' in 1939. The inquiry is a valuable source to understand the technological dimension of Modern Movement structures. This example shows the inquiry in German language. Collection: Wessel de Jonge architects.

CIAM inquiry of 1939 therefore is an interesting source to understand the technological dimension of the preservation of Modern Movement neighbourhoods and social housing projects, but may also lead to more general conclusions.

The 'functionally differentiated' outer wall

Despite the title of the inquiry on 'functional outer walls', the key concept of the document is more precisely defined as the 'functionally differentiated' outer wall. Functional differentiation was introduced to contrast the integrated character of the solid brick wall, where all kind of different – and even conflicting – functions, that in fact require principally different materials, must be performed by a single material. Although brick successfully combines some material properties, like its capacity to bear loads and to absorb heat, it is rather unfit for thermal insulation, for example, particularly under humid conditions.

Functional differentiation departs from the idea to split up the outer wall into various layers or components, each with particular performance characteristics, and often separated by air cavities. The various functions to be performed by the outer wall, i.e. wind and water proofing, thermal insulation and accumulation, sound proofing and even bearing loads, are then designated to individual layers that are specifically designed to respond to one or more of these functions. Also the arrangement of the layers is important, as water proofing needs to be performed on the outside, while thermal accumulation is probably most effective on the inside to stabilise the interior climate. Load bearing capacities are often found in separate frame constructions[7] but may also be combined with the thermal accumulation performance of an inner layer made of perforated or light brick or light concrete block. For the latter, a variety of light concrete materials was tried, including cellular or 'foam' concrete types, produced with the help of gas or air, as well as concrete with light aggregates such as slag or pumice.

The outline of the 'functionally differentiated' outer wall had already been described by Szymon Syrkus in his paper for CIAM IV in Athens in 1933, that was published in Dutch in *De 8 en Opbouw* in the summer of 1934. Although the term itself it not yet used, and various experimental constructions of this kind had already been used since the mid-1920s, his presentation may be seen as an important historical source of this theoretical concept. Syrkus writes that a lecture by Le Corbusier 'on air, sound, heat and light' at CIAM III (Brussels, 1930) had inspired him.[8]
In this article he identifies the static, acoustic and thermal performance as main fields of concern in the design of outer walls. Thermal insulation is addressed as a matter of comfort, but also in terms of economy as a result of high fuel prices 'since 1917', apparently as a result of the First World War. Various trials are analysed, referring to a small series of experimental buildings by the architects of the Polish *Praesens* group.[9]

The CIAM Inquiry of 1939

From the introduction in *De 8 en Opbouw* can be concluded that the inquiry had been spread over all 23 countries participating in CIAM at that time.[10] The contents of the original inquiry forms can be derived from this publication as well, and involve eight parts. The first is a brief inventory of national regulations concerning thermal insulation and the constructions for outer walls that are usually applied. The second part lists the climate conditions in the country or region concerned, based on registered averages of at least ten years.
The third chapter gathers information on the type of heating systems, fuel consumption and the performance requirements for the insulation of outer walls. These data are linked to energy costs and various aspects of building physics, such as condensation. The solid brick wall serves as an ultimate example of an integrated, thus 'non-functional' construction. As is common practice amongst building physicists since the late 19th century, the solid brick wall is used as an easy comparison with 'modern', functionally 'differentiated' outer walls.[11] The question raised here is whether a massive brick wall, that meets the requirements for thermal insulation, would also be economical in the country concerned. Remarkably, the answers given by the various municipal building authorities in the Netherlands are totally contradictory to each other, but the editors respond negative.
The fourth part deals with the economical and domestic aspects of thermal insulation. The economical aspects concern the determination of the price of various fuels, related to the labour costs for bricklayers. The other

enquête

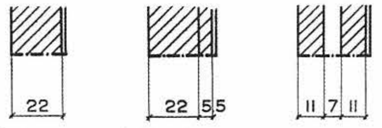
functionele buitenwanden

vragen — antwoorden

I. hier te lande gebruikelijke wandconstructies
(ter vergelijking met constructies in andere landen)

1. Worden in uw land door gemeentelijke verordeningen of door Rijks-instanties eisen gesteld inzake een maximum warmte-doorgangsgetal (k) voor woonruimten? — Neen.

2. **Wat is de gebruikelijke wanddikte van baksteenmuren? (in cm)** — Voor buitenmuren 23 cm, 28,5 cm en 30 cm (zie schetsen).



3. Beantwoordt deze wanddikte aan de voorgeschreven minimum eisen der warmte-isolatie? — Er zijn geen voorschriften (zie vraag 1).

First questions and answers from the Dutch results of the CIAM Inquiry; *De 8 en Opbouw*, 1939.
It reads as follows:

I. usual wall constructions in your country
1. Q. Are there in your country technical regulations about a maximum heat transmission value (k-value) for dwellings, prescribed by municipal or state authorities? A. No.
2. Q. What is the usual thickness of brick walls (in cm)? A. for external walls 23 cm, 28,5 cm and 30 cm (see sketches).
3. Q Do these wall thicknesses respond to official regulations about minimal heat insulation? A. There exist noregulations (see question 1).

paragraphs survey financing models, maintenance, fire regulations and insurance.
The fifth chapter inquires after the scientific researches carried out to survey the connection between initial investments and running costs over a longer period, including maintenance, repair and energy cost.
Construction materials are the subject of the sixth chapter, that rows a variety of materials and their prices related to the costs of brickwork. Comparing the results in the various countries in their answers to the questions in the seventh chapter would be very interesting for us, since this part tries to map the possible co-operation between designers and the industry. Also the experimental housing projects executed in the respective country are listed here. The last chapter deals with the practical experiences with 'modern' construction in the country concerned. The CIAM groups are asked to answer the related questions individually for each interesting building in their country, which would have provided an interesting catalogue of 'peer reviewed' buildings of the era.[12]

For our analysis, it may be rewarding to study the questions raised in this last chapter. Some of the queries are obviously aimed at a confirmation of the advantages of 'dry' assemblage of prefabricated components over traditional 'wet' building methods. For instance, the change in thermal performance over time and the suspected interrelation with the amount of water used when constructing the wall and its present absorption capacity, is extensively questioned.
There are critical queries about the occurrence of deviations between calculated values, for instance for surface temperatures, and the performance as measured in the completed building. This may have to do with the recording of such differences to serve further scientific research on building physics, as performed for instance in German laboratories since the late 1880s[13], in order to improve calculation methods.

From the Netherlands' publication can be learned that the results of the international inquiry were to be compared and published later. The list of functional outer walls, as required in the last question, was to be presented in a uniform style of drawing, obviously with the idea to publish them. With the Dutch publication dated September 7, 1939, I assume the outbreak of World War II a few days later prevented this work being done.

Buildings and systems

A primary conclusion that appears from my survey of original publications of the Modern Movement in the Netherlands is that these architects were much more concerned about the balance between the construction of a building and the related service systems than is mostly assumed. As a matter of fact, these installations were of great interest to many of these architects - who preferred to coin themselves building engineers rather than designers - as proper knowledge of ventilation, heating and cooling systems was decisive in designing light, open-plan or even semi-open-air buildings for our climate.[14] Unfortunately, research on the historic development of such systems is so far equally limited as surveys on the development of building physics in general, and again we have to rely largely on period publications like *De 8 en Opbouw*.

From some of his 1932 publications we can see that Jan Duiker was not in favour of leaving the interior climate of buildings exclusively to the heating engineers, since they lack an integrated vision. He argues that their analysis of building constructions is limited to heat transmission and therefore, in their view, large windows, that were essential to the modern living and working environment, are only a source of energy loss. According to Duiker, insufficient account is taken of the side effects of ventilation, and the favourable solar gain in winter through the large glass surfaces that allow the light waves in, but capture the resulting heat radiation. The latter point is related to Duiker's concern that the effects of radiation are generally disregarded, including also the negative aspects of heat radiation in summer.[15] He is backed up by the heating engineer J.J. De Ridder, with whom Duiker developed several interesting prototypes of innovative heating systems not much later, like the patented hot-air system for the 1934-1935 *Gooiland Hotel*.[16]

De Ridder also argues that the calculations by heating engineers disregard the differences in transmission between dry and humid walls, whereas a 30 % reduction should apply. Also De Ridder promotes the idea of the differentiated outer wall, with a separate layer of dry insulation material, which can be achieved by the introduction of an air cavity. Remarkably, he points at a difference between Holland, where such cavities are ventilated in order to achieve a dry environment, and Germany, where the air layer is stationary in order to increase the insulation performance. Employing German calculation methods and parameters, Dutch calculations often disregard this difference and value the insulation performance too high.[17]
It is interesting to see how Duiker, in his 1934 design for Gooiland Hotel in Hilversum, introduced a double brick wall, enclosing a cavity indeed without ventilation. The humidity risk was to be mastered by a waterproof outside cladding of glazed tiles. The fact that humidity problems may arise from damp that migrates from the interior and the consequent condensation inside the wall may have been insufficiently understood. Together with poor maintenance of the joints in the tiled surface, this has caused severe corrosion of the structural steel frame that is locked between the inner and outer brick wall, and the consequent spalling of the tiled outer wall.[18]

Light or heavy?

An interesting argument in the columns of *De 8 en Opbouw* is started by De Ridder in 1932, when he promotes large glass surfaces to *improve* heating efficiency due to reduced heat accumulation in heavier walls. In apparent contrast to the ideas of his Polish colleagues, he considers heat accumulation as a main reason for energy loss, as it slows down heating up in the morning and saving it until after hours. At the time the effect of heat loss through glazing was well recognised, and even used by critics of the Modern Movement to object large windows. But according to De Ridder, the reduction of heat absorption levels by increasing the glazed surface would make the heating of such buildings still more efficient.
In further editions of the magazine, De Ridder explains various calculations theories and methods, considering heat transfer by conduction, radiation and convection, and

taking account of the side-effects of joints in window frames, promoting double-rebated window frames. The exercise between architect and engineer comes to a conclusion in the 1933 volume, with a further elaboration of heat transmission through glass. Probably his most fascinating remark is that the issue whether glass should be considered as a *medium*, like air, or as a *body*, is still undecided at that point.[19]

As a matter of fact, the above chain of reasoning regarding heat accumulation is not without problems. A low level of heat absorption indeed will allow a room to heat up more quickly but at the same time, the heat loss through the large window would also increase energy consumption. Additional research would be required to understand the obvious interrelation between these two phenomena but, at least in the Netherlands, light constructions are promoted for exactly the reason that De Ridder mentions. This may explain the broad interest in heating systems that are based on radiation and hot air. What seems to be largely overlooked, however, is that the appropriateness of heat accumulation may vary depending on a building's usage, i.e. whether it is in more or less permanent use, like dwellings or hospitals, or only at wider intervals, like schools or churches.

In order to balance these aspects, an integrated design approach would be required, taking into account the building's usage, its building parts and constructions as well as systems in order to master the interior climate of buildings. Some architects were quite well aware of this, and building physics were seriously studied by Duiker, Wiebenga, Van Loghem, Limperg and some others, most of whom were also members and editors of *De 8 en Opbouw*. Although identified as 'a great triumph in building construction', Van Loghem warned his collegues in his 1936 handbook 'that the elimination of the load-bearing function true eliminated one problem, but that the requirements of "Het Nieuwe Bouwen" on the other hand created at least ten new problems'.[20] He suggests that the main reason for his publication has been the lack of knowledge among most 'modern' architects, that were therefore insufficiently able to cope with the technical problems that had been introduced by the Modern Movement in the first place.[21]

In view of this, also the publication of Syrkus' paper for the Athens CIAM Conference in the 1934 volume of *De 8 en Opbouw* must be regarded as a strong promotion for an integrated approach. These innovative concepts are continuously brought up in the entire series, for instance in the critiques published in 1936 on the Doldertal apartments in Zürich by Afred and Emil Roth and Marcel Breuer (1932-36), and again in 1938 on the Kralingseplaslaan Flats, a residential high-rise in Rotterdam by Van Tijen and Maaskant (1938).[22]

Functional façade constructions

From the pages of *De 8 en Opbouw* we can sense the great and continuing interest of the architects of the Modern Movement in the concept of the functionally differentiated outer wall throughout the 1930s. In the 1933 edition for instance, Le Corbusier's Swiss Pavilion (Paris Cité Universitaire, 1930) is extensively covered. The remarkable façade of this building consists of perforated brick, of which the tiny channels with stationary air provide thermal insulation, with a cavity on both sides that is apparently unventilated. The outside is clad with 40 mm cast stone panels, while the inside is covered with 30 mm heavy plywood sheeting.[23]

As an interesting feature of this building is also mentioned the sound absorbing partitions between the rooms, which are made of 'Treetex' panels, with a cavity on both sides.[24] The dividing wall is then covered with asbestos-cement panels that are mounted with sound-absorbing felt strips and screws in rubber sockets against a light timber frame. The construction is designed to 'convert sound waves into heat', thus to absorb airborne sound.[25]

Most other façade constructions that are published represent two different principles. The first type concerns 'functionally differentiated' façades without an air cavity, mostly with an outer wall of brick or perforated brick, rendered on the inside with cement plaster, and an interior wall of pumice-concrete block set right against it, which is than finished on the inside with plaster.[26] Other examples include the Amsterdam Quinine Factory by Joh.H. Groenewegen of 1932, which involves a 80 mm concrete outer layer, covered on the inside by plastered 50 mm Heraklith panels, and the Parklaan Flats by Van Tijen, completed in 1933, featuring a perforated clinker outer layer, with a waterproof rendering on the inside, and a pumice-concrete inner layer finished with plaster.[27]
The majority of published examples however involves 'functionally differentiated' façades with an air cavity, including[28]:

- the *Canneel-Claes House* in Auderghem, Belgium, by L.H. De Koninck (1931), with an outer wall of metal mesh with shot concrete on both sides, the outside finished with stucco, and a 60 mm pumice-concrete inner wall, finished with plaster;
- the *Sonneveld* and *Bouvé* Houses by Brinkman and Van der Vlugt in Rotterdam (designed 1929-1932 respectively 1931-1932, both completed 1933), both with a stuccoed brick outer wall, rendered on the inside and then sprayed with asphalt, with an interior wall of 'aerocrete' panels, respectively brickwork, and finished with plaster;
- the *Bergpolder Flats* by Brinkman, Van der Vlugt and Van Tijen in Rotterdam (designed 1932-1933, completed 1934), with galvanised steel sheeting, a cavity and an inner wall in pumice-concrete block, which 'forms a thermal buffer, improving the equability of the interior climate';
- the *Montessori School* by Van Tijen in Amsterdam (designed 1933-1934, completed 1936) featuring brick clinker with silicate paint, a cavity, and a rubber-coated 90 mm pumice-concrete block inner wall, finished with plaster;
- the *Gooiland Hotel* by Duiker and Bijvoet in Hilversum (designed 1934-35, completed 1936), with an outer wall of brick, finished with glazed tiles, a non-ventilated cavity, and a light-brick inner wall, finished with plaster; and
- the *Kralingseplaslaan Flats* by Van Tijen and Maaskant in Rotterdam (designed 1936-1937, completed 1938), which has timber fronts with galvanised sheet metal or wired glass, an air cavity, a rubber-coated inner wall of 90 mm pumice-concrete block, finished with plaster.

Functional roof constructions

As a principle, the flat roof is promoted in various essays that were published in the Netherlands over the years, following Le Corbusier's writings and other foreign publications. Traditional pitched roofs are perhaps most strongly rejected by Koen Limperg in the 1933 edition of *De 8 en Opbouw*.[29] He argues that, by lack of cross-ventilation, heat accumulation under pitched roofs cause the attic floor to work like a radiator panel in summer. Further ideas about the construction of functional, thus flat roofs largely follow the theories about the 'functionally differentiated' façades. This appears mainly from the critiques published on reference projects such as the Neubühl housing scheme in Zürich in the 1932 edition.[30] An interesting example appears in 1940 with a publication on Van Tijen's 'Agatha Home'.[31] The roof of this summer camp dormitory involves a double air cavity, the outer one ventilated, and the inner one with a stationary layer of air, combining best of both worlds. Both cavities are separated with by an air-tight layer of coconut-fibre reinforced gypsum board. The ceilings are additionally insulated with glass wool to avoid heat radiation into the dormitories. Such double cavity constructions have so far not been found for façades in Dutch buildings.

RESTORATION AND ADAPTIVE RE-USE

The 'unbearable' lightness of building

The second part of my paper addresses the challenge of restoration and adaptive re-use of some noted 'modern' buildings, including the upgrading of their skins in terms of building physics. If we accept the idea that, in principle, every building can be restored (either by conservation, reconstruction or any other way of preservation) to its original state, including the related performance level, the first question is why such upgrading is necessary in the first place. On close inspection, the demand for upgrading results from changing requirements rather than a decline in performance of the structures themselves. In terms of architectural conservation, it is important to realise that even when a building is in a good condition, or can be easily restored to that state, change is sometimes difficult to avoid. This can be explained as follows.

If, at a certain moment in time, the performance characteristics of a building meets the performance requirements, we may conclude that a building performs well. Ill performance occurs when the two do not match, which must be attributed to design or construction failure if this happens shortly after completion. Later on, it may be the result of decay of the building itself, for instance when water penetration causes defective insulation materials. In such a case the degree of failure may also increase over time. The other reason for ill performance may be that the requirements themselves have been set at higher standards. As we all know, since the 1930s this has been the case in all Western countries, most notably regarding the energy performance of our buildings in response to the first energy crisis in the 1970s.
In spite of the decline of global energy resources, our own standards of comfort are slowly rising as well. Shortly after the Second World War, design temperatures for a living room or office space were about 18° C and people were used to adjust their second skin by wearing a sweater or a winter suit. Today design temperatures of 21-23° C are common and people are used to wear light clothing also in winter. No wonder that, even when a well-designed 1930s or even a 1960s building is in perfect condition, it will no longer match the performance requirements for the same usage today.[32] Obviously, such failure can not be attributed to poor design or construction, so we have to be very careful not to blame the building or the architect too easily.
Even in restoration practice, it is not self-evident for a client to accept a substandard building, may be with the exception of a private house for an *aficionado*. In most other cases, the match between the requirements and the performance of such buildings has to be re-established, either by changing their usage or improving their performance. As the first option typically requires a downgrading in economic terms, it is mostly the building that will either have to change or be demolished and replaced. In other words, for their present users, the effects of the lightness of these buildings have become unbearable.

Fundamental adaptive solutions

In the previous paragraphs, a series of buildings with relatively light façade constructions have been presented. When such buildings are encountered with adaptive re-use and upgrading in mind, there are three principle strategies to improve the hygro-thermal and/or acoustic performance of a façade:

- the upgrading of the envelope itself;
- adding a secondary skin on the inside; or
- adding a secondary skin on the outside.

Again, their success will also depend on the improvement of the climatisation and ventilation systems. If the hygro-thermal and/or acoustic upgrading of a building would *solely* depend on interventions in the building substance, i.e. the construction and materials of its outer shell, the required alterations would be so disproportionate that - if possible at all - any listed building would probably loose its historic integrity. The reversed strategy, i.e. trying to solve the problem *only* by introducing climatisation systems such as full air-conditioning wouldn't work for most historic buildings either. Apart from the physical damage that will be necessary to fit in the excessive amount and dimensions of ducts, the introduction of climatisation systems would probably cause serious damage due to uncontrollable condensation.
An interesting case study in this respect is the *Groot Handelsgebouw* in Rotterdam, a large scale wholesale centre designed by Maaskant and Van Tijen in 1944-48 and completed 1951. In the late 1990s, this 128.000m^2 building had been upgraded solely by adding full air-conditioning systems at the expense of the building itself. Since air was used as a medium for heating and cooling, the necessarily bulky ducts seriously compromised the building's original interior integrity, while enormous air-conditioning units were placed on the roofs. In 2001, Van Stigt architects intervened and developed a much more balanced strategy. The façades were upgraded by installing very light sun-reflective insulation glazing and restraint thermal insulation of the concrete parts. The climatisation systems' performance requirements could thereby substantially decrease. In addition, by choosing a system that employed water as a medium, the systems

could be dramatically reduced in dimensions. Finally, the heating and cooling plants were removed from the roofs and relocated in the basement.[33]

When considering the three above strategies within the perspective of the design concepts of the 1920-30s, it occurs that the double-skin solutions actually comply with the concept of the functionally differentiated outer wall, and even take it to an extreme. Of course the three above strategies do not exclude each other and may be combined. But, starting with the last one, let's first have a closer inspection of their merit.

I. Secondary skin, outside

The addition of a secondary skin on the outside involves the construction of a new, mostly light façade around the existing volume. In order to allow for sufficient daylight and fresh air, the secondary skin is often glazed and with operable vents. In case of common structures this concept may work nicely to provide a new image for a building, without loosing rented floor space.

The secondary skin may even be constructed without disrupting its continued usage. No doubt, the overall energy and acoustic performance of a building will benefit from a double-skin envelope, whether the secondary façade is inside or outside, as it allows for many of the advantages of the 'active envelope' concept.

In case of historically significant buildings things are more complicated, as the architectural qualities of the façade may remain hard to perceive and hence, the design authenticity of the structure may be seriously compromised. Still, this concept could be an option when the outside façade represents a greater value by its material authenticity then by its design authenticity but, at the same time, is exceptionally vulnerable to climate conditions and needs integrated protection to save the physical substance. It may also work when the historic value of the outside of the building is relatively insignificant as compared to the interior. But to my mind, the concept of adding a secondary skin on the outside is not an obvious solution for listed buildings. As I haven't seen any successful restoration example so far I will not discuss this as a restoration strategy in further detail.

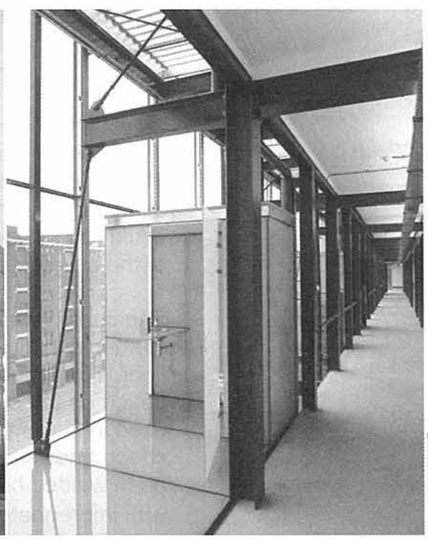
Examples from practice

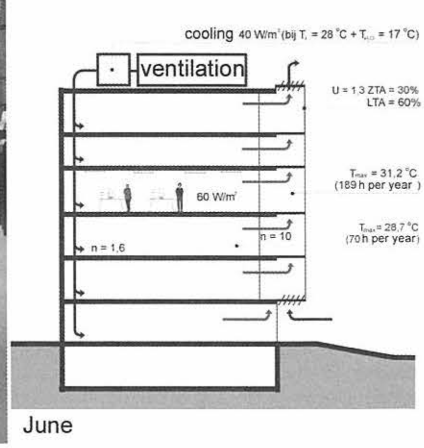
That does not mean that this type of intervention cannot lead to interesting architectural solutions in case of buildings that may not be listed, but that may be kept for other good reasons. A good example may be the 25 kV building in Rotterdam by architect Robert Winkel. An old electricity converter station has been transformed into studios for the graphics and media industry by adding a shallow glass volume with corridors, stairs, sanitary facilities and pantries against the old structure, also bringing life to the outside. In case of listed buildings this idea can still be valuable if one realises that one may avoid further interventions in the building itself to fit in such obligatory functions for public use.

Probably better known is the SUVA Insurance building in Basel by Herzog and De Meuron, where a strong architectural concept guided the refurbishment of the façades. The existing building can be described as a modest example of 'solid' 1950s corporate architecture with well designed sandstone façades, that did no longer reflect the company's present views. When an extension had to be designed, the architects decided to cover old and new with one single envelope. I imagine that the desire to change the image of the existing structure has been leading in this project, but it's a pity that the sandstone relief sculpture at the corner has been rendered almost invisible.

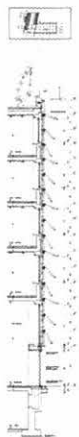
II. Secondary skin, inside

Adding a secondary skin on the inside may be possible if the existing façade can continue to withstand the climatic





The 25 kV building, a former power station in the Rotterdam harbours, was transformed into offices and studios for new media by Robert Winkel of *Mei architecten en stedenbouwers*. The position of the secondary glazing has been chosen so as to create an additional zone for corridors with meeting points, toilets and pantries. Photos: Luuk Kramer. Diagram of the climatisation principle for the 25 kV building, as it functions in the summer. Drawing: *Mei architecten en stedenbouwers*, Rotterdam.



The SUVA building in Basel, Switzerland, with its characteristic sand stone façade, before the intervention. Photo: unknown.

The SUVA building after extension and intervention by Herzog & De Meuron (1988/93) is a rare example of an external secondary glazing. Photo: Hisao Suzuki. Detail of the façade relief in sand stone, now hidden behind the secondary glazing of the SUVA building. Photo: Wessel de Jonge. Principle section of the double façade. Drawing: Herzog & De Meuron architects.

conditions or can be restored to do so. Typically, it involves the internal construction of a new, mostly light façade at some distance to the original outer wall. As the original façade continues to counter primary rain, wind and noise attack, the second skin can be designed just to comply with the other performance requirements, so that fewer requirements apply to both. In order to allow for sufficient daylight and fresh air, the secondary skin is often glazed. Ventilation may either require particular features in the secondary façade, or extensive climatisation. Again, the double skin can be designed as an 'active envelope' with all the related advantages. Although mostly less energy-efficient as compared to the addition of an external skin, this concept is more suitable to retain the essential qualities of the façades of historically significant buildings, since both the design authenticity and the material substance of the structure may be respected to a large extent. It works best if the outside façade represents a great historic value while, at the same time, the interiors are of relatively modest importance or less unique. The disadvantage of loosing valuable space in the interior may be countered by smart interior arrangements.

It is obvious that a double-skin - either inside or outside - may work for larger, (semi-)public or commercial buildings, and sometimes even for apartment blocks, but not for individual and specific objects like a private house. A by now well-known example of an added secondary façade on the inside is the conversion of the Van Nelle factories in Rotterdam. As a result, the outside of the buildings could be kept and carefully restored, using similar materials as originally used.

The Van Nelle 'Design Factory'

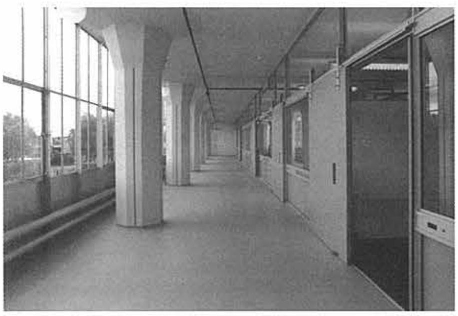
The tobacco, coffee and tea factories of the Van Nelle company, designed between 1925-1931 by Brinkman & Van der Vlugt, and completed in various stages between 1928-1931, are amongst the most remarkable examples of Modern Movement architecture in The Netherlands.[34] They are emblematic for the fascination with rational planning, 'modern' architecture, industrial efficiency and marketing as seen in North American examples, that was shared between client Kees van der Leeuw and the architects. The American 'daylight factory' was a main source of inspiration, which lead to the use of a concrete construction with 'beamless floors', making use of mushroom columns, flat floor slabs and hence flush ceilings, and a steel-and-glass curtain wall.

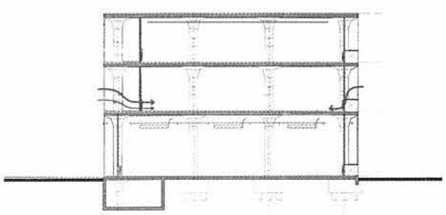
By placing the mushroom columns off the perimeter of the floor slabs, a reduction of static moments was achieved. The zone between the columns and the façade could be used for systems and conveyors. Also, the curtain wall could run smoothly and uninterrupted over the full height of the buildings.

The curtain wall consists of self-supportive façade elements in zinc-sprayed steel, that span from floor to floor. The proportioning of the façade fronts is entirely based on the standard size of glass panes as they were used in Holland's green houses, which were therefore cheap and readily available. Double steel sheets have been welded between standard steel sections, and filled with impregnated peat to create a spandrel.[35] The units were finished with oil-based aluminium-paint. The buildings were heated by steam that was produced in the boiler house on site and then transferred to tubular radiators in the various buildings. Also the machines

The glorious 1928 Van Nelle factories after restoration in 2004. According to the 1999 master plan by Wessel de Jonge architects, special care was given to retain the original façade fully intact. Photo: Sybolt Voeten.

The secondary glazing at Van Nelle sits at a distance from the original façade, creating a semi-climatised corridor in the cavity between them. Photo: Fas Keuzenkamp.
Diagram of the climatisation principle for the Van Nelle Design Factory. Natural air supply is allowed through the automated windows in the west façade (right), through the climate-regulating wall and acoustic inlets in the secondary glazing, to enter the work spaces where a mechanical exhaust system creates an under-pressure. Exhaust ducts are inserted in the 100 mm topping on the concrete floors. Diagram: Claessens Erdmann architecten, Amsterdam.
The interior of a design studio at the Van Nelle Design Factory after intervention. The separations are always glazed where they meet the ceiling or the original facades, in order to retain the spatial characteristics of the original buildings. Photo: Sybolt Voeten.





produced a considerable amount of heat. In summer, excess heat was carried off by cross-ventilation through the vertical pivot-windows. American sunshades made of aluminium-sprayed wooden slats controlled solar gain.

Adaptations

Due to a quite exceptional level of maintenance performed until then, the condition of the original façade elements still allowed for repair, grit blasting and repainting during a first large-scale refurbishment operation around 1990. In 1998, the 60.000 m^2 structures have been acquired by a property developer to transform the complex of buildings into the Van Nelle Design Factory aiming at small and medium-sized companies operating in the creative industries. Our office has been charged with the master planning and supervision over the complete works.
The outside of the buildings has been carefully kept intact by large-scale maintenance and repair of glass breakage with (drawn) sheet glass, as still used in green house construction. Within this authentic envelope an infill has

been conceived in order to secure proper indoor conditions in terms of hygro-thermal aspects, ventilation, as well as sound and fire proofing, while retaining the original appearance of the structure almost completely. With the aim to create appropriate workspaces the principle of a double façade has been proposed by project architects Claessens Erdmann from Amsterdam, introducing secondary glazing on the inside.

The infill has been designed so as to maintain the transparency of the building as much as possible. The new partitions parallel to the façades, made of custom-designed aluminium profiles, are fitted with various types of glass. Partitions between the rented units are still transparent above door height, and never meet the original façade. By leaving the ceilings and characteristic mushroom-shaped column heads untouched, the spatial qualities are still perceptible.
At the shadow-side, the secondary glazing is located at distance from the original façade leaving enough space for corridors. At the sun side the glazing sits between the columns, corresponding with the position of the original sunshades, creating a climate-regulating wall. Solar gain is caught in between, as is the noise from the nearby railway.

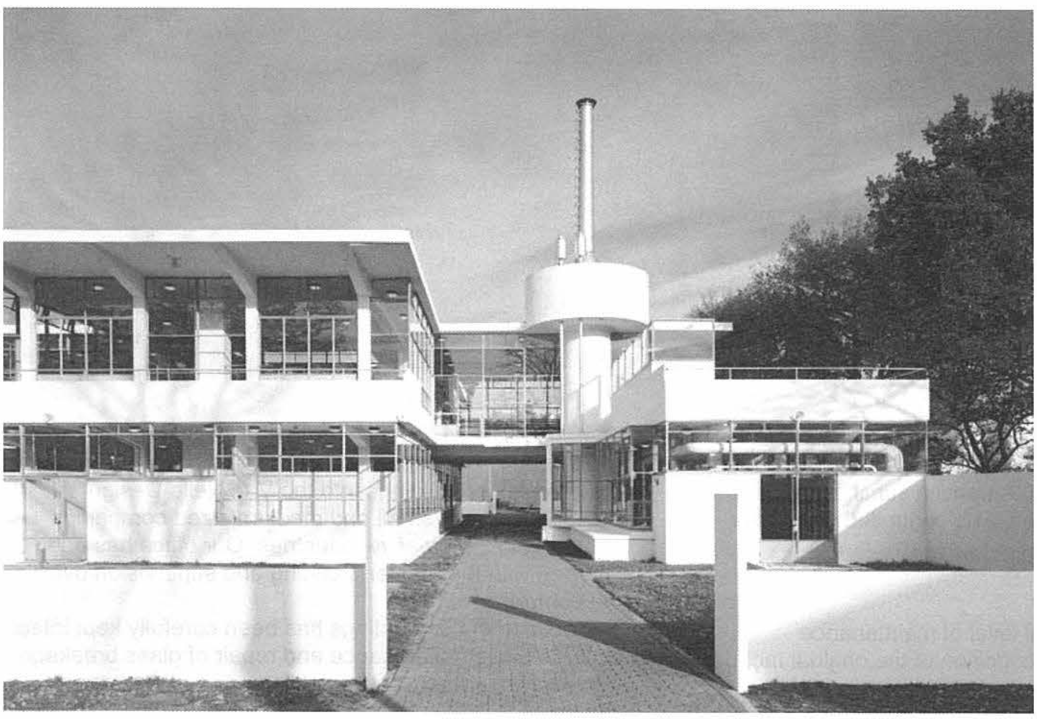
Natural air supply is allowed through the automated windows in the façade, through the climate-regulating wall and acoustic inlets in the secondary glazing, to enter the work spaces where a mechanical exhaust system creates an under-pressure. Like in the past, all ventilation ducts, piping, and data systems are accommodated in the zone between the columns and the façade, and further distributed through the topping on the concrete floors. Steam heating is presently no longer feasible and the original tubular radiators are now filled with hot water to heat the corridors. As the efficiency of hot-water heating is much lower, additional heating radiators and fan-coil units have been placed in the rented units. Thanks to the improved thermal performance of the doubled façades, the heating capacity is sufficient to reach the design temperature of 23□C. Due to the secondary glazing, cross-ventilation is no longer possible and cooling is provided through the fan-coil units in summer.

Before the secondary glazing was finally agreed, extensive tests were performed to minimise the effects of double reflections. The impact of the interventions towards the outside has been carefully orchestrated, including even the effects of the new lighting fixtures. As the original opaque balloon light fixtures had all been lost and would have created glare in the monitor screens, a standard fluorescent lighting fixture produced by Zumtobel has been modified so as to recreate the original lighting conditions without compromising their performance in terms of contemporary use. The potential tenants accepted a general light level of 200 lux. Some salvage (but not original) opaque balloons, sufficed for the corridors and the staircases.

In order to maintain the strong image of the building intact for the benefit of all tenants, guidelines have been defined as regards some aspects of the interior fittings and the positioning of high furniture. However, the attraction of this powerful machine excites enough enthusiasm with the tenants to compensate for these limitations.

III. Upgrading of the envelope

In contrast to what many are inclined to think, the upgrading of the envelope itself often requires more radical interventions than the previous two strategies. Mostly, it implies that the existing façade will have to be changed to quite an extent, including some of its most characteristic features, or replaced altogether. In an effort to still match with the original features of the façades, complicated solutions may result in high expenses. Typically, it involves the replacement of the original glass panels by insulated glazing units, which often requires the



The 1928 *Zonnestraal* sanatorium, Hilversum, after restoration in 2003, evidently showing the lightness of this transitory structure. Photo: Sybolt Voeten.

original window frames to be replaced as well. Blank façade areas may have to be insulated and clad or plastered, either from the outside or the inside, thereby loosing the original surface finishes. This approach may be an option in case the original materialisation of the façade has gone lost already, or when the material aspects of the building are regarded of less importance than the conceptual and/or spatial qualities.

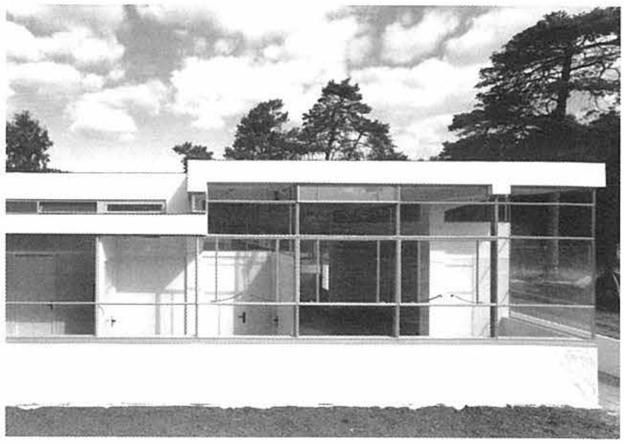
The choice to follow this strategy is mostly made in order to retain the historic value of an object by respecting the original design intention. It is true that both double-skin solutions seem to compromise the design authenticity to a greater extent. Quite paradoxically, in terms of material authenticity, the opposite mostly appears to be true. Still, the majority of restoration works so far have been based on this strategy, and there is a range of examples available to be reviewed. As mentioned before, the 1951 *Groot Handelsgebouw* is an interesting example that sets a standard for the rehabilitation of historic commercial buildings. The restoration and adaptive re-use of the 1928 *Zonnestraal* Sanatorium surely is a more radical example that took place within a less commercial context. It is presented here as it allows me to draw from our own experience.

Zonnestraal Health Care Centre

Jan Duiker's Sanatorium *Zonnestraal* in Hilversum has arguably been one of the most clear cut demonstration of the vanguard philosophy of the Modern Movement in architecture in The Netherlands. It was conceived between 1926-27, and built between 1927-28 with a second pavilion completed in 1931, in co-operation with Bernard Bijvoet (1889-1979). Quite significantly, structural engineer Jan Gerko Wiebenga (1886-1974) was involved with the design of the Van Nelle at the same time.[36] Albeit partly, with the first stage of the restoration completed in 2003 the great value of Duiker's work is now again attainable to the expert community as well as the public at large.

Based on a solid belief in Science and Progress, the sanatorium was established in the conviction that tuberculosis would be exterminated within thirty to fifty years, and the building was designed not to last beyond that period.[37] Duiker managed to subtly balance user requirements and technical lifespan with the limited budget of the client, creating a structure of breathtaking beauty and great fragility at the same time. Hence, we are faced with the conservation of a structure that was intended to be transitory. It is clear that the restoration of his buildings poses great challenges in both conceptual and material terms as, in such cases, the idea of transitoriness must be understood as part of the original design intention.

A rigorous distinction was followed out between load bearing structures and light infills, in order to allow for maximum flexibility. Related to the idea of varied lifespans was the introduction of prefabrication for building components, since it allowed the easy replacement of deteriorated or malfunctioning parts, as well as later adaptation to respond to functional change.



The only remaining section of the original 25 mm steel framed windows was relocated to an area where single glazing would not disturb the functional re-use of the building. Photo: Sybolt Voeten.

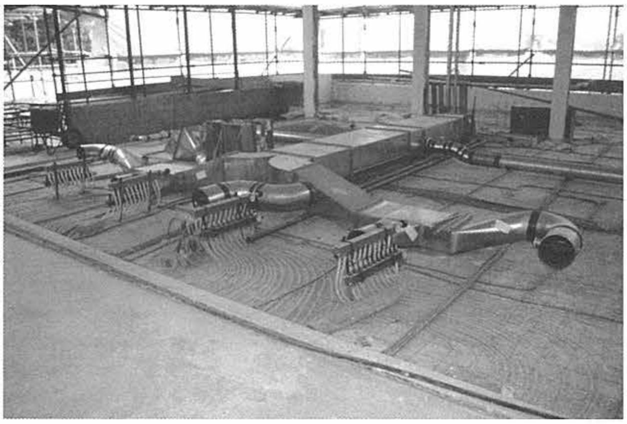
Industrial technologies

Our preparatory research showed that *Zonnestraal* has been a test ground for new and experimental building technologies.[38] Though aimed at industrial mass production and the dry assemblage of prefabricated building parts, most solutions that were actually adopted in the main building still involve hand-made prototypes, with all the related problems and failures. Remarkably, Duiker had the opportunity to improve on some of the technologies applied in the main building and first pavilion of 1928, when completing the second pavilion in 1931.

The main building of 1928 involved a prototypical curtain wall, consisting of individual window units made of 25 mm steel profiles, mounted on site against vertical steel posts IPE 8 that ran between the floors. The 25 mm deep window profiles were so shallow, that the 1.50 m wide top hung casements were too unstable to avoid early glass breakage. When the other pavilion was finalised in 1931 these shortcomings were countered by choosing a stronger 40/42 mm profile series, introducing side hung casements of much smaller size.

Another example of improvement was the construction of the parapet. In 1928, steel mesh was fixed between the steel posts under the windows. After the lower half of the mesh was covered on both sides by several layers of cement plaster, the upper half was folded inward to create an inner skin by plastering the interior surface. A similar technique was used for the partitions.[39] As a matter of fact, this had nothing to do with dry assemblage but a lot with the desire to create an abstract, pristine surface. The parapets of the 1931 *Dresselhuys* Pavilion on the other hand involve prefabricated spandrel panels made of clay wire mesh and 6 mm steel reinforcement bars, again plastered by several layers on both sides until 50 mm thick. By welding the ends of the rebars against the IPE 8 posts, the panels were fixed vertically.

The sanatorium was transformed into a general hospital in 1957, just before it reached the end of its predicted life. As a result, numerous extensions were added, and wooden barracks were scattered all over the estate, compromising the serene clarity of the original lay out. The main building



Ventilation ducts and floor heating/cooling equipment to climatise the main hall upstairs were later concealed by the reconstructed podium. Photo: Wessel de Jonge architects.

was also extended, the interior arrangements were radically altered, almost all the partition walls were removed, the slender steel framed window casings were replaced by wide aluminium ones with double glazing and the colour scheme was changed.

Function follows form ...

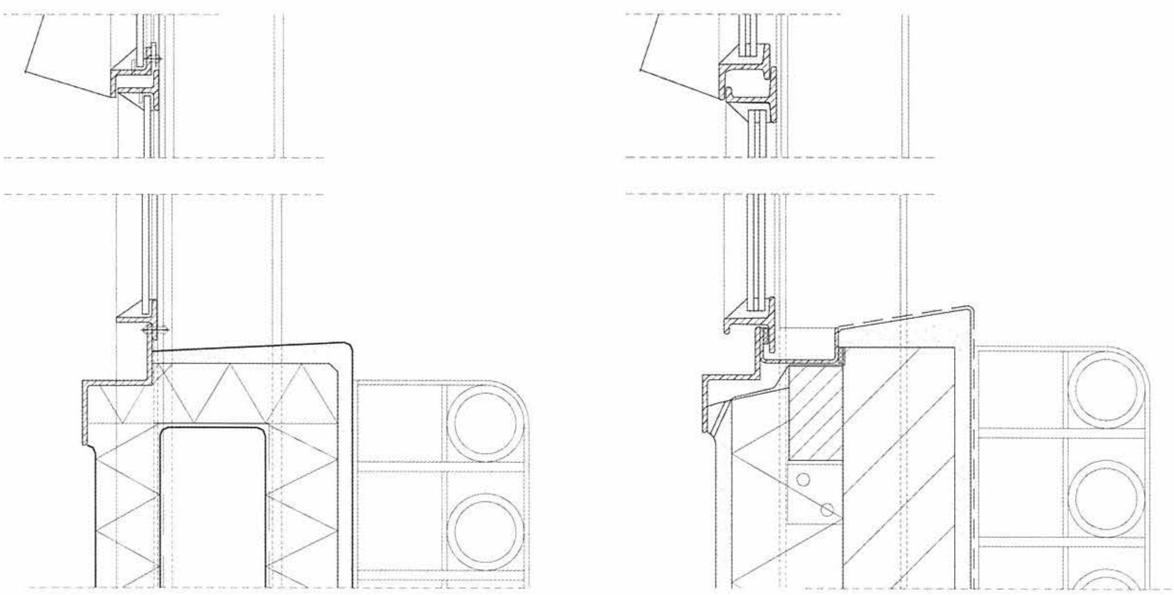
Since 1995, a new set up as a health care centre has been developed into a master plan for restoration and extension of the original ensemble by Hubert-Jan Henket architects and our office, in co-operation with the landscape architect Alle Hosper.[40] The main building was actually restored from September 2000 to July 2003 and so far accommodates a sports injuries' rehabilitation clinic and a conference centre in the main hall upstairs. The original interior lay out was largely compatible with the new functions required.

A particular challenge has been, that these buildings have been designed at a time when the energy performance of buildings was quite differently considered as we are used to since the energy crisis of the 1970s. This is even more the case since *Zonnestraal* has been designed with a user in mind who advocated to keep all windows open at all times, also in winter. Despite efforts to improve the performance of the buildings in energetic terms it has been obvious right from the start that present requirements can never be met without totally destroying the essence of *Zonnestraal*.[41]

As a result, the comfort level inside will be hardly fair according to present standards. Rather than trying to change this against all odds, we proposed to look for a new and appropriate use that could comply with these facts. Matching form and function reminds of Duiker's efforts when designing the buildings 75 years ago. But Louis Sullivan's credo 'form follows function' that was adopted by the Modern Movement as a guideline, has now been reversed. Given the conceptual importance of the climatisation systems, we have tried to restore the most essential elements of the installations like the tubular heating radiators. In view of the excessive cost for these replicated heating bodies, their installation was limited to the most public areas, i.e. the corridors and the main hall upstairs. Since the original radiators were fuelled by steam and their replicas by hot water, additional floor heating was applied for the single glazed main hall. Together with sun-reflective curtains, solar gain is largely compensated by switching the floor heating to cold water in the summer, with an additional system to provide cool air from under the podium structure. In doing so, a climatising system according to present standards could be inserted to ensure a pleasant indoor climate around the year without compromising the fragile transparency of the original building.

Curtain wall

Apart from a section that could be reconstructed from salvage material, the façades have been built up from new, steel framed window casements. As the shallow 25



Comparison of glazing details before and after the restoration of *Zonnestraal*. Only workspaces have been fitted with double insulation glazing, featuring drawn glass outer panels. Drawing: Wessel de Jonge architects.

mm profiles of the original casements could not hold double glass and the initial stability problems had to be avoided, the new units have been made of slightly heavier 37 mm profiles. These are similar to the 'improved version' of 40 mm that Duiker used himself in the 1931 pavilion, but still a bit more slender.

Being nothing more than a concrete frame with a transparent membrane enclosing it, this building required serious efforts to find types of glass that would allow to perceive the original building as closely as possible. Sheet glass as used for *Zonnestraal* was slightly rippled, producing vertical distortions, which was essential to the vision and reflection qualities of the state-of-the-art curtain wall of 1928. Moreover, the colourless glass of the 1920s, made of low-iron sand could only be found at reasonable cost in the new member states of the EU. For *Zonnestraal*, colourless sheet glass was eventually imported from Lithuania.[42]

Single glass has been used again in spaces that did not require careful climatisation, such as corridors and staircases. Also the spacious main hall upstairs is single glazed, as its size allows people to move away from the glazing sufficiently not to be affected by cold draughts. As the cross shape of the hall easily allows for sight lines through four layers of glazing, the issue of glass colour has been particularly essential here.

Double glazing

For the workspaces, single glazing was not acceptable and a sophisticated solution for double glazing was designed to meet the required conditions. As double and single glazing would be applied right next to each other it was particularly important to reduce any differences in appearance. Therefore we wanted the Lithuanian glass for the outside pane.

To avoid any colouring of the double glass unit as compared to the single glass next to it we had Starphire float glass imported from the US for the inside pane, which is of even more neutral colour. Very recent developments in UV-proof adhesive technology allowed the rippled Lithuanian glass to be joined with the float glass pane in a Belgian factory, using a neutral grey U-PVC spacer that was specially produced in Italy.

On close inspection, the expert eye may find the multiple reflection of the double glazing units slightly diverging from those of the single panes. But casually seen and surely from a certain distance the slightly blurred reflections from the sheet glass surface are predominant. The 11 mm thick double glazing units could be accommodated by the new window units. The increased depth of 37 mm of the steel profiles allowed for similar putty framing as found in the original single glazed section of the façade.

CONCLUSIONS

Specificity, time and adaptability

When speaking about an architecture that pursued industrial building methods and the assembly of machine produced components, one could argue that the very materials are indeed not essential. The restoration of *Zonnestraal* taught us that such an alibi can easily be false, as the restored building has produced a convincing demonstration of the paradox between the progressive and daring architectural concept, and, as it appears to us, its awkward and sometimes even naive materialisation. Understanding the original design approach appeared critical to the conservation process. Precisely Duiker's buildings and his ideas on their materialisation made us comprehend that the exposed constructions themselves are vital to the original concept.[43] Even if some of his technological innovations failed, we must be aware that the experiments of modern engineers and architects represent a historic significance of their own. Although the building's envelope has largely been reconstructed, the material truthfulness of the restored building helps us to understand what may appear to us as an anachronism of the era.

Although the *Van Nelle* buildings appear as stout and robust, primarily due to their immense scale, in fact also these glass-enclosed volumes are fragile like soap-bubbles: Their envelope may burst as soon as the balance between content and surface tension is disturbed, i.e. when the new programme is insufficiently compatible with the characteristics of the original shell.
The authentic skin of the buildings is characterised by the absence of material rather than the presence of it. And if there is little substance at all, it is almost impossible to change or add anything without disturbing the essence of the existing materialisation. Hence, the strategy of the secondary façade allowed us to respect the essential characteristics of the buildings, as well as its material authenticity.

In both cases, however, our understanding of the original concept of the 'functionally differentiated' outer wall has been helpful in the development of a successful preservation strategy for the outer shell.
But as a whole, observing the obvious differences between both rehabilitation projects, we concluded that the contrasting visions in the 1920s of how to respond to short-lived functional programs, have produced buildings that show great differences regarding their suitability for adaptive re-use. A highly specific, tailor-made 'functionalist' building like 'Zonnestraal' may not be easily adaptable to functional change and is likely to have a short functional life expectancy. With a striking example of 'rationalism' like the *Van Nelle* factories, the a-specific, neutral space could be relatively easily adapted to a new use as a centre for design studios.[44]
Such a conclusion underscores the necessity to study comprehensively the conceptual background of a building – next to the material aspects – before making decisions as part of the redesigning or restoration process. Even within the Modern Movement, various architectural concepts lead to principle differences between modern buildings, that must again lead to different approaches when planning their preservation.

History: perspective for the future

The restoration and adaptive re-use of the presented structures provides us with much more than just a renovated building that can serve another term (under certain conditions). It provides us as well with knowledge

and an understanding of the relationship between concept, form, materials, technology and sustainability over time, and the variety of design decisions that have produced some of these magnificent works.
The pioneers of the Modern Movement were confronted with the great social issues of the rapidly developing industrial society that needed to be responded with very limited means. These restrictions *inspired* them to develop a new and innovative vision and working method, aimed at functionality. However, their buildings were not only functional environments to live and work in, but were just as well supposed to *express* such qualities, as symbols of a new era.

Although at that time they had to respond to restricted financial means, in our time it is all about responding to the increasing scarcity of natural resources and the pollution of our environment. I believe that this must be taken as an inspiration for architecture today. Obviously, there are some parallels between innovative design in the Modern Movement and in our times, in defining a cultural reinterpretation of *changeability*. Then and now, temporality and flexibility in use have been key in these innovative developments, or, more conceptually speaking, in the relationship between *continuity* and *change* in architecture. The adaptive re-use of these pioneering modernist buildings may teach us to get a better understanding about the future performance of our own, newly designed structures today.

First steps for further research

However brief the above inventory and analysis of the hygro-thermal aspects of 'historic' building physics and climatisation systems may have been, some conclusions may still be drawn. First of all, it appears from my survey of original publications that many of these architects were dedicated to master building physics in order to arrive at an integrated design approach, balancing the construction of a building and the related climatisation systems. It is rather *our* lack of knowledge that makes the opposite sometimes seem true.

In retrospect, we see that the subjects that are addressed in *De 8 en Opbouw* at the level of the buildings themselves do not cover the full spectrum of building physics. The issue of room acoustics and sound insulation is rarely brought up, may be because this was less of an issue then, as compared to today.

For further research on acoustics it may be more rewarding to take Van Loghem's 1936 handbook as a starting point for qualitative considerations and a review of calculation methods. The many as-built examples that are published in *De 8 en Opbouw* may serve as guinea pigs to get a picture of the acoustic performance of Modern Movement design in the 1930s.

The process of heat transmission was well researched and understood, although calculations did not take humidity levels of the construction sufficiently into account. Noteworthy is the difference in views whether to ventilate a cavity or not. Another point of discussion is that some engineers regarded heat accumulation as an advantage, implicitly promoting the use of a certain amount of 'heavy' materials, like we find in the trial projects of the Polish *Praesens* group. Others, like the influential heating engineer De Ridder, regarded accumulation a main reason for energy loss, which may explain the 'light' constructions we often find in prewar Modern Movement buildings in the Netherlands.
At some major points, qualitative views still diverged from the practice of quantitative calculations. For instance, architects were concerned that heating engineers generally omitted the effects of radiation from heating calculations. The use of large windows, as advocated by the Modern Movement, was therefore discredited as a cause of heat loss, whereas the positive effects of solar gain were disregarded.
Also more in general, the effects of radiation were apparently not very well taken into account. We repeatedly run into articles explaining the negative impact of walls and ceilings that heat up too easily in summer and work as heating radiators, or the wholesome effects of radiation heating in spaces with large expanses of glass or open windows: Apparently, some missionary work was still necessary! This relates to a fascinating yet largely unexplored field, which is the many innovative heating systems that were developed at the time. This is certainly a concern for further research, as many original systems are still lost as a result of ignorance.

To my mind, the biggest issue still to be explored is the quantitative side of our hygro-thermal considerations, i.e. to what extent the calculation methods, values and standards of the time are still in line with present day views on building physics. We may have to call in the expertise of building physics engineers to help us evaluate and analyse the various theoretical concepts and tried constructions in order to get a clearer interpretation of their merit. Even if, as mentioned before, the necessity for upgrading mostly results from changing requirements rather than a decline in building performance, an important question is, whether such interpretations are suitable as a basis for restraint adaptation of the original building shell, in order to avoid far reaching refurbishment.

In 1992, at the *Bauhaus Dessau*, I have proposed to establish an international research programme within the DOCOMOMO organisation, on the 1939 inquiry results in the 23 CIAM-countries, in order to verify and broaden our knowledge of the techniques applied by the designers of the Modern Movement.[45] A positive result of such an investigation would contribute enormously to our understanding of the technological dimensions of their buildings and how these relate to their concept of architecture. Unfortunately, except for the Netherlands' entry, no further information has emerged so far. This will remain an ambition for the future.
But my invitation to specialists on Modern Movement technology to join in with this research programme has had one result, which is the foundation of our International Specialist Committee on Technology, that met in the present seminar on climate and building physics for the ninth time.
The series of seminars so far, and certainly this ninth edition will prove to be instrumental in opening up this important field of research. We may probably not be able to draw final conclusions or find satisfying answers yet. Further research and analysis will still be needed on building physics and climatisation systems in order to improve on the restoration and adaptive re-use of Modern Movement buildings.

Literature

Allan, J.: *The Conservation of Modern Buildings*, in E. Mills (ed.), *Building Maintenance & Preservation. A guide to design and management*, 2nd revised edition, Butterworth Architecture, Oxford 1994, pp. 140-180

Behne, A. *Der Moderne Zweckbau*, Munich 1926, translated as *The Modern Functional Building*, the Getty Research Institute for the History of Art and the Humanities, Santa Monica, Cal. 1996

Bugge, A., *Ergebnisse von Versuchen für den Bau wärmer und billiger Wohnungen*, Berlin 1924

Bugge, A., *Amerikas små hjem, deres planlegging, konstruksjon og utførelse* (Norwegian: *American small houses – Planing, Stucture, Building*). Oslo 1927

Cunningham, A. (ed.), *Modern Movement Heritage*, SPON/Routledge, London 1998, ISBN 0 419 23230 3

Flügge, R., *Das warme Wohnhaus – Ein Leitfaden zur Anwendung wärmestechnischer Gesichtspunkte im Wohnungsbau*. Halle a. S. 1927

Henket, H.A.J. and W. de Jonge: *Het Nieuwe Bouwen en Restaureren. Het bepalen van de gevolgen van restauratiemogelijkheden*, Dutch text with English summary pp. 96-100, Zeist/Den Haag 1990, ISBN 90 1206 5402

Jester, T.: *Twentieth Century Building Materials. History and Conservation*, Washington DC 1995, ISBN 00 7 0325731

Jonge, W. de: *Onderzoek Ingreepkeuzen Buitenhuid Gooiland*, unpublished research report II.3, TU Eindhoven, Eindhoven 1 december 1988

Jonge, W. de: *Contemporary Requirements and the Conservation of Typical Technology of the Modern Movement*, in H.A.J. Henket and W. de Jonge (ed.), *1990 First DOCOMOMO Conference Proceedings*, DOCOMOMO International, Eindhoven 1991, pp. 84-89, ISBN 90 3860 0615

Jonge, W. de: *CIAM inquiry on functional outer walls - A proposal for an international DOCOMOMO research program on Modern Movement technology* (unpublished manuscript), paper for the Second International DOCOMOMO Conference, 16-18 September 1992 Bauhaus Dessau, Germany

Jonge, W. de: *Bergpolder Flats. Too fit to survive?*, in K.H. Burmeister and W. de Jonge (ed.), *1992 Second DOCOMOMO Conference Proceedings*, DOCOMOMO International, Dessau 1993, pp. 198-203

Jonge, W. de: *Early modern architecture. How to prolong a limited lifespan*, in Conference Proceedings *Preserving the Recent Past*, Chicago 1995, pp. IV 3-9

Jonge, W. de (ed.): *Curtain Wall Refurbishment. A Challenge to Manage*, Conference Proceedings of the First International DOCOMOMO Technology Seminar, Eindhoven January 25, 1996, preservation technology dossier 1, Eindhoven 1997, ISBN 90 6814 0698

Jonge, W. de, and O. Wedebrunn (ed.): *Reframing the Moderns. Substitute Windows and Glass*, Conference Proceedings of the Third International DOCOMOMO Technology Seminar, Copenhagen May 20, 1998, preservation technology dossier 3, Delft 2000, ISBN 90 8057 0214

Jonge, W. de, *The Technology of Change. The Van Nelle Factories in Transition*, in H.A.J. Henket and H. Heynen (ed.), *Back from Utopia. The Challenge of the Modern Movement*, Rotterdam 2002, pp. 44-59, ISBN 90 6450 4830

Jonge, W. de: *Three Modern Preservation Cases*, in *The Double Dimension: Heritage and Preservation*, Sydney 2004, pp. 39-61, ISSN 1447-1167

Jonge, W. de: *"Zonnestraal" Restoration of a Transitory Architecture. Concept, Planning and Realisation in the Context of its Authenticity*, in *Technology of Sensations. The Alvar Aalto Vyborg Library*, Conference Proceedings of the Seventh International DOCOMOMO Technology Seminar, Vyborg September 18-19, 2003, preservation technology dossier 7, Copenhagen 2004, pp. 12-33, ISBN 87-7830-108-4

Jonge, W. de: *Restorations of the Sanatorium "Zonnestraal" (1928-31) and the Van Nelle Factories (1928-31) compared. Hands-on Experience Results on 1920s Metal and Glass Curtain Wall Preservation*, paper presented at the Eight' International DOCOMOMO Technology Seminar on 1 October 2004, New York, USA, preservation technology dossier 8, to be published in 2006

Kaa, H. van der; Eesteren, C. van; Syrkus, H.; Syrkus S.; Hubacher, C.; Bodon, A.; Elzas, A.; Groenewegen, J.H.; Limperg, K.; Van Loghem, J.B.: *Functionele buitenwanden. Enquête der C.I.A.M.*, in *De 8 en Opbouw*, 2 September 1939, pp. 175 - 189

Krischanitz, Adolf and Kapfinger, Otto, *Die Wiener Werkbundsiedlung. Dokumentation einer Erneuerung*, Beton Verlag, Düsseldorf 1989, ISBN 3-7640-0258-1

Kuipers, Marieke: *Bouwen in Beton. Experimenten in de volkshuisvesting voor 1940*, thesis with English summary, Rijksdienst voor de Monumentenzorg, Den Haag 1987, ISBN 90 12 05513

Limperg, K., *Naar warmer woningen*, Thermotechnische Dienst der Warmestichting, Amsterdam 1936

Loghem, J.B. van: *bouwen/bauen/bâtir/building*, Dutch, German, French and English text, Amsterdam 1932

Loghem, J.B. van, *Acoustisch en thermisch bouwen voor de praktijk*, Amsterdam 1936.

Loghem, J.B. van: *De gedifferentieerde wand in warmtetechnisch, geluidtechnisch en economisch opzicht*, in *De 8 en Opbouw*, 2 September 1939, pp. 199 - 208

Var.: *Voorstel tot het bouwen van proefwoningen,* in *De 8 en Opbouw*, 2 September 1939, pp. 196-197

Molema, J. and P. Bak (ed.): *J. Duiker bouwkundig ingenieur*, Dutch text, Bouw Publishers, Rotterdam 1982, ISBN 90 6632 001 X.

Molema, J. and W. de Jonge: *Johannes Duiker*, in *The Architectural Review*, 1055 (1985), pp. 49-55

Molema, J. and P. Bak (ed.): *Jan Gerko Wiebenga. Apostel van het Nieuwe Bouwen*, Rotterdam 1987

Molema, J.: *Ir. J. Duiker*, English/Spanish text, Gili, Barcelona 1989, ISBN 90 6450 0436

Molenaar, J., F. Kauffmann, A.M. Backer, M. Dicke, E. Gude, W. de Jonge, A. Koch, M. Kuipers (et.al.), *Van Nelle. Monument in Progress*, Rotterdam 2005, ISBN 90-6906-038-8

Mostafavi, M. and D. Leatherbarrow: *On Weathering. The Life of Buildings in Time*, MIT Press, Cambridge Mass 1993, ISBN 0-262-123291-5

Syrkus, Szymon, *Het Nieuwe Bouwen in Polen. De buitenmuur, ondervindingen in de laatste jaren*, in *De 8 en Opbouw*, 23 June 1934, pp. 105-110

Tomlow, J.: *Sources of Momo Technology - "Wie bauen?" (1927/1928) and the Dutch results of a CIAM inquiry "functional exterior walls" (1939)*, in *1998 Conference Proceedings Fifth International DOCOMOMO Conference. Vision and Reality - Social Aspects of Architecture and Urban Planning in the Modern Movement*, Stockholm 1998, pp. 158-162

Wiggington, M.: *Glass in Architecture*, Phaidon Press, London 1996, ISBN 0 7148 2922 6

Zijlstra, H.: *Groothandelsgebouw Rotterdam Reviewed*, paper presented at the *Eight DOCOMOMO International Conference* on 28 September 2004, New York, USA, to be published in 2006.

Notes

[1] For example the following publications in *De 8 en Opbouw*: A. Rollier: (untitled), 1932 p. 70; J. Duiker: 'De Nieuwe Zakelijkheid in Zomer en Winter', 1932 pp. 140-143; and, most particularly, J. Duiker: 'Hoe is het met onze kleeding', 1932 p. 166

[2] According to this publication, Helena and Symon (sic.) Syrkus (Warsaw) and Carl Hubacher (Zürich) are the authors of the inquiry. The Netherlands' team that prepared the Dutch entry involved the architects A. Bodon, A. Elzas, Joh.H. Groenewegen, K. Limperg and J.B. van Loghem, with draftsmen J. Elzas and G. Arpeau. Introductions by H. van der Kaa and C. van Eesteren, and various additional essays completed the edition. See Kaa, Van der (et.al.) 1939.

[3] Bugge 1924, Bugge 1927. See also the contributions by Ola Wedebrunn and Jos Tomlow.

[4] These experimental constructions ranged from assemblage and frame systems (Bron, Hunkemöller, Bims Beton Bouw, respectively Dorlonco) to poured-concrete systems (Kossel, Korrelbeton, Non Plus) and construction blocks (Olbertz, Isotherme, Winger), and involved the works of architects like D. Greiner, J. Gratema, H.W. Valk, J. Hulsebosch, W. Greve, J.B. van Loghem, H.F. Mertens, J.H. Mulder and D. Roosenburg. These trial projects are reviewed again in connection to the CIAM inquiry, see Loghem, 1939. A minute description and expert analysis of *Betondorp* and other experimental concrete housing in the Netherlands can be found in Kuipers, 1987.

[5] See Krischanitz and Kapfinger, 1989, pp. 24, 25, and Rietveld, G: *Zelfs te Weenen zit men nog niet bij de pakken neer. De Werkbund tentoonstelling te Weenen, juni-juli 1932*, in *De 8 en Opbouw* 1932, pp. 149-154.

[6] Also the *Praesens* group apparently used small test 'buildings' to perform such experiments, see Syrkus, 1934. In his 1939 article, Van Loghem suggests that similar tests have been performed also in France not long after the Polish, German and Dutch experiments. It is not clear whether, where, and to what extent such experiments may have been carried out in other countries as well. Researchers of this field in other countries are herewith invited to contact the DOCOMOMO International Specialist Committee on Technology if they have additional information in order to widen the scope of this research program.

[7] Initially load bearing frames of steel were generally promoted. Due to the economic decline since the early 1930s and the reduced use of steel in industries like ship building, steel was relatively cheap until the demands of the war industry prohibited the use of steel in the second half on the 1930s.

[8] Since the mid-1920s, similar experimental designs were conceived and applied in other countries as well. It has not yet been properly researched whether this theoretical concept was exclusively developed within the *Preasens* group, inviting other CIAM members to follow. Some buildings and innovative developments as published in other countries before Syrkus' lecture in Athens (1933) suggest that there has been a wider international engagement that, at least initially, developed independently.
The translation of the original title of Syrkus' lecture reads, according to Jadwiga Urbanik, 'The external wall in skeleton building'. It was published in Dutch on June 23, 1934, in *De 8 en Opbouw*, see Syrkus, 1934, and the contribution by Jadwiga Urbanik in this volume.

[9] Including the House for Dr. B. of 1931 and the House for Dr. N., probably designed in 1931 although the Dutch publication mentions 1932 which may be the year of completion, both designed for a location in Konstancin-Skolimów near Warsaw. See Syrkus, 1934, and Jadwiga Urbanik's paper in this volume.

[10] According to the publication the following 23 countries participated in CIAM in 1939: Algeria, Argentina, Austria, Belgium, Brazil, Czechoslovakia, Finland, France, Greece, Hungary, Iran, Italy, Japan, the Netherlands, Norway, Poland, South Africa, Spain, Sweden, Switzerland, the United Kingdom, the USA and Yugoslavia. It is unclear which CIAM groups actually completed and/or published the inquiry.

[11] See as an example Flügge 1927, p. 51, 53, where a 38 cm brick plastered wall of Munich bricks has the reference number 100 for heat transmission. Similar Cammerer, J.S., Der Wärme- und Kälteschutz in der Industrie, Berlin 1928, p. 204 referring to Hencky as the author of this idea.

[12] The Netherlands' CIAM group selected the *Van Nelle* factories (Brinkman and Van der Vlugt, 1928-31), Bergpolder Flats (Brinkman, Van der Vlugt and Van Tijen, 1934) and Kralingseplaslaan Flats (Van Tijen and Maaskant, 1938) in Rotterdam, Van Loghem's 1932 'Blauwvoet' Recreation Home in Driebergen and his 1935 Sportfondsenbad swimming pool in Haarlem, a timber-framed docter's practice (K. Limperg, 1939) in 's-Gravendeel, the Gooiland Hotel and Theater (Duiker and Bijvoet, 1935) in Hilversum, and the 'Apollo' sports hal (A. Boeken, 1935) and a Quinine Factory (Joh. H. Groenewegen, 1932), both in Amsterdam. Remarkably, the 'Zonnestraal' Sanatorium (Duiker, Bijvoet and Wiebenga, 1928-31) in Hilversum, is not mentioned.

[13] Building Physics theory and calculation in the Netherlands depended strongly on German research and handbooks. See German references of sources for k-values in Limperg 1936. Limperg refers also to an American source: Heat Transmission Through Building Materials by Frank B. Rowley and Axel B. Algren, Vol. XXXV, no 49. August 1, 1932, Mineapolis and to research results by the Dutch *Warmtestichting in Utrecht*, which figured as co-author in Limperg's publication. One should see critical that inside the small community of Dutch architectural research of those times, sometimes no proper literature references are given. Remarkably negative in this respect is Van Loghem 1936.

[14] Striking examples are the open-air schools that were conceived at the time, most remarkably the Open-Air School that Jan Duiker designed for Amsterdam in 1927-28, that was constructed in 1929-30. To allow the windows to remain open most of the time, the building featured a heating system with radiation panels at the ceilings.

[15] Duiker, J.: *Over centrale verwarming*, in *De 8 en Opbouw* 1932, p. 22; *De Nieuwe Zakelijkheid in zomer en winter*, in *De 8 en Opbouw* 1932, p. 143.

[16] Ridder, J.J. de: *Nieuwere inzichten in Centrale Verwarming*, in *De 8 en Opbouw* 1932, pp. 143-145, 155 and 211. Further episodes of his article were published in 1933, pp. 7-8, 31-32 and 153-154. The hot-air heating system for Gooiland is described in J.J. de Ridder: *Stralingsverwarming en ventilatiesysteem*, in *De 8 en Opbouw* 1936, pp. 252-258. The related patent was registered as *Octrooi No. 38201; Centrale verwarmingsinrichting met als medium warme lucht* (Central heating system with hot air as a medium), Jan Jacobus de Ridder en Ir. Johannes Duiker, 21 April 1936 - roughly a year after Duiker died. The patent was published in: Duiker, J., Jelles,E.J. & C.A.Alberts. *Duiker 1890-1935*. extra issue, 1976. Reprint of nos 5 & 6 (Jan. 1972) of *Forum voor architectuur en daarmee verbonden kunsten'*, p. 72.

[17] The concept of air cavities in outer walls is preceded by the use of perforated or hollow brick, as applied for instance for the exposed brick facades of the Berlin School (Schinkel et.al.) in the early 19th Century. Although the perforations find their origin in the desire to reach an even temperature level without deformation of the block while in the oven, they also proved advantageous in terms of thermal insulation. A common technical problem with hollow brick walls occurs when the thin exterior surface is broken and rain water penetrates into the cavities, which often leads to severe frost damage in winter.

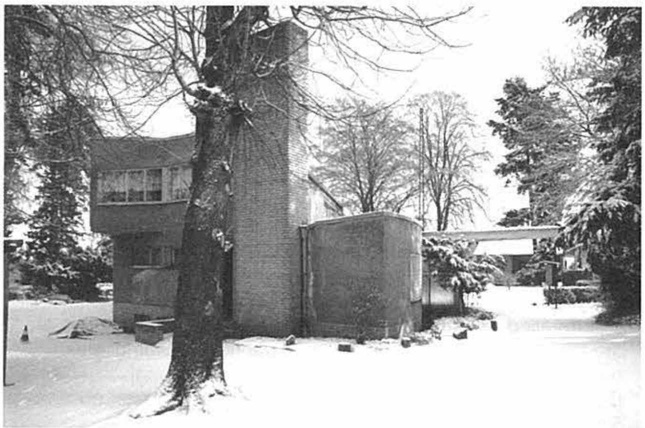
[18] The cracks in the tiled facades caused progressive damage in the 1980s, leading to a full restoration of the facades in 1989, introducing ventilated air cavities. The restoration works were designed and carried out by the architect Jacq van Klooster, as suggested by Lichtveld Buys & Partners building physics consultants. I have consulted the works, in my capacity as a researcher of the Faculty of Architecture, Eindhoven University of Technology; see De Jonge 1988.

[19] Ridder, J.J. de: *Nieuwere inzichten in Centrale Verwarming* (eerste vervolg), in *De 8 en Opbouw* 1932, p. 155, elaborated in the further episodes, see note 16. Ridder, J.J. de: 'Nieuwere inzichten in Centrale Verwarming (eerste vervolg)', in De 8 en Opbouw 1932, p. 155, elaborated in the further episodes, see note 16. The positive effect of solar gain in winter is well known and documented qualitatively in older publications. See: Flügge 1927, p. 18,19. Allready the Greek philosopher Socrates had develloped a flat roofed house concept with an open and wider south façade in order to make use of the flat winter sun, early 19th C. rediscovered by Faust. See: *Dr. Bernhard Christoph Faust's "Plan einer Stadt"* von Dr.-Ing. Hans Plessner. *Gesundheitsingenieur*, Jahrgang 1933, S. 403-405., Plessner, H., *Die Sonnenbaulehre des Dr. B. C. Faust, ein Beitrag zur Geschichte der Hygiene des Städtebaus*. Diss. Technische Hochschule Berlin 1933, and Irmtraud Sahmland: *Zur Sonnenbaulehre Fausts*, in *Bernhard Christoph Faust 1755-1842*, Bückeburg 1982.

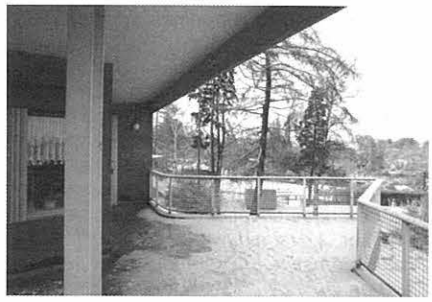
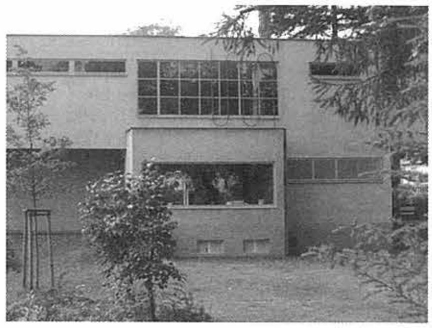
[20] Loghem 1936, pp. 136-137.
[21] Loghem 1936, pp. 5-7, 173.
[22] Boeken, A.: *Villa-flats te Zurich*, in *De 8 en Opbouw* 1936, pp, 305-310, and Van Tijen, W.: *Hoogbouw aan de Kralingsche Plas te Rotterdam. Ir. W. van Tijen en H. Maaskant*, in *De 8 en Opbouw* 1938, pp. 99-105.
[23] Duiker, J.: *Het Zwitsersche Studentenhuis in de Cité Universitaire te Parijs*, in *De 8 en Opbouw* 1933, pp. 55-57.
[24] 'Treetex' is also repeatedly advertised in *De 8 en Opbouw*. Other advertisements promote innovative building materials like 'Poriso' light-brick; 'Moler' perforated brick; insulation panels like 'Insulwood', 'Presdwood', 'Quatrboard', 'Sundeala', 'Citopon', 'Insulite', 'Heraklith', 'Eternit', 'Masonite', 'Celotex', 'Triplex' and 'Donacona'; floorings like 'Linoleum', 'Eubölith', 'Bat´a' and 'Hevea' (rubber) and 'Suberit' (cork); 'Asbestona' and 'Ferrocal' asbestos panels, roof coverings and ducts; 'Terranova' stucco; and 'Stopstara' glazing putty.
[25] Duiker, J.: *Iets over geluidwering en Het Nieuwe Bouwen*, in *De 8 en Opbouw* 1933, pp. 57-62.
[26] In Dutch, 'pumice-concrete block' is commonly referred to as *drijfsteen*, similar to the German term *Schwemmstein* or the English synonym 'floating brick', and also as *bimsbetonsteen*, which is similar to another German synonym. In English some sources use 'Rhenish brick', but most native speakers seem unfamiliar with this term. French terms found in publications include *brique de latier* or *pierre de tref.*
[27] Duiker, J: *Het nieuwe kantoor- en laboratoriumgebouw van de Amsterdamsche Kininefabriek, Architect Joh.H. Groenewegen*, in *De 8 en Opbouw* 1932, pp. 73-76, and Van Tijen, W.: *Flatgebouw Parklaan*, in *De 8 en Opbouw* 1933, pp. 140-146. Parklaan Flats were designed in 1931-32, in co-operation with A. Ahronsohn, J.H. Van den Broek en J. Uijterlinde, and completed in 1933.
[28] As respectively published in 'de 8 en Opbouw' as follows: 1933, pp. 91-94 (by K. Limperg); 1934, pp. 77-79 (by B. Merkelbach); 1934, pp. 45-49 (by W. van Tijen) and again 1939, p. 193 (as part of the CIAM inquiry); 1936, pp. 61-65 (by W. van Tijen); 1936, pp. 235, 236-249 (by A. Boeken) and 250-251 (by J.P. Kloos); and 1939, p. 195 (as part of the CIAM inquiry).
[29] Limperg, K: *Een plat- of een hellend dak?*, in *De 8 en Opbouw* 1933, pp. 95-102. See also Duiker, J.: *De Nieuwe Zakelijkheid in zomer en winter*, in *De 8 en Opbouw* 1932, p. 143. Later, also W. van Tijen en H.A. Maaskant give their view on flat versus pitched roofs in *De 8 en Opbouw* 1940, p. 87.
[30] Giedion, S.: *Woonwijk "Neubuehl" te Zurich*, in *De 8 en Opbouw* 1932, pp. 23-30.
[31] Van Tijen and Maaskant: *Stichting "Agathahuis"* , in *De 8 en Opbouw*, 1940, pp. 21-23.
[32] It is beyond the scope of this paper to analyze the dramatic economical effects of the increase of performance requirements, as each time higher standards are set, yet another part of our building stock may instantly be coined as 'substandard' and will soon become obsolete. It is obvious that such decisions are therefore contrary to sustainable development.
[33] See Zijlstra 2004.
[34] For a comprehensive historic overview of the *Van Nelle* factories and detailed reports on the research, planning and execution of the restoration works, see Molenaar (et.al.) 2005.
[35] Micro-cracks in the welded joints of the outer panel allowed water to penetrate into the ventilated spandrel construction, which combined with some of the chemical components of the 'Torfoleum' insulation into phosphoric acid, soon causing substantial corrosion damage to the spandrel construction. After some years, the double spandrel construction was replaced by single steel sheet panels without further insulation or ventilation.
[36] De Jonge, W.: *Wiebenga and Van der Vlugt. The teamwork that had to stop*, in *Wiederhall* (14) 1993, pp. 18-21; De Jonge, W: *De Amerikaanse inspiratie*, in J. Molema and P. Bak (ed.): *Jan Gerko Wiebenga. Apostel van het Nieuwe Bouwen*, Rotterdam 1987, pp. 56-63; and De Jonge 2002.
[37] During the preparatory meetings for the planning of the sanatorium the Board of *Zonnestraal* indicated a life expectancy of 30 years. The minutes of these meetings are today in the International Institute for Social History (IISG) in Amsterdam, which has been catalogued since our primary research in the 1980s.
[38] See Henket and De Jonge, 1990. Since than, the building history of the individual buildings has been reported in greater detail by our office in various unpublished volumes.
[39] A construction after American examples advocated by Wiebenga before, shortly after his return to Europe: Wiebenga, J.G., *Amerikaansche bouwmethoden een economisch succes* in *Gewapend Beton* 1926, pp. 32-35, see also Henket and De Jonge 1990, and Molema and Bak 1987.
[40] A detailed report on the research, planning and execution of the restoration works at the *Zonnestraal* main building, was presented by the author at the Seventh International DOCOMOMO Technology Seminar in Vyborg, Russia, on September 18, 2003, and published Copenhagen 2004.
[41] See Henket and De Jonge 1990, pp. 53-54, 81-82, 85-86, 99.
[42] For the *Van Nelle* factories, sheet glass in smaller sizes was found in the Czech Republic. Similar glass is artificially reproduced at higher cost, for instance as 'Bauhaus Glass' by Schott, Germany. More about glass types and production technology in De Jonge 1996, Wiggington 1996, and De Jonge and Wedebrunn 2000.
[43] Henket and De Jonge 1990.
[44] See De Jonge 2004. Comparing both restoration cases with each other and with the conservation works for Rietveld's 1953 Netherlands Pavilion at the Biannual of Venice, has also been elaborated in various of my recent lectures (see www.wesseldejonge.nl/publications) and in further publications like De Jonge, W: 'Innovation in restoration. From *New Building* to *Sustainable Building*', in *ARCHIS* (5), December 2004, pp. 16-17, ISSN 1380-3204.
[45] See De Jonge 1992.

Speaker resume

As a practising architect in Rotterdam, The Netherlands (Wessel de Jonge architecten bna bv), Wessel de Jonge (1957) has been involved in such prominent Modern Movement restoration projects as the Van Nelle 'Design Factory' in Rotterdam and Rietveld's Netherlands Pavilion at the Biannual in Venice. In co-operation with Hubert-Jan Henket architects he has been in charge of the restoration of 'Zonnestraal' sanatorium. He combines his professional career with an academic position as a researcher at the TU Delft, Faculty of Architecture. From 1990-2002 he has been the founding Secretary of DOCOMOMO International, and the founding Chairman of their International Specialist Committee on Technology from 1994-1998. Today he is a member of the DOCOMOMO ISC/Technology and the DOCOMOMO International Advisory Board.






Scharoun




Hans Scharoun's Schminke House in Löbau (Saxony)

Building Science Aspects, Heating and Ventilation Concepts

Architect Hans Scharoun (1893-1972), with *Baumeister* Walter Vetter (1891-1947)
design and building phase: 1930-1933, restoration: 1998-2000

by Dr.-Ing. Klaus Graupner

The Schminke house (*Haus Schminke*) – which belongs to the classic Modern architecture of the 20^{th} C – was built some 75 years ago. At that time the scientific discipline Building Science (*Bauphysik*, *Bauklimatik*) did not yet exist. Today, building science is a recognized branch of engineering science. The term Building Science (*Bauklimatik*) signifies particularly the holistic view on aspects like heat/moisture protection, heating, ventilation and utilization. "Holistic" means, in this case, that no defects or building damages, which are conditioned by the climate, may occur at any time of the year. Speaking of climatic requirements concerning the utilization of the building and its parts implies the "present-day", respectively "modern" use.

These are generally speaking climatic requirements, which were not yet relevant when the building was erected.

In other words: One has to count with climate-conditioned problems up to severe damages to the building and its equipment, if during the planning process the relevant building science aspects are not recognized and respected in their full complexity.

Like other buildings of the classic Modern Movement, the *Haus Schminke* has a – from today's viewpoint – deficient heat insulation and holds numerous technical details which are even worse in terms of building science (cold bridges etc.).

But: The historical building *Haus Schminke* did function well from the building science aspect and no climate-conditioned severe damages could be traced.

This means that: The existent components – heat insulation / utilization / heating / ventilation – resulted in a functioning system in terms of building science! This was due primarily to the architect and his technical assistants.

For today's "modern building" practice conditions are in many ways completely different from the time in which *Haus Schminke* was built. These prevailing conditions imply – strictly speaking – almost the exclusion of climate-conditioned damages, since there are now for example:

- numerous technical possibilities for the general structure of a building;
- numerous very good technical details for construction;
- numerous technical possibilities regarding the heating and ventilation equipment, and
- since Building Science (*Bauphysik* and *Bauklimatik*) is now a recognized branch within **engineering** science.

Nevertheless: A great part of today's building production does not perform well, or not at all, from the aspect of building science! This assessment gains even more importance if for a judgment of its functioning the aspect of "energy consumption for the building's cooling during the hot season" is included.

This obvious but sad observation about today's architecture may have a number of reasons and influences. Essential are:

- The architect and his knowledge level about elementary coherences in the building physics field. (Principally this is also valid for the planner of heating and ventilating equipment.) Could it be the case that – at least some – architects aim at a good aesthetic result, while neglecting however the technical (and physical) functioning?
- An insufficient cooperation between the architect, the planner of heating/ventilation, and the building science engineer.

About the catchphrase "Cooperation in planning":
In this respect too *Haus Schminke* can be seen as exemplary. The level of practical cooperation between architect and heating planner of some 75 years ago is not reached nowadays, neither in new building, nor in restorations of old ones. The today possible and sensible inclusion of a building science engineer, especially when it comes to historical architecture, is still not common.

As a whole, the historical heating and ventilation concept of *Haus Schminke* was plausible in such a degree – also as regards the building science aspect in general – that it could be accepted for the renovation. Above all: It has proved itself in practice over a long period!

Out of renovation practice of classic modern buildings one may often observe a very particular phenomenon: Parts of the historical building's equipment still exist. In *Haus Schminke* this is true particularly for the heating equipment. It was the aim to conserve the historical technical equipment and even, to a great extent, to use it. It was important to preserve it as a technical monument, but primarily as an inseparable component of the interior arrangement and furnishing. The stock of original cast iron radiators (*Rippenheizkörper*) was the primary concern. Due not least to the excellent handicraft of the involved firms the above-mentioned aim could be achieved.

In the following some technical details will be explained.

Ventilation

There are a multitude of options for window ventilation in *Haus Schminke*. Among these, there is a remarkable differentiation, so that the user's demands in summer and winter may always be complied with. This may be the case for classic modern architecture in general, whereas today's window construction does not reach this at large!

Heating

Consequently, heat is supplied chiefly in sitting areas (thermal zoning). In order to compensate for the discomfort raising from the windows (cold surfaces, draft effects), the radiators are placed underneath the windows in full width. The warm air ascending from the radiators is not obstructed by the windowsills.

Special notice deserves a partial radiant floor heating, which exists in the northern part of the winter garden. The heating element, in shape of a simple pipe coil (two parallel tubes connected with an end curve), is located directly over the deep-set basic floor surface. A metal grating serves as a cover.

Because the pipe coil is not embedded in the basic floor's concrete this radiant floor heating system is less inert compared to today's common floor heating systems, and it may be easily tailored to meet the requirements. Actually, the denomination "radiant floor heating" is not quite correct when it comes to this construction. It is a combination of radiant floor heating and air heating. Through the holes of the gratings cool room air may be led directly next to the pipe coil, warmed up there in order to reach the room again through the openings as warm air. From the viewpoint of building science a very sensible solution, dating as early as around 1930. (Compare contribution by Emanuelle Gallo; ed.)

Thermal Bridges and Windows

The *Haus Schminke* is a steel skeleton structure and shows numerous thermal bridges (spots with thermal losses), for example cantilevers, encasements for blinds, joining of materials. The actual original windows – a single glass pane in an unsealed metal frame – were in winter even colder than the thermal bridges, and thus, if any condensation should occur, it would be on the glass surface.

Since the thermal bridges could not be eliminated in general, from building science and other viewpoints a replacement of the historical windows by today's heat-insulating glass was not appropriate. In winter the inadequate heat-insulation of the windows could – and still can – be improved essentially by closing the exterior roller venetian blinds and by the curtains, thus obtaining a temporary heat-insulation effect. (The two sliding doors connecting the living space with the spacious hall and the winter garden reduce in winter cold draft and heating-energy loss; ed.)

Heat Protection in Summer

In summer heating-up of the building could be evaded by the existent heat protection devices (exterior venetian blinds and light-coloured curtains) together with excellent ventilation possiblities (cross-ventilation throughout the whole building). Thus, instead of a mechanical air-conditioning a conscious application of built-in equipment!

Final Statement

The house for the Schminke family, realized by the architect Hans Scharoun, is not only one of the major masterpieces of classic 20th C modern architecture, but also from a conceptional viewpoint a highlight of building science, with a convincing technical implementation.

The building science conception – which lacks in terms of an explicit document – and its still existent technical realization were far ahead of their time. Even now the holistic approach might stand any criticism. One will hardly find this engineering aspect mentioned in any other publications on the restoration of *Haus Schminke*.

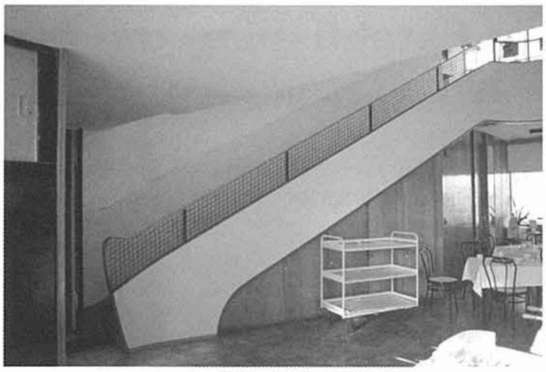
Moreover – astonishingly – one will even fail to recognize it in many buildings of the "present-day Modern Movement" . . .

References

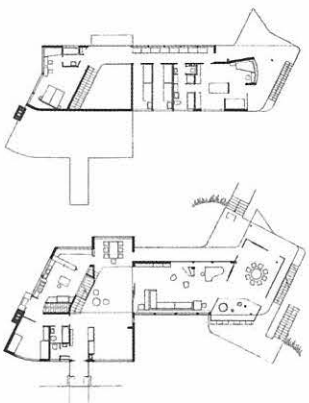
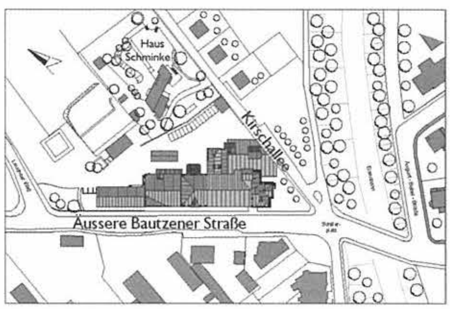
On the history and restoration of the Schminke house please read:
Burkhardt B. (editor), Scharoun. *Haus Schminke*, die Geschichte einer Instandsetzung. Karl Krämer Verlag Stuttgart – 2002. ISBN 3-7828-1514-9
This publication contains a comprehensive presentation of building science aspects: Graupner, K., Lobers, F. Bauklimatische Aspekte, Heizungs- und Lüftungskonzept, pp. 120-135. The restoration of *Haus Schminke* took place under the joined responsibility of the Wüstenrot Stiftung Ludwigsburg and the Löbau municipality. Additional financing by the Bundesrepublik Germany and the Freistaat Sachsen.

Dr.-Ing. Klaus Graupner is teaching at the Technische Universität Dresden, Fakultät Architektur, Institut für Bauklimatik and has cooperated in numerous important renovation projects.

The pictures belonging to this contribution show several aspects of *Haus Schminke*. Photographers Friedegard Eichler, Ingo Schneider, Jos Tomlow.





Haus Schminke
Kirschallee
Aussere Bautzener Straße


First Steps in Establishing the Discipline of Building Science – The Research Institute of Thermal Insulation in Munich

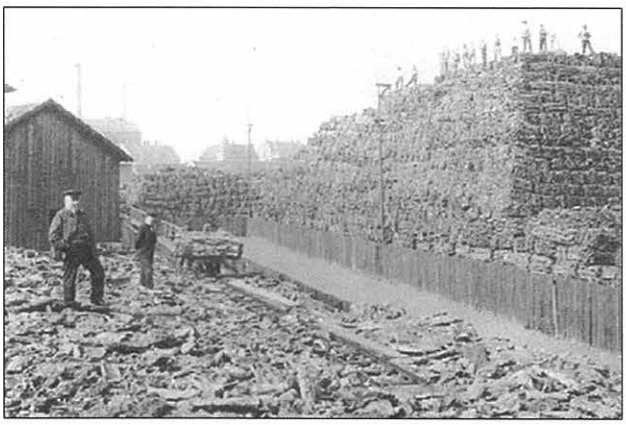
by Roland Gellert and Horst Zehendner

Between 1860 through 1920 cork was the main insulating material in buildings, either as loose filling material or in expanded form bonded by a bituminous "glue". For high temperature application in the industry differently shaped products made from silica were in use up to a service temperature of 600 °C.

Advertisement for a cork insulating product for buildings, stating economy in construction and high comfort in summer and winter for dwellings.

The firm A. Haacke & Co. in Celle was founded in 1879.

Geheimrat Prof. Dr. phil, Dr.-Ing. e.h. Oskar Knoblauch (1862-1946) Founding director of the FIW.

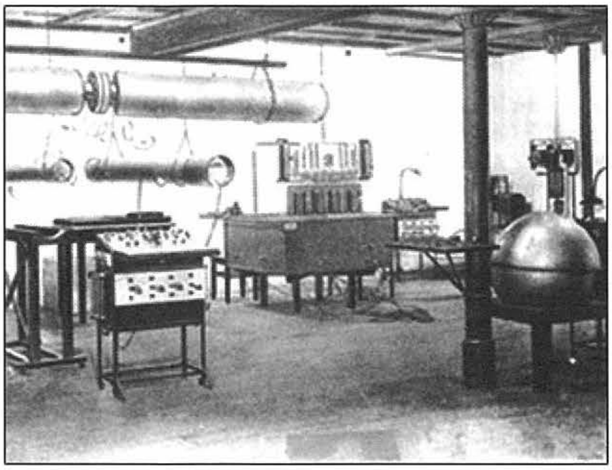


G+H – cork storage area in Ludwigshafen/Rhine (1911) and the cork storage after the fire of 1912.

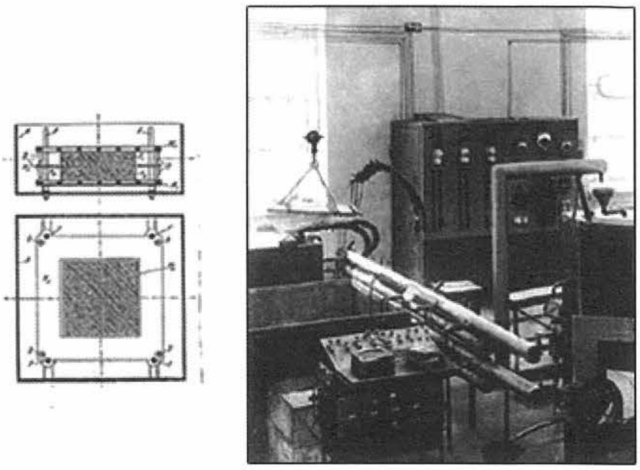
Dr.-Ing. habil. Joseph Sebastian Cammerer, pioneer for researching the physics of heat flow and insulation. From 1920 – 1922 researcher in the FIW Institute. He joined industry later.

Systematic research into the physical and technical aspects of thermal protection technology commenced in the beginning of the 20th century. Especially the laboratory for Technical Physics at the Technical University in Munich headed by Prof. Dr. Knoblauch implemented testing devices to measure the thermal conductivity: Nusselts's sphere (1909), dual hot-plate apparatus according to Poensgen (1912) and test pipes according to Rinsum (1918).

After the war beginning in 1918 the need was felt to design technical processes and buildings that used as little energy as possible. Due to the political and economic circumstances energy savings were a must especially for large quantities of new living quarters for ex-soldiers and their families, which would be erected soon.



Nusselt's sphere, various cylindrical test pipes and hot plate apparatus up to 600 °C in the laboratory of FIW (1921)

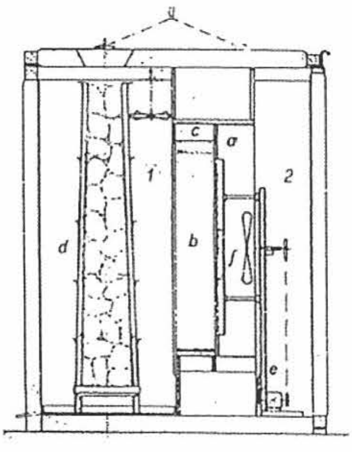


FIW-laboratory with guarded hot-plate apparatus (1927)

This new demand and the limited supply of the natural material cork led to the development of alternative materials – plus the unfair competition of some producers of insulating materials on the market based on individually generated performance data – led industry to the foundation of an independent research and testing institute in Munich in 1918, then called *Forschungsheim für Wärmewirtschaft*. Its specific goal was to establish quality assurance criteria for the producers.

Companies founding the institute in 1918 were:
- Grünzweig & Hartmann GmbH, Ludwigshafen/Rh.
- A. Haacke & Co., Celle bei Hannover
- Rheinhold & Co., Hannover
- Asbest- und Kieselgurwerke, Uelzen
- Torfoleumwerke Dyckerhoff, Poggenhausen near Neustadt am Rübenberge
- Vereinigte Deutsche Kieselgurwerke, Hannover
- Wirtschaftliche Vereinigung des Isoliergewerbes GmbH, Dortmund

Using the testing devices of the technical university (initially on a contract basis) Prof. Knoblauch and Dr. Hencky, who headed the institute, started to test the performance of insulating materials on a scientific basis and provided application rules for the construction of low-energy-consuming houses. It is interesting to note even today that authorities in Berlin and Munich issued building permits at that time only after a statement about adequate energy conservation was provided by the applicant.



First measuring arrangements for the testing of wall sections, FIW design from 1921

1 cold section
2 hot section
b wall section (test specimen)

The institute started to generate reliable thermal performance data for insulating materials like cork, peat and saw dust – then often in use – on the basis of which the energy performance of the building was calculated.

Knoblauch and Hencky published in: Bayerische Industrie- und Gewerbeblatt, Nr. 7/8, 1919, the scientific basis for "k-values" (heat transmission value; now U-value).

$$\frac{1}{k} = \frac{1}{\alpha_1} + \frac{\delta}{\lambda} + \frac{1}{\alpha_2}$$

$\rightarrow \lambda$ heat conductivity measured under standardized conditions (validation of moisture effects)
$\rightarrow \alpha$ surface coefficients for different directions of heat transfer (horizontal – up – down)
$\rightarrow \delta$ layer thickness

Since 1920 the institute started to publish data on a regular basis, including heat transfer data for model walls (1 m x 1.5 m x thickness) taking into account moisture and humidity effects.

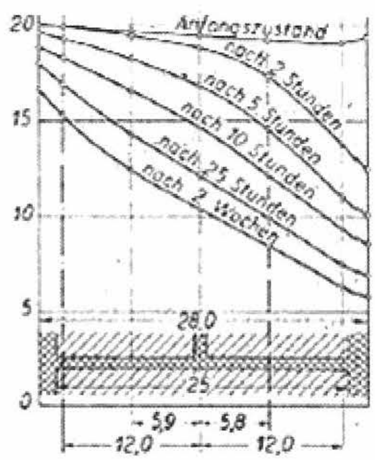
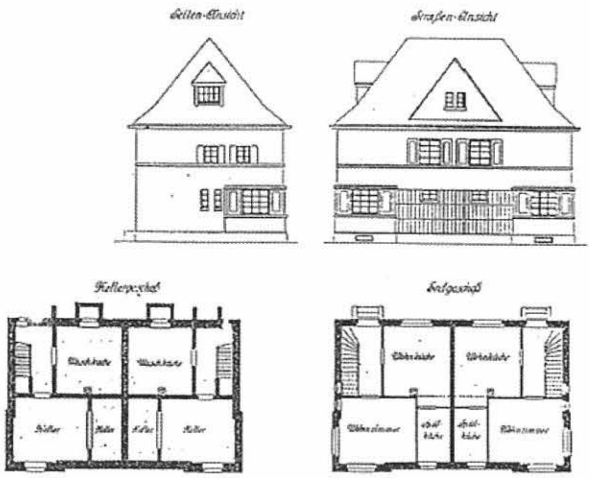


Diagram of a brick wall showing heat loss in a period of 2 weeks, based on experiments by FIW.



Hencky (1919): Model house proposals by Schachner. Type A with reduced energy consumption by using double glazed windows instead of one, and adding insulation.

In model house type B the design of type A was optimized by reducing the window surface and relocating the living in a more central position with a reduced exterior wall surface.

By 1924 the publications included more and more data on building and insulation materials (e.g. wood wool, sheep's wool, ceramic materials and also reed, straw) that had started to enter the market. An example is: *Thermal Conductivity of materials based on test results,* 1924, by Dr.-Ing. E. Schmidt. Even today these data are often the basis for energy performance calculations of buildings and industrial application.

Dr.rer.nat. Roland Gellert and Dipl.-Ing. Horst Zehendner are director and former director of the Forschungsinstitut für Wärmeschutz e.V. München

Logos symbolic for quality assurance of thermal insulating materials in Germany and Europe.

Literature

Cammerer, J.S., *Der Wärme- und Kälteschutz in der Industrie*, Berlin 1928

Cammerer, J.S., *Konstruktive Grundlagen der Wärme- und Kälteschutz im Wohn- und Industriebau*, Berlin 1936

Hencky, K., *Der Wärmeschutz von Gebäuden – Mitteilung aus dem Forschungsheim für Wärmewirtschaft.* In: Bayerische Industrie- und Gewerbeblatt, Nr. 7/8, 1919

Hencky, K., *Nachtrag zum Aufsatz "Der Wärmeschutz von Gebäuden".* In: (Sonderdruck) Bayerische Industrie- und Gewerbeblatt, 1919

Knoblauch, O., *Die wissenschaftlichen Grundlagen des Wärmeschutzes.* In: Bayerische Industrie- und Gewerbeblatt, nr. 7/8, 1919

Knoblauch, O., *Bericht über die wärme- und schallttechnischen Untersuchungen in der Versuchssiedlung München.* In: *Reichsforschungsgesellschaft für Wirtschaftlichkeit im Bau- und Wohnungswesen e.V. Bericht Nr. 1*, August 1930

Künzel, H., *Bauphysik – Geschichte und Geschichten*, Stuttgart 2002

n.a. *75 Jahre FIW Forschungsinstitut für Wärweschutz.* Geschichte und Tätigkeit des Instituts FIW-München, 1993

Schachner, R., *Gesundheitstechnik im Hausbau*, München 1926

Schmidt, E., *Die Wärmeleitzahl von Stoffen aufgrund von Meßergebnissen.* In Mitteilungen des Forschungsheimes für Wärmeschutz e.V., München, Heft 5 1924

Die wissenschaftlichen Grundlagen
des Wärmeschutzes
von Prof. Dr. Osc. Knoblauch
und
Der Wärmeschutz von Gebäuden
von Dr.-Ing. K. Hencky

Sonderdruck aus dem Bayerischen Industrie- und Gewerbeblatt 1919 mit einem Nachtrage.

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Szymon Syrkus

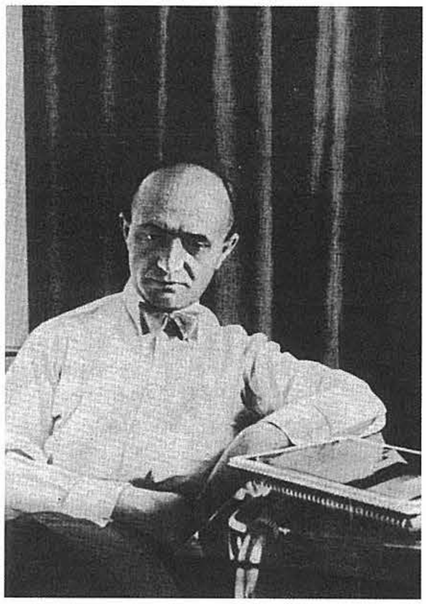
CIAM Representative of Poland and Pioneer in Integrating Building Science in Modern Movement Architecture

by Jadwiga Urbanik

Talking about Szymon Syrkus without mentioning his wife would be incomplete. Helena Syrkus, an architect (family name: Niemirowska) was not only his wife but also his partner. They were a wonderful couple, extremely engaged in developing modern Polish architecture, who took part in the life of European architecture avant-garde. In 1928 they became members of CIAM. Syrkus's way to modern architecture had started earlier in December 1924 when the young architect came back from France to Poland where he noticed the need for realising his ideas. He saw all the difficulties he would have to overcome. Of course, he couldn't predict that those difficulties would pile up and he would have to cope with them till the end of his life. In 1939 when the war broke out he found himself in a mortal danger. Although his CIAM friends wanted to help him emigrate, he decided to stay in occupied Poland. In consequence he was imprisoned and spent the last three years of the war in Auschwitz concentration camp.
The most important part of his creative life was his work on forming a massive housing building program which he had started to think of at the end of his stay in Paris. Syrkus's life credo, as his wife wrote in her marvellous book dedicated to her husband *Towards the idea of social housing estate*, was: *"participation in the struggle of co-operative movement members for creation of Polish theory of social housing and its practical realisation on the strength of experiences of international architecture leaders of CIAM"*[1].

Being terrified by the housing demand (in the twenties there was a shortage of one million rooms in Polish cities), incompetence and architecture backwardness, power of eclecticism, superficiality of fashionable box-like architecture, Syrkus decided to deal with all the problems in order to cause ferment which could lead to positive changes in the existing situation.

Overcrowded small dwellings in Poland in comparison to Germany/Berlin and Great Britain/London. *Osiedla Robotnicze*, Biblioteka Polskiego Towarzystwa Reformy Mieszkaniowej, Seria I, nr 8, Warszawa 1937.



Szymon Syrkus (1893-1964). Helena Syrkus 1976, p.5

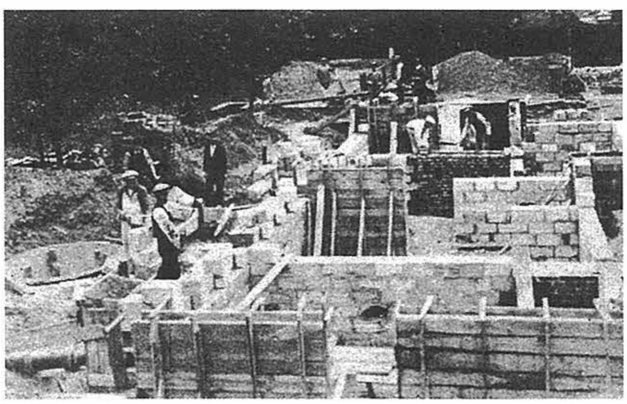
In 1926 Syrkus took part in the first International Modern Architecture Exhibition in Warsaw, which was a big event in the life of Polish architecture society and Syrkus's designs (shown at the exhibition) were certainly very innovative in Polish architecture[2]. For Syrkus that exhibition was a stimulus to promote modern architecture in Poland. First he did it by means of the magazine "Block" and others[3]. In his early opinions it was possible to notice clearly stated problem of prefabrication which could solve the enormous housing needs.

In the first half of 1926 the Block group split. On Syrkus's initiative the *Praesens* creative group was founded. Its members were: B. Elkouken, Jan Golus, Katarzyna Kobro-Strzemińska, Karol Kryński, Bohdan Lachert, Józef Malinowski, Helena Niemirowska (Szymon Syrkus's wife-to-be), Maia Nicz-Borowiakowa, Aleksander Rafałowski, Henryk Stażewski, Szymon Syrkus, Józef Szanajca, Stanisław Zalewski. During the next years, till the year 1930, Barbara Brukalska, Stanisław Brukalski, Marian Jerzy Malicki, Andrzej Pronaszko joined the group, too[4]. In June 1926, a new magazine called *Praesens*-modernists' quarterly started to be published. *Praesens* program was defined in Szymon Syrkus's leading article in the first volume, entitled *Architectural Preliminary*[5]. According to Szymon Syrkus, the only solution by the 20th century standards was the union of architecture and industry and its adjustment to the possibilities of industrial production.

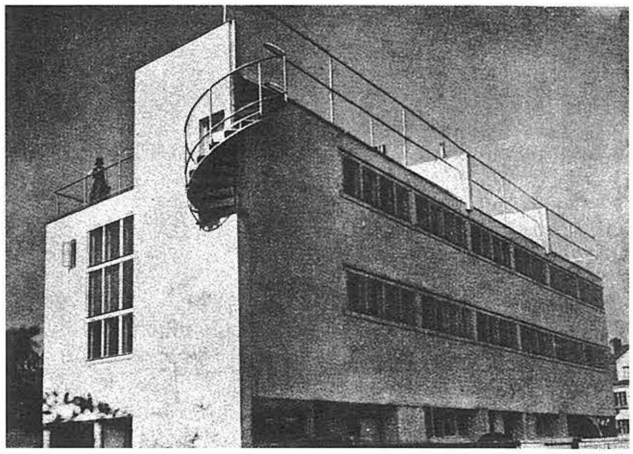
The event which had a very essential influence on the development of modern Polish architecture was the International Competition for the Nations' League Palace in 1927. Five Polish teams took part in that competition[6]. The fact that Le Corbusier was denied the first award caused a lot of protests among different groups of Modernists, also in Poland. The indignation resulted in the protest of *Praesens* Modernists' group. Siegfried Giedion turned to Polish designers. *Praesens* group members Szymon Syrkus and Józef Szanajca took part in the works of the new organisation of CIAM architects struggling for new architecture[7]. It was a great honour for the young Polish architects and motivated them to continue their effort to find new ways for 20th century Polish architecture. Inviting Polish architects to CIAM was not only caused by the fact that they took part in the competition for Nations' League Palace but also their membership in *Praesens* avant-garde group was relevant. Szymon Syrkus was invited to take part in the works of the CIRPAC Executive Committee whose member he was for thirty years, that is, till CIAM ceased to exist[8]. Helena Syrkus also took active part in CIAM works having different functions and after the war became its vice-president. Since 1933 Roman Piotrowski was the Polish representative[9]. Those architects fought actively for the new aspects of architecture not only in Polish press and their designs but also abroad. They spared no time or effort to promote the idea of new architecture using all accessible means and methods as publications, exhibits, competitions or their own arts. Each of their works was a step forward to promote modern architecture.

The CIAM organisation undertook the serious task of educating new architects that would continue to promote ideas in their respective countries. As the whole world would soon see, it became a modern school of architecture, founded for the challenges of its time. What else were the architecture congresses, under preparation for several years, if not a good school of modern architectural design? People attending these congresses were the most dynamic and progressive representatives of their countries. Activities of particular groups within CIAM were in fact the promotion and improvement of the lessons learned at congresses. The big lesson was to solve the space organisation problem to fulfil the needs of modern men.

The CIAM pioneers' main purpose during the 1930s was the strengthening and broadening of the Modern Movement idea, which at that moment meant to be responsive to the needs of the population in large. The



Experimental celolit house under construction, arch. Bohdan Lachert, Józef Szanajca, 1928-1929, Warsaw, Katowicka Street 9-13. *Dom, Osiedle, Mieszkanie*, nr 7, 1929, p.4.



Experimental celolit house, arch. Bohdan Lachert, Józef Szanajca, 1928-1929, Warsaw, Katowicka Street 9-13.
Dom, Osiedle, Mieszkanie, nr 7, 1929, p.1.

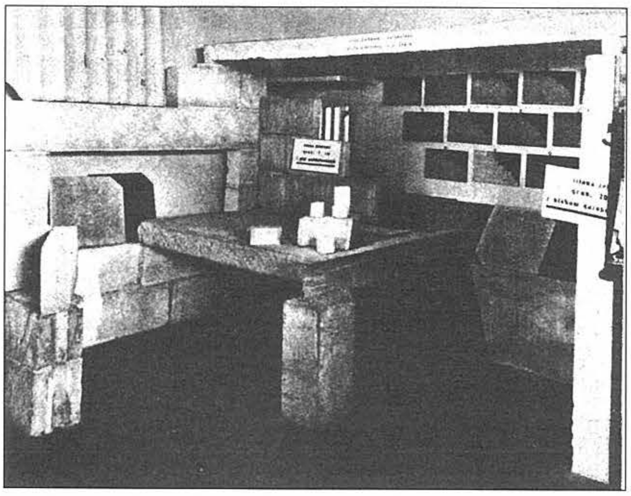
possibility of meeting those needs was used later to promote the new building techniques.

Bohdan Lachert and Józef Szanajca's house built in 1928 at 9, 11, 13 Katowicka Street, Saska Kępa, Warsaw[10], was a major achievement when it comes to its form, construction and new materials applied and it generated major interest. Groups of students and architects visited the building site to learn from its novel design. The construction was based on the system of perpendicular walls supporting ceilings. According to the project, there were three multilevel flats. It was one of the most interesting projects from the twenties that stands favourably the comparison with the most avant-garde buildings in the West. It is worth noticing that this building survived the time challenge from a technical point of view better than many contemporary buildings. It was an experimental house out of Celolit. It was made out of Celolit blocks (20x25x40 cm) with external 25 cm walls and internal 20 cm walls[11].

In 1928 Warsaw Housing Co-operative decided to start the construction of a new housing estate including one thousand flats. It was the beginning of large housing estate complexes. Hempel and Syrkus proposed the steel structure filled with light cellular concrete or with wood-like material by means of a dry mounting method.

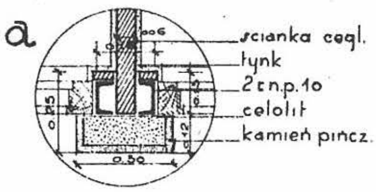
This idea was immediately supported by Teodor Toeplitz[12] because he was interested in the settlement projects of Haselhorst (Berlin) and Dammerstock (Karlsruhe) and their technology. The cost preliminary analysis (made by the Reichsforschungsgesellschaft für Wirtschaftlichkeit im Bau- und Wohnungswesen – Rfg) showed that such a system offers greater savings in comparison with traditional ones (brick wall)[13]. It was the beginning of the struggle for new materials application.

From 1st to 21st of March 1930 "The Smallest Flat" (*Die Wohnung für das Existenzminimum*) Frankfurt Exhibition was shown in Warsaw. The comparison of international projects was only one part of the exhibition. In the second, the Polish one, the new materials and designs were shown in form of fragments of ceilings and walls[14]. Every exhibit was accompanied by its technical details. For the first time in Poland, it was possible to look at real models of different outside walls.

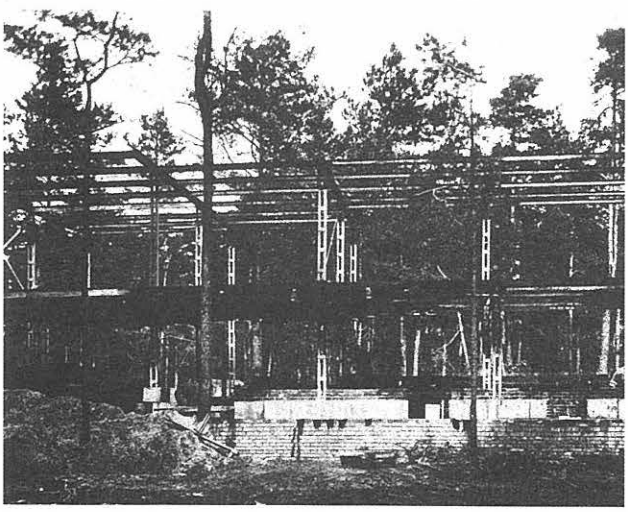


Gas concrete on the exhibition "The smallest dwelling". *Dom, Osiedle, Mieszkanie*, nr 4, 1930, p.38.

Szymon Syrkus, the show organiser, wrote in the exhibition manual that: "*this show material was not comparable from the quantity point of view to the foreign exhibitions but that it proved that there was no lack of new materials on our market, some of which were Polish products (Aerocret, Celolit, Izobet, Berbeca, Cemunit, Trocal, Felisitin, Terrazyt) and Heraklit and Solomit would be made in Poland soon. Polish cement and wood industry were highly developed and there were no obstacles to start the advanced building construction, advanced from the flat and building planning, as well as from the design and technology point of view. It should be noted that the application of new materials requires experience and historical perspective. Modern materials are inexpensive, cheaper than brick but they are unreliable and therefore they should be used professionally and carefully. An unprofessionally built house made of cheap materials may turn out to be expensive in the end, often more expensive than the brick one. However, if we use the new materials with conscience and reason, taking into account their thermal, static, chemical features, then such buildings will be profitable not only from a material and manpower point of view but also from a usage point of view*"[15].



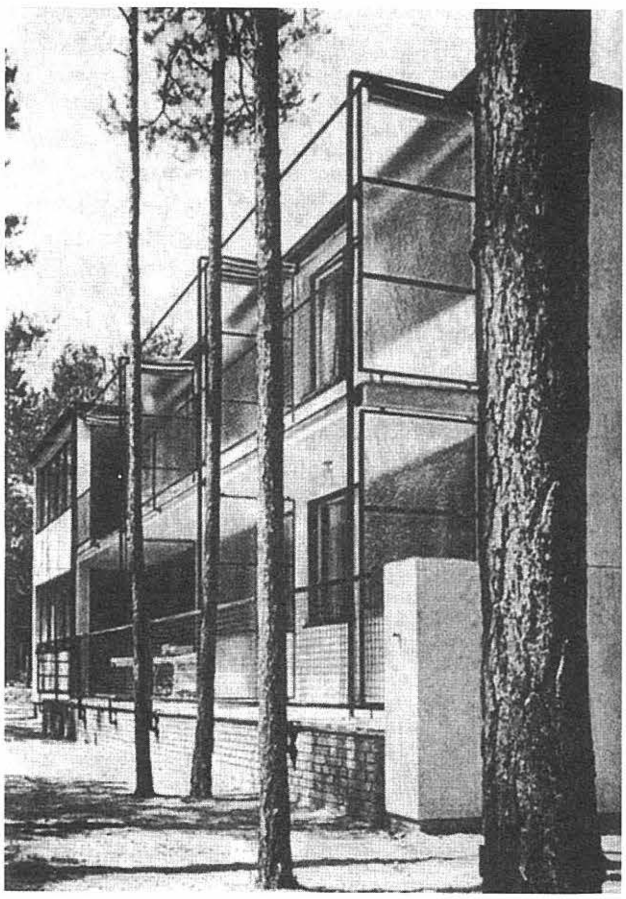
Dr. B. House, Królewska Góra near Warsaw, wall section. *Architektura i Budownictwo*, nr 4, 1934, p.120.



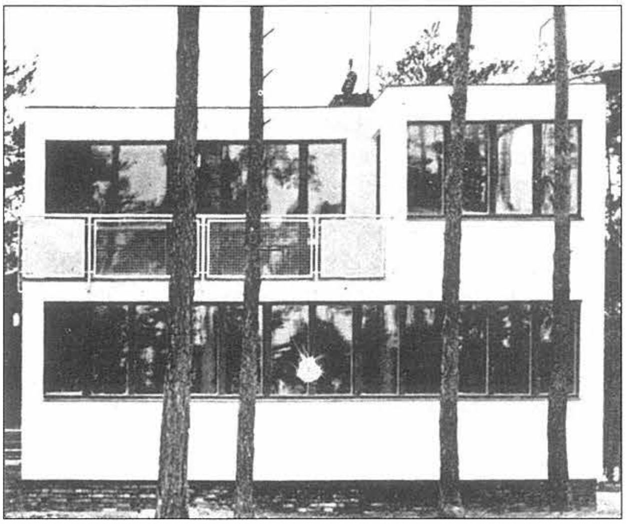
Dr. B. House, Królewska Góra near Warsaw, steel skeleton construction. *Architektura i Budownictwo*, nr 4, 1934, p.121.

The Syrkuses strove for architectural multiplication of design projects. In the winter of 1930/31 they worked out a frame iron structure for high-risers. It was done together with the constructional engineer S. Hempel[16]. Syrkus assumed that the flat factories would be located close to energy and material sources, far from construction sites. By promoting massive flat production, they benefited to new achievements of Polish building technique. They complained that there were not enough possibilities of dry mounting of structural filling. According to the Syrkuses covering walls with wet plaster was the weak point. The choice of large and light building segments, covered from the outside with an impermeable high-grade coat such as, for example, glaze, stone, non-corrosive enamel, sheet metal or reinforced plywood was necessary. It would be possible to start quick production of houses on a mass scale after getting rid of the tradition of covering buildings with a wet coat (layer)[17].

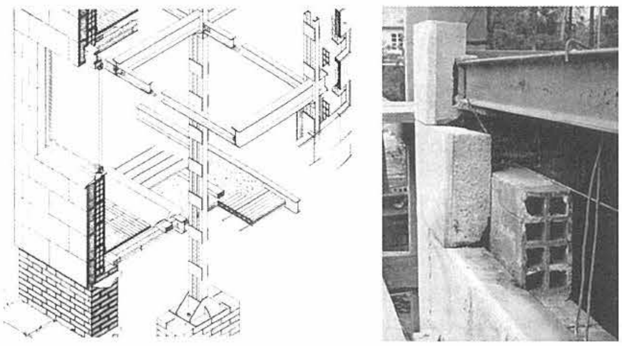
Rakowiec-Warsaw Housing Co-operative estate, designed by the Syrkuses in 1930, was to be the first housing complex in Poland, built according to modern



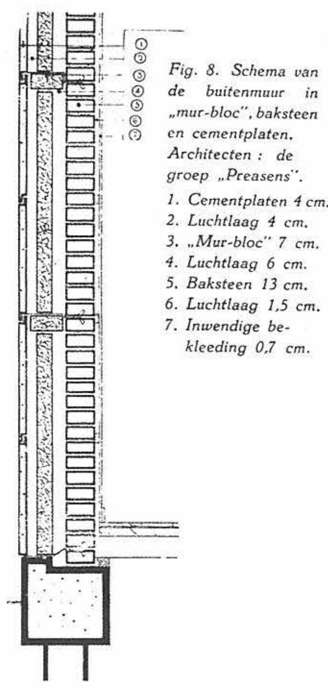
Dr. B. House (small sanatorium), Królewska Góra near Warsaw. *Architektura i Budownictwo*, nr 4, 1934, p.119.



Dr. N. House by the Syrkuses. Loghem, J,B, van, *De gedifferentieerde wand in warmtetechnisch, geluidtechnisch en economisch opzicht*. In: De 8 en Opbouw, 2 september Nr. 17/18, 1939, p. 206



Illustrations of Dr. N. House as published in Loghem, J,B, van, *De gedifferentieerde wand in warmtetechnisch, geluidtechnisch en economisch opzicht*. In: *De 8 en Opbouw*, 2 september Nr. 17/18, 1939, p. 206, 207



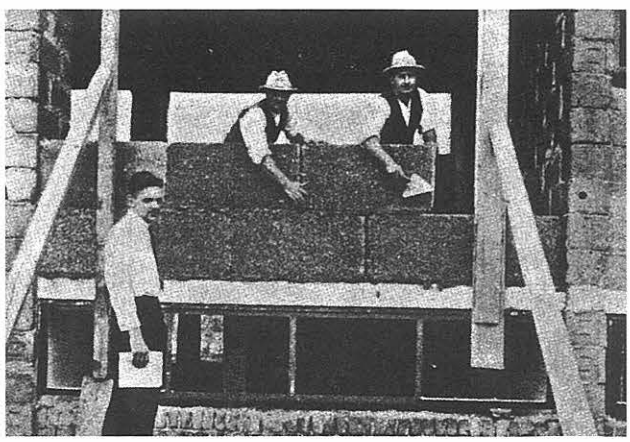
Outer wall section, published in the Szymon Syrkus text presented the new building in Poland. *De 8 en Opbouw*, nr 13, 1934, p.109.

building technique. Detailed cost calculation showed that the most economic structure and technology solution would be a steel structure filled with light Celolit parts with ready-made thin facing of Pińczów stone. The patent for this kind of external wall filling belonged to engineer Czesław Pukiński but *Praesens* group members, Bohdan Lachert and Józef Szanajca, tested the feasibility of Celolit application in houses in Katowicka Street (Saska K□pa, Warsaw), built in the years 1928-1929[18].

Thanks to contracts for designs and building of a one-family house and a small sanatorium on Królewska Góra, Konstancin in 1931, the Syrkuses together with Stanisław Hempel and Czesław Pukiński had the chance to experiment with new kinds of technology before starting the mass production of workers' houses. Doctor N. house situated in Uzdrowiskowa Street, Konstancin, survived the war. The condition of its façade proves that engineer Pukiński's method did prove its usefulness and should be widely applied.

Theoretical designs from 1930/31 and both experimental houses erected on Królewska Góra illustrate the work of Stanisław Hempel's *Iron Frame Structures*[19] and a paper by the Syrkuses *Massive Flat Production*[20] published by the *Praesens* group. That paper was one of the journalistic works which aim was to make new building methods more popular. Following S. Syrkus's influential paper *The Pace of Architecture* two more appeared: *New materials and structures – new architecture* and *The external wall in structure building, Of architecture and workmen's housing production and others*[21]. During the fourth CIAM congress in 1933, Syrkus presented a paper entitled "*The exterior wall in structure building*" illustrated with photographs of houses built according to the Syrkuses' and constructional engineer Stanisław Hempel's projects. All the mentioned works were also published in foreign magazines, for example Belgian, French and Dutch.[22]

The necessity of introducing new materials into building, especially house building was noticed not only by the Syrkuses but also by other architects and constructional engineers belonging to the CIAM group. New technologies were introduced and promoted on every possible occasion. An architect L. Tomaszewski from the avant-garde "*U*" group published an article concerning the

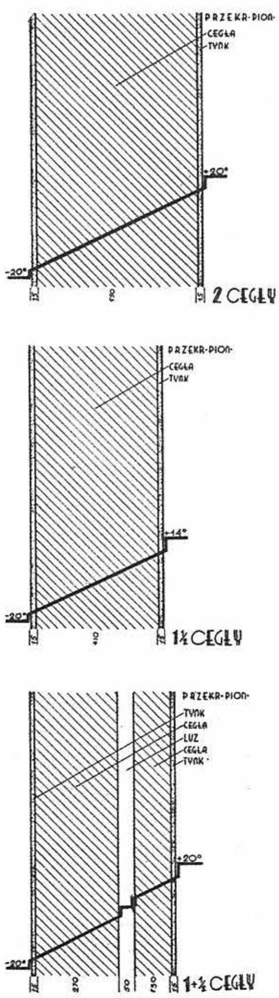


Outer wall made of light slag concrete plates. *Dom, Osiedle, Mieszkanie*, nr 3, 1929, p.8.

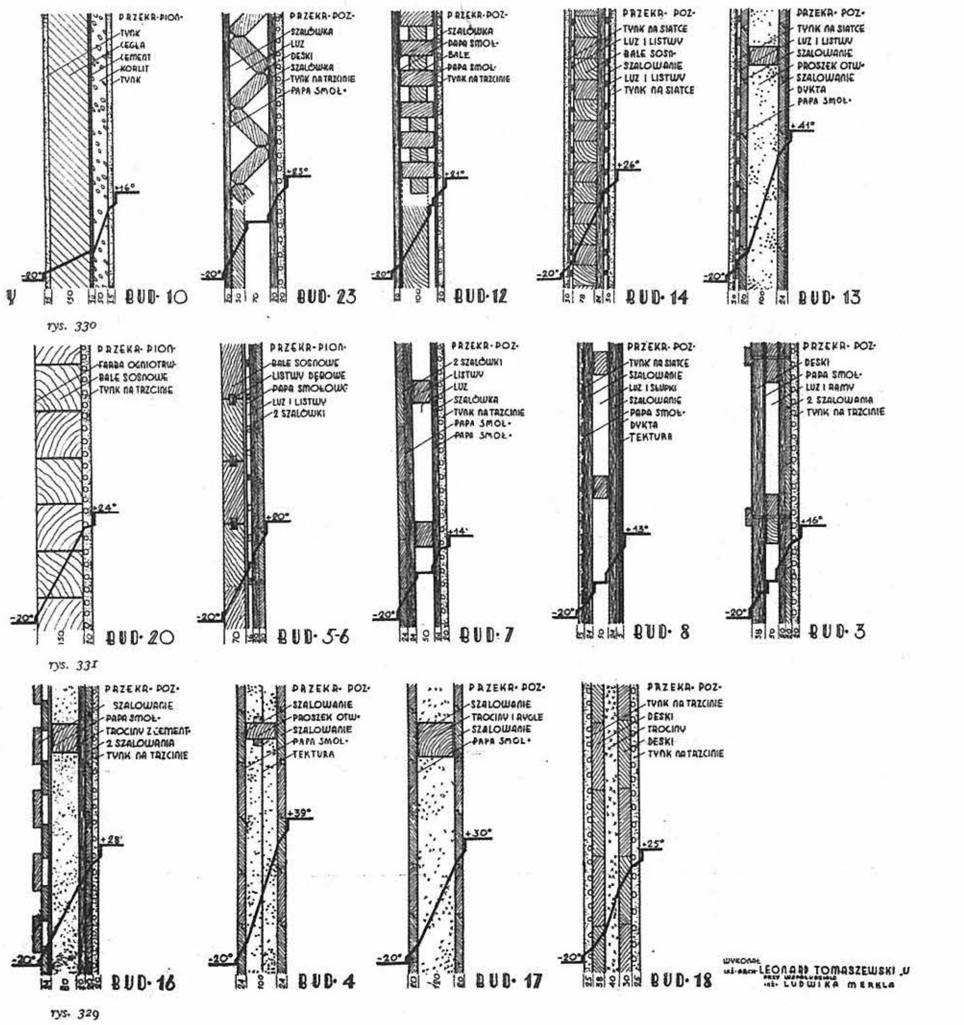
insulation qualities of laminar external walls, paying much attention to two layers – the heat-protective and the heat-absorptive[23]. The first one protects against the heat loss, the second one accumulates and gives heat energy away when the interior gets cooler as a result of the lack of heating or opening of doors or windows. The author also paid attention to wall aeration, which can have an essential influence on the thermal insulation of the external wall[24]. A diagrammatic section of the laminar wall was being presented[25]. Each layer has a different function and should be made of the appropriate materials. The heat absorptive layer can be made of full brick, cavity brick or light porous clay brick etc. The heat-protective layer might be made of straw segment, cork, sawdust, pumice, gas-concrete, Celolit etc. The seal layer of building paper, bitumite felt, or even steel sheet. The author described a lot of different laminate walls presenting their insulative qualities in comparison with traditional brick wall.

It was believed that gas-concrete would be the material allowing one to build houses cheaply and quickly[26]. Teodor Toeplitz, a great promoter of social housing estates, described numerous advantages of this material[27]. First of all, he highlighted the smaller cost of building a wall made of concrete blocks, lighter and bigger than traditional brick, using less mortar with a resulting reduction in the wetness of the wall. The smallest admissible thickness of the external walls, when it comes to climate conditions, was the length of two bricks that was 55 cm. When built with concrete this might be reduced to 20 cm.

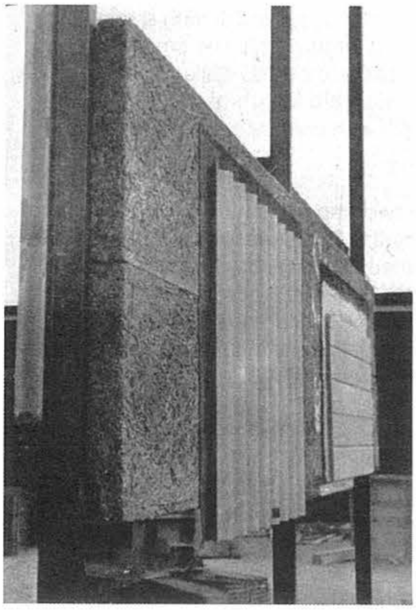
Unfortunately, these two above-mentioned experimental buildings designed by the Syrkuses are the only material proof of the efforts to apply steel structure and screen walls with ready-made face brick in Poland. These projects were repeated several times in Poland and abroad. Before the Warsaw Housing Co-operative found the money to build the Rakowiec housing estate, favourable circumstances for the application of steel in massive building disappeared first in Germany, where it had started, and then in Poland. Steel factories didn't have to look for markets for their products. Their mass buyer, unfortunately, became the war industry. Even traditional Klein ceilings (*Kleinsche Decke*) proved to be too expensive. The housing estate in Rakowiec was built from brick and wood. Nevertheless, its realisation was novel. Hempel, for the first time in Poland, applied a transverse system of 27 cm carrying walls and 6 m spacing, taking to its maximum the strength of wooden binding joists[28].



Insulation characteristic of the brick walls. *Dom, Osiedle, Mieszkanie*, nr 9, 1930, p.28.



Insulation characteristic of the different laminated walls. *Dom, Osiedle, Mieszkanie*, nr 9, 1930, p.30. Instead of expressing the insulation degree with the k-value, it is defined by the inner/outer temperature difference, like -20° to +14° for a bad isolated wall and -20° to +41° for a good one. (ed.)



External wall with corrugated eternit facing as presented on the housing exhibition in Warsaw, 1935 Limperg, K.: *Naar warmer woningen.* Amsterdam 1936. p. 53

Although countries, much richer than Poland, like England, Austria, Germany or USA had a well developed research system, they still asked for greater research, intensification of theoretical studies and experimental building. In Poland there was no money for this kind of research. The architects carried it out at their own expense. Szanajca for the first time introduced durable corrugated Eternit (asbestos cement) facing instead of external plaster in the house at Inwalidzi Place, Warsaw. Czesław Pukiński's system – the Celolit external wall with ready-made stone facing – was also applied in a multifloor ZUS block of flats built in 1935 in Gdynia according to Piotrowski's project. Every exhibition in the years 1930-1936 organized by PTRM (Polish Association of Housing Reform), SARP (Society of Polish Architects), TOR (Worker's Housing Estate Association), WSM (Warsaw Housing Co-operative) or even the Bank of Country Economics in Bielany, Koło, Rakowiec or Zoliborz initiative was taken as an occasion to exhibit and present new structure systems as well as new technological and installational achievements.

After the war in 1945 the Syrkuses undertook work in the Warsaw Restoration Office where Szymon became one of the managers. In 1946 along with the *Warsaw accuses* exhibition the Syrkuses visited England and USA, renewing CIAM contacts and co-operation lasted till CIAM ceased to exist in 1957[29]. In 1963 professor Szymon Syrkus retired and he died the following year. Professor Helena Syrkus published a book *Towards the Idea of Social Housing Estate* which is a summary of their life achievements and participation in the Polish and European Modern Movement. The Industrialisation of housing architecture was the problem which appears over and over again in their work that falls into the golden era of Modernism, which they co-created in Poland and Europe.

Literature

Awangarda polska - architektura i urbanistyka 1918-1939. Ed. by Olgierd Czerner i Hieronim Listowski, Paryż, Warszawa 1981.
Czerner Olgierd, *W poszukiwaniu nowej treści i formy.* In: *Awangarda polska - architektura i urbanistyka 1918-1939.* Ed. By. Olgierd Czerner i Hieronim Listowski, Paryż, Warszawa 1981, pp. 64-100.
Eksperymentalny dom z celolitu, "Dom, Osiedle, Mieszkanie", 1929, no 7, pp. 1-4.
Faryna-Paszkiewicz Anna, *Saska Kępa 1918-1939. Architektura i urbanistyka.* Wrocław, Warszawa, Kraków, Gdańsk, Łódź, 1989.
Gazobeton a cegła, "Dom, Osiedle, Mieszkanie", 1930, no 3, pp. 51-53.
Gazobeton, "Dom, Osiedle, Mieszkanie", 1930, no 9, pp. 42-44.
Gazobeton na wystawie, "Dom, Osiedle, Mieszkanie", 1930, no 4, pp. 38.
Kłosiewicz Lech, *Modernizm polski. Seminarium w stulecie urodzin modernistów polskich*, "Kwartalnik Architektury i Urbanistyki", 2000, no. 2, pp. 84-95.
Kolanowska Helena, *Warszawa funkcjonalna. Uczestnictwo Polski w CIAM.* In: *Awangarda polska - architektura i urbanistyka 1918-1939.* Ed. by. Olgierd Czerner i Hieronim Listowski, Paryż, Warszawa 1981, pp. 49-63.
Produkcja celotexu, "Dom, Osiedle, Mieszkanie", 1930, no 9, pp. 45-46.
Roguska Jadwiga, *Helena i Szymon Syrkusowie: koncepcje typizacji i uprzemysłowienia architektury mieszkaniowej*, "Kwartalnik Architektury i Urbanistyki", 2000, no. 2, pp. 105-119.
Syrkus Helena, *Ku idei osiedla społecznego 1925-1975.* Warszawa 1976.
Syrkusowie Helena i Szymon, *Dom wypoczynkowy na Królewskiej Górze pod Warszawą*, "Architektura i Budownictwo", 1934, no. 4, pp. 117-121.
Syrkusowie Helena i Szymon, *Masowa produkcja mieskań*, "Dom, Osiedle, Mieszkanie", 1931, no 9, pp. 2-15.
Syrkusowie Helena i Szymon, *Rodowód architektury funkcjonalnej*, "Dom, Osiedle, Mieszkanie", 1939, no 6/7, pp. 35-42.
Syrkus Szymon, *Het Nieuwe Bouwen in Polen - De buitenmuur - Ondervindingen in de laatste jaren*, "De 8 en Opbouw", 1934, no 13, pp. 105-111.

Syrkus Szymon, *Fabrykacja osiedli*, "Architektura i Budownictwo", 1928, no. 8, pp. 227-303.
Toeplitz Teodor, *Betony lekkie*, "Mieszkanie, Dom, Osiedle", 1929, no 9, pp. 3-8.
Tomaszewski L., *Wartości izolacyjne ścian zewnętrznych*, "Dom, Osiedle, Mieszkanie", 1932, no. 9, p. 26-30.
Wisłocka Izabella, *Awangardowa architektura polska 1918-1939.* Warszawa 1968.
Wystawa "Mieszkanie najmniejsze", "Dom, Osiedle, Mieszkanie", 1930, no. 3.
Żenczykowski Wacław, *Konstrukcje i materiały budowlane w ramach wystawy*, "Architektura i Budownictwo", 1935, no. 5, pp. 154-160.

Szymon Syrkus

1893	born April 24 in Warsaw
1964	died June 6 in Warsaw
1911	architectural studies at Technical Universities in Vienna
1912-1914	in Graz
1915-1918	in Riga and in Moscow
1920-1921	at the Academy of Fine Arts in Cracow were he joined the group of Formists
1918-1922	at the Faculty of Architecture at Warsaw Technical University
1922-1924	practice in Berlin, Weimar (Bauhaus) and in Paris (Academie des Beaux Arts) where he became acquainted with works of Cézanne and ex-cubists, at Mondrian's studio he met architects, members of *De Stijl* group
1924	returned to Poland in December, work in the office of H. Gay, an architect
1925-1917	co-operation with H. Oderfeld, with whom he participated in the competition for the League of Nations Palace in Geneva
1925	accession to the Blok group
1926	participation in the 1st International Exhibition of Modern Architecture in Warsaw
1925-26	foundation of the *Praesens* group (by Syrkus), beginning of the cooperation with Helena Niemirowska, his future wife
1927	participation in the Machine Age Exposition in New York
1928	appointment to a C.I.A.M. representative in Poland
1939-1942	work in a clandestine Architecture and Town-planning Workshop
1942	arrest and deportation to the concentration camp at Auschwitz
from 1945	assistant manager in the Capital City Reconstruction Office
from 1949	Professor at the Faculty of Architecture at Warsaw Technical University, in the City Planning and Architecture Department

Poland's participation in C.I.A.M. congresses and C.I.R.P.A.C. conferences

CIRPAC, Comité International pour la Résolution des Problèmes de l'Architecture Contemporaine was the elected executive organ of CIAM (Congrès Internationaux d'Architecture Moderne). Source: *Awangarda polska - architektura i urbanistyka 1918-1939.* Ed. by Olgierd Czerner i Hieronim Listowski, Paryż, Warszawa 1981 and Wisłocka Izabella, *Awangardowa architektura polska 1918-1939.* Warszawa 1968

1928 June 25-29, **1st C.I.A.M. Congress**, La Sarraz Castle. A written invitation was extended to the Polish delegate **Szymon Syrkus** about July 10. J. Szanajca became his deputy.

1929 From February 2, Conference of C.I.R.P.A.C. Delegates. Basel. **Szymon Syrkus** and **Helena Syrkus** took part in the conference. They presented a model of the country group connected with the organisation in charge of the building of workers' settlements.

1929 October 24-26, **2nd C.I.A.M. Congress**, Frankfurt on the Main, **Szymon Syrkus** (delegate), J. Szanajca (deputy). T. Toeplitz and **Helena Syrkus** (members of the delegation). Poland submitted designs by: Warsaw Housing Co-operative (B. and S. Brukalski and B. Zborowski); Gdynia Housing Cooperative (R. Gutt, J. Jankowski, A. Paprocki, J. □akowski); □ód□ Workers' Colony in Polesie Konstantynowskie (J. Berliner, S. J. □ukasik, M. Słońska, W. Szereszewski), and filled in questionnaires. One of these was prepared with great care by T. Toeplitz, a non-architect, yet a C.I.A.M. member. After the Congress, a touring exhibition "The Smallest Dwelling" was organized in Poland in one of the buildings of the Warsaw Housing Cooperative at □oliborz.

1930 Conference of C.I.R.P.A.C. Delegates. Paris. **Szymon Syrkus** and **Helena Syrkus** took part in the conference.

1930 From November 27, **3rd C.I.A.M. Congress Brussels. Szymon Syrkus** delivered a lecture on housing conditions in Poland and cited the example of the Rakowiec Project, the first linear estate in Poland.

1931 June 4-7, Conference of C.I.R.P.A.C. Delegates. Berlin. **Szymon Syrkus** and **Helena Syrkus** took part in the conference.

1932 Conference of C.I.R.P.A.C. Delegates. Barcelona.
No polish participation.

1933 Conference of C.I.R.P.A.C. Delegates. Paris. **Szymon Syrkus** and **Helena Syrkus** took part in the conference. S.Giedion, Secretary-General of C.I.R.P.A.C. and C. van Esteren, member of the Praesidium, visited Warsaw and discussed the programme for the 4th Congress with the Polish C.I.A.M. group.

1933 July 29 - August 13, **4th C.I.A.M. Congress**. "Patris" ship. Marseilles - Athens - Marseilles. S. Brukalski becomes member of the Friends of the Congress Organisation Commission. R. Piotrowski (Resolution Commission), **Helena Syrkus** (Commission of Protocols) and **Szymon Syrkus** (Press Commission). In a review of town planning, **Szymon Syrkus** presented a report on Warsaw. He also contributed to the work of the group which was to set up an outline of the programme of the further activity of C.I.A.M. B. and S. Brukalski prepared a lecture entitled: *Works of the Warsaw Housing Cooperative and Dwelling Conditions*. **Szymon Syrkus** delivered a lecture *The External Wall in Skeleton Building* illustrated with photographs of buildings designed by H. and S. Syrkus and S. Hempel. **Helena Syrkus** co-operated with Le Corbusier and S. Giedion in elaborating reports from particular sessions of the 4th Congress. Beginning from 1933 **Helena Syrkus** cooperated permanently with the C.I.A.M. Secretariat. R. Piotrowski became a C.I.R.P.A.C. delegate in 1933.

1934 Conference of C.I.R.P.A.C. Delegates. London.
J. Chmielewski and Szymon Syrkus, representatives of the *Praesens* and Urbanistics (P+U) groups presented at the conference the project *Functional Warsaw, a contribution to the urbanisation of the region of Warsaw*, which aroused great interest (a letter from C.I.R.P.A.C. to the Polish authorities concerning the realisation of this project). For the additional 5th Congress theme – External Walls in Skeleton Buildings – a list of questions and illustrations were prepared by **Helena Syrkus** and C. Hubacher.

1935 Conference of C.I.R.P.A.C. Delegates. Amsterdam. **Szymon Syrkus** and **Helena Syrkus** took part in the conference.

1936 Conference of C.I.R.P.A.C. Delegates. La Sarraz. **Szymon Syrkus** and **Helena Syrkus** took part in the conference.

1937 June 22 - July 2, **5th C.I.A.M. Congress**. Paris. During the Congress **Szymon Syrkus** delivered one of the main lectures outlining the work of architect-urbanists in the new branch of planning, village planning. S. Tołwiński had a lecture on the organisation of summer holidays in workers' settlements. He was invited to join the C.I.A.M. **Helena Syrkus** discussed the conditions of building workers' houses in Poland.

1938 Conference of C.I.R.P.A.C. Delegates. Brussels. **Szymon Syrkus** and **Helena Syrkus** took part in the conference.

1939 Conference of C.I.R.P.A.C. Delegates. Zurich. Although invited, the Polish delegation could not attend the conference.

Notes

[1] Syrkus, H., *Ku idei osiedla spo□ecznego 1925-1975.* Warszawa 1976, p.28.

[2] Wisłocka, I., *Awangardowa architektura polska 1918-1939.* Warszawa 1968, p.109-110.

[3] Magazine of avant-garde Blok group.

[4] Wisłocka, I., *Awangardowa architektura polska 1918-1939.* Warszawa 1968, pp.110-111; Roguska, J., *Helena i Szymon Syrkusowie: koncepcje typizacji i uprzemys□owienia architektury mieszkaniowej*, "Kwartalnik Architektury i Urbanistyki", 2000, no. 2, p. 105.

[5] Wisłocka, I., *Awangardowa architektura polska 1918-1939.* Warszawa 1968, p.113.

[6] Wisłocka, I., *Awangardowa architektura polska 1918-1939.* Warszawa 1968, p.116. They were: 1. Jadwiga Dobrzyńska and Zygmunt □oboda; 2. Antoni Dygat, Alfons Gravier, Mieczysław Kozłowski and Marian Bolesław □urkowski; 3. Bohdan Lachert, Józef Szanajca and engineer Stanisław Hempel; 4. Henryk Oderfeld and Szymon Syrkus; 5. Juliusz Nagórski.

[7] Wisłocka, I., *Awangardowa architektura polska 1918-1939.* Warszawa 1968, p.115-116; Czerner, O., *W poszukiwaniu nowej tre□ci i formy.* In: Awangarda polska - architektura i urbanistyka 1918-1939.Ed. by. O. Czerner and H. Listowski, Paryż, Warszawa 1981, p.82-83.

[8] Kolanowska, H., *Warszawa funkcjonalna. Uczestnictwo Polski w CIAM.* IN: *Awangarda polska - architektura i urbanistyka 1918-1939.* Ed. by. O. Czerner and H. Listowski, Paryż, Warszawa 1981, p.50.

[9] Wisłocka, I., *Awangardowa architektura polska 1918-1939.* Warszawa 1968, p.117.

[10] Wisłocka, I., *Awangardowa architektura polska 1918-1939.* Warszawa 1968, p.145. In that house the ceiling was made of 13 cm reinforced Celolit segments. The total thickness of the ceiling with down plaster, seizing with cement dressing, linotol and linoleum layer doesn't exceed 15 cm.

[11] *Wystawa „Mieszkanie najmniejsze*, „Dom, Osiedle, Mieszkanie", 1930, no.3. Celolit plates made with light porous concrete.

[12] Toeplitz, T., social and municipal activist, one of the founders of Warsaw Housing Cooperative (1923), a founder of Polish Society of Housing Reform (1929), publications on co-operative movement, municipal self-government and town planning.

[13] Syrkus, H., *Ku idei osiedla spo□ecznego 1925-1975.* Warszawa 1976, pp.71-72.

[14] *Gazobeton na wystawie*, "Dom, Osiedle, Mieszkanie", 1930, no 4, p.38. Special attention was paid to gas concrete. The 20 cm external gas concrete block wall on gas concrete mortar was shown. It substituted if it comes to the thermal insulation level, a 55 cm brick wall. Further exhibits were 14,10 and 7 cm gas concrete partition walls, reinforced gas concrete segment ceiling, reinforced gas concrete beam for window lintels. *Wystawa "Mieszkanie najmniejsze", Dom, Osiedle, Mieszkanie*, 1930, no.3. It is a special magazine volume devoted to the exhibition which contains a detailed manual of Polish exhibitions with the description of new building materials such as: Aerocret, gas concrete, Celolit, Izobet and Alfa hollow brick, (materials used for building walls and carrying ceiling), Heraklit, Tekton, Celdex, Peatoleum, Berbeca cement, Trocal, peat segments, wooden-magnesite segments (material filling partition walls, wall and ceiling insulation) and plasters (Felezytyn, Linotol etc.).

[15] Syrkus, H., *Ku idei osiedla spo□ecznego 1925-1975.* Warszawa 1976, p.95.

[16] Syrkusowie, H. and S., *Masowa produkcja mieszka□, Dom, Osiedle, Mieszkanie*, 1931, no 9, p.3. Family detached houses as well as town houses were designed by T.Michejda.

[17] Syrkusowie, H. and S., *Masowa produkcja mieszka□, Dom, Osiedle, Mieszkanie*, 1931, no 9, p.10-11.

[18] Syrkus, H., *Ku idei osiedla spo□ecznego 1925-1975.* Warszawa 1976, p.104.

[19] Hempel, S., *Szkieletowe konstrukcje żelazne*. Warszawa 1933.

[20] Syrkus, H. and S., *Masowa produkcja mieszka□, Dom, Osiedle, Mieszkanie*, 1931, no.9.

[21] Syrkus, H., *Ku idei osiedla spo□ecznego 1925-1975.* Warszawa 1976, pp.105-107.

[22] Foreign publications by S. Syrkus are: *Architecture opens the volume*, Catalogue of the *Machine Age Exposition*, New York, 1927; *Le probleme de l'habitation en Pologne*, La Cité et Technique, 1931; *Production des logements en masse* (with H. Syrkus), L'architecture Aujourd'hui, 1932' *Le mur exterieur*, Texnica Xponica, 1933; *Het Nieuwe Bouwen in Polen*, De 8 en Opbouw, 1934, no 13, pp. 105-111; *De l'architecture et de la production des habitations ouvrieres* (with H. Syrkus), Brussels, 1935; *Logis et loisirs - cas d'application: villes et campagnes*, le livre du V-me Congres CIAM, 1938.

[23] Tomaszewski, L., *Warto□ci izolacyjne □cian zewn□trznych, Dom, Osiedle, Mieszkanie*, 1932, no 9, p.26-30.

[24] Tomaszewski, L., *Warto□ci izolacyjne □cian zewn□trznych, Dom, Osiedle, Mieszkanie*, 1932, no 9, p.26. He debates with the accepted view that the external wall must be airy. He recalls Prof. E. Jobst Siedler (Berlin), stating that the wall should be airy when the room lacks other types of ventilation, or when the wall is saturated with moisture. Moisture excess may be introduced during the construction or because of rain. The wall could have an excess of moisture from internal condensation (in particular in bathrooms and laundry rooms) and also from the moisture condensation contained in an air layer in external walls, for example, hollow concrete bricks. In case the wall is not exposed to internal or external moisture, airy walls are not needed. In fact, it could be disadvantageous because of heat loss.

[25] Tomaszewski, L., *Warto□ci izolacyjne □cian zewn□trznych, Dom, Osiedle, Mieszkanie*, 1932, no 9, p.27. This section was presented by prof. E.J.Siedler in „Bauwelt", no. 2, 1931.

[26] *Gazobeton, Dom, Osiedle, Mieszkanie*, 1930, nr 9, s.42-44. Polish patent No. 8404. *Gazobeton a ceg□a, Dom, Osiedle, Mieszkanie*, 1930, no.3, pp.51-53. *Gazobeton na wystawie, Dom, Osiedle, Mieszkanie*, 1930, no.4, p.38.

[27] Teodor, T., *Betony lekkie*, "Mieszkanie, Dom, Osiedle", 1929, no 9, pp.3-8.

[28] Syrkus, H., *Ku idei osiedla spo□ecznego 1925-1975.* Warszawa 1976, pp.105-107.

[29] Roguska, J., *Helena i Szymon Syrkusowie: koncepcje typizacji i uprzemys□owienia architektury mieszkaniowej*, "Kwartalnik Architektury i Urbanistyki", 2000, no. 2, p.114.

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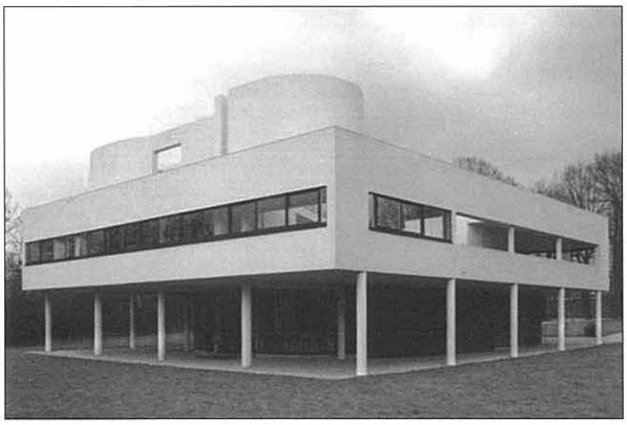
The Modern Movement and the Flat Roof discussion

by Anke Zalivako

It is evident that flat roofs have been built a long time before the Modern Movement appeared in architecture. Buildings from classical periods often had a horizontal top with flat pitched metalsheated roofs hidden behind a parapet. This construction method can be considered as preparation for the upcoming Modern Movement that dissolved the traditional context of construction parts turning these into a new composition of mostly cubic forms. Le Corbusier's and Ozenfant's programme of *l´esprit nouveau* or the Russian Constructivist manifest which was published in the journal "Sovremennaja Architektura" with a similar philosophy[1] are just mentioned here in order to bring to mind the theoretical background of the early 1920´s. Le Corbusier's Villa Savoye (Poissy 1929) became an incarnation of his five theses about the "new" architecture as proclaimed in his book "vers une architecture". The roof was named as 5th view of the house. The flat roof with a minimum slope of about 3% had to fulfil three different functions: structural, waterproofing and insulating plus occasionally working as an additional floor: as a roof garden.



Le Corbusier, Villa Savoye (Poissy 1929)

5

ТЕЗИСОВ КОРБЮЗЬЕ

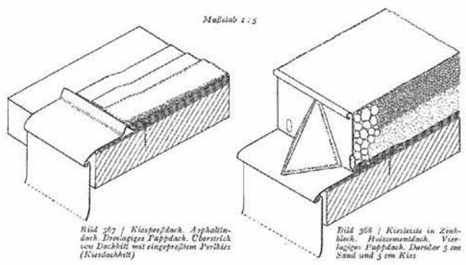
I. СТОЛБЫ

VEISSENHOFSIEDLUNG STUTTGART. ZWEIFAMILIENHAUS VONLE-CORBUSER UND P. JEANNERET

Review Sovremennaja Architektura 1926, No. 1,

"Wood-cement" roof

The prototype of later flat-roof constructions was the "wood-cement" roof (*Holzzement*). In Germany it was introduced in the 1870-80´s, when it became technically possible to construct waterproofing out of one single piece of material, using layers of roofing felt upon lagging (*Holzschalung*) on wooden beams.[2] Those roofs had a pitched part to the street facade covered with roofing tiles and a flat part to the back. Later the general understanding of a wood-cement roof in Germany was defined as "several, but minimum three layers of roofing felt covered for UV-protection with a minimum of 10 cm sand or gravel".[3]



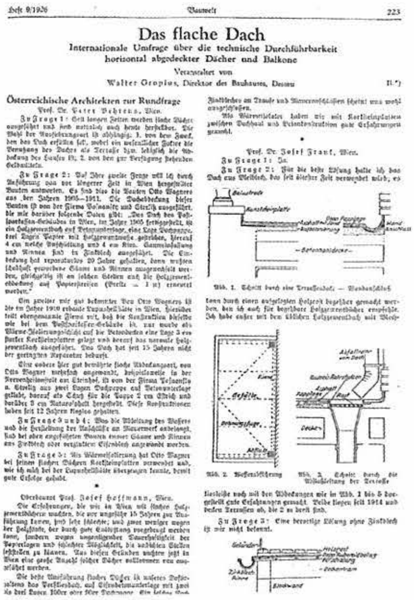
Gravel and woodcement flatroof. Ed. Jobst Siedler: *Die Lehre vom neuen Bauen*

"Gravel" roof

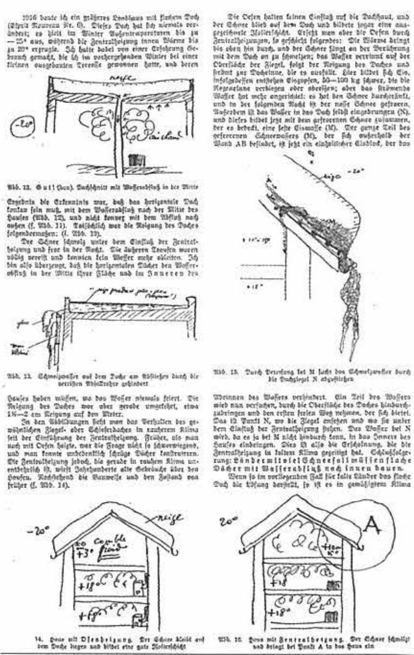
The gravel-covered roof was quite popular in Germany in the 1920´s, too. It was the attempt to postpone UV-lighting and aging of the roofing felt: Several layers of roofing felt were painted with mastic, the last one covered with pressed-in "silvergrey pea-size gravel"[4] that prevented the surface from drying out. The edge of the roof was made by metal profiles out of zinc, copper or aluminium. This was a typical construction for the roofs in the Frankfurt settlements, for example in Frankfurt Praunheim (architect Ernst May). While erecting these worker´s settlements in Frankfurt, the *Bauhaus* buildings in Dessau in 1925-1928[5], and the dwellings within the exhibition of the German *Werkbund* in Stuttgart 1927, many different methods for constructing a flat roof were employed. This included construction upon wooden beams and lagging, or alternatively upon a concrete slab, or massive brick ceilings with thermal insulation materials such as light concrete, cork or *Torfoleum*-tiles with waterproofing layers made from Ruberoid, asphalt (goudron), pitch-bitumen binder, lead roofing felts (*Bleipappen*) or mastic (Durumfix).

The *Werkbund* exhibition in Stuttgart (1927) comprised the *Weissenhof* settlement itself and a test site adjacent to the settlement, where modern building materials and new construction methods were shown. The *Weissenhof* settlement together with the *Bauhaus* became the manifestation of the Modern Movement in Germany. However, this process provoked strong opposition among

Werkbund Exhibition in Stuttgart-*Weissenhof*, 1927



Walter Gropius, *Das flache Dach. Internationale Umfrage über die technische Durchführbarkeit horizontal abgedeckter Dächer und Balkone*, Bauwelt 1926, No. 9, p. 223. Answers by Peter Behrens, Josef Hoffman and, illustrated, Josef Frank.



Gropius' inquiry on the flat roof; entry by Le Corbusier. Bauwelt 1926, No. 9, p. 226.

Gropius' inquiry about the flat roof with an entry by Erich Mendelsohn. Anketa OSA ploskaja kryša // Sovremennaja Architektura 1927, No 5-6, p. 127.

architects themselves. The representatives of the Modern Movement like Hugo Häring, Erich Mendelsohn, Ludwig Mies van der Rohe, Richard Döcker, Walter Gropius, Hans Poelzig and Bruno Taut were – so did Paul Bonatz, Paul Schmitthenner and Paul Schultze-Naumburg – just to list the wellknown ones.

The "*Weissenhof* accumulation" of flat roof buildings flared up the dispute about the preference of either a pitched or a flat roof. The extreme traditional *Kochenhof* settlement erected 1933 in the same neighbourhood with its pitched roofs is still illustrating the argument about the flat roof.[6] Here, as well as in Berlin, traditional and "modern" settlements were built right next to each other and caused the so-called "Zehlendorf roof war". As usual, when a new technical solution appears, this is accompagnied by arguments with traditionalists, in this case questioning any advantage of a flat roof. They were doubting the construction method itself, whereas the architects of the Modern Movement were supporting the idea of a better fire protection, additional rectangular space under the flat roof, and the fact that a flat roof would be more economical being of less volume. However "the discussion focused on the form – flat or pitched roof – became synonyms for two different professional attitudes."[7]

One more reason for inflaming the discussion in Germany was the *Bauhaus*-interview about "technical feasibility of flat roofs and roof gardens", initiated by Walter Gropius in 1926, which was published in several issues of the German review *Bauwelt*.[8] Five questions about the flat roof helped to collect international knowledge among architects. These were:

1. With today´s knowledge in building construction, do you think that it is possible to construct an absolutely waterproof flat roof?
2. Which technical solutions you would prefer? How long do the roofs, which you have in mind, already work properly?
3. Do you think it is possible to avoid using zinc for the joint between the flat roof and an adjacent wall or other vertical parts of the building?
4. Which technical solution within a surrounding parapet would you prefer in order to get rid of the rainwater?
5. Which kind of thermal insulation within a flat roof above apartments would you think is good to use?

The answers of well known architects such as Mendelsohn, Oud, Le Corbusier and many other architects have been published. All of them were convinced that the flat roof would "win through", although, as J.J.P. Oud said: "the technical basis of what we as architects want to create is still not developed at all".[9] The flat roof interview from 1926 and 1927 had been published in other European countries, such as in the Soviet journal "Sovremennaja Architektura", adding the answers of the Soviet architects.[10]

Paul Schultze-Naumburg, *Flaches oder geneigtes Dach, mit einer Rundfrage an Deutsche Architekten und deren Antworten*. Berlin 1927 (Flat or pitched roof, with a inquiry for German architects and their answers).

The peak was passed when Paul Schultze-Naumburg being a represent of the traditional architects published another pamphlet with a similar title: *Flaches oder geneigtes Dach, mit einer Rundfrage an Deutsche Architekten und deren Antworten*, Berlin 1927.[11] He introduced the book with his theory of the "pitched roof as an essential part of occidental houses" and criticized that "the introduction of oriental flat roofs would be something similar as if we were recommended to wear white linen clothes and a tropic helmet."[12] Schultze-Naumburg explains his personal point of view in five chapters.
In Schultze-Naumburg's mind roof terraces and flat roofs were only acceptable in such cases where the budget was not limited at all, for example, if a "royal castle" is erected, but not for ordinary people's dwellings. In his mind flat roofs were disturbing the town´s appearance from an aesthetical point of view, too. For him the flat roof appeared simultaneously "with the deterioration of good building skills and traditions of the 19th C."[13], when roofing felt and woodcement appeared on the market. He presents Gropius' Villa Auerbach in Jena, which was Gropius first "Modern Movement" house, as an illustration of bad examples.
In the second chapter Schultze-Naumburg explains that the pitched roof is the prototype of construction under the northern sky. He says "that every child would know, that water is much better draining down from a pitched than from a nearly horizontal plain."[14]
In the third chapter he lists the disadvantages of a flat roofs being "cheap and not durable", listing in return the advantages of pitched roofs. The titles, "The advantages of a pitched roof" and "The disadvantages of a flat roof" were chosen by Schultze-Naumburg for his summary ending with the following explanatory statement: "The proposal of Le Corbusier to put the drain pipe into the center of the house, can only be considered as dilletantism."[15] This statement refers to Le Corbusier's thoughts about a useful type of drainage in question No. 4 of the *Bauwelt*-interview. Le Corbusier illustrated, how the invention of central heating in combination with useful space directly under the pitched roof would make the

Paul Schultze-Naumburg's example of a "modern" Villa in Stuttgart (Schmitthenner), *Flaches oder geneigtes Dach*, p.33

snow melt and then freeze again in the gutter, which would cause leakage and damages as a result. Le Corbusier's conclusion was that "countries with a lot of snow should have flat roofs with a slope of 1-2 cm and an internal drain pipe".[16]
In the fourth chapter Schultze-Naumburg gives another pathetitic description of the beauty of a pitched roof covered with a red *Biberschwanz*-tile being "the ideal material for the German roof". This is followed by a strange theory stating that each "human race" or "blood-community"[17] has its own typical dwelling types. This illustrates the author´s affinity to the Nationalsocialist thinking of that time in Germany.
In his final conclusion the author presents an analogical "report on the opinion about the flat and the pitched roof"[18] based on the following questions:

1. Do you feel that it is time to switch to flat roof construction for houses in general?
2. Do you think that there is any advantage to use a flat roof for a house if it is possible to construct a pitched roof for the same price taking into account the additional space under the pitched roof?
3. Did you ever notice leakage with flat roofs?
4. Do you think that it is more difficult to discover the point of leakage within flat roofs rather than within pitched roofs?
5. If there is no special reason for this, would you prefer inside drainage to external gutters?

Bild 14. Moderner Villenbau ohne Dach.

Paul Schultze-Naumburg entitled Auerbach House in Jena (Walter Gropius 1924) as a modern villa without roof. *Flaches oder geneigtes Dach*, p.20

Auerbach House in a contemporary photo

Schultze-Naumburg published the answers of not very well-known university teachers of that time, but also from Prof. Dr. Paul Bonatz, Stuttgart, Prof. Dr. Theodor Fischer, Berlin, as well as from Prof. Paul Schmitthenner, Stuttgart. All their statements support his own views on the subject.

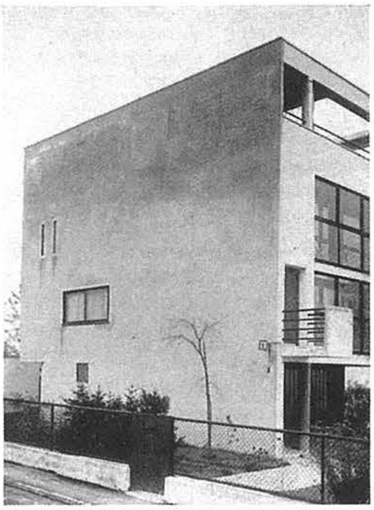


Abb. 47—48. Die Hauswand ist vollkommen durchnäßt. Innen auf der „freundlichen" Dachterrasse sieht man die einzelnen Steine des Mauerwerks durch den Putz. Besonders „eigenartig" ist auch der über der Haustür vorgezogene Balkon, der an einen herausgezogenen Karteikasten erinnert. Die waagerechte Gitteranordnung ist zu verwerfen. — S. 27, 45, 56. (Stgt-W 154.)

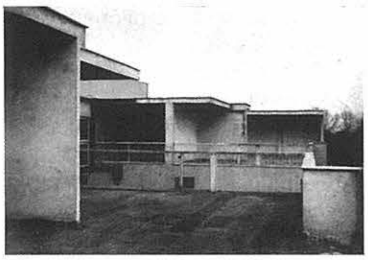
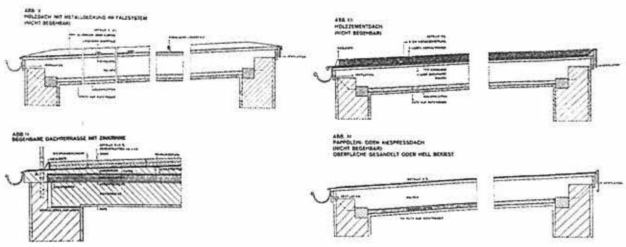


Abb. 22. Dachterrasse voller Winkel und Ecken; Dächer, die doch nicht genügend schützen. Das Ganze kahl und ungemütlich. — S. 24, 26, 40, 43. (Bresl 63.)

Abb. 121. Flachdächer wirken von oben gesehen meist häßlich, daher in bergigen Gegenden auch aus diesem Grunde zu vermeiden. Sie erfordern häufigere Reparaturen, wenn sie nicht sehr sorgfältig ausgeführt sind. — S. 19. (Stgt-W 165.)

Critical comments on Modern Movement technology. Helmut Hempel, *Vermeidet Mängel im Wohnungsbau. Ein Buch warnender Beispiele.* Berlin 1935

The German Modern Movement architect Ernst May generally commented on publications like the one published by Paul Schultze-Naumburg in an article in the journal *Das neue Frankfurt* (1927, No.1). He writes: "Unfortunately the dispute about 'flat' or 'pitched' roof often exceeds any neutral discussion. The defenders of pitched roofs have got to the point where they exaggerate their criticism of the flat roof denying this one together with modern architecture in general. One honourable architectural journal does not even shrink back (...) to publish the photo of a just fresh plastered wall to make readers think that the spots were caused by mistakes in the roof-construction.(...) The construction of flat roofs is no more a problem, in fact, there are various technical solutions of how to build a proper flat roof which are fully meeting the requirements of thermal insulation and waterproofing. With no doubt bad roofs with wrong detail



Flat roof structures in use for Frankfurt settlement houses by Ernst May. *Das neue Frankfurt* 1926, No. 27, p. 159-160

design and materials are still existing and should be avoided in the future."[19]

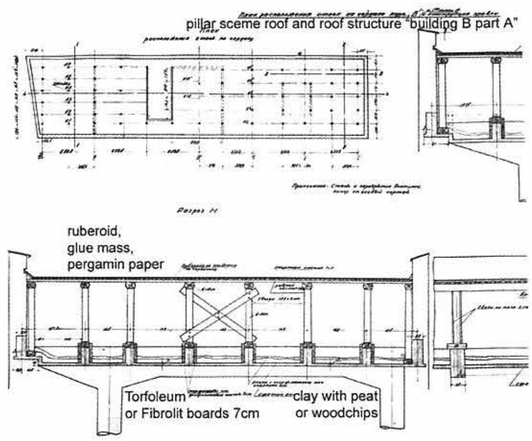
Ernst May´s article is illustrated with some examples of flat roofs that had been built in Frankfurt´s worker's settlements. A summary of popular construction methods of that time can also be found in Siedler's book, table no. X and XI.

"Metal" roof

In the Frankfurt settlements flat roofs had been constructed and covered with metal sheets on shuttering above wooden beams as well as on in-situ concrete slabs as what we call „warm roofs" today.[20] Typical was the coverage of the insulation layer such as cork or *Torfoleum* with a slightly sloped concrete screed. This unavoidably caused tensions within the construction with the changes of temperature and led to cracks as a result.[21] The defenders of flat roofs were aware of this problem. Ernst May recommended movement-joints in his article: "It has long been known how to construct a flat roof above wooden beams. But we should be very careful with regard to movements within the roof while constructing flat roofs above in-situ concrete slabs. Here we need quite a number of movement joints in order to deal with the changes of temperature and to avoid cracks."[22]

'Ruberoid' roof

The Ruberoid roof normally consisted of two layers and was as popular as the gravel-covered roof, also in the Soviet Union: Two or three layers of ruberoid, consisting of asphalt–roofing felt were sticked with mastic glue on wooden lagging. This is how the roof of Le Corbusier's *Centrosojus* building in Moscow had been constructed by Nikolai Kolli, who was in charge of the detail design.[23]



Centrosojus building, by Le Corbusier and Nikolai Kolli, Moscow 1929.

Under the waterproofing layer there is a properly ventilated space within the roof. The framework is made from wood and covered with a layer of sphagnum (moss), which actually was a popular solution, often chosen by the Constructivist architects. It caused a lot of problems in Russia's flat roofs of the 1920's. Siedler shows such a construction, built in Stuttgart in his table X, No. 3. Here it consists of two layers on 2% sloped shuttering on wooden beams. The space between the beams was filled with pumice concrete.

"Paste" roof

Siedler defines "roof-pastes" as "roof-mastic consisting of bitumenous substances such as bitumenous coal tar (*Steinkohlenteer*), petrol bitumen or rubber-oil."[24] Several layers of such pastes (f.e. "Durumfix" or "Awegit"-roofing paste in Germany) with a dividing layer of bitumen roofing felt have been used on shuttering and wooden beams as shown in Siedler's table X, No.1 in Stuttgart, No.6 und 7 in Dessau-Törten or on a levelling concrete screed on an in-situ-concrete slab (s. table XI, No.2 in Stuttgart und No. 6 in Dessau-Törten). This levelling concrete screed could also be made from 4 cm sloped cement flooring on cork as insulation layer or on pumice or furnace cinder concrete.
The described solutions show that the construction methods for flat roofs were just about to be properly developed in the 1920's. It must be mentioned that there was no obligatory thermal insulation layer within flat roofs yet. In practice this was limited to pumice or furnace cinder concrete filling within wooden roofs or even with debris from construction works as it was done in Dessau-Törten (see Siedler table X, No.6). In Germany they also used 3-4 cm thick insulation boards from cork or pressed peat (*Torfoleum*) or *Celotex* boards that were only 1 cm thick. In the Soviet Union the Constructivist architects normally used pumice or cinder concrete filling or sphagnum for insulation purposes.

Asphalt roofs

Asphalt was used simply as a natural asphalt layer of about 2 cm or as "soldered asphalt-tiles on a *Torfoleum* layer"[25], as in the *Bauhaus* building and the Masterhouses in Dessau, and also within the *Weissenhof* settlement in Stuttgart.[26]

Siedler's book gives an evaluation of the different construction methods for flat roofs that had been built between 1926 and 1929. This means that they were pretty young when he published his book in 1932. Siedler comes to the conclusion that most of the built flat roofs in Germany have been made with ruberoid or roof-pastes and that "(...) waterproofing roofs with bitumenous pastes or mastic does not work very well".[27] His evaluation table, No. XIII, shows that *Ruberoid* roofs tend to provoke "bubbles" within the waterproofing layer. 10 out of 18 different construction methods for waterproofing on flat roofs were already defective, when Siedler made his summary.

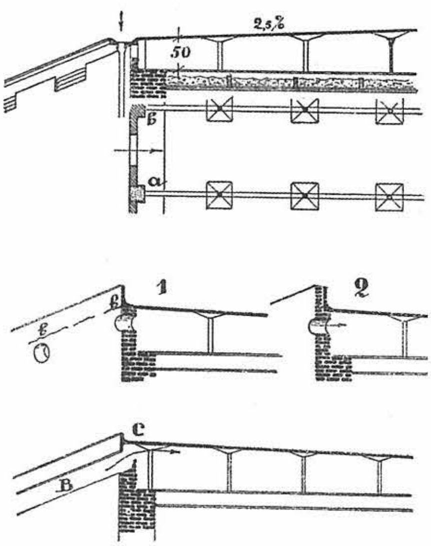
Table X and XI from: Siedler, E. J., *Lehre vom neuen Bauen - Ein Handbuch der Baustoffe und Bauweisen*. Berlin 1932.

Tafel X Flachdächer auf Holzdachstuhl

Lf. Nr.	Ort der Ausführung	Konstruktive Durchbildung des Daches: Schnitt	Konstruktive Durchbildung des Daches: Bemerkungen	Gefälle in %	Wärmeschutz: λ Mittlere Wärmeleitzahl kcal/m h°; k Wärmedurchgangszahl kcal/m² h°; s_z Gleichwertige Vollziegelwand in cm	
1	Stuttgart	0,5 / 2,5 / A / 10 / 5 / 2	2 Lagen Bitumitekt 0,5 cm Bituplast 0,5 cm Bretterschalung 2,5 cm Aufrippung, Gefälle Holzbalken Leistenzellen 5 cm Putz	5	λ = 0,27 k = 0,96 s_z = 64	Mindestwärmeschutz = 42 cm Vollziegelwand 42 cm
2	Stuttgart	0,5 / 2 / A / 18 / 4 / 2	3 Lagen Asphaltpappe 0,5 cm Bretterschalung 2 cm Aufrippung, Gefälle Holzbalken Leistenzellen 4 cm Putz 2 cm	7	λ = 0,51 k = 1,56 s_z = 34	
3	Stuttgart	0,5 / 2 / A / 18 / 2,5 / 1,5	2 Lagen Ruberoid 0,5 cm Bretterschalung 2 cm Aufrippung, Gefälle Holzbalken mit Bimsschüttung. Latten Rohr, Putz 1,5 cm	2—3	λ = 0,15 k = 1,00 s_z = 61	
4	Stuttgart	0,5 / 2 / A / 16	2 Lagen Ruberoid 0,5 cm Bretterschalung 2 cm Aufrippung Holzbalken mit Foniturplatte als Einschub Rabitzputz	4	λ = 0,39 k = 1,08 s_z = 56	
5	Stuttgart	0,5 / 2 / A / 18 / 2 / 1	2 Lagen Ruberoid 0,5 cm Bretterschalung 2 cm Aufrippung Isolierpappe Zickzack-Holzbretterdecke mit Bimskiesauffüllung Gipsdielen 2 cm Putz 1 cm	2—3	λ = 0,37 k = 0,73 s_z = 88	
6	Dessau-Törten	0,5 / 2,5 / 20 / 25,5 / 2,5	Awegit-Dachkitt mit Pappeinlage 0,5 cm Gespundete Bretterschalung 2,5 cm Holzbalken mit Bauschutt als Fehlboden Schalung Rohr, Putz 2,5 cm	3	λ = 0,21 k = 0,90 s_z = 70	
7	Dessau-Törten	0,5 / 2,5 / 20 / 24,5 / 1,1	Awegit-Dachkitt mit Pappeinlagen 0,5 cm Gespundete Bretterschalung 2,5 cm Holzbalken mit Schlackenfüllung Celotexplatten 1,1 cm ohne Putz	3	λ = 0,145 k = 0,58 s_z = 1,27	
8	Frankfurt-Praunheim	2,5 / 16 / 23,5 / 3 / 1,5	Kiespreßdach oder Pappolein oder teerfr. Pappd. } Dachhaut Gespundete Bretterschalung 2,5 cm Holzbalken darunter Isolierplatten 3 cm Putz auf Putzträger 1,5 cm	5	λ = 0,213 k = 0,78 s_z = 82	
9	Frankfurt-Praunheim	2,5 / 16 / 22 / 2,5	Dachhaut wie unter Nr. 8 Holzsparren mit eingeschobener Isolierplatte Rabitz oder Rohrputz 1,5 cm	5	λ = 0,172 k = 0,67 s_z = 98	
10	Frankfurt-Praunheim	2,5 / 16 / 22 / 2,5	Metallabdeckung im Falzsystem Gespundete Schalung Holzsparren mit Isolierplatte Rabitz oder Rohrputz	5	λ = 0,178 k = 0,69 s_z = 95	

Tafel XI Flachdächer auf Massivdecken

Lf. Nr.	Ort der Ausführung	Konstruktive Durchbildung des Daches: Schnitt	Konstruktive Durchbildung des Daches: Bemerkungen	Gefälle in %	Wärmeschutz: λ Mittlere Wärmeleitzahl kcal/m h°; k Wärmedurchgangszahl kcal/m² h°; s_z Gleichwertige Vollziegelwand in cm	
1	Stuttgart	1 / 4-10 / 5 / 24 / 34-40 / 2 / 6 — 27 — 6	2 Lagen Ruberoid } 1 cm 1 Lage Asphaltlack Gefälle Bimsbeton 4—10 cm Eisenbetonstegdecken Rabitzputz 2 cm	2	λ = 0,74 k = 1,16 s_z = 51	Mindestwärmeschutz = 42 cm Vollziegelwand 42 cm
2	Stuttgart	2 / G / 16 / 30 / 3 / 1,5	Streusand 1 Lage Bituplast Jutegewebe } 2 cm 1 Lage Bituplast Asphaltlack Gefälle Bimsbeton Rapidbalken Torfisotherm 3 cm Gipsputz 1,5 cm	2,5	λ = 0,27 k = 0,75 s_z = 86	
3	Stuttgart	4 / 5 / 26,5 / 16 / 1,5	Kiesschüttung 4 cm Durumfix Eisenbetonrohrzellendecke 21 cm Gipsputz 1,5 cm	3	λ = 0,60 k = 1,59 s_z = 34	
4	Stuttgart	3 / 12 / 19,5 / 1 / 3,5	2 Lagen Ruberoid Gefällebeton Kleinsche Decke N. P. 18 gestelzt Gipsputz an eingeschob. Latten	2	λ = 0,37 k = 1,23 s_z = 47	
5	Stuttgart	0,5 / 5 / 5 / 6 / 27 / 4 / 6 / 0,6	2 Lagen Ruberoid 0,5 cm Gefälle Bimsbeton 5 cm Armierte Betonpl. 5 cm Eisenträgermontagedecke Korkplatte 4 cm Celotexplatte 0,6 cm	2	λ = 0,21 k = 0,57 s_z = 119	
6	Dessau-Törten	0,5 / 6 / 24 / 16 / 1,5	Awegit-Dachkitt mit Pappeinlage 0,5 cm Gefälle Bimsbeton 6 cm Rapidbalken 16 cm Putz 1,5 cm	3	λ = 0,49 k = 1,59 s_z = 33	



Electrotechnical Institute, Moscow 1929 A. V. Kuznecov and others. Kusnecov, A. V. Examples of ventilated "cold" roofs. Promyšennoe stroitel'stvo. To rkret i ego primenenie dlja ploskich kryš, part 1 // Stroitel' naja Promyšennost' 1929, No. 1, p. 50.

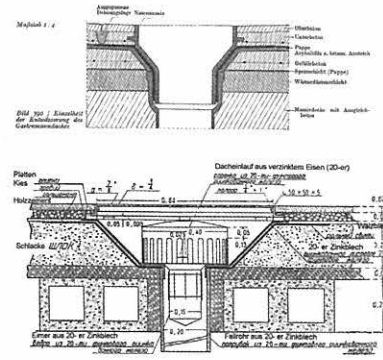
Torkret and *Ceresit* roofs

In addition to this there were some experiments on how to improve waterproofing qualities of the concrete itself with pressure, called *Torkret* concrete (shotcrete), or through adding special substances such as *Ceresit* to Portland cement as an additional mortar-layer onto the concrete-slab. These attempts were made in Russia, too, but not very successful. The buildings for the State Electrotechnical Institute, built in Moscow between 1929 and 1930 got an "umbrella-roof" as prototype of todays ventilated "cold" roof. The space between the last concrete slab, insulated with sphagnum-peat, and the waterproofing thin torcreted concrete slab above was ventilated through a gap in the wall.[28] The final slab could also be slightly sloped and hidden behind the parapet. This was the compromise of the Constructivist architects to introduce the flat roof despite Russia's cold climatic conditions. In Germany *Torkret* concrete was used to erect the cupolas of various planetariums that have been built in the 1920's in Jena or Berlin for instance.

Roof gardens

Constructing a roof garden was a special challenge for the architects of the Modern Movement. For constructing a surface where people could walk on the waterproofing layers, made from roof pastes or roofing felts, it had to be covered by tiles or just with another cement screed in order to prevent the waterproofing from damages.

Similar roof drainage systems in Europe and Russia



"Gartenmann" roof

The Swiss *Gartenmann* roof garden was most popular in southern Germany. Special about it was the system of the floor finishing consisting of two layers of poured concrete on top of prefabricated crossed metal profiles dividing the roof area into 1 x 1m sections on minimum two layers of bitumenous roofing felt as waterproofing. The waterproofing was covered by a cement screed. Waterproofing and insulation layer below were divided by a sloped concrete screed.
The detail design for the *Gartenmann* roof is very similar to the roof of the *Narkomfin* house in Moscow. Its architect Ginzburg designed all his apartment blocks with roof gardens, but he used the Russian version of "wood cement" for waterproofing which is quite similar to the German flat roofs with mastic and roof-pastes. Of course there are lots of damages in this roof today, but it is still there, even the roof drain is still in place. This proves that it could not have been such a bad detail and leads to the conclusion about the 1920's flat roof discussion:

Roof drainage in *Narkomfin* House, Moscow, 2004

Most of the building materials that appeared together with the flat roof in the 1920´s such as metal, pastes, mastic, bitumenous roofing felt or asphalt are still in use in today´s construction practice for flat roofs. Nobody doubts that a lot of mistakes have been done while developing proper construction methods for the flat roof making the first attempts. The reasons for damages at that time are evident with the high-level requirements contradicting the low-level knowledge in terms of building physics at that time.[29]

Semi-detached house on stilts in *Weissenhof* settlement, Stuttgart by Le Corbusier 1927

Notes

[1] *Sovremennaja Architektura* 1926, No. 1, p. 1-4.
[2] Adolf Loos, *Trotzdem*, Neudruck, Wien 1982, p. 200f.
[3] Siedler, E. J., *Die Lehre vom neuen Bauen*, Berlin 1932, p. 199.
[4] Siedler, E. J., p. 199.
[5] The architect was Walter Gropius and the *Bauhaus* architectural office with financial support from the German government´s experimental programme of the *Reichsforschungsgesellschaft – RFG für Wirtschaftlichkeit im Bau- und Wohnungswesen e.V.* – German research society for economy in building and housing.
[6] The *Kochenhof* settlement comprises wooden houses. See: Dietrich W. Schmidt: *Exhibition Wohnhausprojekte für die geplante Werkbundsiedlung Deutsches Holz in Stuttgart 1932-1933* (2004) and the contribution by Jos Tomlow.
[7] Jürgen Joedicke, *Weissenhofsiedlung Stuttgart*, Stuttgart 1989, p. 19.
[8] Walter Gropius, *Das flache Dach. Internationale Umfrage über die technische Durchführbarkeit horizontal abgedeckter Dächer und Balkone*, part 1 // *Bauwelt* 1926, No. 8, p. 162-168, part 2 // *Bauwelt* 1926, No. 9, p. 223-226, part 3 // *Bauwelt* 1926, No.14, p. 322–324.
[9] as above, p. 226.
[10] I. Nikolaev, *Opyt funkcional´nogo issledovanija sovremennoi krovli // Sovremennaja Architektura* 1927, No. 2, p. 68–74. D. Markov, *Anketa o ploskoi kryše // Sovremennaja Architektura* 1927,No. 4, p. 98–103, and no author., *Anketa OSA ploskaja kryša // Sovremennaja Architektura* 1927, No. 5-6, p. 127–132.
[11] see J. Tomlow, *Notes on a bibliography of literature on MoMo Technology: A case study of publications in German Language 1920–1940, in: Docomomo Journal* 22. Delft 2000., p. 10: „A special category of books is the "negative manifesto"; Publications by diverse enemies of MoMo that criticize or ridiculize technical aspects, like the much discussed flat roof, instead of the traditional pitched roof. (A rather mild example is: Paul Schultze-Naumburg, *Flaches oder geneigtes Dach, mit einer Rundfrage an Deutsche Architekten und deren Antworten*. Berlin 1927.)", as well as Helmut Hempel: *Vermeidet Mängel im Wohnungsbau. Ein Buch warnender Beispiele*. Berlin 1935.
[12] Paul Schultze-Naumburg, p. 17.
[13] Paul Schultze-Naumburg, p. 19.
[14] Paul Schultze-Naumburg, p. 21.
[15] Paul Schultze-Naumburg, p. 52.
[16] Walter Gropius, *Das flache Dach. Internationale Umfrage über die technische Durchführbarkeit horizontal abgedeckter Dächer und Balkone*, part 2 // *Bauwelt* 1926, No. 9, p. 226.
[17]Paul Schultze-Naumburg, p. 59.
[18] Paul Schultze-Naumburg, p. 69.
[19] Ernst May, *Das flache Dach // Das neue Frankfurt* 1927, No.7, p. 155.
[20] Siedler, E.J., *Die Lehre vom neuen Bauen*, Berlin 1932, Table X and XI.
[21] Jobst Siedler, p. 206.
[22] Ernst May, *Das flache Dach // Das neue Frankfurt* 1927, No.7, p. 155.
[23] Centrosojuz, 1928–36, arch. Le Corbusier and Nikolai D. Kolli for detail design and contact architect.
[24] Siedler, E.J., p. 201: *Anstrichmassen und Pasten.*
[25] Walter Gropius, p. 15.
[26] Siedler, E.J.,Table XII, No.5
[27] Siedler, E.J., Table XIII, p. 222, No.3.
[28] A. V. Kuznecov (1929) *Promyšlennoe stroitel´stvo. Torkret i ego primenenie dlja ploskich kryši, part 1 // Stroitel' naja Promyšlennost´* 1929, No.1, p. 50.
[29] See citation by J.J.P. Oud, note 9.

Literature

Ahnert, R., K.H.Krause, T*ypische Baukonstruktionen von 1860 bis 1960 - zur Beurteilung der vorhandenen Bausubstanz - Stützen, Treppen, Balkone und Erker, Bogen, Fußböden, Dachdeckungen. And: Gründungen, Wände, Decken, Dachtragwerke*. Berlin 1996
Block, F., F. Schumacher, A. Gellhorn, F. Paulsen u.a., *Probleme des Bauens*. Potsdam 1928
Braun, I., O. Zucker, W. Baune, W. Matuschke, *Ein*

Industriebau - Von der Fundierung bis zur Vollendung. Berlin 1927
Döcker, R., *Terrassentyp - Krankenhaus - Erholungsheim - Hotel - Bürohaus ... und die Stadt.* Stuttgart 1929
Dorn, J.F., *Praktische Anleitung zur Ausführung der neuen flachen Dachdeckung - Anlegen künstlicher Fußwege etc.* Berlin 1838
Düwer, D., W. Friedrich. *Die Feuersicherheit des Pappdaches und sein Verhalten bei Bränden.* Halle um 1931
Eckstein, B., D.W.Schmidt, C.Nielsen, J.Urbanik, A.Denk, *Auf dem Weg zum Neuen Wohnen – Die Werkbund-siedlung Breslau 1929.* Basel, Boston. Berlin 1996
Falian, C. (Hg.), Vedag-Buch 1931, 4. Jahrgang (Dachpappe). Berlin 1931
Gropius, W., *Das flache Dach. Internationale Umfrage über die technische Durchführbarkeit horizontal abgedeckter Dächer und Balkone*, part 1 // Bauwelt 1926, No. 8, p. 162-168, part 2 // Bauwelt 1926, No. 9, p. 223-226, part 3 // Bauwelt 1926, No.14, p. 322–324.
Hawranek, A., *Der Stahlskelettbau. Mit Berücksichtigung der Hoch- und Turmhäuser.* Berlin und Wien 1931
Heinicke, E., *Die Flachbauwohnung für das Existenzminimum – Der wirtschaftliche Baubetrieb*, Band 5. Berlin 1931
Hempel, H., *Vermeidet Mängel im Wohnungsbau. Ein Buch warnender Beispiele.* Berlin 1935
Henn, W., *Das flache Dach.* München 1962
Hirdina, H. (Hg.), *Neues Bauen Neues Gestalten - Das neue Frankfurt - Eine Zeitschrift zwischen 1926 und 1933 (Auszüge).* Dresden 1991
Joedicke, J., *Weissenhofsiedlung Stuttgart*, Stuttgart 1989
Kolbe, E., *Die wichtigsten Decken und Wände der Gegenwart mit Berücksichtigung ihrer nutzbaren Eigenschaften ... durch den Bergbau unterminiertem Gelände.* Oberhausen /Rhein 1905
Kutzner, E., *Ein neuzeitlicher Großbau von der Fundierung bis zur Vollendung - Erläutert am Beispiel des gemeinsam mit Prof. F.Becker erbauten Palasthotel Mannheimer Hof.* Stuttgart 1930
Kuznecov, A. V.: *Promyšlennoe stroitel´stvo. Torkret i ego primenenie dlja ploskich kryši, part 1 // Stroitel´naja Promyšlennost´* 1929, H. 1, p. 46–50. part 2 // *Stroitel´naja Promyšlennost´* 1929, H. 2, p. 131–135. (Russ.)
Kuznecov, A. V.: *Architektura i stroitel´naja technika v XIX. i načale XX. veka.* Moscow 1934. (Russ.).
Lange, B., J.Schäfer, H.Malchow, F.Kramer, Th.Temme u.a., *Mitteilungen aus der Dachpappen-Industrie 1938.* Berlin 1938
Lindner, W., *Bauten der Technik - ihre Form und Wirkung - Werkanlagen.* Berlin 1927
n.a., *Die konstruktive Lösung des Flachdaches. Ein Beitrag aus der Praxis.* 1931.
Plessner, H., *Dr. Bernhard Christoph Faust's „Plan einer Stadt"*, in: *Gesundheitsingenieur - Zeitschrift für die gesamte Stadthygiene*, Jg. 56, Berlin 1933, p. 403-405
Pöthig, O., *Das Problem der deutschen Dachform im Einzel- und Städtebau und die neuen Dachkonstruktionen.* Berlin 1911
Rasch, H. u. B., *Wie bauen? Bau und Einrichtung der Werkbundsiedlung am Weißenhof in Stuttgart 1927.* Stuttgart 1927
Rasch, H. u. B., *Wie bauen? Materialien und Konstruktionen für inustrielle Produktion - Jahres-Ausgabe 1928.* Stuttgart 1928
Riepert (Hg.), *Der Kleinwohnungsbau und die Betonbauweisen - Zement-Verarbeitung Heft 15.* Charlottenburg 1926
Roth, A. (Hg.), J.P.Samson, F. Gschwind, *La Nouvelle Architecture/ Die Neue Architektur/ The New Architecture.* Zürich 1940
Roth, A., H. Hildebrandt, *Zwei Wohnhäuser von Le Corbusier und Pierre Jeanneret.* Stuttgart 1927 (Stuttgart 1991)
Schaal, R., S. Pfister, G. Scheibler (Hg.), *Bautechnik I - Zum Rohbau - Baukonstruktion der Moderne aus heutiger Sicht.* And: *Bautechnik II - Zum Ausbau - Baukonstruktion der Moderne aus heutiger Sicht.* Basel, Boston, Berlin 1990
Schönberg, A., *Die Pappdächer - Erfahrungen über Haltbarkeit und Werth.* Dresden 1857
Schultze-Naumburg, P., *Flaches oder geneigtes Dach? Mit einer Rundfrage an deutsche Architekten und deren Antworten.* Berlin 1927
Schultze, K. W., *Der Stahl-Skelettbau - Geschäfts- und Hochhäuser.* Stuttgart 1928
Seeßelber, F. (Hg.), *Das flache Dach im Heimatbilde - als kulturelles und wirtschaftliches Problem gefasst und im Auftrage der Hauptstelle für Bau- und Kunstberatung* ...Berlin, before 1914
Siedler, E. J., *Lehre vom neuen Bauen - Ein Handbuch der Baustoffe und Bauweisen.* Berlin 1932
Sigrist, A., *Das Buch vom Bauen - Wohnungsnot - Neue Technik - Neue Baukunst - Städtebau.* Berlin 1930
Spiegel, H, *Der Stahlhausbau -Wohnbauten aus Stahl 1.* Berlin 1929
Spiegel, H., *Der Stahlhausbau 2. Grundlagen zum Bauen mit Stahl.* Berlin 1930
Stegemann, R. (Hg.) u.a., *Vom wirtschaftlichen Bauen "Holz- oder Massivdecken im Wohnungsbau - eine Wirtschaftsfrage".* Dresden 1928
Zalivako, A., *Zur Erhaltung der Bauten der 1920er Jahre im Vergleich Bundesrepublik Deutschland – Russische Föderation (Moskau) unter besonderer Berücksichtigung der baukonstruktiven Voraussetzungen: Probleme, Erfahrungen, Perspektiven.* (Dissertation TU Berlin), Berlin 2003,

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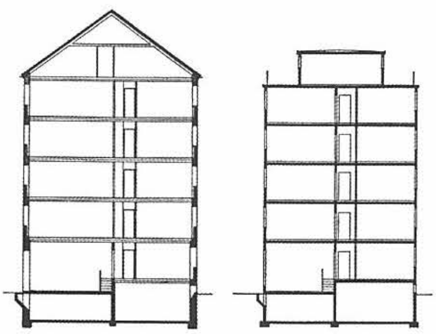
Since 2005 research at theTechnical University of Berlin, Faculty for Achitecture, Environment and Society, Institute for Architectural history and Theory of Architecture, Building- and townplanning history. Initiative of "Heritage at Risk. Preservation of 20Th Century Architecture and World Heritage. Moscow, 17-20th April 2006".

Thermal Strategies – Towards a Modern Insulation

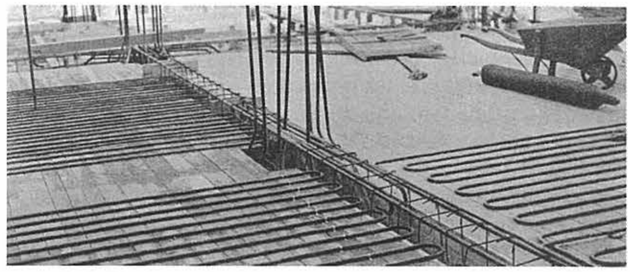
by Torben Dahl, Ola Wedebrunn

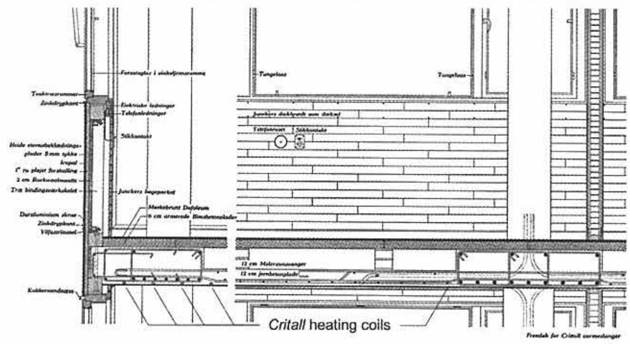
Until the 1940s, the only insulation requirement for the outer wall had been that it should correspond with the insulating properties of a solid 1½-brick wall. With the introduction of slender concrete structures, however, there arose a need for actual insulating materials.

These two sections illustrate the significance of concrete to the structural dimensions required. To the left, a standard brick-built house with quite substantial wall thicknesses in the lower floors – and to the right, an in-situ cast concrete house. Both building types have load-bearing outer walls and main partition walls.



Source: *Murværk og Jernbeton* (Brickwork and Reinforced Concrete), Copenhagen, 1938.





Heating coils from *Crittall* in the floor of the Copenhagen Air Terminal, designed by Vilhelm Lauritzen in 1939.
The water pipes were carried through the columns of the building to the storey partition.

Modernist architecture, thus, was faced with a dilemma, when it came to thermal insulation. On the one hand, there was an increasing demand for heat-saving measures due to a shortage of fuel. On the other hand, it was one of Modernism's chief aims to minimize the building structure in order to reduce the consumption of materials and permit the construction of larger-sized rooms. Since the adding of insulation will inevitably increase the dimensions of the construction, it was with a distinct sense of ambivalence, that architects set about increasing the thickness of walls and roofs, in order to improve the heating economy and comfort.
Owing perhaps to this clash of interests, there was in the technical literature of the time a great awareness of the importance of heat radiation and its significance in relation to structural heat loss and to the human body. It was common knowledge that as long as the surfaces of a room are warm, it will matter less if the air within it is not, whereas one would feel cold in a room with normal air temperature, if walls, ceiling and floor are cold. This knowledge manifested itself, among other things, in the application of relatively thin insulators to the inside of the exterior wall, often covered by a thin layer of plaster. This way it would take less time to heat the room surfaces, and with a potent radiant heater (a stove or a radiator) it would be easier to keep the surface relatively warm.

Advertisements from the time – as well as actual buildings– show overhead heating systems with built-in hot-water pipes cast into the surface of the ceiling. The effect of these systems relies on the heating of the room's surfaces – both of the ceiling surface in which the heating pipes are cast, and the transmission of radiant heat to the rest of the room surfaces. The *Crittall* system was employed, for instance, in the Copenhagen Air Terminal, 1939, and an office building from 1935 at Vesterbrogade 10 in Copenhagen.

Insulation values

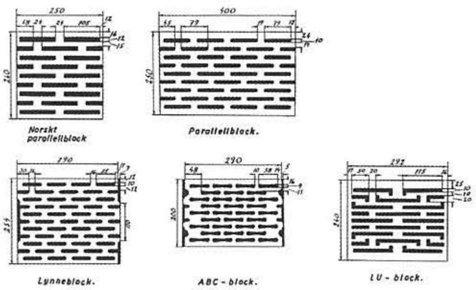
The growing need for slimmer alternatives to the normative insulation of a 1½-brick wall was accompanied by a need for a comparative survey of the insulating properties of various materials and structures.
Metering and calculation of insulating values, therefore, became an increasingly important part of the planning of especially the modernist buildings.

Materials and construction were graded in terms of thermal conductivity and of heat or transmission resistance. In the following, the former will be indicated as kcal/mh°C, and the latter as k-values measured in kcal/m^{2}h°C. Today, the term k-value has been replaced by U-value (W/m^{2}h°C). To convert kcal into W, one applies the following: 1 kcal/m^{2}h°C = 1.16 W/m^{2}h°C.

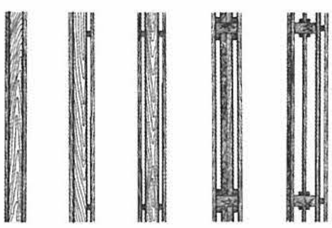
In the early 20s, professor, architect Andreas Bugge of the Trondheim School of Architecture (NTH) carried out a series of full-scale experiments in order to determine the insulating properties of a variety of different structures and materials. Among these were tests with several separate air spaces enclosed in wooden structures.[1]

Structural insulation

Stationary air is, in fact, the most effective insulator of all, and insulation materials are principally developed with the purpose of enclosing stationary air. The hollow of the cavity wall was therefore a valuable contribution to the insulating property of the outer wall, and moreover material-saving. A solid 1½ -brick wall of ordinary bricks had a k-value of 1.35, whereas a cavity wall (20 % filling) with the same thickness, and built with the same type of brick, had a k-value of 1.29.[2]



Development of air-space patterns in concrete blocks for better insulation performance. From *Värmeisoleringsförmågan hos hålblock av beton eller tegel* (Heat-insulation Capacity in Hollow Blocks of Concrete or Brick), Hjalmar Granlund, Chalmers Tekniska Högskola (Chalmers University of Technology), 1948.



Experiments with respectively testing of the insulation capacity of wooden partitions with built-in air spaces separated by various kinds of felt. From *Om Luftskiktenes Varmeisolering* (On Heat-insulation with Air Spaces), A. Watzinger and E. Kindem, Trondheim 1936.

Thus, constructions with several layers of enclosed air were not uncommon in the lightweight architecture of the thirties. It was common knowledge that the employment of one single air space would have only a rather limited effect, due to the circulation of air inside the cavity and the radiation transfer from one surface to another. The air space between two 3 mm glass panes will, for instance, give the following values:

Width of the air space, cm 0	1	10	
Transfer value, k-value	3.1	2.6	2.3

There is, it appears, no extra value to be gained by increasing the distance from 1 to 10 cm. If the number of air spaces were increased within the same 10 cm, there would, however, be a lot more in it:[3]

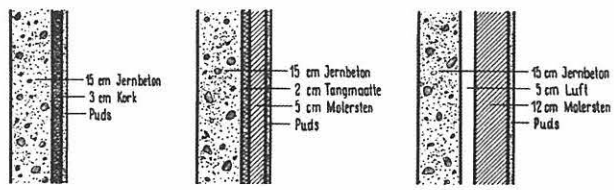
Windows, glass layers	1	2	3	4
Transfer value, k-value	5.0	2.3	1.4	1.1

This theory of window constructions has been applied to light exterior walls with several air spaces, separated with heavy paper of very strong quality.

Structure

The outer wall was, at the start of the period, deeply rooted in the structural tradition of brickwork. The main part of the house building was subject to demands, which were primarily there to safeguard the building's structural stability through statutory dimensioning regulations. These defined the required dimensions of load-bearing outer walls as follows: the top floor – 1½ brick, the two floors below this – 2 bricks, the two following storeys – 2½ bricks; below these, half a brick was added to the wall for each floor. The k-values of these heavy brick walls ranged from 0.64 for a 3½ brick wall, to 1.32 for a 1½ brick wall. If the wall had an inside of moler brick, the value was 30% lower.[4]

The introduction of concrete outer walls resulted in a decisive reduction in the insulation value, and it was therefore necessary to supply additional insulation.

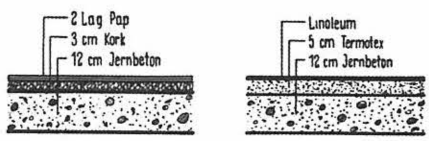


Common types of insulation in reinforced concrete walls *Murværk og Jernbeton* (Masonry and Ferroconcrete), 1938.

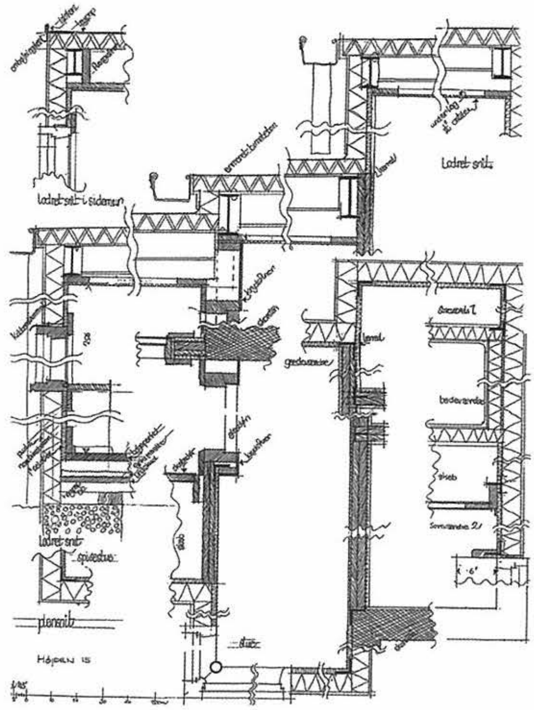
The first figure represents the most common model of procedure, in which an insulating board (cork, bituminous straw-slab or fibreboard) is fitted to the reinforced concrete wall, and afterwards roughcast and plastered. The boards may be mounted within the formwork prior to the casting of the concrete wall. However, this might cause the air pores of the insulation board to fill with cement mortar, and the board to absorb water from the concrete, both of which will lessen the insulating effect. Alternatively, the boards may be mounted after the wall has been cast and the formwork dismantled, in either asphalt or cement-mortar. This method is to be preferred, with a view to the risk of dehydration of the wall. The k-value of a 12 cm reinforced concrete wall, which is insulated with a 3 cm cork board and (subsequently) plastered, will be approximately 0.92.

The second figure represents a reinforced-concrete wall, to the inside of which seaweed matting (*Arki matting*) has been fitted after the casting and the dismantling of formwork, and on top of this, a 5 cm moler brick wall. In this case, k-value will be approximately 0.76.

The third figure represents a similar type, without the seaweed matting but with a wall of 12 cm moler bricks and an air space in between the two wall leaves. Here, the k-value will be approximately 0.78. There was, at the time, an on-going debate about the placing of the insulation within the outer wall. During the early years of Modernism, the relatively thin concrete wall had been insulated on the inside, as many of the new insulators were organic in origin, and therefore sensitive to moisture. But the introduction of inorganic, concrete-based insulators brought about a new interest in exterior insulation. There are several instances from this period of exterior insulation with either lightweight concrete boards (gas concrete or cellular concrete) fitted to the concrete wall as an exterior cladding, or in some cases – in roof constructions, for instance – with an external layer of cast cellular concrete. In either case the lightweight concrete will be provided with an external layer of plaster of approx. 2 cm. Contrary to the outer wall insulation, roof constructions made from ferroconcrete boards are often insulated on their cold upper sides and then covered by roofing felt, in order to avoid great variations of temperature.



Typical insulation of ceiling, roof and floor constructions in reinforced concrete structures *Murværk og Jernbeton* (Masonry and Ferroconcrete), 1938



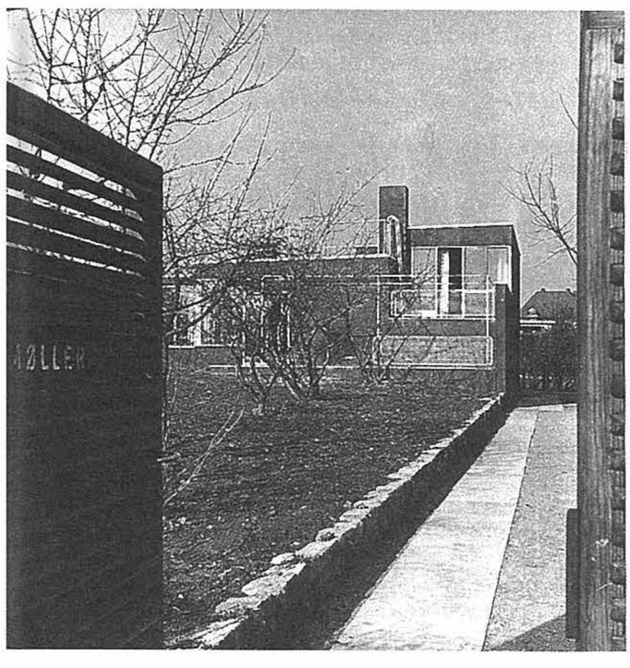
The left figure below represents a reinforced-concrete slab with a 3 cm cork insulation covered by two layers of roofing felt. The k-value here will be approx. 0.95.The right figure below shows a floor construction with ferroconcrete boards, which are insulated on their upper sides with 5 cm *Termotex* concrete – or cellular concrete, or moler concrete – and topped off with linoleum flooring. Here, the k-value is approximately 1.50, depending on the conductivity of the insulator.

Insulating materials

The growing interest in fuel consumption and insulation resulted, among other things, in the emerging of a great number of new insulation products, many of which were produced from organic material.

Below follows a specification of the main typological groups and product brands. A survey may be found, for instance, in contemporary editions of *Håndbog for Byggeindustrien* (Directory of the Building Trade). The building insulation requirements have been tightened considerally since the war, and an attitude to thermal reinsulation now forms a natural part of any renovation or modernization. The cubistic idiom, according to which windows and doors should be perceived as a coherent external skin, plays an important part in the modern architecture; and the chosen solution is therefore often to supplement with internal insulation.

The many organic insulation materials involve a certain risk of collapse or deterioration due to rot or insect attacks. Other insulators have since been banned due to fire hazard, among these the internal cladding with soft *Celotex* boards.



Steel-frame structure with a cladding of pumice concrete, and interior insulation with *Celotex*. På Højden 15, Gentofte. Architect Vilhelm Lauritzen, 1933.

Organic

Soft wooden fibreboards (*Celotex*) – *Celotex* boards are made from bagasse, which is washed and steam processed in order to remove any soluble substances. After this, the fibres are impregnated to make them water-repellent, and then felted into 8 ft wide boards, and dried at temperatures of up to 175°C. *Celotex* boards were originally made in several thicknesses (11.5, 19 and 24 mm) and could be procured in thicknesses of up to 125 mm. The thermal conductivity value of these boards was 0.035. They were used for internal insulation of both light and heavy outer walls, often covered by a layer of plaster, and for concreting in storey partitions or roof constructions.

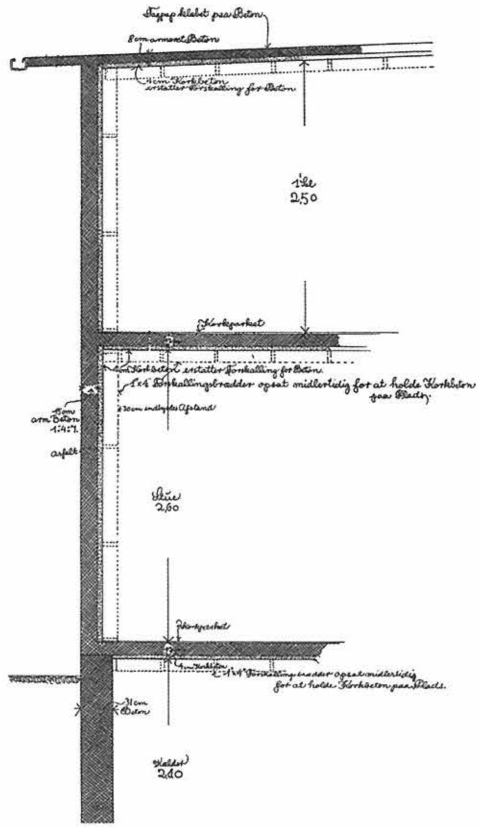
Cork (*Expanko*) – Trademark for expanded corkboards or cork-granulate used for insulation against cold and heat. *Expanko* S.B. boards are lightly impregnated with bitumen, and are found in thicknesses ranging from 12 to 30 mm. These boards, which were used for insulation in ordinary housing, have a conductivity coefficient of 0.035. *Expanko* was also produced as wall panels – lined with bitumen felt on one side, as "paper boards" – with a layer of bitumen felt attached to its reverse and a layer of asbestos plaster on the front, as *Korkotex* – with felt on both sides, and as *Gulvisol* and *Sanisol* – with bitumen and felt on both sides, used for insulation of floors and walls.

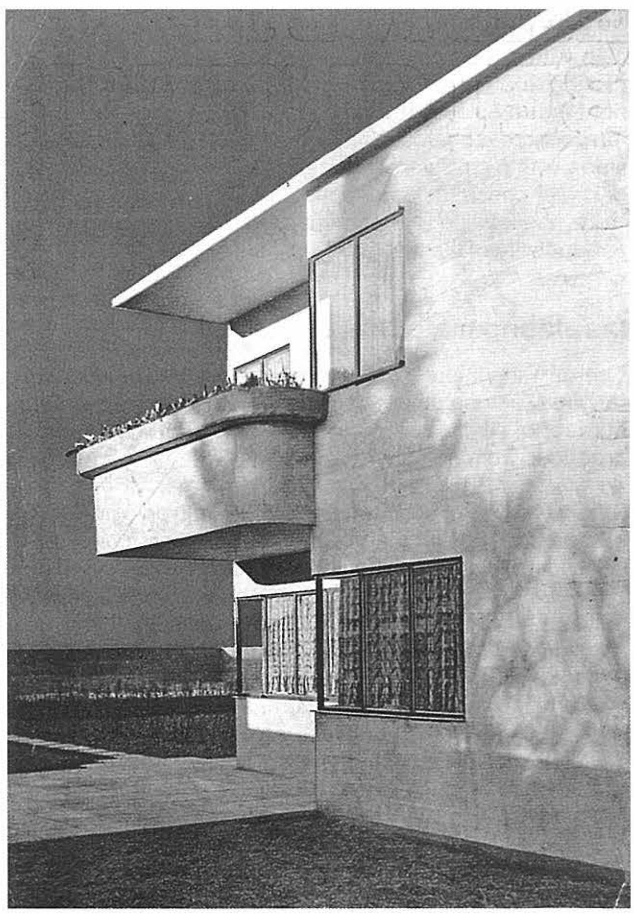
Straw (*Artex* and *Soralit*) – Dry straw compressed with a bitumen binder. These were sold as facing slabs for plastering in formats of 10 by 50 and 50 by 100 cm, with thicknesses ranging from 2 to 5 cm.

Coconut (*Tela matting*) – Coconut-fibre matting, sown into kraft or sheathing paper, or up against a sheet of wire mesh. The mats contain millions of air cells and were sold in rolls, which were 90 cm wide and up to 26 m long.

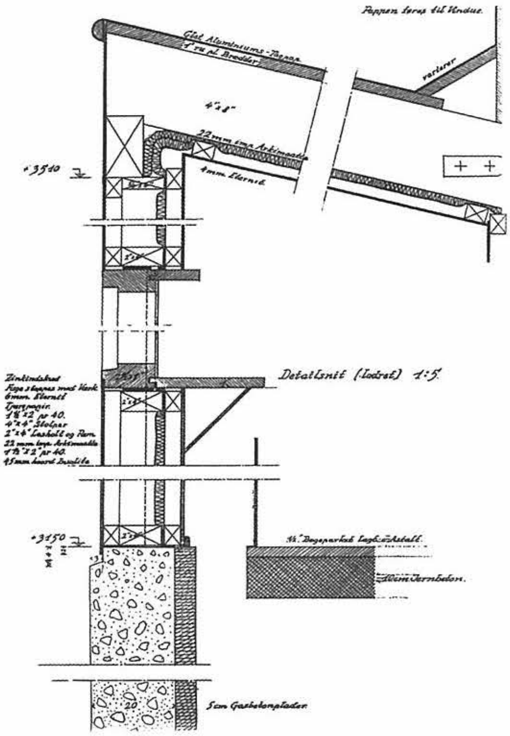
Seaweed (*Arki matting*) – Trade name for a kind of matting produced in Denmark for insulation against sound, cold and heat. *Arki* mats were made of a particular species of seaweed, which was gathered, among other places, on the island of Enehøje in Nakskov Fiord. The seaweed was sown in between two layers of a special kind of paper, and made into rolls, which were 90 cm wide and 26 m long. The thickness was 12, 16 or 22 mm. The relative density of seaweed mats is 0.1-0.2 kg/l and its coefficient of thermal conductivity 0.025.

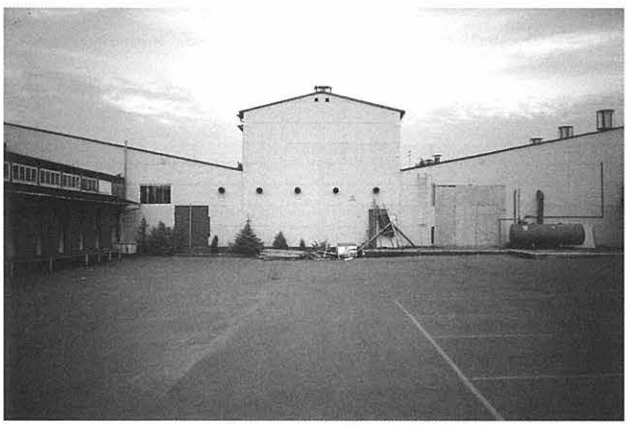
Peat board (*Vilmo*) – Board made from peat fibres and used as insulation against cold and heat. When employing peat boards one needed to make sure that the moist, which was absorbed in the boards, would be able to evaporate again without difficulty. These boards were quite soft, and for most purposes it was necessary to protect them with a layer of plaster. The boards were used for wall insulation and similar purposes, and were 50 by 100 cm, with a thickness of 3 cm. On brick walls they were mounted in cement-lime mortar. On boarding they were nailed down. The conductivity coefficient is approximately 0.034.





In-situ cast concrete with interior cladding of thin corkboards. Bernstorffsvej 17, Gentofte. Architect Frits Schlegel, 1930.



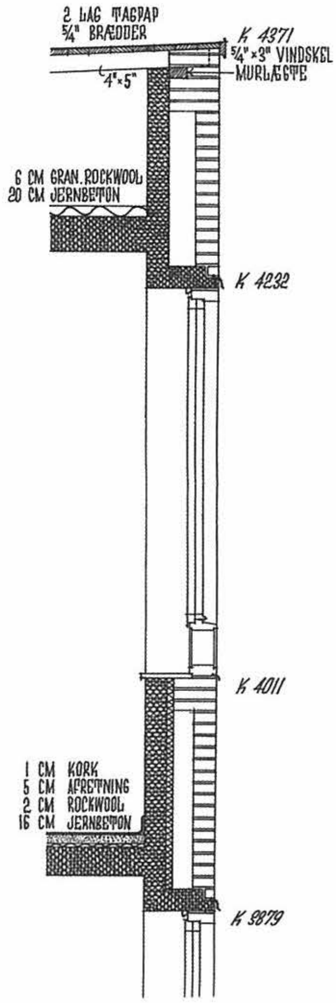


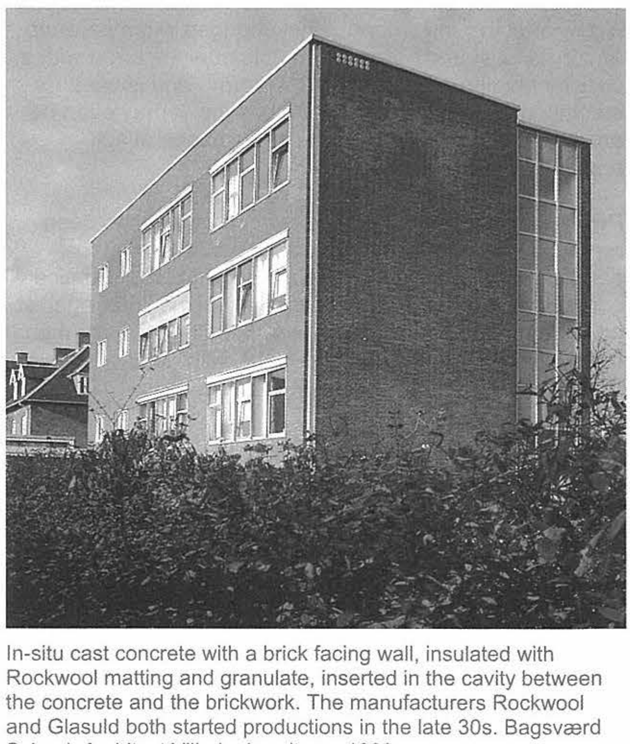
Wood-frame construction with a cladding of *Eternit* sheets, and interior insulation with *Arki* seaweed-matting and Insulite wood-fibreboards. Dehns Vaskeri in Gladsaxe (demolished). Architect Poul Henningsen, 1936.

Inorganic

Mineral wool (*Rockwool* and *Glasuld*) – The two large mineral wool manufacturers Glasuld and Rockwool began their enterprises in the late 30s, but their products are only found in a few pre-war buildings. The use of these highly developed insulators did not catch on until after World War II. Shortly after the war, however, the many organically based materials, which had formed part of the international Modernism of the 20s and 30s, were outcompeted.

Cellular bricks (*Cellelersten*) – Porous bricks made by the drying and baking of a clay gruel, which has been mixed with foam in order to make it porous. The bricks are frost-proof and their compression strength – for a relative density of approximately 1.0 – is c 60-100 kg/cm^2. The conductivity coefficient is c 0.19. Insulation with cellular





In-situ cast concrete with a brick facing wall, insulated with Rockwool matting and granulate, inserted in the cavity between the concrete and the brickwork. The manufacturers Rockwool and Glasuld both started productions in the late 30s. Bagsværd School. Architect Vilhelm Lauritzen, 1939.

bricks is, in other words, three times as effective as with ordinary bricks. Cellular bricks are therefore employed anywhere there is a need for a particularly powerful thermal insulation.

Moler bricks – Light insulating bricks made by the baking of moler. Moler is a natural and very homogeneous mixture of diatomite and clay. It is found on the islands of Fur and Mors (in the Liim Fiord). Moler consists of deposits of microscopic diatoms and clay – the air-filled diatom shells render it lighter than ordinary clay. Moler bricks were produced in standard brick sizes – for partition panels (23x30x5-15 cm), for floor blocks (30x30x10-15 cm) and in several other shapes. The relative density of the moler brick is 0.7-0.95, and its conductivity coefficient is 0.16.

Cinder concrete – Lightweight concrete with a low content of cement, in which stone has been replaced as an aggregate with crushed coke cinders. Clinker concrete has a density of approximately 1200 kg/m^3. It is made into slag plates for use in light partition walls, or used for concreting in floors, or for roof slabs made for insulation and adjustment purposes.

Gas concrete – Lightweight concrete contains lots of enclosed air cells. Gas concrete is made from fine sand, cement, lime and a small quantity of aluminium powder, which brings about the characteristic porosity. After the swelling, a process very similar to fermentation, the gas concrete is steam cured in an autoclave. It is used for the insulation of partitions or of solid load-bearing outer walls and infill walls in frame constructions. At a relative density of 600 kg/m^3, its conductivity coefficient is 0.12.

Cellular concrete – Concrete made from cement mortar, which is beaten with lather – with the result that the material after hardening appears filled with countless separate cells. Due to its texture the cellular concrete is a highly effective insulator against changes in temperature and against sound propagation. It is manufactured with a density ranging from 300 to 1200 kg/m^3, and is used for insulation of roofs, floors, heat pipes etc. It may even be employed in roof constructions in the shape of self-supporting, reinforced boards.

Pumice concrete – Concrete in which stone has been replaced with pumice from porous lava. It is used for partition walls and roofs in the shape of boards. Pumice concrete is fire proof and effective as an insulator against cold, heat and sound. The density is 0.85-1.10, and the conductivity figure ranges from 0.18, with no sand in it, to 0.30 or more with an aggregate of sand.

Notes

[1] The results of these experiments where published in: Bugge, A., *Amerikas små hjem, deres planlegning, konstruksjon og utførelse* (Norwegian: American small houses – Planing, Stucture, Building). Oslo 1927. See also the contribution by Jos Tomlow.
[2] Source: HfB Håndbog for Byggeindustrien 1935, p. 754-755.
[3] Source: E. Suenson, *Byggematerialer II* (Building Materials), 1922.
[4] Source: *Murværk og Jernbeton* (Masonry and Ferroconcrete), 1938.

Annex

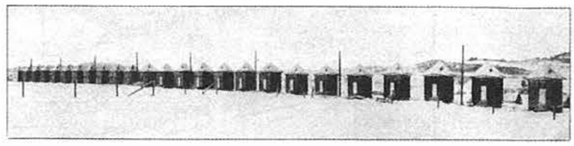


Fig. 102.

VII. RESULTAT AV EN REKKE VARME- OG BYGNINGSTEKNISKE FORSØK

UTFØRT I FORSØKSHUSENE VED NORGES TEKNISKE HØISKOLE 1920—22 OG 1925—27

DELS direkte og dels indirekte foranlediget ved studiereisen i Amerika, er der i den forløpne vinter utført forskjellige varmetekniske og bygnings tekniske forsøk med veggkonstruksjoner i i forsøkshusene* ved Norges Tekniske Høiskole. Til forsøkene er dels brukt amerikanske og dels norske materialer.

Til utførelse av en flerhet av forsøkene er av A/S Norsk Varekrigsforsikrings Fond bevilget kr. 4 000,00 og av Den Tekniske Høiskoles Fond kr. 2 500,00.

Enn videre er der utført nogen forsøk for firmaer, som selv har bekostet de dermed forbundne utgifter.

De varmetekniske målinger og beregninger er utført av laboratorieingeniør Leif J. Hanssen.

Beskrivelse av forsøkenes art og resultat følger nedenfor. Der medtas også nogen forsøk som er utført i 1925. Med andre ord samtlige forsøk, som er utført i forsøkshusenes 2nen målingsperiode, tidsrummet 1925—1927, opføres her nedenfor.

1ste målingsperiode falt i tidsrummet 1920—1922. Denne periodes målingsresultater er av hensyn til oversikten også medtatt i dette kapittel.

Forklaring til nedenfor brukte betegnelser: K = *varmeforbrukstallet* er den varmemengde i kg.kal., som strømmer gjennem 1 m.^{2} vegg i 1 time, når temperaturforskjellen mellem indre og ytre luft er 1° C.

λ = *varmeledningstallet*

(materialkonstant) er den varmemengde i kg.kal., som strømmer gjennem

* Se forord.

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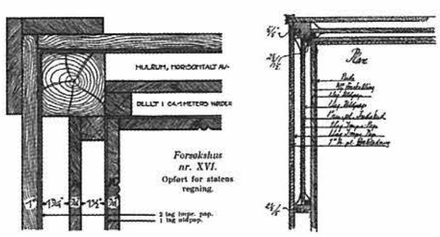
A page from Bugge 1927 and a photograph of the experimental structures.

Horizontal section of experimental house XVI in wood by Bugge based on the sketch detail of a single-family house at I.H. Mundtsvej 16, Lyngby, by the Edvard Heiberg, 1924. It comprises a structural insulation with insertions, two layers of wool paper and two layers of impregnated paper in a light outer wall.



Both authors are researchers at The Royal Danish Academy of Fine Arts, School of Architecture, Copenhagen. Torben Dahl, Assoc. Prof., Architect and Head of the Institute for Technology. Assoc. Prof. Arch. Phd. Ola Wedebrunn, chair of Danish DOCOMOMO working party, DOCOMOMO ISC/T and member of the DOCOMOMO international executive committee. They wrote a.o.: Dahl, T., Wedebrunn, O., Modernismnes Bygninger – Anvendt Teknologi. (The Buildings of Modernism - Applied Building Technology). The Danish Ministry of Environment and Energy. 2000.

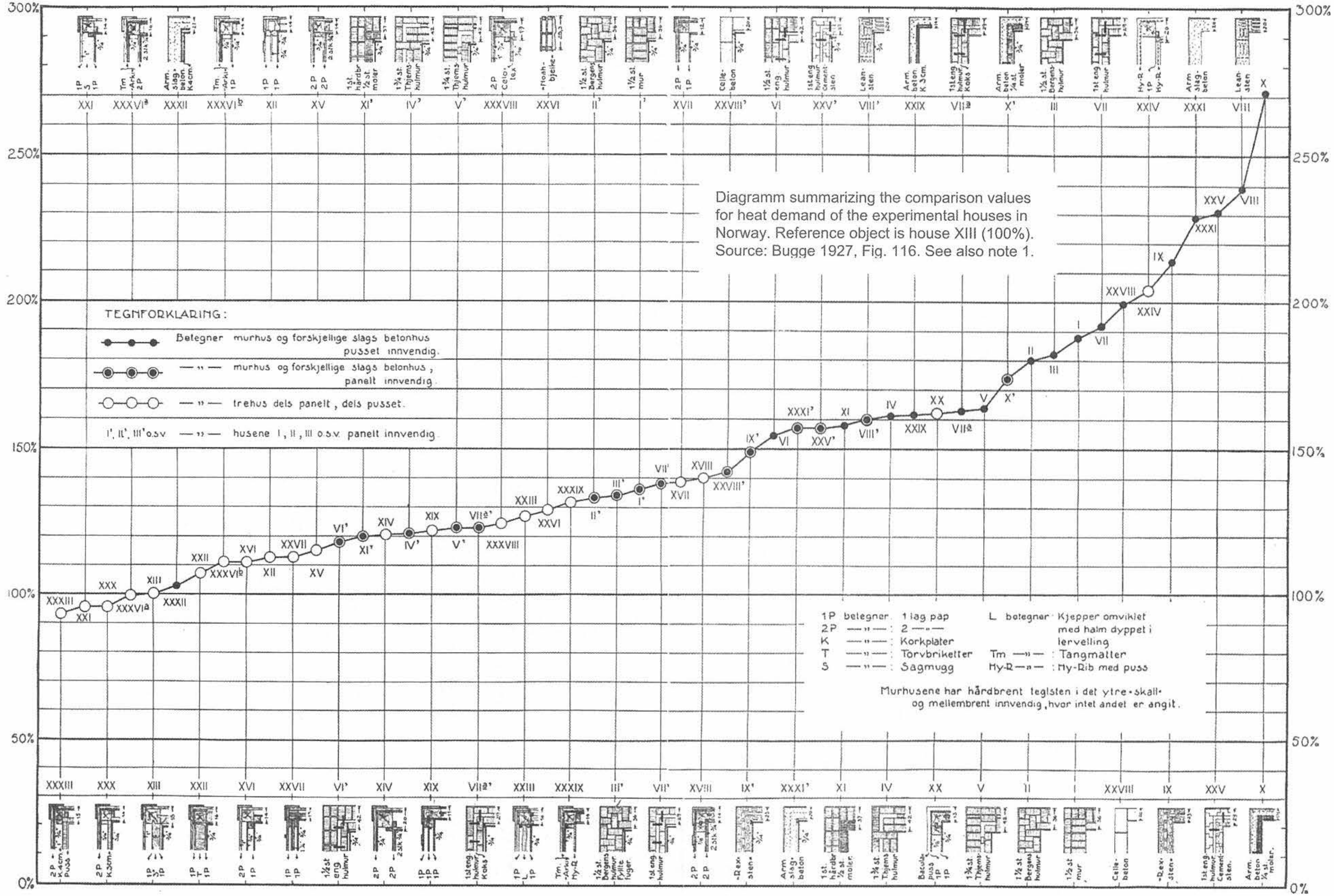


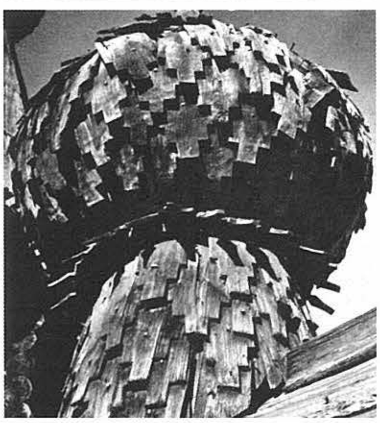
Diagramm summarizing the comparison values for heat demand of the experimental houses in Norway. Reference object is house XIII (100%). Source: Bugge 1927, Fig. 116. See also note 1.

Severe Climate as a Condition: The Construction of Modern Movement Buildings in Siberia

by Ivan Nevzgodin

Siberia is generally associated with coldness, snow, darkness, exile and danger. Yet Siberia in general knows variation in climate. The Trans-Siberian railway runs for the greater part in a continental climate with hot summers (+30 °C) and cold winters (-30 °C). As the weather changes very gradually, people, and to some extent buildings, do not undergo the extreme difference in temperature as a drama. Furthermore, along the Trans-Siberian railway Siberia is not dark. Even in winter there are many sunny days.[1]

But how does one deal with this continental climate in building construction? To answer this question we may start with an example from the beginning of the Russian exploration of Siberia. The Church of the Saviour and the Transfiguration, built around 1700 by the Siberian carpenters' brigade of Andrei Khovarov, is unique as being the only monument of old Russian wooden architecture that has kept its original architectural forms. This is due to a terrible disaster: the 1883 smallpox epidemic killed almost the whole population of the arctic town of Zashiversk. After the epidemic nobody settled in Zashiversk, and the church, like a sole monument to the dead town, remained separated from the nearest dwelling by 170 km of "endless" taiga. Only in the 1960s scientists rediscovered it.[2] Thus, this Siberian church became the most reliable source in the study of old Russian wooden architecture. At the same time, the good condition of this church, after eighty years without any maintenance, clearly demonstrates what material is the best for building in the Siberian climate. Wood is the perfect insulation material. It is also light and easily transportable. Furthermore there is plenty of timber in Siberia. Moreover the Russian builders had knowledge of this material and provided their constructions with good ventilation in order to prevent putrefaction. It is intriguing to compare the condition of this church with the conditions in which we find today the majority of Modern Movement buildings, some seventy years after their construction.



Andrei Khovarov. Church of the Saviour and the Transfiguration. Zashiversk (Yakutia, now in the Open-Air Museum near Novosibirsk). ca. 1700.

'Building rationality on the basis of new technology'

Moscow and Leningrad (now St.-Petersburg) served, without any doubt, as cradles for Russian avant-garde in architecture. But very soon the industrialisation of the First Five Years' Plan would spread the ideas of the Modern Movement to the East of the country. New, socialist towns should be built in the Urals and in Siberia. The avant-garde induced not only an aesthetical revolution in architecture; it also caused a turning point in the generation of architects. Young inexperienced Soviet architects took over the initiative from the old guard. The greater part of this young generation was trained in Central Russia, but Stalin's industrialisation granted them the possibility to realise their ambitious plans in the Asiatic provinces of the USSR.

The international reputation of the Russian avant-garde found a basis in their incredible experiments with architectural form. One group, known as the *Constructivists*, proclaimed to concentrate on the functional organisation of the buildings and find efficient solutions for building constructions, details and materials.[3] Their experimental work on new constructions for Soviet mass housing reached its zenith with the construction of the communal house of the Narkomfin (1928-1929) in Moscow and the standard designs of the famous Stroikom group.[4] In the publication of their designs the group formulated the main principles of rationalisation of the constructions as follows:

1. Mass building is possible by using cheaper constructions;

2. Full use of the strength of constructions;

3. Calculation of the exploitation period of the building and its elements. The quick changes in society do not allow for permanent structures;

4. Simplify and speed up the construction processes. The goal is montage from prefabricated elements;
5. Mechanisation of the construction;
6. Rationalisation of the use of materials. The use of cheap, local and waste materials;
7. Simplify and speed up the design processes. Use of standard elements and solutions;
8. Healthy construction;
9. Calculation with the local climatic conditions.[5]

Cover of the book *Stroikom RSFSR . Typical Projects and Structures for Residential Buildings, recommended for construction in the year 1930*
Moscow 1929.

It is incredible, that even the most pragmatic architects of the Russian avant-garde in such an enormous country as the Soviet Union was, with its great variety in climates, would place the calculation of the local climatic condition as the last point. Very soon it became obvious, that this miscalculation was going to be the main mistake of the Soviet and foreign architects and town planners, who were participating in the construction in the USSR in the beginning of the 1930s.

The Modern Movement comes to Siberia

Already the construction of the first *Constructivist* building in Siberia, the House of Commerce in the Siberian capital, Novosibirsk, led to a contradiction between the ideas of the Modern Movement and the local climatic conditions. In

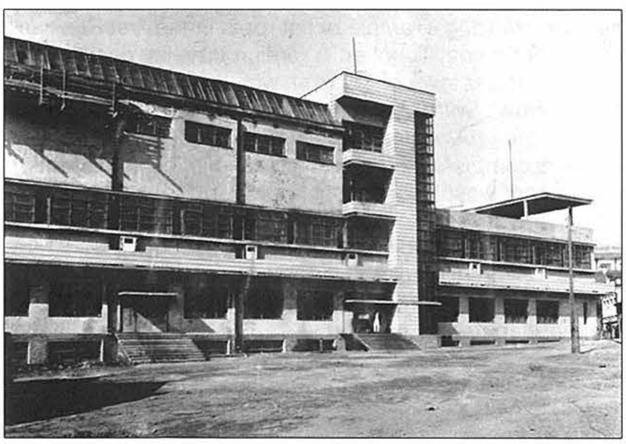
Daniil F. Fridman. House of Commerce in Novosibirsk. 1926-1928

his winning design for a closed competition, organised in 1925 by the Moscow Architectural Society, the Muscovite avant-garde architect Daniil F. Fridman (1887-1950) proposed a complete concrete frame for this building.

This confronted the Siberian engineer Ivan A. Burlakov, who was to be responsible for the realisation, with the problem of how to protect a concrete frame from the harsh climate. He invited a professor from Tomsk Technological Institute, Mikhail A. Ul'ianinskii, to solve this problem. The professor proposed cork panels as protection of the frame. Already before the revolution of 1917 these panels were well known in Russia. But there was no cork in the USSR, so it had to be imported. The deficit of currency made wider use of cork as insulation material impossible; although in the Novosibirsk building the results of this insulation were satisfactory.

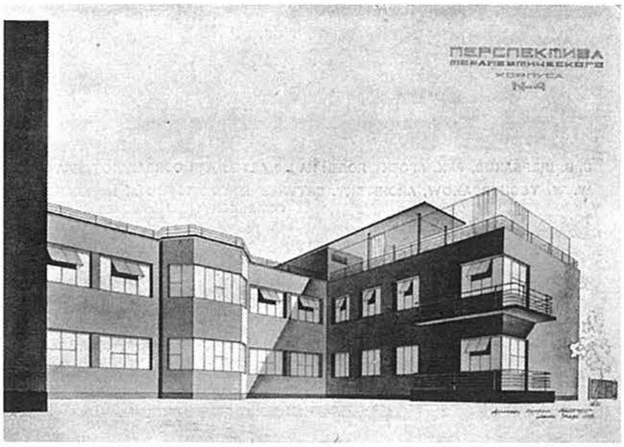
Alterations caused by the Siberian climate

In the 1920-1930s Novosibirsk served as a testing ground for Modern Movement architecture. Numerous *Constructivist* buildings were erected, but neither those Muscovite architects who made designs for Siberia nor the local Modern Movement architects at that time seemed to be fully aware of the conditions ordained by the severe continental climate. They designed bold glazing, open terraces and roof shelters. After some cold winters these elements had to be dropped.

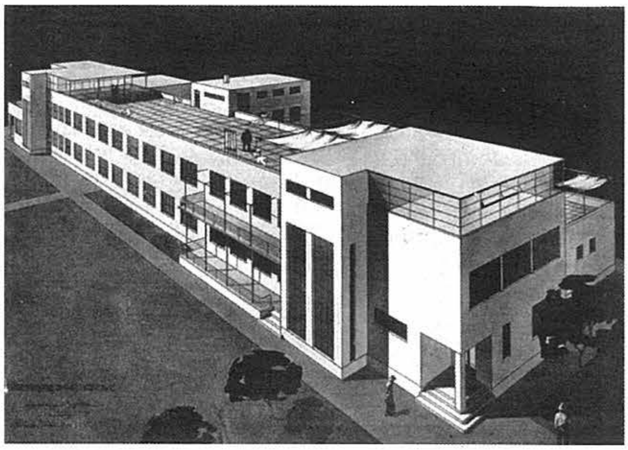


One of the best *Constructivist* buildings built behind the Urals in the USSR, "Dinamo" Sports Club in Novosibirsk. The architects Boris A. Gordeev and Sergei P. Turgenev, and the engineer Nikolai V. Nikitin erected this building in 1932-1933.

The photograph shows the building of the Sports Club after completion. Very soon the inclined glazing at the top (at the left) and the sheltered terrace on the flat roof (at the right) disappeared as unacceptable elements in the Siberian climate.



Alexander Z. Grinberg. Regional Hospital. Novosibirsk. 1928-1929. Design drawing and photograph after the completion.



Another design drawing and recent photographs.

One of the examples of climatically correct building interventions is the complex of the Novosibirsk Regional Hospital, built in 1928 after the design of Alexander Z. Grinberg (1879-1938), an architect from Moscow, who had received the first prize in the national competition. The complex is one of the best examples of Modern Movement hospital architecture in the USSR.

Yet it is strange to see the contrast between Grinbergs dream and the reality, between the beautiful perspective design drawings and the corrections resulting from the Siberian climate.

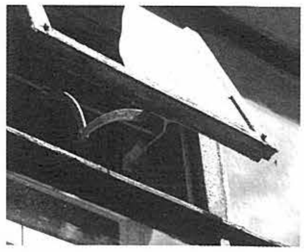
It is remarkable that neither Muscovite architects, nor local young MoMo architects in their beautiful presentation drawings ever drew their buildings in the winter. Usually their perspective drawings were linear and so abstract that the location of the building (Moscow, Leningrad, Novosibirsk or Samarkand) became unimportant. In this light the presentation drawings of an old guard Siberian architect, Andrei D. Kriachkov (1876-1950), such as the one he made for the Sibrevkom (the Siberian Revolutionary Committee) built in Novosibirsk in 1925-1926, are peculiar. Kriachkov, who was very much against the Modern Movement, deliberately made a perspective drawing of the building in the snow. He wanted to show that he was an experienced engineer, whose buildings were solid and stable and fit for Siberian climate. Even later, when Kriachkov after tough critique was forced to build in the *Constructivist* manner, his buildings never had so much glazing as applied by other architects, and he consistently used for stucco a cement-lime mortar. Avoiding superfluous glass in the façades he prevented heating-up problems in summer and cooling-down in winter, while his stucco façades proved their durability in the Siberian climate.

Andrei D. Kriachkov. A design for the Sibrevkom (the Siberian Revolutionary Committee) in Novosibirsk. 1925-1926

Flat Roof

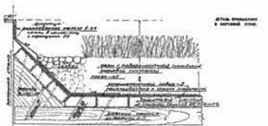
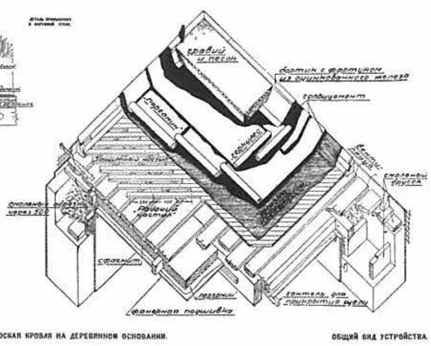
In addition to the article by Anke Zalivako and in the context of the *Flat Roof Discussion* I would like to mention here an amazing example of flat roofs in the first Russian capital of Siberia, Tobol'sk. A foreign traveller described in 1666 the lower town of Tobol'sk with the Tatars' houses as '*very low*', '*without any roof… completely flat, a thick layer of the ground lies above it, therefore in the summer they are completely green*'.[6] This description proves that the flat roof wasn't something special in Siberia, as it has its advantages: in the cold winter the snow not only supplies the insulation for the inner space, but it also preserves the roof construction itself. In the summer the layer of earth and grass is perfect as insulation against the Siberian heat.

The revival of the flat roof in Siberia took place in the 1920-1930s. The German writer Franz Carl Weiskopf (1900-1955) wrote in the newspaper *Berlin am Morgen*: '*Sib-chic – so half-seriously, half-ironically Siberians call Novosibirsk, the capital of Western Siberia. It means Siberian Chicago… They build here without interruption: houses, groups of houses, big shops, schools, hotels. All* of these are skyscrapers in miniature, of "only" 6 or 7 floors, very stable, skillfully and strongly built, with flat roofs, with high and wide windows and balconies... But not only the dwellings and houses are built here without tiredness, here the New Men are growing'.[7] While the growing of "the New Men" may be true, Weiskopf was mistaken about "the flat roofs". At that time all buildings in Novosibirsk had pitched roofs, sometimes disguised with high parapets for aesthetic reasons. These parapets worked as obstacles for the wind to blow off the snow and caused many problems when the collected snow started to smelt. The flat roof became a fetish for Soviet architects, mostly for aesthetic reasons as Jeanneret and Le Corbusier described it in their answer to the Bauhaus questionnaire: *All architectonical endeavors, from the present till back into the early Middle Ages have been focused on hiding the tilted roof and on emphasizing an horizontal line which borders the heaven. The aim is a simple cubic prism, which satisfies the plastic sense much more perfectly than inclined and complex prismatic shapes.*[8]

Moisei Ya. Ginzburg. The apartment and communal housing block for the State Insurance Bureau, Gostrakh. Moscow. 1926-1927, with window detail.

The building technology in the USSR was so little developed that in many cases it was impossible to make the flat roofs proper, therefore they usually leaked. There was also a deficit of the steel needed for the reinforcement of concrete, therefore wooden reinforcement was applied.

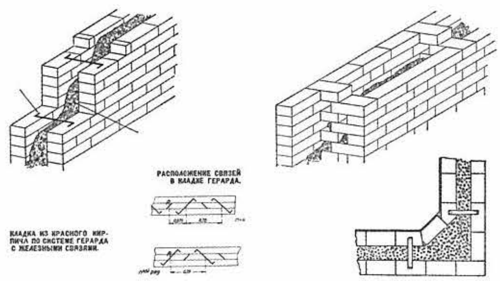
Section of Soviet flat roof with wooden reinforcement

Yet, already in the 1920s, if made precisely, the flat roof would work well. The proof is in the apartment and communal housing block for the State Insurance Bureau, Gostrakh in Moscow, built in 1926-1927 by Moisei Ya. Ginzburg. This modest building is lesser known than the Narkomfin house, but here Ginzburg had the financial means and skilled workers to test his technical solutions for the house of the future. Some details of this building, such as the window constructions, are refined. Ginzburg was so satisfied, that in 1926 he showed the roof terrace of this building on the front page of the first issue of SA as an illustration to his article *New methods of architectural thought*.[9]

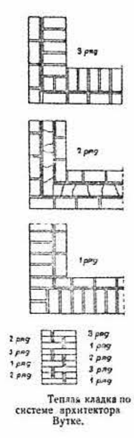
Wall constructions

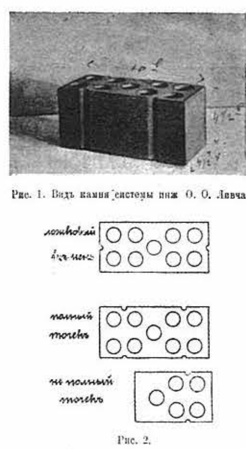
The Dutch architect Johannes Bernardus van Loghem (1881-1940), who worked in Kemerovo in 1926-1927, has been – of all architects who came to Siberia in those years – the most realistic in his experiments with cavity brick walls. Van Loghem applied the construction of walls with a filling of coal slag, which was known in Russia as the *Gerhard System*. Anton Gerhard introduced his system of the brick masonry already in 1829.[10] His system had some problems, especially when the cavity was not filled up properly. Soviet architects applied this system widely in the 1920-1930s. They elaborated for the *Gerhard System* a special solution for corners. To supply the corner with the same insulation and improve the air circulation in the rooms, they bevelled the corner inside.[11] The Soviet architect Oleg A. Vutke (Otto G. Vutke 1891-1937), invented another brick masonry system at the end of 1920s. He proposed a special insulation band from asbestos or other material. Although this construction wasn't fireproof it was used in the Siberian building practice.

Catherine Cooke described the already mentioned house of Narkomfin, built in Moscow in 1928-1930 after the design of Moisei Ya. Ginzburg en Ignatii F. Milinis, as follows: '*Totally new in Russia were the "cold" (i.e. non-*

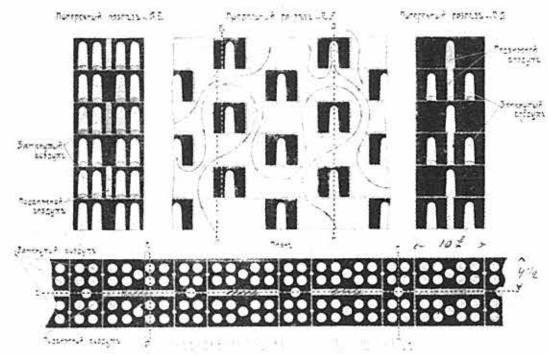


The *Gerhard System* for brick walls with the improved special corner solution.





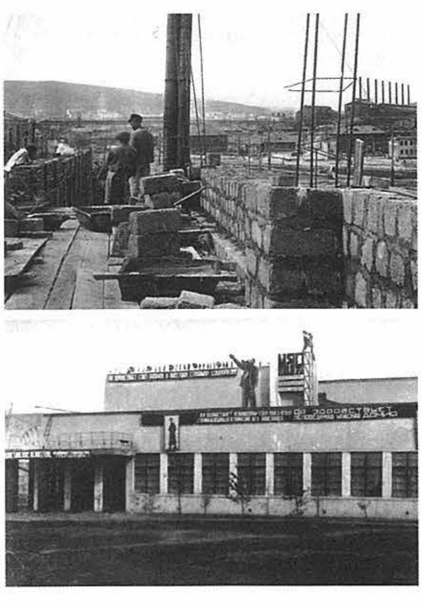
The *Vutke System* for brick walls, left, and the hollow concrete block of the *Livchak System*. 1911, right.



Hollow concrete block wall of the *Livchak System*. 1911.

insulating) hollow blocks which the engineer, S.L. Prokhorov of Tekhbeton, applied for internal walls and the floor slabs. Blocks of identical form from "slag concrete" used for outside walls were already known as the "Peasant" system. (Unfortunately these are now the main cause of the building's decay.)'[12] The use of hollow concrete blocks for floors (with the pipes and wires placed in the holes), though borrowed from German practice, was indeed new for Moscow. But as Cooke indicated the hollow concrete blocks existed in Russia. They had been used already for more than twenty years. The concrete blocks came from North America and were mostly applied for buildings in agricultural areas, which needed fireproof constructions. Russian engineers developed there their own hollow concrete blocks, as for example, the engineer Fedor O. Livchak (1878-1919) in 1911. Livchak also elaborated equipment for the production of the *Livchak System Blocks* by unskilled peasants. This possibly explains the strange name '*Peasant*'.

While the modern movement architects prescribed the use of them in their designs, in Siberia walls from hollow concrete blocks were rarely used because of the little developed building industry. Nevertheless, the German architect Gerhard Kosel (1909), a former student of Bruno Taut (1880-1938) and Hans Poelzig (1869-1936), applied slag concrete blocks in the walls of the city theatre of Novokuznetsk, which was built in 1933 in a period of 200 days.

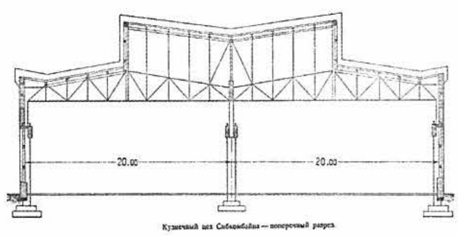


Gerhard Kosel. A city theatre for Novokuznetsk. 1933.

Siberian architects and engineers discussed further the possibilities of industrial building construction with prefabricated elements. But the undeveloped building industry in Siberia did not provide an opportunity for a widespread application of new materials, methods and constructions; this caused many palliative solutions and imitations of such modern architectural elements as flat roofs, open corners and window bands.

Construction during the winters

Not only the exploitation of MoMo buildings in the harsh climate but also the construction during the Siberian winter became subject to experiments in the 1920-1930s. The construction of the factory in Novokuznetsk became the important testing ground for such experiments. Already in 1929 the gravel for the concrete for the main administrative building of the factory was heated with boiling water. Felt covers and hemp were used as insulation of concrete structures. In the winter of 1930-1931 a series of experiments with concrete works were executed. As a result several instructions were formulated. Attention was given to the relation between temperature and the composition of the cement mortar, for the special framing and the good insulation of tubes and cars for transportation of concrete. But in general the solutions were quite primitive. Thus in very cold days the concrete was insulated with manure and straw. In March-April of 1933 the laboratory in Novokuznetsk made proofs of brick masonry in the winter. As the most effective for housing blocks masonry work with cold, dry bricks and mortar, warmed to a temperature of + 10°-12°C, was chosen. For less important buildings with a height of eight meters or less a cement-lime (non-hydraulic) mortar was allowed. But in the last case the walls should be protected from the sun with canvases in the spring. Otherwise the walls would unfreeze irregularly and the whole construction could collapse.



Section of the Smithy for the Sibcombine (Siberian Combine, the factory for agricultural machinery) in Novosibirsk, 1930.

North-American industrial architects

Even those North-American industrial architects, who were involved in the realisation of the First Five-Years Plan, although being more pragmatic, applied solutions in their standardised designs that were inefficient in the Siberian climate. Americans in Russia had problems with built in culverts (subterranean channels) and too excessive use of steel constructions. Later they applied more wood in their constructions and gave better insulation to their roofs. Also the Americans widely applied the Butterfly roof system, known in Russia as pond, which not only supplied daylight to industrial buildings, but also organised their natural ventilation. But, unlike the USA, in Russia wood was used for its construction. Also in Siberia two sorts of operational windows were provided: one for the cold winters above, and another for the hot summers beneath.

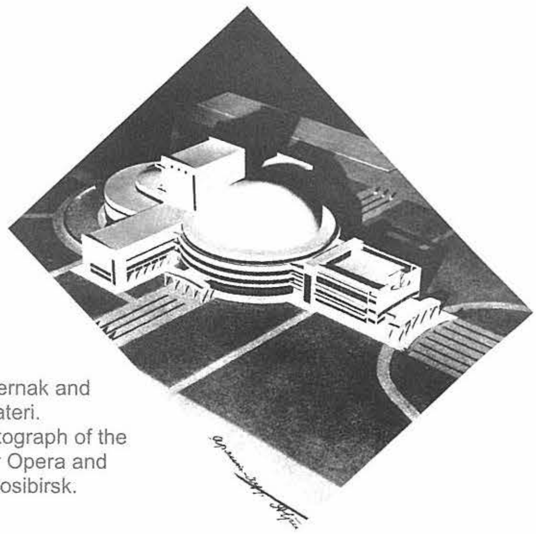
Alexander V. Shvidkovskii, Georgii P. Golts, Sergei N. Kozhin. Building for the Industrial Bank. Novosibirsk. 1925-1926. Nikolai s. Kuzmin, V.A. Dobrolybov. Rebuilding of the Industrial Bank for the municipal executive Committee of the Communist Party. 1935-1954.

Decorative re-buildings

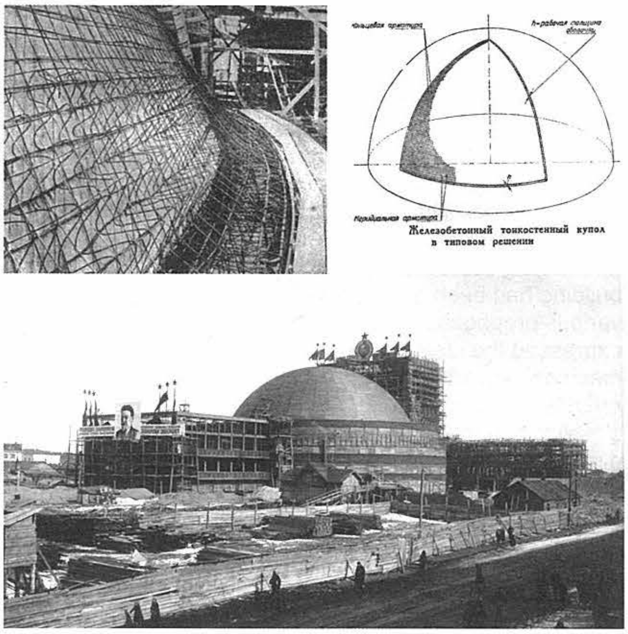
Although the purely ideological nature of the great turn in Soviet architecture has been stressed in many publications time and again, we could suggest that to some extend the general public's discredit of the Modern Movement was caused by MoMo architects' miscalculations of climatic conditions. In 1932, after the results of the international competition for the project of Palace of the Soviets in Moscow had been made known, the New Architecture in the USSR was proclaimed erroneous. When the Soviet architecture changed her direction, the '*Constructivist* physiognomy' of the Siberian capital became inappropriate. City authorities gave clear instructions to architects to base their work on the classical 'legacy'. A lot of *Constructivist* buildings were reconstructed and got a decorative quasi-classical order. '*Façade plastering projects*' became widespread.
One of the most notorious examples of this is the refurbishment in 1935-1954 of the Industrial Bank building. The original building had been built in 1925-1926 after a national competition. Its façade composition was based on the dynamic contrast between massive pylons and large glass surfaces. On special occasions the building had been decorated with agitation slogans and various propagandistic installations, which clearly had expressed the idea of a building as a propaganda machine. Nevertheless the addition of two stories and the refurbishment resulted in a rough interpretation of neo-classicism in the façades. Window openings were diminished. Here we should admit that this was not only done for aesthetical reasons. The huge shop-windows were a disaster for the users of the building. They suffered from heat in the summer and cold in the winter. Furthermore the façades of the building were decorated with flat five-storied pilasters of a large order with big one-story-high massive capitals of Socialist Realist interpretation.

From an avant-garde performance centre to a traditional theatre

While the greater part of the buildings were decorated after their completion the contemporary Opera and Ballet Theatre in Novosibirsk was already redesigned during the construction of the building, which started in 1931, as part of the huge complex of the House of Culture and Science. It was supposed to become '*a theatre of technology and real atmosphere (air, water, car, tractor, etc.)*'. Spectators were to see columns of marchers coming from outside, cars, tractors or carriages moving at high speed, while circular platforms could at the same time move in the opposite direction. The '*high-tech planetarium-like theatre*' was to be transformable into a circus or a swimming pool for '*water pantomime*'. Films were to be projected on the inner surface of the cupola. The reinforced concrete cupola of the Novosibirsk Theatre was an outstanding construction for its time.[13] It was 60 m wide, 25 m high and only 8 cm thin at the top, 1/750 of the diameter! To admit temperature deformation of this huge monolith construction the basis of the cupola can move freely on



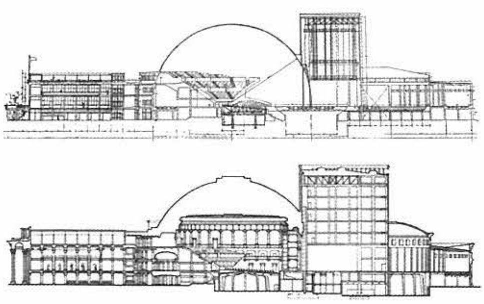
Peter Pasternak and Boris F. Materi. Model photograph of the Theatre for Opera and Ballet. Novosibirsk.



Peter Pasternak, Boris F. Materi. The reinforced concrete cupola of the Theatre for Opera and Ballet. Novosibirsk. 1931-1934.

the supporting annular beam. But in fact, the necessity to protect the constructions and interiors from the low temperatures made these impressive engineering achievements superfluous: on the wet concrete a wooden raster and sawdust were laid; this was covered with a layer of asphalt paper. Then 12 cm thick insulation panels of foamed concrete were laid over it. This work was finished in the autumn of 1934. Thus in Novosibirsk foamed concrete was used for insulation for the first time in the USSR. Nevertheless, the concrete dome had to be protected later on with an extra 2,5 m high wooden structure. The intention to use the vault for planetarium-like cinema projections caused the application of a pure spherical form, which is disastrous for acoustics.[14] First the Russian engineers proposed the system of broad '*Fakel*' (jets) to improve the acoustics. The air flow should act as a sound reflector. Then the inventors Velezhov, Movshovich and Abramovich elaborated an acoustic material from seaweed. The panels from this material should be placed on the inner surface of the vault. Later, after some tests, this material was distrusted, because it could be eaten by moth or rot.

In 1933, when the building was roughly finished, its *Constructivist* forms began to be criticized. Therefore in 1934 a competition for the building's exterior was announced, and in 1935 the alteration of the building into



Sections of the Theatre for Opera and Ballet in Novosibirsk in the original design and after the rebuilding proposal.

an ordinary theatre started. To improve the building's acoustics a wooden ceiling was hung from the reinforced concrete vault. An ordinary, but huge scenic box was added. A twelve-column portico appeared in the front. As a result of all these alterations, the building has so many unnecessary rooms, that their area equals several auditoria. The problem of providing the main auditorium with good acoustics has only partly been resolved by the recent restoration activities, finished in 2005.

Failures and challenges for the future

In spite of many failures, the 1920-1930s were the time of experiments that still have great value for our present and the future. The knowledge of and interest for building physics grew among the architects. Many important tests of new materials and constructions were made; new building regulations and standards were formulated.[15] The county was divided in climatic zones. Yet it is incredible how little the MoMo architects learned from their predecessors. The Soviet architects ignored the climatic conditions, even in the Khrushchev period, when the Communist Party allowed Modernism again. The impotence of the Modern soviet architects in the 1960s and 1970s to build in accordance with the Siberian climate was shown most comically in the building of Novosibgrazhdanproekt (The Novosibirsk Design Institute for Residential and Public buildings) in the centre of Novosibirsk. This design institute, the biggest beyond the Urals, built this elegant high-rise slab with band windows in the 1970s for its own offices. The general public would laugh for many years, while architects gummed aluminium foil on the glass of the band windows to protect themselves from the sun. Many problems of the 1920-1930s related to climate construction became urgent after the fall of the USSR. Thus new building regulations forced to apply cavity brick walls. The experiments to reduce the thickness of the external brick walls, started in Siberia by the before mentioned Siberian architect Andrei Kriachkov already before the revolution of 1917, were continued in contemporary practice.

The construction with due regard for the Siberian climate can be solved not only with the application of special constructions, details and materials, but also by the special spatial compositions and good organisation of the plans. Unfortunately, the already mentioned Dutch architect Van Loghem, who tried to arrange optimal heating and ventilation in his 'Houses for Specialists' in Kemerovo in 1926-1927 by intelligent planning solutions, is an exception in Siberian building practice.

In this aspect the intelligence of traditional Siberian constructions, both by aborigines and Russians, is fascinating. I would like to finish with an example from Tomsk, which clearly demonstrates this idea. The city architect Petr F. Fedorovskii (1864-1944) built a wooden house in 1903 in two parts. One part has small windows and is very compact (cubic) in form. It is massive and well insulated by thick walls from heat and cold. The other part has a nearly completely glazed gazebo. During the sunny days of winter the sun basks it and the separation from the closed part can be removed, which gives the possibility that warm air moves to the closed part, while during the cold winter nights this open part is reliably isolated from the closed part, which prevents the unnecessary loss of warmth. In combination with the traditional Russian stove this system secures a perfect

Petr F. Fedorovskii. Private house on Krasnoarmeiskaia Street no. 67a in Tomsk. 1903.

natural ventilation of the house. Unfortunately some of the Modern Movement architects of the 1920-1930s as well as many contemporary Siberian architects could not comprehend this simple wisdom of vernacular architecture.

Notes

[1] Traditional wooden Siberian houses took profit of these sunny days. The windows were large. One of the European travellers was surprised by such huge Siberian windows, compared to Central Russian examples. He thought that the Siberians worshiped the sun.

[2] For the description of this unique monument see: Opolovnikov A., *Otkrytie v Zashiverske* (The discovery in Zashiversk), in: *Zodtchestvo* (The Architecture), 1 (20), Moscow, 1975, pp. 207-214.

[3] The Modern Movement architects in Soviet Russia can be clearly divided in three main groups: the '*constructivists*', supporters of 'the functional method' developed by Moisei Ya. Ginzburg (1892-1946) and the Vesnin Brothers (united in the group *OSA*), '*rationalists*', supporters of the theory of visual perception of the architectural space and form elaborated by Nikolai A. Ladovskii (1881-1940; the leader of the group called *ASNOVA*), and architects applying stylizations from the vocabulary of Modern Movement. Surely some exceptional figures as Konstantin S. Mel'nikov (1890-1974) en Ilia A. Golosov (1883-1945) didn't suit in any of these categories. Yet even in their individualistic architectural theories and works we can find their inclination to one of the three already defined groups.

[4] *Stroikom* is an acronym for the Construction Committee of the RSFSR (Russian Federative Socialist Republic).

[5] *Stroikom* RSFSR, *Tipovye proekty i konstruktsii zhilishnogo stroitel'stva rekomenduemye na 1930 g.* (Typical Projects and Structures for Residential Buildings, recommended for construction in the year 1930), Moscow, 1929, pp. 79-80.

[6] Alekseev M.P., *Sibir' v izvestiiakh zapadno-evropeiskikh puteshestvennikov i pisatelei XIII-XVII vv.* (Siberia in descriptions by West-European travellers and writers from the thirteenth till the seventieth century), Irkutsk, 1941, p. 344.

[7] *Press-fight for Socialist Cities, For the Socialist reconstruction of towns*, SOREGOR, 1933, no. 1, p. 37.

[8] *'Alle architektonischen Bestrebungen, von heute bis zurück zum fernen Mittelalter, sind darauf gerichtet gewesen, das schräge Dach zu verstecken und eine horizontale Linie zu betonen, die den Himmel wagerecht begrenzt. Das Ziel ist ein einfaches kubisches Prisma, das das plastische Empfinden viel vollendeter zu befriedigen vermag als abgeschrägte und komplizierte Prismaformen'* (translation by ed.) Jeanneret, Le Corbusier, Französische Architekten zur Rundfrage, in: Gropius, W. (red.), *Das flache Dach. Internationale Umfrage über die technische Durchführbarkeit horizontal abgedeckter Dächer und Balkone*, Bauwelt, Heft 9, 1926, p. 227. The Russian translation of this questionnaire, nearly simultaneously with the original, was published in the two most influential architectural journals. El Lissitzky, *Ploskie kryshi i ikh konstruktsii, Stroitel'naia promyshlennost*, Moscow, no. 11, november 1926, pp. 820-822; Markov D., *Anketa, provedennaja v Dessau, Sovremennaia arkhitektura,* Moscow, no.4, 1926, pp. 98-103. We should admit how Modern Movement architects were enamoured with the flat roof. Even such an honest person as Van Loghem (1881-1940) was cunning by answering that there was no problem with his flat roofs in Haarlem.

[9] *SA* is an acronym for *Sovremennaia Arkhitektura* (The Contemporary Architecture), most important publication of the Russian *Constructivists*.

[10] For detailed information in Dutch about Van Loghem see: Eggink, R. A., *J.B. van Loghem: architect van een optimistische generatie*, PhD dissertation at the Technical University Delft, 2 vol., Delft 1998.

[11] In 1927 the State Institute for Building Structures tested this corner construction in the experimental Garden City-like workers settlement Sokol (Moscow).

[12] Cooke, C., *Russian avant-garde. Theories of art, architecture and the city*, London 1995, p. 136.

[13] In the German building practice of the 1920s many sphere or flattened cupolas were built for planetariums, exhibitions halls and markets. The engineers of the Carl Zeiss factories at Jena were the pioneers of such constructions. Franz Dischinger (1887-1953) of the firm Dyckerhoff&Widmann contributed in important degree to the theory and the practice of concrete cupola construction. Indeed in Germany concrete cupolas larger than those in Novosibirsk had been built, but for such large spans Germans made cupolas with ribs. In the Soviet Union concrete cupola shells were in use for industrial buildings. A planetarium in Moscow in 1927-1928 was built in the Carl Zeiss System.

[14] The acoustic problems of the pure sphere were in that time well known. Hans Poelzig (1869-1936) applied Stalactites to solve this problem in his refurbishment of Zirkus Schumann for Max Reinhardts Großes Schauspielhaus in Berlin (1918-1919).

[15] There is very little research about building physics, construction and materials in the work of Russian avant-garde architects of the 1920-1930s published in Russian or in English. This gap was recently filled up to some extent by a German dissertation: Zalivako, Anke, Zur Erhaltung der Bauten der 1920er Jahre im Vergleich Bundesrepublik-Russische Föderation (Moskau) unter besonderer Berücksichtigung der baukonstruktiven Voraussetzungen, Dissertation, Berlin 2003.

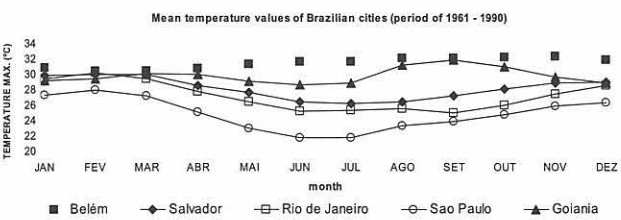
Dr. Dr. Ivan Nevzgodin. Research fellow at Faculty of Architecture, Delft University of Technology, 1998. Doctor thesis, "Het nieuwe bouwen in West-Siberië: architectuur en stedenbouw in de jaren 1920-1940" (The impact of the Modern movement in Western Siberia: architecture and town planning in the 1920-1940s), Faculty of Architecture, Delft University of Technology, The Netherlands, 2004. Kandidatskaia dissertation, "Architectural Exchanges between Russians and Dutch, 1900-1935, in the Urals and Siberia", Novosibirsk State Academy of Architecture and Fine Arts, Russia, 2002. Master of architecture (with Honour), Novosibirsk State Academy of Architecture and Fine Arts, 1998

Aspects of the Tropical Climate Adaptation in Brazilian Modern Movement Architecture

by Griselda Pinheiro Klüppel

Introduction

There are several elements which characterise the modern architecture in Brazil. They represented, beyond the formal language and aesthetic value, the materialisation of inherent concepts to good architecture, which adapted itself to the local climate.



Two of these principles or basic concepts are: the open character of the architecture and the interior/exterior integration specific of certain housing typologies either rural or built in urban peripheries since the middle of the 19th century. From this time are also the external elements of solar protection, the lattice windows, the trellis as well as glazed tiles applied to external walls, which were recovered and used in the modern architecture built in Brazil.

It is important to look at these principles and concepts and how those elements were used, in order to understand tropical climate as well as the appropriation and transformations undertook by them in their utilisation and articulation as elements and solutions within Brazilian modern architecture.

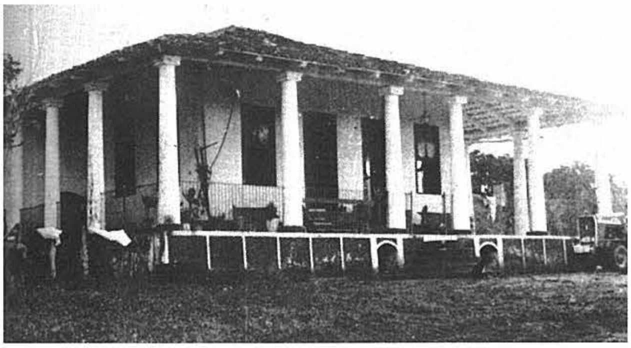
The search of "appropriate" solutions

According to Goodwin "Although the first modern impetus came from imports, very soon Brazil found its proper way." This proper way does not allude to the utilisation of, like Goodwin said "...innovations destined to avoid the heat and the lightened reflexes in glass surfaces, by means of external special *quebra luzes."*

Quebra luzes is the same as the French word *brise soleil* (sun breaker). Much more than that, one can dare to assert, some concepts and bio-climatic principles are inserted in many of the found solutions: concepts such as cross ventilation with specific zones, of in-and-out ventilation, of non-fragmented spaces enlarged and integrated with the exterior, intermediary spaces of protection and connection with the mild nature of the place, besides other elements that constitute the skin of the buildings, which will be detailed later on.

"Shadow street" by pilotis in modern build in Salvador Down Town.

Playground and garage by pilotis in the Comendador Horácio Urpia Build, in Salvador, by Diógenes Rebouças, 1957.



Aspect of colonial house with verandas all around the building.

The adoption of new ideas and the need of an architecture responding to the changes and modernisation occurring in the country somehow supported innovation in the governmental machinery. These factors where, without doubt, determinant for new building patterns which were grounded in a cultural as well as proper climatic reality, that allows, without being arrogant the assertion, following Morais: "Brazilian Modernism is, simultaneously, an effort of actualisation and a rediscovery of our cultural roots, a renovation within a tradition."

Enlarged spaces and zones of exterior-interior integration

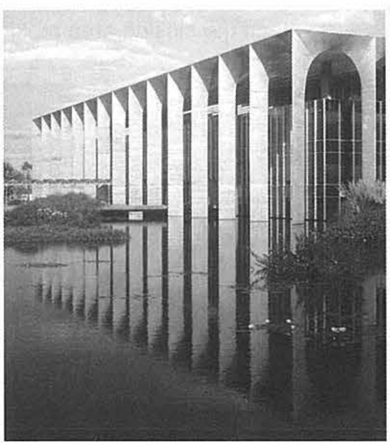
The enlarged spaces of colonial architecture, determined either by the great height of the rooms or by non-fragmentation of the spaces, are also present in Brazilian modern architecture. These large areas allow great cubature of air facilitating thermal changes among diverse air layers in the internal environment.
This concept of large room height is extensively used in modern architecture via the introduction of the mezzanine. In the work of Oscar Niemeyer, Atílio Correia Lima, the brothers Marcelo and Milton Roberto, Vilanova Artigas, Oswaldo Bratke, and others, mezzanines are mainly found in outstanding buildings which give an idea of the amplitude and flow of the space and air through the double height of some areas. Among other smaller buildings, notably residences, double height spaces can be seen in several parts of the country.
The other constant reference of traditional Brazilian architecture is the indoor/outdoor integration through multiple openings pierced in the façades and by the *varandas* (verandas) around the *casa grande* (manor house) of the colonial period. This space acts as shock absorber of the thermal impact on the walls as well as shadow and protection zone against the direct action of the sun on people. In this space one feels sheltered and it expands the relations of the very building, interacting directly with the nature of the surroundings, with its maximum enlargement in the pilotis.

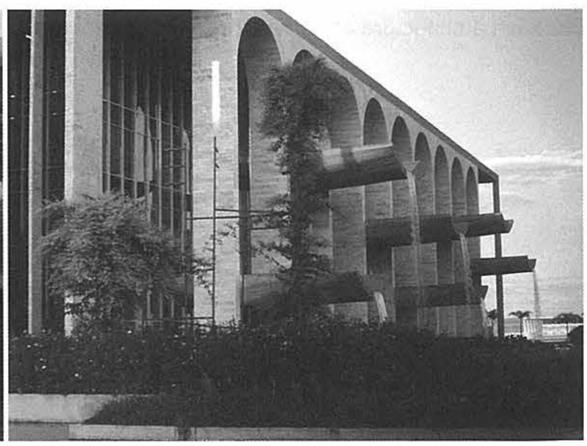
In modern architecture the veranda has a character of great protection and formal expression of the covering as one can see in Niemeyer's works, where the lengthening of the roof forms terraces all around. At the same time the body of the building is halted and free in its interior, integrated to the exterior through the mild transparency of the glass. Another great example of this protection by a lengthened roof is the Museu de Arte Moderna (1954) by Affonso Reidy. Here the building basically hangs in the large roof that shelters it, and the exterior spaces invade the covered area, resulting in shadowy gardens.

The utilisation of these intermediary areas between inside and outside presented huge advantages in a hot and humid climate that dominates a great part of Brazilian territory. Besides the promotion of shadow and effective blocking of direct solar radiation, the integrated areas facilitate the flow of the air inside the building, allowing the flowing off of the wind, that with low pressure easily penetrates the building through the windows facing the veranda. This shadowy area also serves to diminish the natural light intensity in the interior rooms reducing the effect of dazzling of this light and makes, principally, an intermediary space that integrates the building with the nature all around.

Besides protecting the walls and creating shadow the veranda works as a disperser of heat, which captors the breeze and facilitates its penetration of the building. In the same way as in the protected corridors and sidewalks generated by the marquises or by over-hangings of buildings over pilotis they created a continuous shadow in the public space.

Building on pilotis promotes sheltered circulation from the sun, and ameliorates the quality of the urban environment from the point of view of salutary ventilation, by allowing greater flowing and dispersion of air at street level. It also reduces the dampness of the floors and it has the great





ABI Building in Salvador by Helio Duarte, Zenon Lotufo and Abeladro de Souza 1945/1951. Itamaraty Palace, and Justice Palace in Brasilia, DF, by Oscar Niemeyer, 1959 – 1967.

advantage of isolating the walls of the building from the natural action of the rising damp through capillary attraction. Thus it contributes to a better conservation of the bases of walls and generally speaking of the building as a whole.

Treatment of external walls

The constitutive elements of the external walls or the surface treatment of the buildings include openings and closing elements, which were very much responsible for thermal changing between the building and external environment. Through these one can promote an architecture that works passively with the climate guaranteeing desirable levels of comfort inside the buildings principally when the climate is mild without great thermal amplitudes as in most parts of the Brazilian territory.

The glazed tiles on the façades

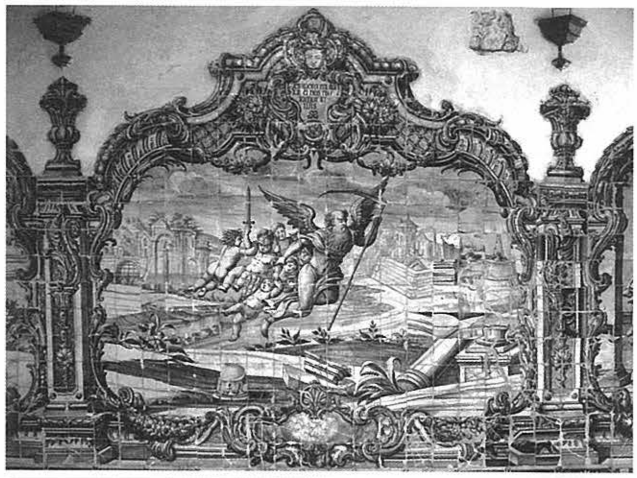
Glazed tiles used as facing material of walls in Brazilian architecture is an issue that deserves to be studied due to its large employment. Not only as a compositional element from colonisation times till the architectural Modern Movement in Brazil, but also as an impermeable isolating facing material for walls and façades in regions with high rains.

Regarding thermal aspects the glazed tiles' smooth surface has a function of reflecting solar radiation that is greater than that of plasterwork. Therefore, theoretically, it absorbs less radiation and has a density that presents a major thermal inertia that is larger then that of plaster. The result is that the tiled wall absorbs less thermal energy. Consequently, the internal surface of the wall transmits less heat to the interior of the building, when compared in a similar period of time, to an equal wall without tiled revetment.

Besides being expressive, the reuse of glazed tiles on the walls of the Ministério da Educação e Saúde (1936-1945), redefines a recovering of cultural roots. Beyond its useful functions it carries a powerful symbolic meaning as an architectural monument, demonstrating a renewal of cultural and constructive tradition representative of the country.

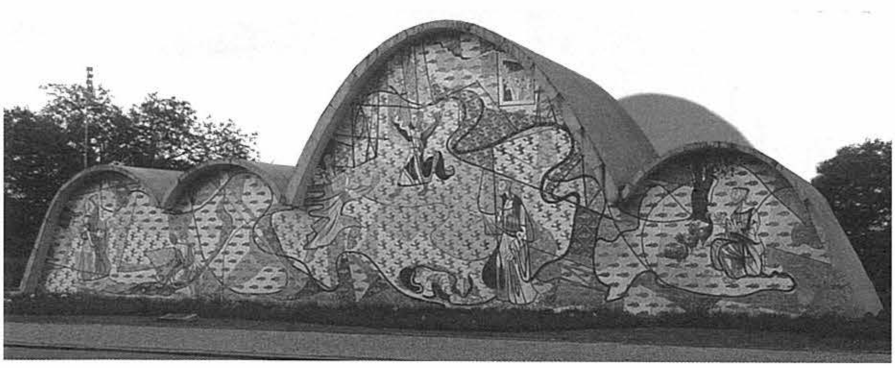
The *combogós* or enlarged trellis

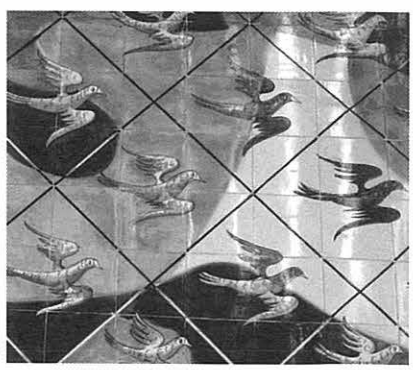
An element which was developed and largely employed in Brazilian architecture after the thirties is the *combogó*.



Portuguese tiles panels by XVIII century, in the cloister of São Francisco convent, Salvador, BA, and tiles façades in colonial houses in São Luis, MA.

This element possibly originated in Pernambuco made of clay or cement which has a hollow area which is bigger than its mass. Its function may be compared to the wooden trellis of the old *gelosias* that filled up the window's openings or the ancient *muxarabis* of the Brazilian colonial architecture. These, although blocking the entrance of direct solar radiation and allowing certain ventilation through the interstices of the wooden frame, resulted in small openings that darkened too much the interior of the room. The resultant open space was smaller than the closing area making difficult the penetration of





São Francisco de Assis Church, by Oscar Niemeyer, 1943. Tiles by Cândido Portinari.

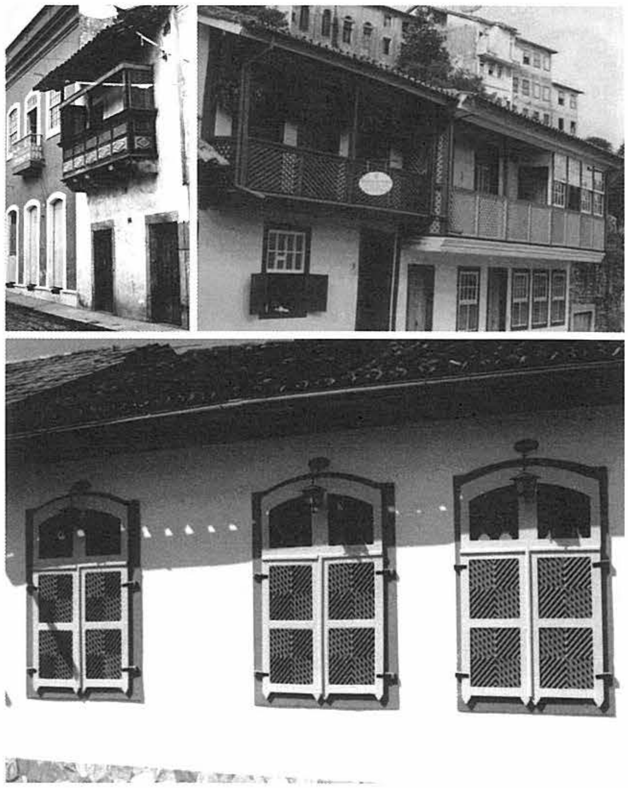
external ventilation and the free circulation of air inside the houses.

The *combogó* on the other hand, solves these problems and may be considered as an enlarged trellis. It presents few structuring material and larger apertures. This empty / full relation represents a great advantage, from the ventilation point of view, for it permits a free circulation either at the entrance or at the withdrawal of air inside the building.

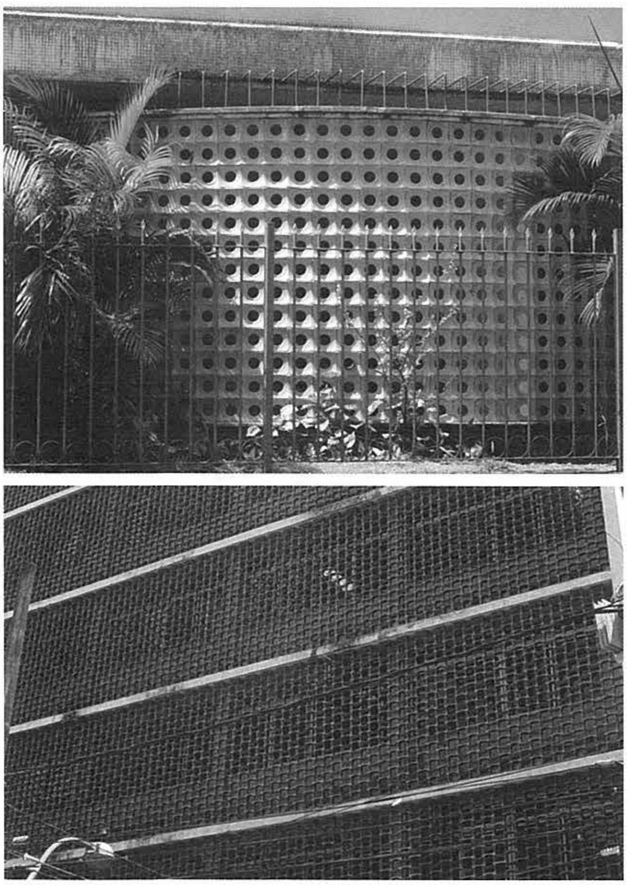
According to the pattern arrangement and its localisation in the façade in relation to the relative sun positions in the sky they can minimise or even hinder the entrance of direct solar radiation inside the rooms. Therefore a west wall of *combogó* is much more effective from the thermal point of view than an open wall, while it offers shadow and works perfectly when these openings are directed to the air exit. With the direct solar radiation occurring in this pierced wall the half-open space creates a heated air-mattress that works as an air sucker through the apertures of the intermediary wall between this limited area by the combogó and the interior space. This means, it produces a chimney effect facilitating ventilation from the opposing exterior wall.

Lattice windows

Lattice window with diverse variations is another element that largely has been used in the modern architecture in Brazil. This type of frame was already extensively used in the country in the second half of the 19^{th} C. Its adoption meant the integration of the wooden strips of the *esteiras-da-china* to the window frame. It was a sort of exterior movable curtain, made of small horizontal juxtaposed slabs, fastened laterally by strings that, when closed allowed regular intermediary open spaces between them.



Ancient *muxarabis* in Olinda, PE, old verandas with trellis in Ouro Preto MG and trellis windows in Mariana MG.



Crockery's combogó in a modern building in Salvador and ceramic combogó in the INPS Ajuda Building in Salvador 1948/1950.

Superimposed to the casement fastened by the outer side at the upper part of the openings, these elements assured not only privacy inside the rooms but also and principally they allowed the efficient control of the natural light excess and the direct solar radiation through the glass windows.

These wooden elements counterpoising or substituting the glass casement corrects the utilisation of glass windows in two crucial aspects, from a climate point of view. They allow the direct and diffuse radiation control and the air transport into and out of the rooms. The parallel plates that may be fixed or preferably movable allow total control of quantities of ventilation and natural lighting inside the building through the openings formed by the continuous intervals.

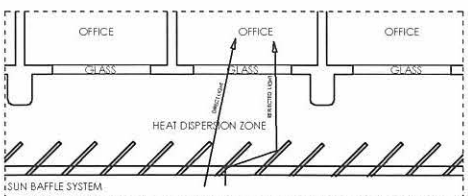
One can mention many instances of correct use of lattice windows and glass applied in modern architecture in Brazil as for example the employment of horizontal pivoting windows, where the very window serves as a barrier against solar radiation while permitting the natural ventilation inside the room.

Aspect of lattice windows in old house in Belém, and lattice windows in a residential building in Salvador by José Bina Fonyat, 1950s.

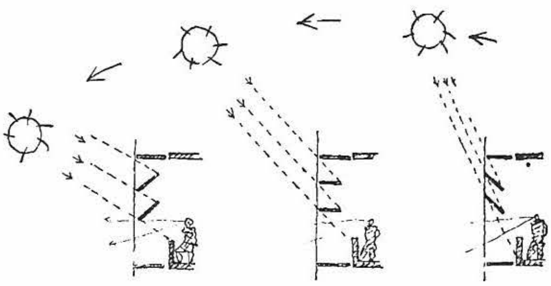
Brise-soleil and *quebra-sol* versus glass panels

Undoubtedly the influence of Le Corbusier over the group coordinated by Lúcio Costa for designing the *Ministério da Educação e Saúde* (1936), in Rio de Janeiro, was remarkable and brought conclusive outcomes to the modern architecture built subsequently in Brazil.

From this influence stands out the attitude of searching solutions in building materials and characteristic aspects of local construction like designing buildings and façades considering the climate. As examples one can mention the protection against solar radiation by *brise soleil* elements, first developed by Le Corbusier for a project in Algiers (1933) but already used at the façade of the *Associação Brasileira de Imprensa* by M.M. Roberto designed and built in Rio de Janeiro between 1936 and 1938.



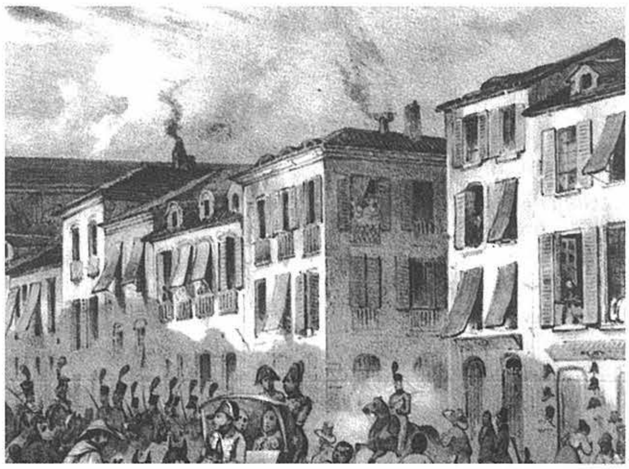
Detail for the brise soleil of the Brazilian Associated Press by M.M. Roberto in Rio de Janeiro, RJ, 1936 – 1938.



Original design by Lúcio Costa to the apparent course of the sun and the barrier from *quebra sol* for the *Ministério de Educação e Saúde*, by Lucio Costa and others, Rio de Janeiro, RJ, 1937 – 1943. Source: Cavalcanti Lauro 2001.

Elements of exterior protection applied on the openings had already been tested and their efficiency was well-known in Brazil. The *esteiras da china* were introduced in order to correct or diminish thermal effects and problems originated by massive use of English glass windows or sash windows, that had become a substitute to the *gelosias* from the second decade of the 19th C.

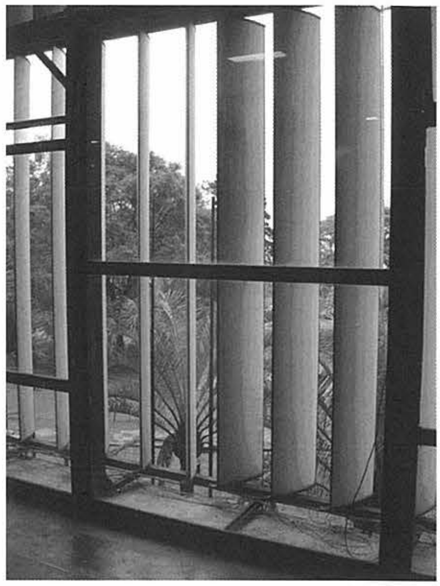
Certainly these external curtains, which appeared by the middle of the 19th C. as can be seen in engravings and photographs of some cities as Salvador and Recife were the harbingers, in Brazil, of the lattice windows that worked as the future *brise soleil*. Superimposed to the windows they hindered the direct solar radiation penetration, thus guaranteeing ventilation through its gaps.



Detail in Rue Droite à Rio de Janeiro by Rugendas, 1835 in Rio de Janeiro. and Aliança de Seguros Building with horizontal brise soleil in Salvador 1956.

The brise soleil solution has the great advantage of belonging to the body of the building and formally defining it. The decision of using them might be incorporated in the design process, for its correct localisation assures the efficiency of the protection element as barrier against the direct sunlight. The correct design is of extreme importance during the elaboration of the project.

With the localisation of the *brise-soleil* or *quebra-sol* superimposed to the façades, externally to the curtain



Industry Palace in Ibirapuera Park, São Paulo, and brise soliel's details, by Oscar Niemeyer with collaboration by Zenon Latufo, Hélio Uchoa and Eduardo Kneeze de Mello, 1951 – 1955.

wall, it is much more efficient from the thermal point of view, than any other element or barrier that eventually may be used inside the openings. In this way it blocks the direct action of the solar radiation, reducing significantly its thermal effect on the glass, known as "green house effect".

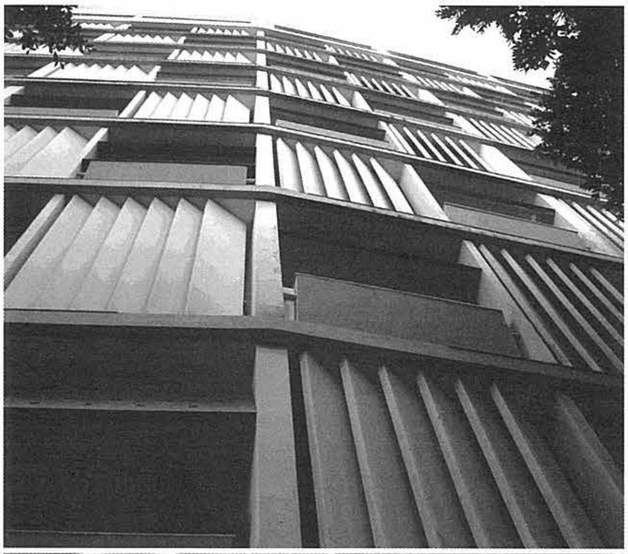
In order to guarantee its efficacy, the *quebra-sol* in façades should be correctly designed considering the latitude of the place, the apparent course of the sun in the sky, the orientation of the façades, the topography of the plot, the characteristics of the surroundings and the different positions of the sun during the year.

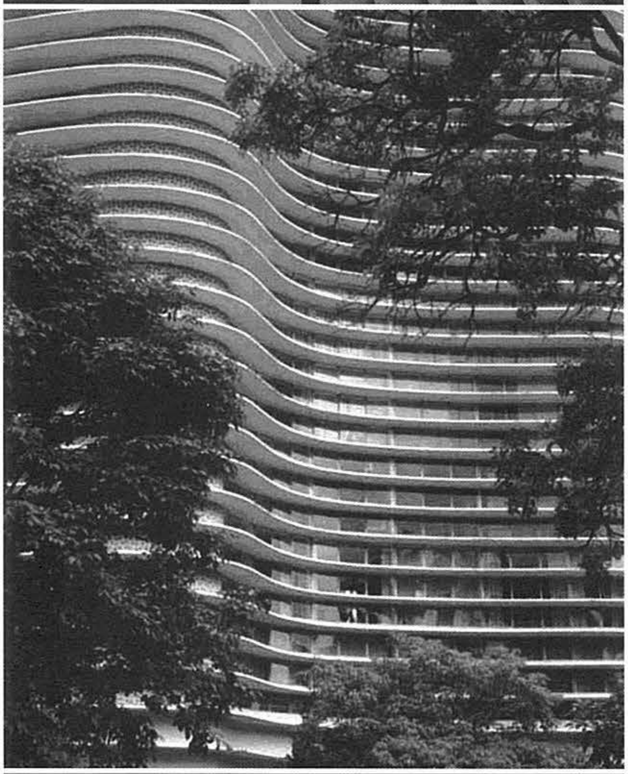
All these factors might be considered for a correct definition of the slab position and of the slab dimensions in the *quebra-sol*. As we can see in some buildings they appear indistinctly in façades receiving little or no sun. And even if the orientation of the plates is incorrect, it might happen that they serve as captor of direct solar radiation instead of being protective. In these cases the *brises* loose their function and turn to be mere superimposed three-dimensional objects to give movement to the façade and an illusion of good architecture.

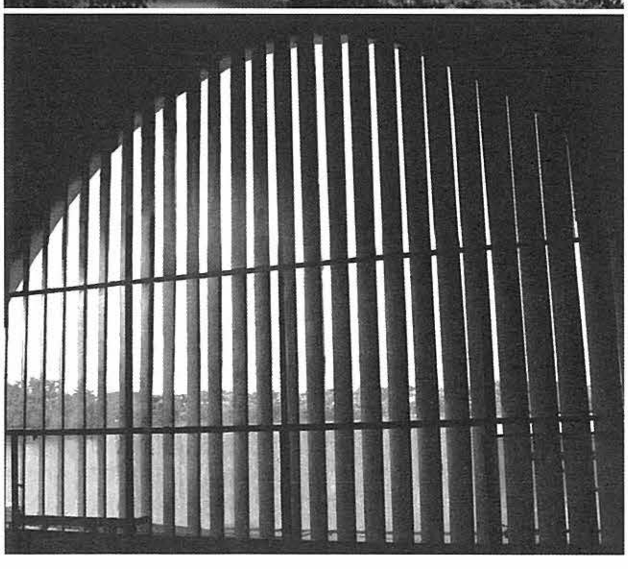
In Brazilian modern architecture one can find an extreme formal diversity in the way brise soleil are applied regarding the direction and the dimension of its plates. Examples vary from huge vertical panels in concrete, to small attached slabs or alternated panels with narrow slabs to movable panels. Regarding horizontal plates, one can mention, among others, the movable panels constituted by small slabs, similar to the ones of *esteira-da-china*, the movable panels of asbestos with large width and length equal to its window frame as well as fixed plates. Another important reference by Reidy is the extreme movement resulting from the fixed and movable *quebra-sols*, simultaneously using horizontal and vertical plates with diverse proportions, posed to the west façade of the Instituto de Previdência do Estado da Guanabara headquarters (1957).

Conclusion

Brazilian modern architecture stands out in the national and international scenario for its differentiated repertoire. It appropriates some concepts which were first developed in other countries, adapting and intermingling them with needs, concepts and constructive elements already existing in Brazil. It develops without copying mimetically, and it elaborates a repertoire based on formal and constructive responses that adapt itself to the place where it works passively with the climate, somehow obeying to a *bio-climatic* basis.







It is necessary to say that the protection elements and the treatment of the building skin which represented the Brazilian modern architecture were sometimes used empirically and at other times integrated to the façades searching to create more aesthetic than functional expression.

Nowadays it is necessary to rescue these constructive elements through a correct evaluation of their use.

However, it is also necessary to promote the diffusion of these fundamental concepts and patterns once they work well, thus establishing an architecture that functions passively in favour of the climate and in consonance with energy economy necessary to the development in this new millennium.

Literature

Alcântara, Dora, *Azulejos na cultura luso – brasileira*. Rio de Janeiro, IPHAN. 1997

Andreoli, Elizabetta and Forty Adrian, *Arquitetura Moderna Brasileira*. Phaidon Press Limited, 2004

Bonduki Nabil, Portinho Carmen, *Affonso Eduardo Reidy*. Editorial Blau e Instituto Lina e P. M. Bardi. 2000

Bruand, Yves, *Arquitetura contemporânea no Brasil*. 3ª edição, São Paulo, Editora Perspectiva S. A. 1997

Cavalcanti Lauro, org., *Quando o Brasil era Moderno: Guia de Arquitetura 1928-1960*. Aeroplano Editora, 2001

Costa, Lúcio, *Lúcio Costa: registro de uma vivência*. São Paulo, Empresa das Artes/UNB. 1995

Goodwin, Philip L., Brazil Builds: *Architecture New and Old 1652 - 1942*. New York, MOMA. 1943

Mindlin. Henrique, E., *Modern Architecture in Brazil*. Rio de Janeiro / Amsterdam, Colibris Editora Ltda. 1956

Penedo, Alexandre, *Arquitetura Moderna em São José dos Campos*. São José do Campos, São Paulo, A. Penedo. 1997

Segawa, H. e Dourado. G. M., *Oswaldo Arthur Bratke*. São Paulo, ProEditores. 1997

Prof. Arch. Griselda Klüppel. Federal university of Bahia, College of Architecture, Department of Creation and Graphical Representation. Master in Architecture and Urbanism, Federal university of Bahia, UFBA, Brazil, "Environmental comfort in 19th century houses in Salvador" (1991).

Verticals and horizontal brises in Comendador Horácio Urpia Building, in Salvador, by Diógenes Rebouças, 1957.

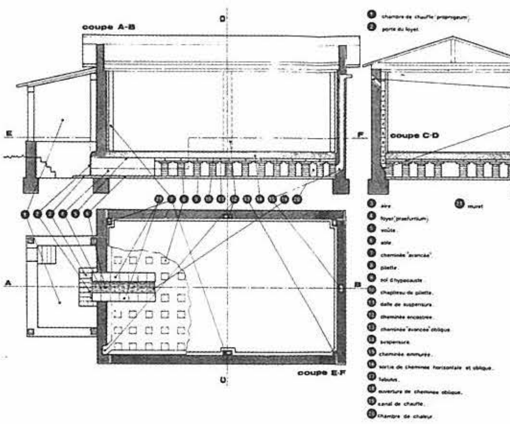
Residential Building in Belo Horizonte, MG, with verandas like horizontals brise soleil by Oscar Niemeyer 1955-1960.

Vertical brise soleil in the São Francisco de Assis Church, by Oscar Niemeyer, 1943.

Modern Movement Architecture and Heating Innovations in France 1900-1939

by Emmanuelle Gallo

Modern Architecture is usually associated with technical innovations that resulted in a new set of aesthetics. The radical revolution of heating systems had already occurred during the previous century. But the beginning of the 20^{th} C. was not an uninteresting period; on the heating issue, several significant improvements occurred and these will be discussed here.

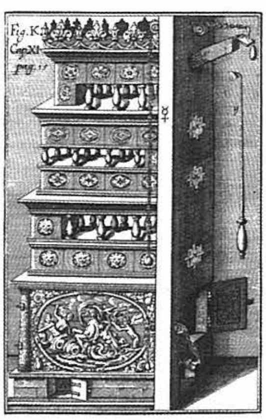


Example of a roman hypocaustus. Drawing by Jean-Marie Degbomon, in Jean-Marie Degbomon, *Le chauffage par hypocauste dans l'habitat privé de la place St-Lambert à Liège et l'aula Palatina de Trêves*, Etudes et recherches archéologiques, Liège 1984, 240 p.

A brief history of heating

The first interesting period in the history of heating is the Roman Empire. At that time was invented the *hypocaustus* which spread throughout the North of Europe, in bath houses and important villas.

The next heating revolution came between the 10th and 13^{th} C. with chimneys standing against a wall and the first stoves made of baked clay in the Alemanic area (with Alsace in France).



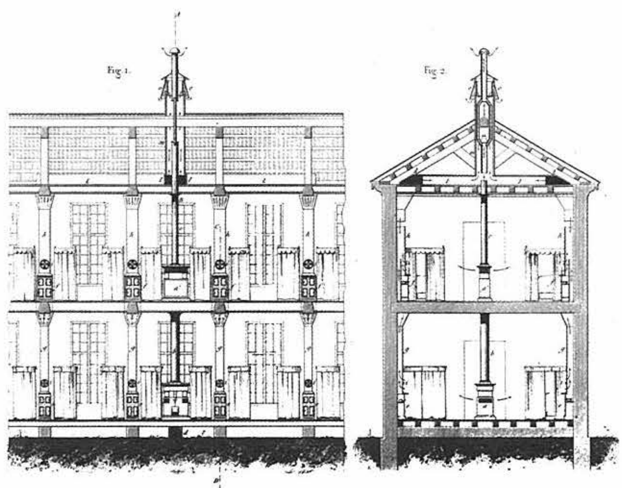
Iron and ceramic stove. Georg Andreas Böckler, *Furnologia oder Haushältiche Oefen Kunst*, Georg Müller, Franckfurt 1666, p.15.

During the second half of the 18^{th} C. and first part of the 19^{th} C., were developed new ways of building chimneys, with smaller fireplaces and radiant angles. Stoves were also developed by that time from short series to industrial manufacturing. Different kinds of central heating were tested, using hot air, hot water or steam and also combined solutions. The use of coal or coke, more common in Britain, came also to France.

By the second part the 18^{th} C. all these changes were experimental, but during the 19^{th} C. the different systems were developed, first for collective programmes such as: prisons, hospitals, theatres, university amphitheatres, textile mills (to facilitate production), or glass houses (to grow exotic fruits), but rarely for lodgings.

In France, hot water systems became more popular (except for large scale buildings) because they imposed less of a restraint on the settlement, the boilers did not need the same level of control and users were less alarmed. These systems usually functioned without pump and were named *thermosiphon*.[1]

The 19^{th} C. architectural press surveyed the developments in heating technology, especially in the *Revue Générale de l'Architecturale et des Travaux Publics*, which publishes articles by René Duvoir, a heating systems manufacturer[2].



Heating and ventilation of an hospital. René Duvoir, *Chauffage et ventilation d'hopital*, Revue générale d'architecture et des travaux publics, n°5, 1844, pl.27.

The context at the beginning of the 20^{th} C.

At the end of the 19^{th} C., the idea of using central heating for domestic purposes has become more acceptable even if it is not generalized, like it will become after the Second

Standard radiator. Compagnie Nationale des radiateurs, *Radiateurs chaudières Idéal – triple orné avec chapiteaux et bac d'évaporation.* 1911, p.34.

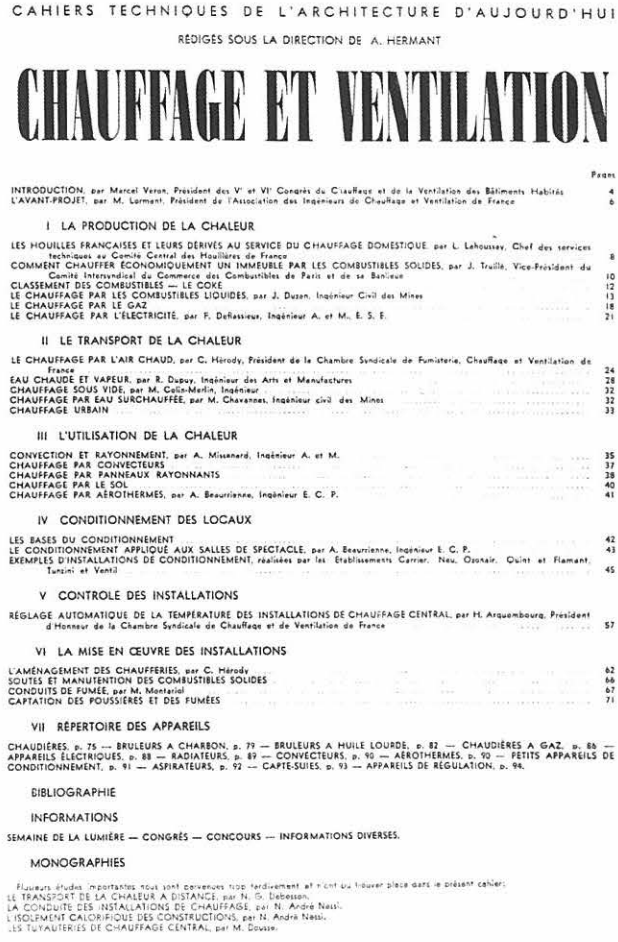
World War. Standardized radiators, the patents of which came from the USA, have replaced the old heat exchangers, as standardized furnaces become more common. Steam boilers bursted less frequently, the legal regulation becomes stable. Meters, clocks, valves, expansion coils, joints and pressure gauges were properly settled.

Important towns installed gas and then electric networks, first for lighting streets and then indoor spaces.

There are no books on heating technology published in France at that time that are written for architects, but there are quite a lot of books, mostly textbooks, for engineers. There exist also papers, or parts of papers, in the architectural press. These sources will be used to present the different innovations developed during the period: the use of fuel oil, the first French district heating networks, the introduction of electric pumps, the heating by radiant floors, the forced air heaters for plants. Several important engineers worked and published during our period, most of them trained at the École Centrale, Henri Arquembourg, Auguste Baurrienne, André Nessi, Victor Kammerer[3]. André Missenard (1901-1989), trained at the *École Polytechnique*, familiarly linked to an important heating manufacturer, also published a textbook on heating and ventilating. He received the Ernst Rietschel price in 1928 for his research on ambiance temperatures[4].

The part played by *L'Architecture d'Aujourd'hui*

When the new architectural journal *L'Architecture d'Aujourd'hui*, first published in 1930, presented the architecture of the modern movement, the technical questions became more prominent. During a couple of years, the technical topics got a special section. Here they were treated as part of the presentation texts of individual buildings. The journal also published in 1933/1934 a technical supplement named *Chantiers,* which means 'building sites', in which they opted for the same solution[5]. In 1935, the journal was restructured and one number a year was dedicated to a technical topic. Number 5, dated May 1935, focused entirely on "Heating and Ventilation". The different chapters were: heat production (fuel and energy), heat carrying fluids, heat transmission means, air conditioning, control and regulation. The papers, presenting the most recent and interesting heating systems, were written mostly by engineers involved in the field[6]



CAHIERS TECHNIQUES DE L'ARCHITECTURE D'AUJOURD'HUI

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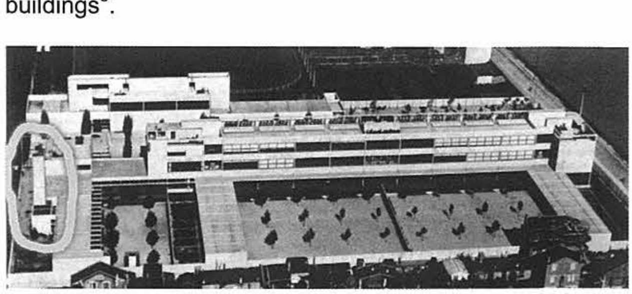
L'Architecture d'Aujourd'hui n° 5, May 1935

The introduction of fuel oil for heating systems

One of the relative novelties is the use of fuel oil in combination with, or instead of, coal. Often it is possible to simply change the burners from coal to oil. Moving from coal to oil reduced the importance of the workforce since the feeding of the furnaces could be done automatically. Even if the cost of this new energy was higher, there was no more the income of the stoker to pay. The calorific power of oil varied from 10,400 to 10,800 calories per kilo, which is higher than that of solid fuel. Oil was especially convenient where there was no gas network.

The "Karl Marx" primary school in Villejuif by André Lurçat (1931-1933) used oil for heating as well as electric pumps[7]. The boiler room was isolated from the other buildings[8].



Karl Marx school, Villejuif, André Lurçat (1931-1933). Boiler room encircled. Pierre et Robert Joly, *L'architecte André Lurçat*, Picard. 1995, p.104-105.

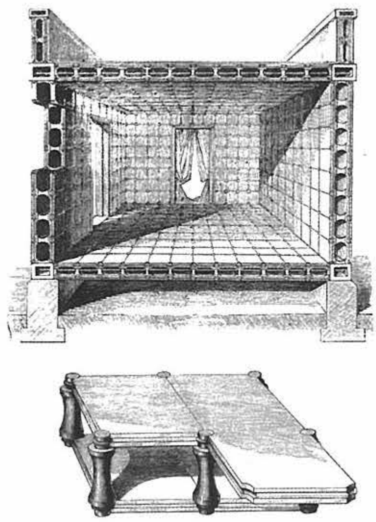
For safety, the furnaces could be fitted with different burners for oil or coal, with appropriate storage units for each. Hot water was sent to radiators with electric pumps but could also function without propulsion by using "thermosiphons". Tests showed that all the building's radiators were sufficiently heated after twenty minutes. Both fuels were tested with similar results. Oil was considered as the most convenient fuel, with coal used as a secondary supply.

Oil was not common in France. The magazine *Chantiers* (n°4, 1934) devoted a full page to the addresses of oil refineries in France[9]. In a suburban context, the luxurious Villa Cavrois in Croix designed by Rob Mallet Stevens in 1932 was also heated with oil[10].

The development of radiant heating

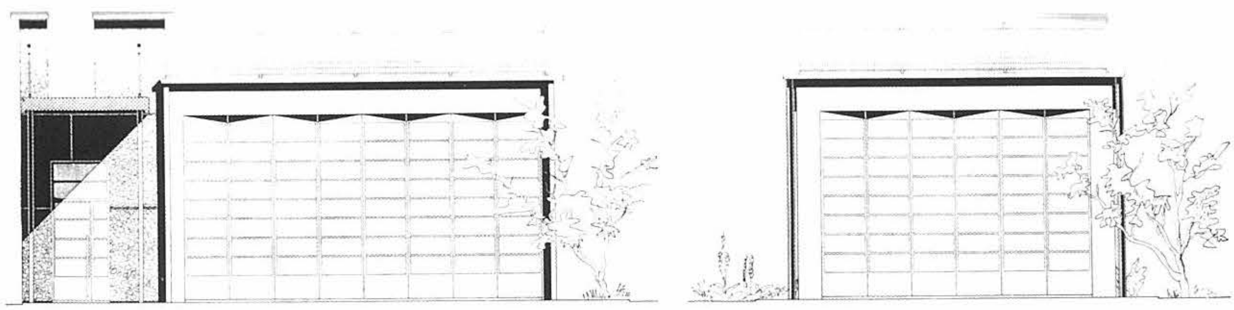
Radiant heating had a long history; already in the Roman time, with the *hypocaustus* system, the rooms were warmed with smoke tunnels located under the floors. The ceramic stove way also used radiant heating in a more localized manner. During the 19th C. several specialists such as Emile Trélat promoted radiant heating for large surfaces, since it could be associated with cool air, a system which he considered healthy[11]. Two proposals for floor radiant heating were presented by Edwin Chadwick in the *Revue Générale de l'Architecture* (1872).

The first proposal involved the heating of a field hospital located in a tent, the other concerned a house built with double-skin walls with smoke in between[12]. These examples show the interest for radiant heating but also the difficulties of making such a system practical at reasonable costs.

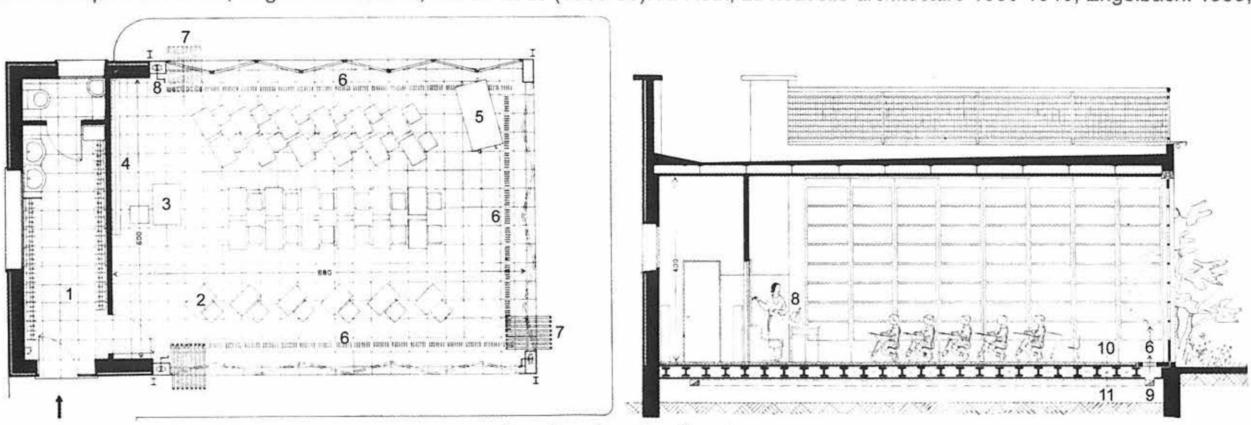


Radiant heating system by Edwin Chadwick. Lavézarri E., *"Traité pratique du chauffage"*, *Revue générale d'architecture et des travaux publics*, n°29, 1844, col.155.

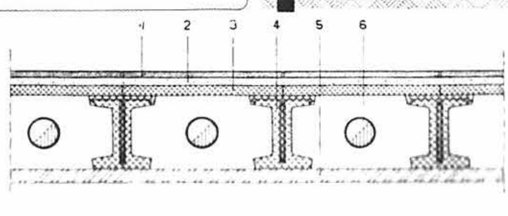
The early 20th C. saw the commercial development of radiant heating. The building presented here is the open air primary school in Suresnes by Eugène Beaudouin (1898-1983) and Marcel Lods (1935-1936)[13]. This experimental school was designed according to the



Suresnes open air school, Eugène Beaudouin, Marcel Lods (1935-36). A. Roth, *La nouvelle architecture 1930-1940*, Engelbach. 1939, p.124

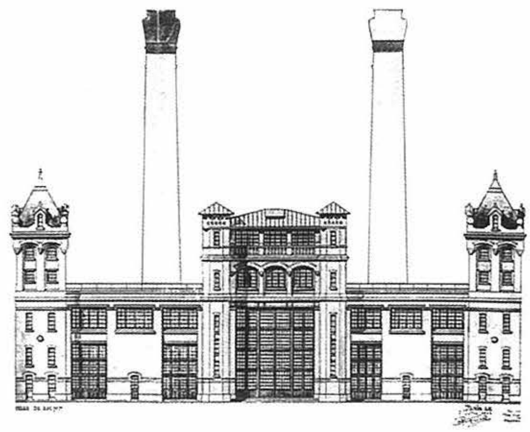


1 entrance, clothes
2 tables
3 teacher's table
4 blackboard
5 rolling cupboard
6 grid for hot air
7 glass folding door
8 crank handle
9 hot air channel
10 heating tube
11 natural stone slabs



1 natural stone slabs (quartzite)
2 sand bed
3 prefabricated concrete slabs
4 prefabricated concrete beam
5 "Isoplac" (magnesium bound wood fibre)
6 heating tube

principles of *hygiénisme* with classes spread out in a garden, three walls made of folding doors and sundecks on the roof. The floors of the classrooms were made of natural stone slabs, and the heating consisted of steel pipes embedded in the floor void. To offset the cold produced by the huge windows, in addition to the radiant heating, they used warm air rising from ducts along the length of the moving wall, when necessary. The heating plant was a low pressure steam system, eliminating all danger of damage by frost during the holidays. Radiant heating was promoted by André Missenard, who wrote a paper on the topic for a special number of *Architecture d'Aujourd'hui*, Missenard conceived such heating at a huge scale during the sixties[14]. Patents were registered by Deriaz and distributed by several firms in Paris: Boeringer, Chaussidière, Gandillot, Albert Hatry and Tunzini[15].

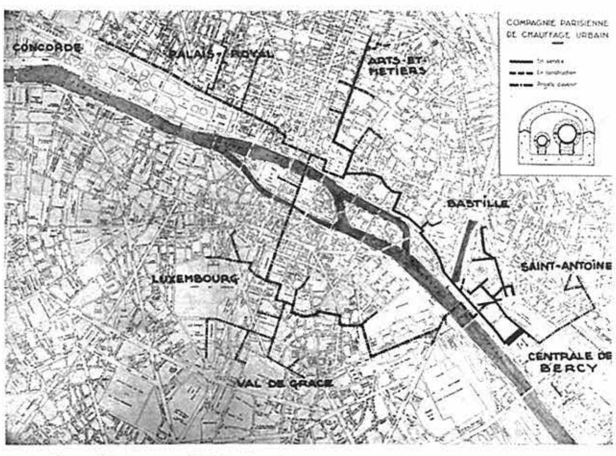


Compagnie Parisienne de Chauffage Urbain. André Hermann, "*Chauffage urbain*", *L'Architecture d'Aujourd'hui*, n°5, 1934, p.33.

The introduction of district heating in France

District heating networks appeared in the state of New York around 1880[16]. The first European network was installed in 1900 in Dresden[17]. Only in 1928 were they introduced in France, even if Augustin Rey (1864-1934), an architect and vigorous hygienist, had already promoted the idea of heating social housings from a central station in 1905[18].

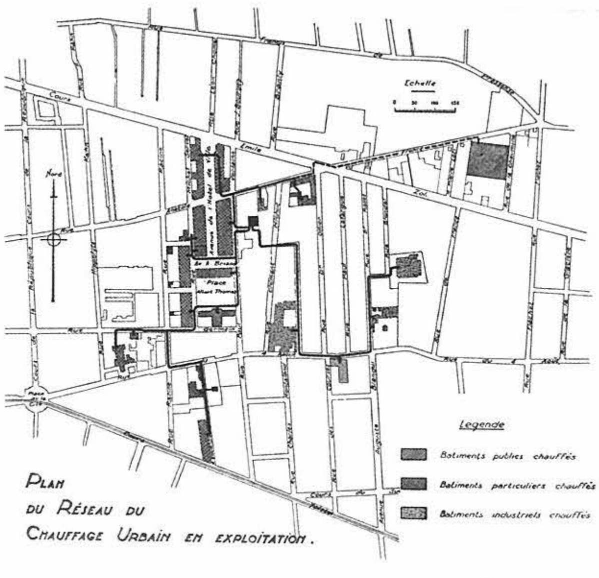
Two networks were created at the time, one in Paris, and the other in Villeurbanne, near Lyon. One of the advantages of district heating is the reduction and the control of smoke nuisance. The extensive use of coal in towns was the cause of dangerous air pollution denounced by many, one being the modern architect Marcel Lods[19].

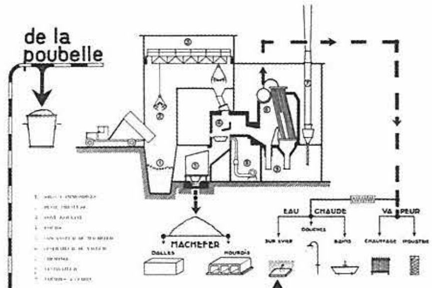


Paris steam network and heating station. André Hermann, *Chauffage urbain*, *L'Architecture d'Aujourd'hui*, n°5, 1934, p.33.

In Paris, this steam network was funded privately. It consisted of an obsolete electric plant designed originally for the subway by the Seine near the Gare de Lyon. The network was extended in the neighbourhood and westwards to the town centre[20]. The city of Paris gave the concession to the *Compagnie Parisienne de Chauffage Urbain*, and prescribed the connection first to public buildings[21].

That is why all the public buildings (owned by the town or by the state) nearby the network were connected: the railway station *Gare de Lyon*, the main town hall, primary schools, the National library, the town hall of the fourth district, the *Palais-Royal* and the *Comédie Française* theatre, the *Conservatoire des Arts et Metiers*, the Turgot high school, but also hotels, cinemas, offices, and Haussmanian residential housings.





Villeurbanne District, Lyon, heating network and the circulation system of the refuse incinerator. Lazare Goujon, *Villeurbanne 1924-1934 ou 10 ans d'administration*, Association typographique (1935, p.370).

From the beginning, the idea was to created a network with several interconnected production units, located in suburbs, producing electricity and burning household refuse, but with the monetary crisis and the war the interconnection had to wait until the 1950s.

In Villeurbanne, the network was begun by the town with its mayor Lazare Goujon (1869-1960), in the context of a global urban and hygienic programme, with a new town hall, a Palace of Labour (*Palais du travail*), and large-scale social housing complexes shaped as skyscrapers[22]. The production station was centred on the refuse incinerator and was complemented with a coal furnace. The heat conducting fluid was hot water under pressure (180°C, 15 kg) and the German company *Caliqua* in charge of the network had a branch in Alsace.

The heat was delivered to the housing units, factories and public buildings, including a swimming pool located in the basement of the Palace of Labour. In this radical socialist town, directed by a doctor, the purpose was to democratize comfort and hygiene with the help of the engineer Jean Fleury.

Heating with gas and electricity

Heating with gas was possible through two ways: central heating or gas radiators designed and produced at the end of the 19th C. This type of heating involved numerous pieces of equipment necessary to heat individual rooms.

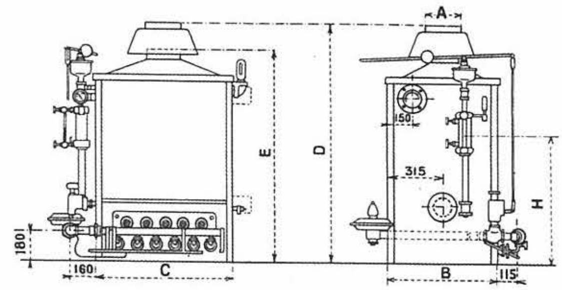
Central heating with gas could be installed for the entire residential building or just for one apartment. The energy efficiency was good (80%) and the regulation was convenient, but the entire system had to be properly and regularly controlled in order to be safe[23].

Calor electric radiator. Postcard, Union des arts décoratifs 1987, photo Sully-Jaulmes.

Gas radiator, photo Emmanuelle Gallo, author's collection, and gas boiler's description.

CHAUDIÈRES A GAZ " IDÉAL GAZINA "

TYPES " GW " ET " GS "

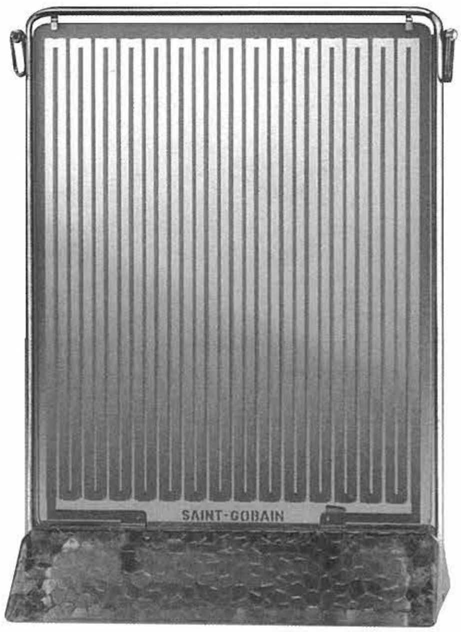


Numéros	Diamètre Raccord Régulateur de pression du gaz m/m	Diamètre Raccord Vanne de réglage m/m	A Diamètre des tuyaux d'évacuation m/m	B Largeur de la Chaudière seule m/m	C Profondeur de la Chaudière seule m/m	D Hauteur avec antirefouleur m/m	E Hauteur sans antirefouleur m/m	Hauteur des départs au-dessus du sol m/m	Hauteur des retours au-dessus du sol m/m	H Hauteur de la ligne d'eau m/m
CHAUDIÈRES POUR EAU CHAUDE										
1-GW- 8	40 /49	40 /49	203	630	875	1405	1210	950	330	—
1-GW- 9	50 /60	40 /49	228	630	975	1480	1210	950	330	—
1-GW- 10	50 /60	40 /49	228	630	1075	1500	1210	950	330	—
1-GW- 11	50 /60	40 /49	254	630	1175	1500	1210	950	330	—
CHAUDIÈRES POUR VAPEUR A BASSE PRESSION										
0-GS- 40	20 /27	26 /34	102	470	350	1310	1220	1040	485	810
0-GS- 50	20 /27	26 /34	127	470	425	1310	1220	1040	485	810
0-GS- 60	26 /34	26 /34	152	470	500	1340	1220	1040	485	810
0-GS- 70	33 /42	26 /34	152	470	575	1340	1220	1040	485	810
1-GS- 40	33 /42	26 /34	152	630	475	1355	1210	950	330	760
1-GS- 50	33 /42	33 /42	173	630	575	1355	1210	950	330	760
1-GS- 60	33 /42	33 /42	203	630	675	1365	1210	950	330	760
1-GS- 70	40 /49	33 /42	203	630	775	1385	1210	950	330	760
1-GS- 80	40 /49	40 /49	203	630	875	1405	1210	950	330	760
1-GS- 90	50 /60	40 /49	228	630	975	1480	1210	950	330	760
1-GS- 100	50 /60	40 /49	228	630	1075	1500	1210	950	330	760
1-GS- 110	50 /60	40 /49	254	630	1175	1500	1210	950	330	760

Accessoires pour les Chaudières à vapeur : Régulateur de pression du gaz, Rampe à gaz complète avec robinets, Vanne de réglage progressif du gaz, Régulateur de pression de la vapeur, Veilleuse thermostatique avec robinet, Antirefouleur, Jaquette isolante en tôle noire (émaillée blanc sur demande seulement), Robinet de vidange, Garniture de niveau d'eau, Soupape de sûreté, Manomètre.

Sur demande et moyennant un supplément de prix, l'Antirefouleur peut être remplacé par un Régulateur automatique de tirage.

The first introduction of electric heating in France took place in 1925, when electric wiring of appropriate size was developed[24]. This system gave a total liberty. By its high price the cost slowed its diffusion, especially in the case of direct electric heating. Storage heaters were more financially attractive.



Saint-Gobain electric radiator *Radiaver*.
Affiche George Fabre, Bibliothèque Forney.

For the period under study, electric heating remained insignificant even if beautiful radiators were designed, especially one by Saint-Gobain for the Paris International Exhibition of 1937.

Conclusion

This period 1900-1939, if not revolutionary when it came to heating, was still innovative. There are new types of energetic sources and networks available. New forms of heating passed from utopia to reality. The architects use more readily the novelties proposed by the engineers even in residential projects. The diffusion of thermal comfort is not yet democratic but it is during this period that everything was settled for a larger availability after the Second World War.

Notes

[1] All these general informations are collected for the author's Ph.D, in working prodress: *Modernité technique et valeur d'usage, le chauffage des bâtiments d'habitation en France*, Université de Paris I, directed by Gérard Monnier. See also: Gallo, E., *Jean Simon Bonnemain (1743-1830) and the Origins of Hot Water Central Heating, 2nd International Congress on Construction History,* Queens' College, Cambridge, UK, 29th March-2nd April 2006, edited by the Construction History Society, p. 1043-1060.
[2] René Duvoir, "*Chauffage par eau chaude*", *Revue générale d'architecture et des travaux publics*, n°7, 1847-1848, col. 509-515
[3] More details on heating of public buildings and *L'École Centrale*: Emmanuelle Gallo, Alice Thomine, *Chauffage et ventilation*, *Le Paris des centraliens, bâtisseurs et entrepreneurs*, Action Artistique de la ville de Paris, Paris (2004, pp. 199-201) directed by Jean-François Belhoste,
[4] André Missenard, *Cours supérieur de chauffage, ventilation et conditionnement de l'air*, Librairie de l'enseignement technique, Paris 1937-1943, 4 vol.
[5] Nathalie Rouleau-Simonot, *Les tentatives d'une revue à forte identité technique au travers de L'Architecture d'Aujourd'hui, puis de Techniques et Architecture (1930-1945)*, *Les Avatars de la littérature technique*, CHTE, CNAM, INHA, (3,4, 5 March 2005) (in press).
[6] *Chauffage et ventilation*, *Architecture d'Aujourd'hui*, n°5, mai 1935,100 p.
[7] *L'école Karl Marx de Villejuif*, *Chantiers*, n°3, 1933, pp.27-28.
[8] Pierre et Robert Joly, *L'architecte André Lurçat*, Picard (1995, pp.103-109).
[9] *Chantiers*, n°4, 1934.
[10] Richard Klein, *Robert Mallet Stevens La villa Cavrois*, Picard. 2005, p. 224.
[11] Emile Trélat et C. Somasco, *Le chauffage et l'aération des habitations*, la bibliothèque des annales économiques. 1889, p. 11.
[12] Lavezzari, E., *Traité pratique du chauffage*, *Revue Générale de l'Architecturale et des Travaux Publics*, n°29, 1872, col. 152-156.
[13] Alfred Roth, *The New Architecture*, 1930-1940, Engelbach 1939, pp. 115-130.
[14] André Missenard, "The radiant heating", *Architecture d'Aujourd'hui*, n°5, 1935, p. 36.
[15] *Chantiers*, n°2, 1934, pp.. 32-34..
[16] Birdsill Holly, of Lockport, New York, United States Patent Office*: Apparatus for Supplying Districts in Cities and Towns with Heat and Power*, n°9, 821, July 26, 1881. *Street-Main*, n°9,730, May 31, 1881. *Meter*, n°241,217, May 10, 1881. *Steam-Pressure Regulator*, n°246,952, September 13, 1881.
[17] Sven Werner, *Fjärrvärmens utveckling och utbredning*, (District heating development and spreading). Stockholm, 1989, 79 p.
[18] Augustin Rey, *Comment chauffer les habitations populaires - Chauffage central par groupe d'immeubles. Compte rendu de la 37e session Clermont-Ferrand 1908 de l'Association Française pour l'avancement des sciences*, Masson, Paris, 1909, p. 1376-1388. Augustin Rey, *Le problème du chauffage collectif des habitations populaires, Revue de l'art de l'ingénieur et de l'hygiénisme municipal.* Paris, oct-nov, 1908, p. 248.
[19] Marcel Lods, *Le métier d'architecte,* Paris 1976, p. 51-62. René Humery, *La lutte contre les fumées poussières et gaz toxiques*, Dunod, Paris, 1933, 350 p.
[20] *Chauffage urbain à Paris, 1929-1954*, CPCU. Paris 1955, p. 29.
[21] L. de Taste, Auguste Lefebure, *Rapport du conseil municipal de Paris n° 144*, 15 novembre 1927.
[22] Emmanuelle Gallo, "*La réception et le quartier des Gratte-ciel, centre de Villeurbanne, ou pourquoi des Gratte-ciel à Villeurbanne en 1932*", contribution à la VII[e] conférence internationale de Docomomo*, Image, usage, héritage : la réception de l'architecture du mouvement moderne*, Unesco. Paris, 16-19 septembre, Presse Universitaire de Besançon, p.149-152.
[23] G. Prud'hon. *Le chauffage central au gaz*, Office technique de chaufage, Paris,1927. Paquier, S. & J.-P. Williot., *L'Industrie du gaz en Europe aux XIXe et XXe siècles ; L'innovation entre marchés privés et collectivités publiques*, Lang. Bruxelles 2005. Henri Besnard, *L'industrie du gaz à Paris depuis les origines*, Domat-Montchrestien. Paris 1942.
[24] F. Deflassieux, *La chauffage par l'électricité, Architecture d'Aujourdhui*, Mai 1935, n°5, p.21-23.

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Air-Conditioning and Installations in the Capitol Building in Madrid (1933)

by César Martín Gómez

Introduction

"Thus is explained that in London, Paris, Berlin, Madrid, the number of construction workers and capable people multiplied extraordinarily [...]. All this produced thousands of well-remunerated employees, people with greater personal exigencies, deciding to taste existence. A result of this desire is the birth, amazing multiplication of theaters, movie theaters, cafés, bars, dance and concert halls. The number of vehicles reaches prodigious amounts. Circulation problems become unsolvable. A new kind of building is born at the time destined to satisfy all these necessities. It houses a theater, a dance-hall, movie-theaters, business offices, etc. This building is yet to find an adequate name. It is called "commercial building", although this really doesn't define its function. One of such has been built in Madrid."[1]

Architect's impression of the Capitol Building, Madrid

Model view of the Capitol Building, Madrid

These interesting words start off a 1935 article about the Carrión Building[2] published in *Nuevas Formas* Magazine describing a situation that seems completely foreign today. Over seventy years ago surged the need to resolve a complicated problem in a singular site while employing the moment's most modern technology in a country ridden with social, economic and political problems. All while reaching an outstanding architectural solution. Even though air-conditioning installation design is the main focus of this article, it is necessary to note that there were also some interesting technological advances: An architect that may adequately integrate the volumes for the production and ventilation is sure to transpose that preoccupation to the spaces dedicated for the rest of the installations. Furthermore, since the air-conditioning system does in fact make up the bulk of the installations, the spaces and necessities hence impelled generate solutions and design criteria that will also be applied to accommodate the rest of the installations. Therefore, before focusing on the air-conditioning system design, without overlooking other fields like acoustics, fire protection or electrical systems, it is convenient to be acquainted with the circumstances of the birth of the building, because as Luis Moya, the construction company's architect, remembers, it "is interesting to recognize the prehistory of contemporary technique"[3]. It is also necessary to note that this study is comprised within the collective investigate work on Twentieth Century Spanish Architecture taking place over the past few years in the School of Architecture of the University of Navarra, particularly, the investigation that I am currently conducting on the design, integration and mechanical systems in the most significant Spanish buildings of the twentieth century[4].

The Capitol Building in a contemporary foto

The construction of the Capitol Building ended in 1933, over seventy years ago. Consequently, not all of the building's documentation is available, especially on such a specific subject. Hence one is obliged to mention the incommensurable help provided by Ignacio Feduchi, son of one of the building's authors.

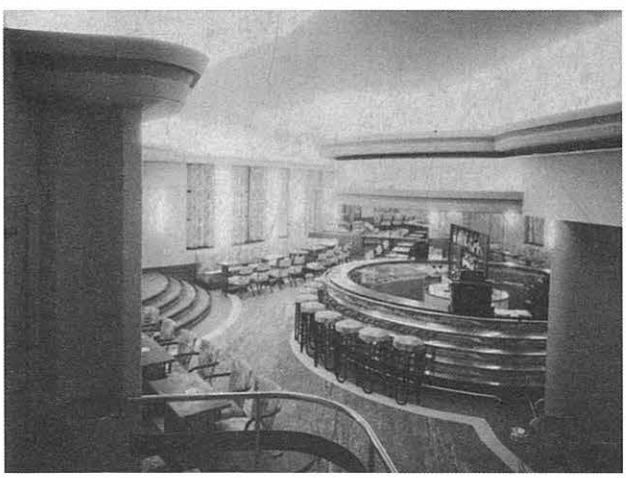
Situation on prominent corner site of Gran Via (Av. de José Antonio) in Madrid

Context, Building and the Architects

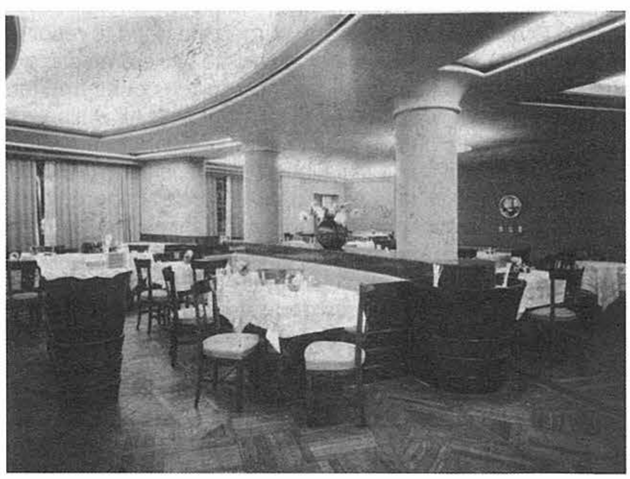
In order to understand the importance of this building, one must note that it portrays the cover of Angel Urrutia's "Arquitectura Española del Siglo XX" (*Twentieth Century Spanish Architecture*). The building constitutes a recognizable icon of an entire century of Spanish Architecture. As Urrutia states, comparing the Capitol Building to the Flatiron Building in New York, the Capitol makes a magnificent example of *urbitecture*[5], of Architecture that makes urbanism, or of urbanism that makes Architecture (capitalized). This is because the origin of such a singular site dates back to the urban project of Gran Vía, an urban space sprinkled with heterogeneous architectures with the common denominators of strong visual impact and monumental yearnings[6] that may be synthesized in four symbols: the 'La Unión y El Fénix' Building, the Telefónica Building[7], the Capitol Building, and the Madrid Tower[8]. The building is sited in an original lot of over one thousand three hundred square meters between Gran Vía and Jacometrezo Street, next to the Callao Plaza, in the heart of Madrid. The building permit was warranted on April 21, 1931 and the Auditorium was inaugurated on October 15, 1933[9]. Overall, it took thirty months to construct a complex, multi-functional building (with cafeteria, reception rooms, offices, apartments...) under the direction of various young architects in the midst of political turmoil and an economically complicated Madrid. The situation was such that during some time the Capitol was one of the few buildings under construction in the city[10]. The building's promoter was D. Enrique Carrión y Vecín, Marqués de Melín. The architects, Vicente Eced y Luis Feduchi, were the winner of a restricted competition in which another five projects were presented.

The architects, Vicente Eced and Luis Feduchi

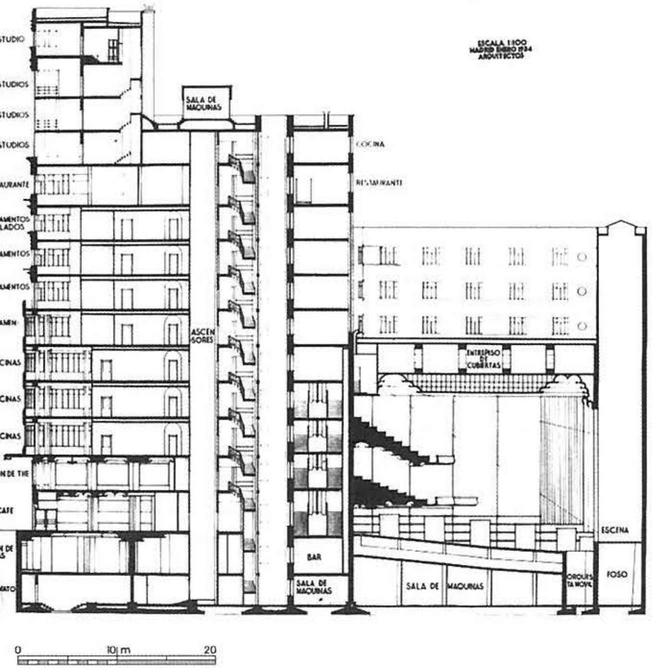
Valencian Vicente Eced and Madrilenian Luis Feduchi "know each other since before being classmates [...]. After the Civil War, in which Vicente Eced serves as Army captain for the republican cause, [Eced] suffers 'temporal disability for public charges and permanent for the undertaking of directive and confidence positions', apart form his incarceration in several prisons in a never-ending pilgrimage until his indictment. He therefore embodies the figure of the non-exiled architect whose professional career gets affected by the military trauma"[11]. Luis Martínez-Feduchi, who will finally simplify his last name to be known as Luis Feduchi, was greatly influenced by his uncle, the architect Luis Cabello Lapiedra. The inclination

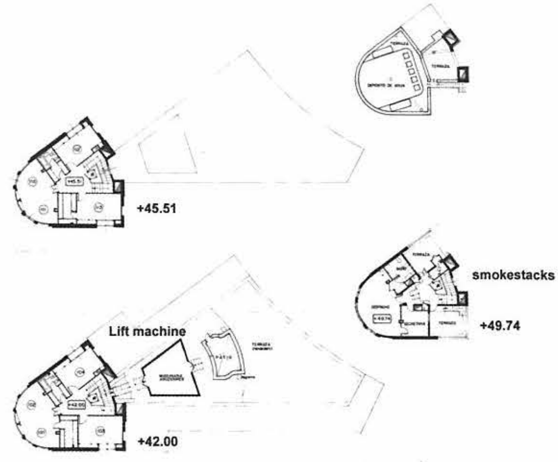


Bar Space

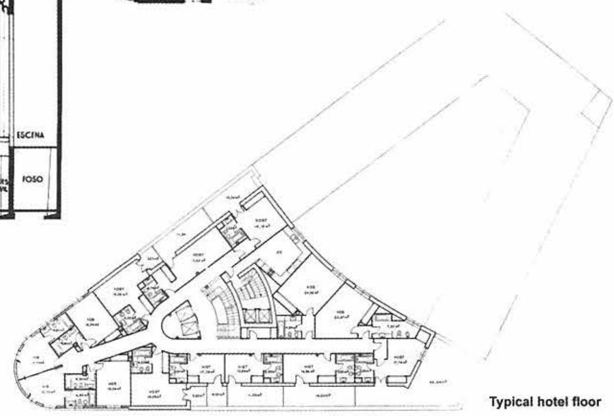


Tea Salon

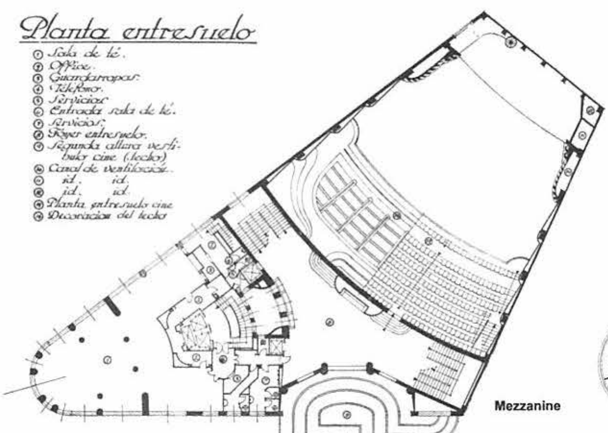




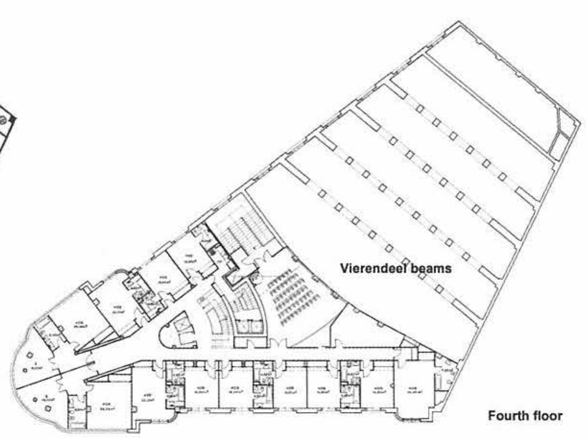
Vicente Eced, Luis Feduchi
Capitol Building, Madrid 1933
Section and floor plans



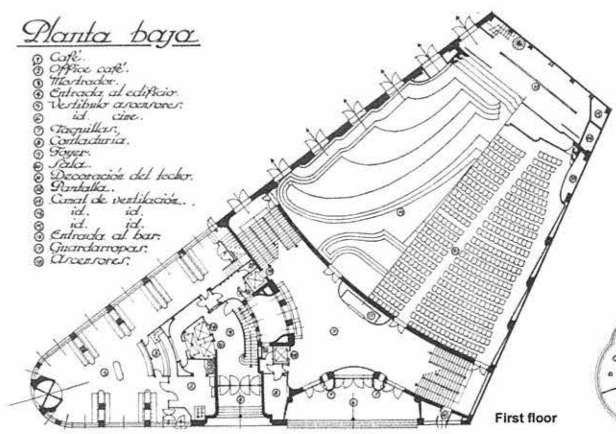
Typical hotel floor



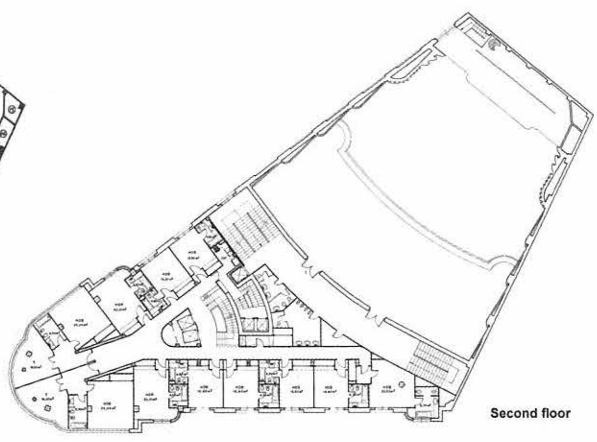
Mezzanine



Fourth floor



First floor



Second floor

towards popular architecture and the valorization of the monuments in all of Spain demonstrate such impact. Among many other activities, Feduchi will develop an important work of interior design, being tied to the firm Rolaco-MAC since 1933, which intervened in the fabrication of the furniture in the Capitol Building[12].As a result of the Capitol project, Feduchi left Spain for the first time. Next to Vicente Eced he visited France and Germany to study the movie theaters that were being constructed at the time, not only for aesthetic reasons, but also from the standpoints of installations (air-conditioning) and structure (Vierendeel structures were used for the first time in Spain in the Capitol Building). The trip to Germany was foresighted since both architects looked towards Germany in those years, especially Mendelsohn. Even though the Capitol in one of the most luminous and fascinating reflections of Mendelsohnian thinking in Spain, it has been completely ignored by European historiography[13], as usually occurs with Spanish realities.

Luis Feduchi also traveled to London, Amsterdam and Hamburg with the engineer F. Benito Delgado to study questions related to illumination[14]. Referring to program, in brief, the building was constituted by a ballroom in the basement, a café on the ground floor, where the access to the hotel and the main hall are also located, a 'tea room' in the mezzanine level, and offices on the third, fourth and fifth floors, leaving the sixth and seventh stories for the hotel. Macazaga was the construction company, which counted with the services of engineer Agustín Arnáiz[15] and architect Luis Moya. According to the latter, Another aspect of the construction of which there was little experience in Spain in those years was the installation of a 'total' air-conditioning system. Its incidence in the interior composition of the building was important, for the large sections of low velocity air ducts needed to assure noise reduction. The problem is now simple, but it wasn't then. The installation was made by Constancio Ara, serving himself from English experience, and if memory does not serve me wrong, employing equipment of the same origin. I was astonished by the work cost, for I believe it was about a fifth of that of the total building; the necessary mechanical room's surface averaged that of the movie theater; also we count with the transformer substation, because of the large energy consumption required by this installation, and the illumination and plumbing system (for pumping).[16]
There is no surviving data as to who was responsible for the installation execution, even though one might observe a rubber seal with the text "Industrias Guillén Zaragoza – Madrid – Valladolid" on the plans.

Concerning the economic factor, the building had a final cost of 10.745.063 pesetas de 1933 (64.759 €), Installation costs being broken-down as follows[17]:

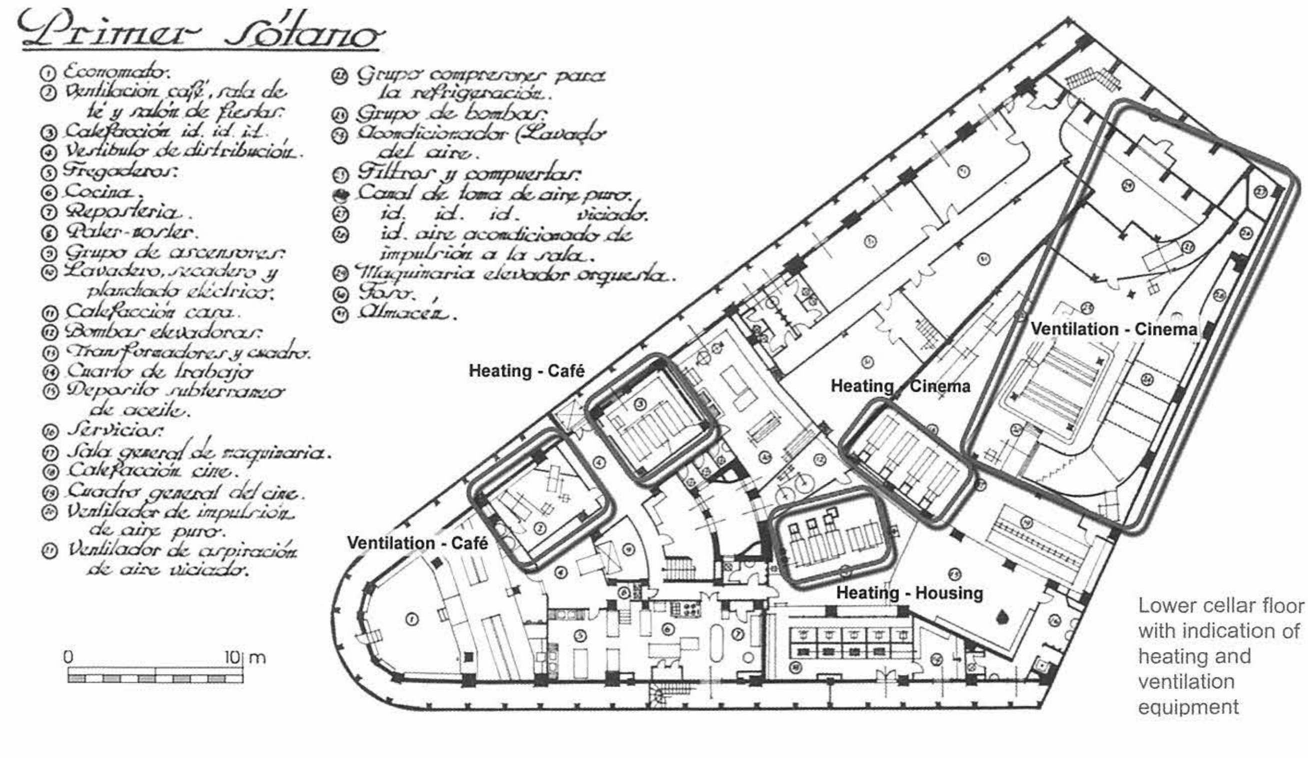
Heating/ventilation/refrigeration/drainage 1.126.144 ptas. 6.788 €
Electricity 1.300.000 ptas. 7.813 €
Elevators 339.781 ptas. 2.042 €
Sound Cinema and T.S.H. 148.959 ptas. 895 €

The installation ensemble supposed 27% of the total cost of the building, in line with the current cost in buildings of similar characteristics.

Air-Conditioning

Preliminary Facts

The first difficulty encountered when analyzing the study of this building's hydrothermal conditioning was the practically non-existing specific documentation of the heating and cooling systems. Among the few available sources was an article published in 1935 in *Arquitectura*. The latter was the actual memoir written by the architects on January 14, 1931 and the plans kept in Ignacio Feduchi's office. These plans are the following: Ventilation Ductwork sketches for the Ballroom in the basement, the Café on the ground floor, and the 'Tea Room' in the mezzanine level. Plan and sections of

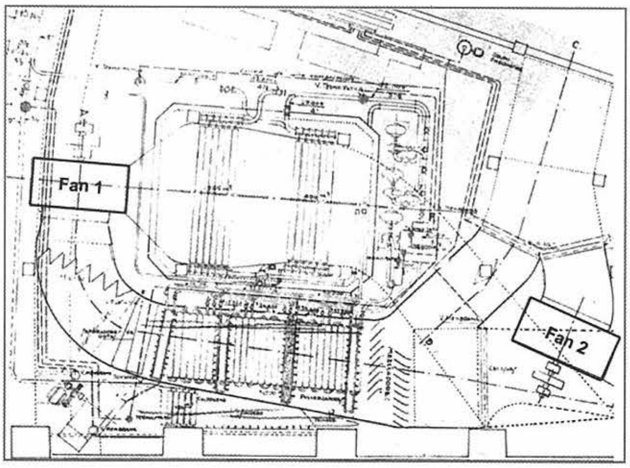


Lower cellar floor with indication of heating and ventilation equipment

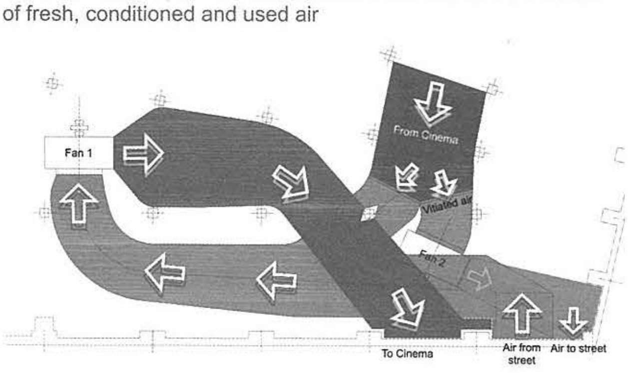
HVAC[18] system, located in the basement, under the main hall. Also, the documentation handed to the city government refers to the project description, plans, and work certificates of the electric, heating, cooling and ventilation installations (Manuel de Ortega, engineer, December 14, 26 and 29, 1933), as well as the project description, plans and work certificates of the elevator and lift installations (Luis M. Feduchi y Vicente Eced y Eced, architects, y Fernando Riaza, engineer, November 11, 1933)[19].
Given the available data, some information would be lacking in order to define for sure each and every one of the installation elements. Therefore, the differentiation made along the text between corroborated data, the recollections of the contributors and Feduchi's children, and the hypothesis of the system's functioning is important.

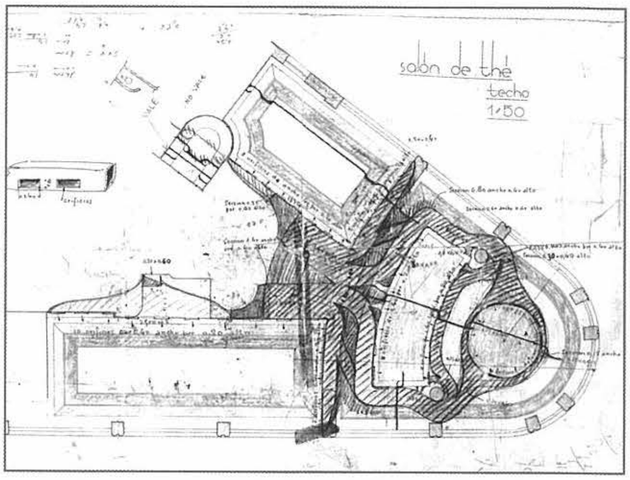
Calculations

In their memoir, the architects justify the applied solutions in relation to the current building code, referring concretely to article 98 of the Public Spectacle Code:
The cubic capability of the area designated to spectators, when it is closed, will correspond to the special ventilation conditions in each premise and the kind of show to which it is destined, but *it will never be less than three cubic meters per person***.**
One may observe that the code provided a minimum volume per person, even though it omitted the amount of air renovations per person and hour. In this case, the architects suppose a total of two thousand spectators and an interior volume capacity of eight thousand five hundred cubic meters. Apart from the two thousand five hundred cubic meter capacity exceeding over the required volume,



Ventilation duct system on lower cellar level with air flow sceme of fresh, conditioned and used air





Scetch design of air conditioning ducts in tea salon

air is constantly renovated and purified, controlling the temperature and humidity exactly like the architects state in their 1931 project description: "through a ventilation system similar to that installed in the 'Paramount' and 'Olympia' cinemas in Paris, 'Kammerland', 'Universium' and 'Ufa' in Berlin, in many English and mostly all the North-American ones".

Heating and Cooling Production (HVAC)

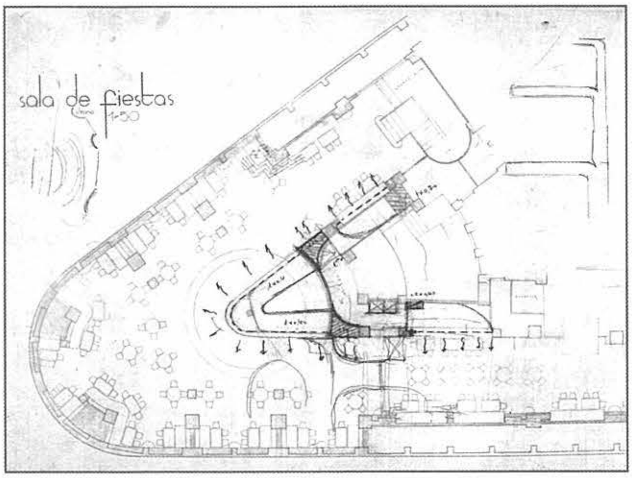
Carrier[20] equipment was used for cool air production. The refrigeration compressors are located in the basement next to the conditioning unit[21]. Heat was produced through sixteen boilers (located in different rooms) with fish-oil burners[22]: three of them serve the café, tea room and ballroom; five serve "home heating"; and four serve the Auditorium. Most of the machinery was placed in the basement thus breathing through portholes positioned in the sidewalks.

Air Installation Design

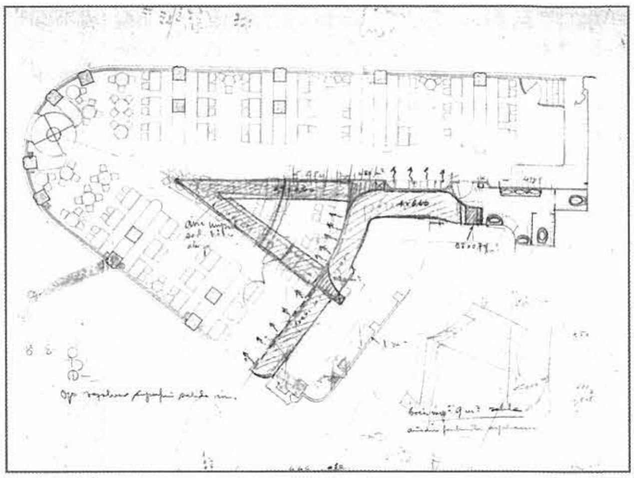
Lastly, we must consign that we plan to endow the cinema with a complete installation for the perfect constant ventilation and refrigeration of the Auditorium, through which we are allowed to maintain in the environment the so-called "artificial Spring climate", as exists in numerous cinemas abroad. The system consists of air renovation in the Auditorium, absorbing use air and injecting new or purified air with a special temperature and humidity, all achieved automatically. To that effect we have disposed of the necessary spaces for the installations and conductions and a four-square-meter pure-air intake on one of the sides of the stage.[23]

The air-conditioned zones were the public areas in the basement, ground floor and mezzanine, as well as the main hall. The rest of the premises had radiators.
The ventilation system is the most modern and complete installed in Madrid: there are two large fans that move a mass of ninety thousand cubic meters of air per hour, meaning that every five to seven minutes the Auditorium is completely purified and with the desired temperature and humidity. The controls are automatic and very modern[24].

The great air volume to be moved forces the creation of a technical room under the main hall that hosts part of the



Air conditioning for ball room in basement floor



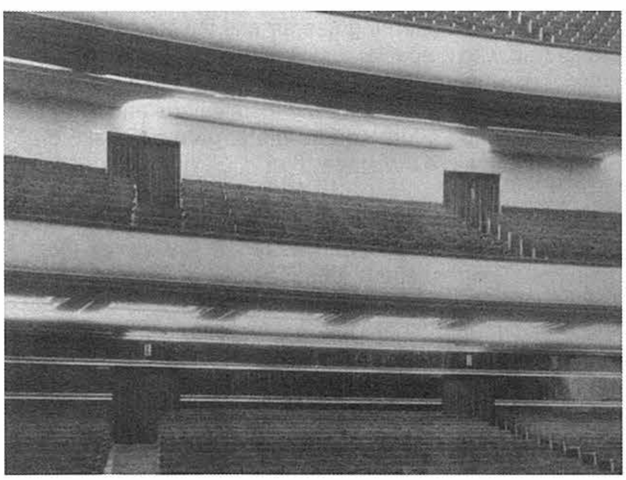
Air conditioning for caféon the ground floor

conditioning and electricity installations. The rest "will be taken in the most part through the space between the roof beams, whose roof space will be perfectly accessible and will even have windows for its proper ventilation"[25].
Thus, the auditorium space was covered with Vierendeel beams. The work's magnitude is evidenced if one thinks that until a few years later these were the biggest ones in the world. This type of beams was used not only for structural reasons, but also because solid or triangulated ones would not allow the exploitation of the technical space in the same way. The clearing for the installations would have been resented notably since it was necessary to dispose of large sections in the ductwork for low air velocity and noise prevention in the premises. Therefore, here lies an example of how a technical necessity generates a structural solution that will invariably influence the final form of the building.

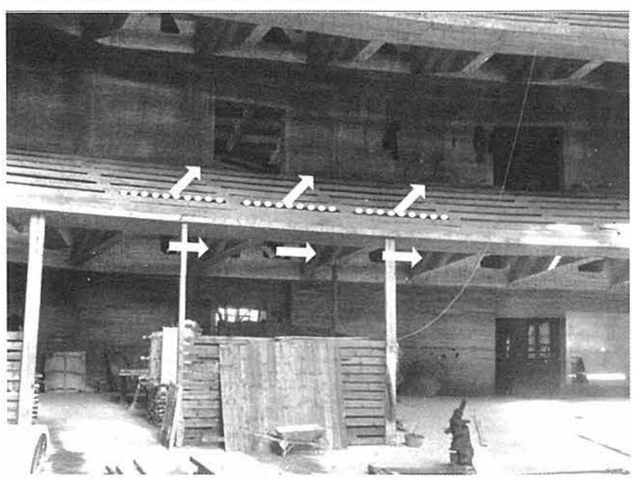
Cold air diffusion in the main hall is done through the ceiling, while hot air is diffused under the seats[26]. The architects take advantage of the shape of the drop-ceiling to hide the diffusers and the grills necessary for air movement in this room as well as in the other premises. The drop ceiling was also designed for acoustic purposes, even though the forms were based on the experience[27]. This illustrates yet another example of how conditioning interacts with other traditional constructive building solutions. Another premise in the basement hosting the fans corresponding to the ventilation of the café, the tea room and the ballroom compliment the installation.

Auditorium HVAC system

The Auditorium's HVAC system occupies a surface of three hundred square meters of the building's basement in a location with a height of five meters. The HVAC plan identifies various elements arranged in the following order (in the direction of air flow): Fresh air intake at street level. Louvered hatch regulating the entry volume of air from the street. Bifurcation of the Auditorium's return-air ductwork by the louvered hatch: part of the air is re-circulated and thus restarting the cycle while part is expelled through an exhaust vent. Mixer combining street air with that from the Auditorium's return duct. Water pulverizers: Four batteries with 63 pulverizers each.
Drop separator, Fan, Water Batteries, Auditorium supply. The whole of the installation is regulated by a pneumatic group that also acts over different membrane valves through compressed air lines. Various control elements like thermostats and humidistats appear. In conclusion, the plan also shows other installation elements like a convector, ductwork registers, coke filter, drains, floater valve, and water circulation pumps.



Balcony in auditorium



Air conditioning inlets in balcony structure of auditorium

Fire Protection

Fire prevention measures take evident importance in buildings of public concurrence such as this one, as well as the evacuation, egress and fire control measures to be taken in case of emergency. Conscious of this, the architects will define from the beginning the measures to be taken to increment fire protection and security: We projected the construction of the movie theater in reinforced concrete, a perfectly fireproof material. After a meticulous study and with an intense preoccupation for the maximum fire-protection guarantees possible, we have determined to also employ incombustible materials for decoration to complement the security that concrete offers against fire. The fabrics we will use for the wall veneers, curtains and seats, as well as the carpeting, with be fireproofed through special procedures already used with absolute efficiency in France and Germany. The seat armors, handrails, railings, and most of the decorative elements will be made out of metal. Marble and fire-resistant materials will be used in the vestibule. All possible parts of the gridirons will also be made out of metal, and, as stated before, a metal safety curtain and a mechanism to project another hydraulic curtain in case it is needed. We will also place pressurized water registers [sprinklers] in strategic places as well as electronic fire detectors of proved efficiency. [28]

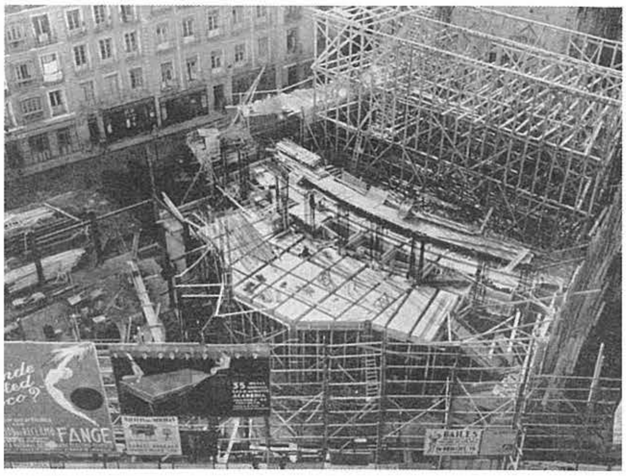
The need to minimize the fire risk is transferred to "the electrical installation following all the measures prescribed in articles 141 to 154 of the Public Spectacles Code and adopting the latest advances in the field that, like the suppression of apparatuses and the employment of insulation procedures, overflow in benefit of lighting security and the diminishing of fire danger"[29].

Acoustics

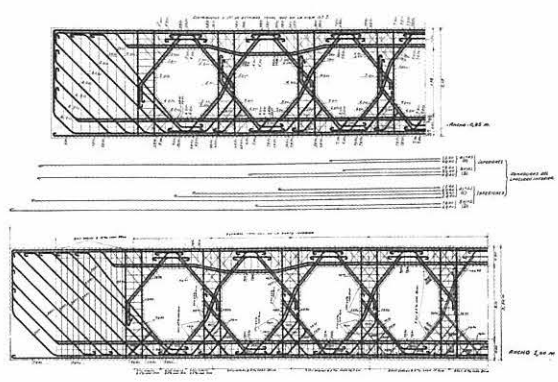
Acoustics should not be considered and installation for it is not. It is the branch of physics that studies the behavior of sound in architectural spaces. Among other things, it is witness and judge to whether or not the architectural measures taken are adequate for an auditorium to person its main function: to hear sound satisfactorily. The measures taken to improve the acoustics of the different quarters of this building were based on experience, did not involve any previous study, and yet the acoustics in the auditorium were resolved in a simple yet effective manner for its uses as cinema as well as theater. The lateral and back walls were veneered with thick velvet-covered cork. The ceiling and the proscenium were left as reflecting surfaces.[30] Vaults and domes in the ceiling were avoided for their capacity to produce echoes that may decompose the sound. The ceiling is projected as multiple surfaces and moldings that favor with their form a perfect acoustic[31].

Electricity and Lighting

An expert in installations and luminotechnia and a constant client of Feduchi's during his entire life, Engineer Francisco Benito Delgado was responsible for the electricity and lighting installations[32]. To give you an idea of the importance of this installation let us just say that in the auditorium's ceiling alone were more than seventy kilometers of different sectioned wires[33]. This abundant

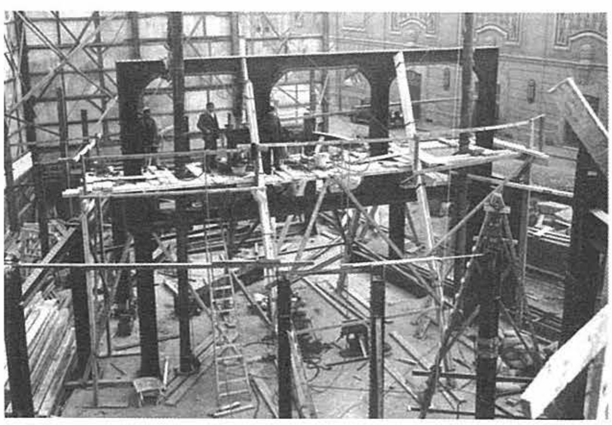


Building site



Drawing of concrete Vierendeel beems over auditorium, 4th floor

Steel Vierendeel structure in façade over entrance to cinema



Steel Vierendeel structure on mezzanine level (tea salon) wiring was paired to a great energy consumption that required a substation with Bordón transformers in the basement to distribute energy to all other installations and a specific premise to locate the electrical command center[34]. "The Auditorium's lighting installation is also interesting. Light regulation is done through a series of levers, a total of 120, which combine into infinite color mixtures"[35]. A regulation that allows a "luminous graduation studied from an ophthalmologic point of view before commencing the session (white-yellow-green-blue-purple-black)"[36].

Other Installations

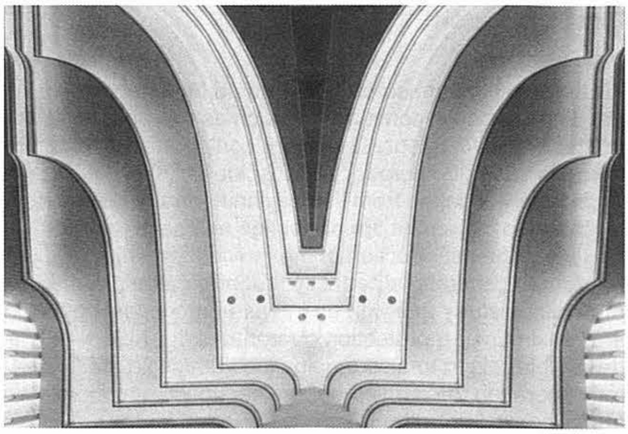
Within this building's engineer-like description one may find opportune to talk about the building's vertical communications: "an elevator system that at best we may call a chain pump, made up of diversely colored cases according to the department to which they are destined"[37]. In the initial memoir the architects point out the usage of "a group of two fast 'Otis' elevators, with a surface of two square meters each, and a freight elevator, also with a surface of two square meters, completing the vertical circulation. One of the elevators had direct access to the upper floors of the tower"[38]. Finally they placed ten elevators, two of which moved at a speed of two meters per second, as well a platform for thirty-six musicians in the Auditorium[39].

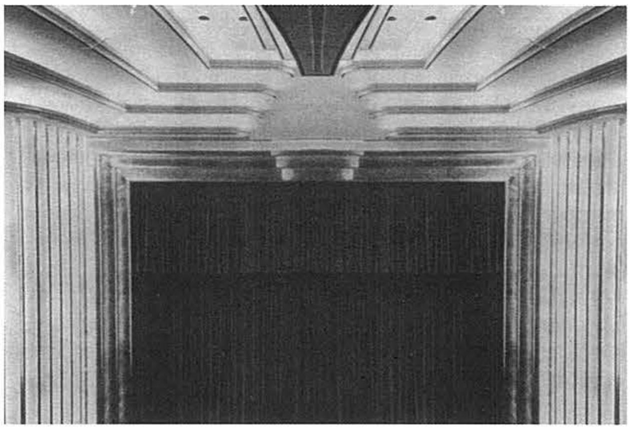
Structure

Given its singularity, it is precise to mention the structural particularities employed in the Capitol, even if it departs from this article's pretensions. The structural engineer was Agustín Arnáiz, military engineer, and according to Luis Moya, collaborated with Flórez and Muguruza in the works done in the *Teatro Real* between 1925 and 1930. The building was done with a metallic structure, except in the two basements and the cinema where reinforced concrete was used (thus anticipating the fire protection norms necessary in this kind of premises)[40]. The Capitol was the first building in Spain to utilize Vierendeel beams[41]. They were also the largest in Europe, having a thirty-one meter span, a height of 3,10 meters and weighting approximately seventy tons each. There is also an iron beam with a fourteen-meter span and weighting close to fifteen tons over the cinema entrance[42]. "The rest of the building was totally constructed with a metal weave, calculating a load between 300 and 400 kg per square meter according to the place and use"[43].

Final Comments

The machines' lifespan ended before 1973, when they were substituted for new ones[44]. The integration of the spaces required for the installations and architecture usually generates difficulties in the design process, and only in order and spatial generosity may they be considered long-lasting values[45]. This building has been able to confront a complex and variable program, over more than seventy years because these principles were considered throughout its design. However, questions arise that may be applicable to other buildings. What are the criteria for the conservation of aged installations after they reach their useful lifespan? Can they be eliminated completely? In time, what will remain or that engineering (if not architectural) memory if they are completely eradicated? All machinery has a useful lifespan that inevitably will not coincide with that of the building. The acting criteria will not be the same in the Parisian Pompidou Center as it will be in an affordable housing block. One must also remember that the Capitol's technical solutions go hand in hand with its construction method: the supply diffusers and return grilles are integrated to the ceiling decorations. Evidently, there is an open debate that should allow the formulation of intervention criteria for the moment in which the building will (or should?) retire their aged installations. The question that we should be asking is how to define at which point architectural constructions can be separated from the installation and the spaces these occupy and contribute to define the ultimate form of the building.





Auditorium

Notes

[1] Nuevas Formas. Revista de Arquitectura y Decoración. Año II 1935 num 1. p. 25
[2] In 1931 Enrique Carrión, Marquis of Melín, convened the " Carrión" competition destined to the development of ideas for the profitable use of a lot of his property. With time, the building came to be known under the name of the name "Capitol".
[3] Revista Arquitectura. "Memorias del Arquitecto de la Contrata". Moya, Luis. Num 236 May-June 1982. p. 60.
[4] At the same time, the Publication Services Department of the School of Architecture of the University of Navarra is preparing a publication about the history and construction of the Capitol Building as part of the Contemporary Architecture Collection (AACC Arquitecturas Contemporáneas).
[5] URRUTIA, Angel. "Arquitectura Española del Siglo XX", Ediciones Cátedra, Madrid, 1997. p. 329.
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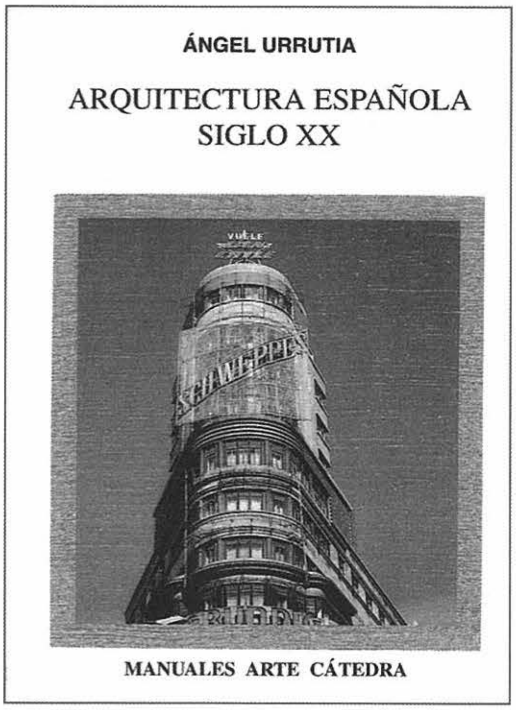


[6] PIZZA, Antonio. Guía de la Arquitectura del Siglo XX. España, Electa, Madrid. p. 276.
[7] Luis Feduchi, "being a student works with Luis Gutiérrez Soto and Ignacio de Cárdenas in the Telefónica Building in Madrid"; this building, finalized in 1930, is partly designed from the United States by the North-American firm Clark Mac Cullen & Riley, and in which the structural conception of the building and the placing of the mechanical systems gain great importance. URRUTIA, Angel. Arquitectura Española del Siglo XX, Ediciones Cátedra, Madrid, 1997. p. 327.
[8] URRUTIA, Angel. Arquitectura Española del Siglo XX. Ediciones Cátedra, Madrid, 1997. pp. 150-151.
[9] "Madrid. El Edificio Carrión'', Arquitectura, Madrid, January-February 1935. p. 4.
[10] Conversation with Ignacio Feduchi. Madrid, May 23, 2003.
[11] URRUTIA, Ángel. Arquitectura española Siglo XX, Ediciones Cátedra, Madrid, 1997, pp. 326-327.
[12] URRUTIA, Ángel. Arquitectura española Siglo XX, Ediciones Cátedra, Madrid, 1997, pp. 327-329.
[13]Nueva Forma. July/August 1971. FULLAONDO, Juan Daniel. "El Capitol, expresionismo y comunicación". p. 5.
[14] BLASCO CASTIÑEIRA, Selina. "Luis Feduchi. 1901-1975". Colección de Arquitectos Españoles.Dirección General de Arquitectura – M.O.P.U. P. 5.
[15] "Memorias del arquitecto de la contrata". Moya, Luis. Nº 236 Mayo-Julio 1982.
[16] Revista Arquitectura. "Memorias del arquitecto de la contrata". Moya, Luis. Nº 236 May-July 1982. p. 60.
[17] "Madrid. El edificio Carrión", Arquitectura, Madrid, January-February 1935. p. 10.
[18] Acronym commonly used to refer to a building's Heating Ventilation and Air Conditioning system.
[19] This documentation could not be retrieved for the editing of this article.
[20] Conversation with Ignacio Feduchi, Madrid, May 23, 2003. Carrie Spain was consulted to confirm this fact but no records were available due to the antiquity of the installation.
[21] "Madrid. El edificio Carrión", Arquitectura, Madrid, January-February 1935, p 6. In the plan that appears reduced in this magazine, the zone where the water pulverizers are located is defined as "conditioning (air cleaning)".
[22] "Madrid. El edificio Carrión", Arquitectura, Madrid, January-February 1935, p. 5.
[23] Memoria de los arquitectos. Madrid, January 14, 1931.
[24] "Madrid. El edificio Carrión", Arquitectura, Madrid, January-February 1935, p. 14.
[25] Memoria de los arquitectos. Madrid, January 14, 1931.
[26] Conversation with Ignacio Feduchi. Madrid. May 23, 2003.
[27] Conversation with Ignacio Feduchi. Madrid, May 23, 2003.
[28] Memoria de los arquitectos. Madrid, January 14, 1931.
[29] Memoria de los arquitectos. Madrid, January 14, 1931.
[30] Revista Arquitectura. "Memorias del arquitecto de la contrata". Moya, Luis. Nº 236 May-July 1982. p. 61.
[31] Nuevas Formas. Revista de Arquitectura y Decoración. Year II 1935. p. 27
[32] BLASCO CASTIÑEIRA, Selina. "Luis Feduchi. 1901-1975". Colección de Arquitectos Españoles.
Dirección General de Arquitectura — M.O.P.U. P. 5.
[33] Arquitectura. Nº1, January-February 1935.
[34] FEDUCHI, Javier, Ignacio y Luz. "Plan Especial Capitol", p 1.
[35] Arquitectura. Nº1, January-February 1935.
[36] URRUTIA, Ángel. "Arquitectura española Siglo XX", p 331.
[37] "Madrid. El edificio Carrión", Arquitectura, Madrid, January-February 1935, p. 24.
[38] Memoria de los arquitectos. Madrid, January 14, 1931.
[39] Arquitectura. Nº1. January-February 1935. p 5.
[40] Revista Arquitectura. "Memorias del arquitecto de la contrata". Moya, Luis. Nº 236 May-July 1982. p 59.
[41] Luis Moya, "Memorias del arquitecto de la contrata", Arquitectura, Madrid, nº 236, May-July 1982, p. 61.
[42] Arquitectura. Nº1. January-February 1935. p. 4.
[43] Memoria de los arquitectos. Madrid, January 14, 1931.
[44] Conversación con Ignacio Feduchi. Madrid, May 23, 2003.
[45] Ignacio Paricio, El tendido de las instalaciones, Bisagra, Zaragoza, 1999, p. 25.

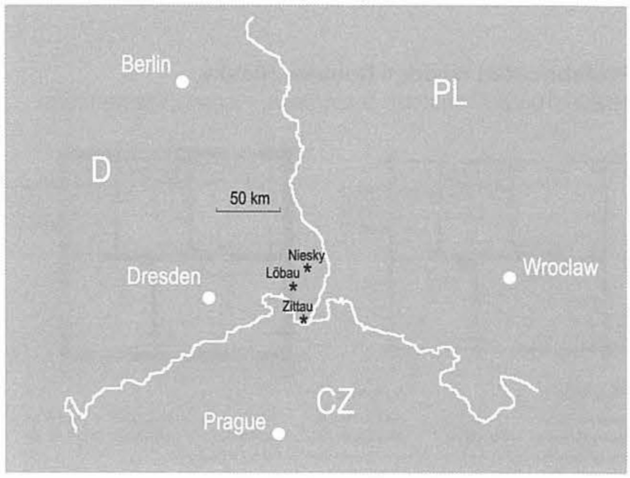
César Martín Gómez. Architectural study (2000) and teaching design of technical building equipment at the ETSAUN University of Navarra, Pamplona. Practice in consultant engineering firm Iturralde y Sagüés Ingenieros, Pamplona, and in the Departamento de Arquitectura del Centro Nacional de Energías Renovables.

Photographers: Jens Freudenberg and Lothar Kahnt

Seminar Programme

9th International DOCOMOMO Technology Seminar, 24-25 June 2005. Löbau, Germany

Climate and Building Physics in the Modern Movement



Thursday, June 23

Evening meeting in Löbau and Zittau

Friday, June 24

Registration und guided visit of House Schminke
Kirschallee 1b, 02708 Löbau, Germany
p 0049 3585-862133 www.hausschminke.de

Welcoming addresses
Rainer Hampel, rector of the Hochschule Zittau/Görlitz (FH)
Berthold Burkhardt, chair DOCOMOMO Germany, advisory board Wüstenrot foundation, Technische Universität Braunschweig
Ola Wedebrunn, chair DOCOMOMO International Specialist Committee –Technology, Royal Danish Academy Copenhagen

Moderation by Berthold Burkhardt and Ola Wedebrunn
Introduction - Building Science as reflected in Modern Movement Literature
Jos Tomlow, Zittau
Restoration of Zonnestraal Sanatorium (1926-28).
Wessel De Jonge, Rotterdam (key note speaker)
First Steps in Establishing the Discipline of Building Science – The Research Institute of Heat-Insulation in Munich
Roland Gellert (presentation) and Horst Zehendner, München
The Modern Movement and the Flat Roof Discussion
Anke Zalivako, Berlin/Moscow
Severe Climate as a Condition - The Construction of Modern Movement Buildings in Western Siberia, 1920-1932
Ivan Nevzgodin, Delft
New Building Materials and Building Science in the Modern Movement
Torben Dahl, Ola Wedebrunn (presentation), Copenhagen
Building Physics and House Schminke - Analysis and Rehabilitation
Klaus Graupner, Dresden
Szymon Syrkus - CIAM Representative of Poland and Pioneer in integrating Building Science in MoMo Architecture
Jadwiga Urbanik, Wroclaw

Evening reception in the Town Hall of Löbau, friendly welcomed by lord mayor Dietmar Buchholz and mayor Guido Storch

Saturday, June 25

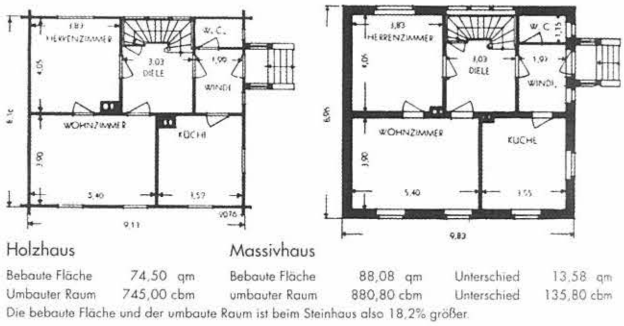
Moderation by Berthold Burkhardt and Ola Wedebrunn
Restoration of the Freylingheusen Morris Studio, Massachusetts
Kyle Normandin, New York, N.Y.
Brise soleil / quebra sol - Climatic Adaption in Brazilian Modern Movement Architecture
Griselda Pinheiro Klüppel, Bahia
Stone and Glass Façades in Modern Movement Architecture - Case Studies in Dessau and Magdeburg
Berthold Burkhardt, Braunschweig
Modern Movement Architecture and Heating Innovations in France 1900-1939
Emmanuelle Gallo, Paris; read by Ola Wedebrunn
Air Conditioning and Installations in the Capitol Building in Madrid (1933)
César Martín Gómez, Pamplona

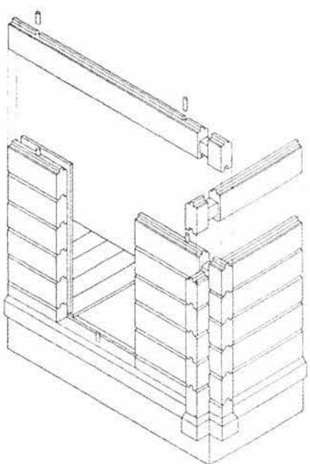
Moderation by Jos Tomlow
Discussion and conclusion
Guided by Jos Tomlow
Seminar Tour

Farewell party in a traditional *Umgebindehaus* Restaurant *Quirle-Häusl,* Waltersdorf, Oberlausitz

Seminar Tour

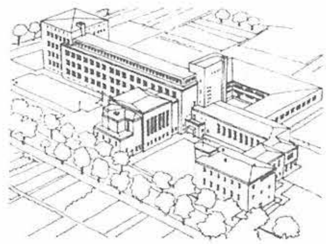
Prefabricated wooden houses, Niesky
1920s-1930s Christoph & Unmack, Konrad Wachsmann

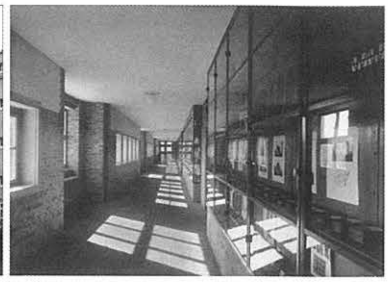




The Christoph & Unmack firm in Niesky became around 1925 the world's leading producer of prefabricated wooden houses. The houses, on a stone socle to prevent moisture damage to the wood, show optimal building physical behavior. Building technology included sytems with post and mullion construction – alike the american balloon frame – and a modern interpretation of traditional log building. Most interesting may be the Director's House (1929), a work by Konrad Wachsmann, who became later an excellent teacher of structural principles. The seminarists were friendly welcomed and informed by mayor Wolfgang Rückert and Eva-Maria Bergmann, director of *Museum Niesky*. Lit.Tomlow DOCOMOMO Dossier 4, 2000, p.46

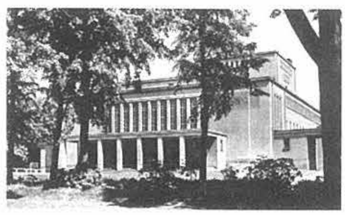
Vocational school centre, Zittau
1928-1931 by Erich Dunger, Max Wiederanders, C. Müller

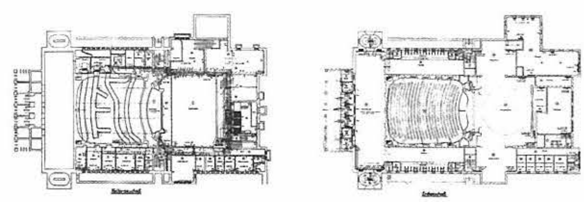




The building complex is composed by volumes around courts with a remarkable functional variety (classrooms, workshops, aula, villa) using topographical features, sun and shade. Glassed openings according to the functions and intended light level inside lead to a lively facade. The white cubic shape is toned down in the corridors and staircase by organic facing brickwork and exposed metal installations with elaborative details. Director Siglinde Neumann of the *Berufliches Schulzentrum Zittau* with technical staff informed amply about this remarkable building complex.

Gerhart-Hauptmann-Theater, Zittau
1933-1936 by Adolf Hopp, Prof. Hermann Reinhard Alker





A medium sized theatre, built as a a transition from the Modern Movement – with its rational layout of structure and functions, reduced form vocabulary – toward National Socialist architecture, expressed by dramatic monumentalism and technocratic elements. Innovative concepts for combined air- and heatconditioning, organic shaped theatre space, with acoustic plaster, original stage technique. The influence of standard norms and increased quality control of the thirties compared to the twenties can be observed. The seminarists could visit all public and tecnical spaces thanks to manager Caspar Sawade and technical director Mario Groß. Lit. Dudeck 2000, p. 110

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Today the built heritage of the Modern Movement is at more risk than at any other period. New materials and construction types, and standardised building methods have been instrumental in materialising modernity in architecture.

Subsequently, climatic conditions and a range of problems with moisture and insulation in completed buildings, obliged Modern Movement architects to take an interest in the then emergent discipline of Building Science. This process was paralleled by conservative criticism on modern movement building practice, which included the "flat roof discussion".

The charming Schminke House by Hans Scharoun (1931-1933) in Löbau, Saxony, has been the location for the seminar *Climate and Building Physics in the Modern Movement* in June 2005.

The development of the then still young Building Physics discipline in the Modern Movement architecture and its attitude towards climate, focussing on the period between 1920 and 1940, has been traced. International experts in building science, technical history and building restoration discussed topics such as:

heat insulation / heat transmission / k-value
experiment houses / new materials
sun orientation in different climates
glassed surfaces, thin walls
air conditioning / heating systems
flat roofs / terraces

This dossier by DOCOMOMO International Specialist Committee - Technology is the result of this innovative seminar.

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