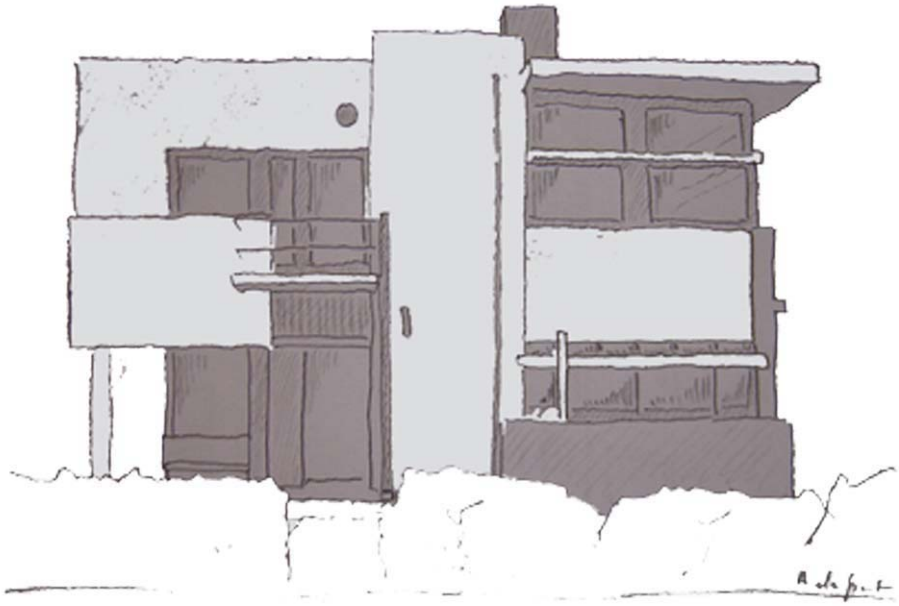
WHEN LESS POWERS MORE

An Analysis of Energy Conservation in Modern Architecture



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An Analysis of Energy Conservation in Modern Architecture

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“We know that the white man does not understand our ways. He is a stranger who comes in the night and takes from the land whatever he needs. The earth is not his friend, but his enemy, and when he’s conquered it he moves on. He kidnaps the earth from his children. His appetite will devour the earth and leave behind a desert. If all the beasts were gone, we could die from a great loneliness of the spirit, for whatever happens to the beasts happens to us. All things are connected. Whatever befalls the Earth, befalls the children of the Earth."

American Indian Chief Seattle[1]

[1] James Wines, *Green architecture*. Köln, London: Taschen, 2000, p.35.

ABSTRACT

The aim of this research report is to consider how much thought was given to energy conservation and material resources in the discourse of the architectural groups “Deutscher Werkbund”, “De Stijl” and “Bauhaus” in the 1920s and early 1930s. The studies of this research paper are focused on the new design and construction techniques of modern architecture, which can be seen as the symbolic representation of ideological and political change. The paper explores ideas like solar design, natural sunlight, passive ventilation, new construction methods, mass production and the use of new technologies that can be linked to energy conservation in modern architecture.

Kenneth Frampton writes that ideas have created buildings and ideas have destroyed them again.[1] In context to this thought this research report considers some examples of new developments in modern architecture. One of these examples is the Weissenhof Siedlung in Stuttgart that presents a wide range of new design solutions and a practical use of mass production during the construction phase of residential buildings. New methods of passive ventilation and air-conditioning are considered as another example to create a higher quality of living space. Natural sunlight and solar design are the last examples to prove that the architects of the modern movement have known about the use of natural energy resources in the building and construction design.

This research paper explores these ideas and developments, which were established during modern architecture and started to take indirectly up the challenge to reduce the wasting of energy and material resources. It shows that modern architecture can be seen as the beginning of a remarkable change in the theory and practice of architecture, but it cannot be called the beginning of a green architecture. This research report explores new building solutions, which were not evolved enough to reduce the level of energy wasting in those days. However, the paper also indicates the high range of changes in the construction and design process. These changes laid the groundwork for other developments, which were followed after the modern movement.

[1] Kenneth Frampton, *Modern architecture: a critical history*, London, England, Thames and Hudson, 1980, p.8.

TABLE OF CONTENTS

TABLE OF PLATES

PART I

CHAPTER 1

PART II

CHAPTER 2

CHAPTER 3

CHAPTER 4

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ABBREVIATIONS

AEG	Allgemeine Elektricitäts Gesellschaft
CIAM	Congrès International d'Architecture Moderne
CIRPAC	Comité International pour la Résolution des Problèmes de l'Architecture Contemporaine

INTRODUCTION

A particular interest in German building history of the 1920s and early 1930s and the climate changes being faced today have inspired my research into the building doctrines of the modern movement in relation to global warming.

The scope and goals of this research paper are to consider how much thought was given to reusable energy use in the discourse and design of modern architecture and by the architectural groups “Deutscher Werkbund”, “De Stijl” and “Bauhaus” in the 1920s and early 1930s. It comes to the point where it needs to be asked if these doctrines of architecture are still relevant. Is less still more? Is it possible that these ideas can still be of use in finding architectural solutions to meet the problem of global warming?

Architecture is one of the most dependable reflections of a civilization’s philosophical foundation. It was the great invention of the modern movement that the task of architecture was to address the social problems of the age and its great conceit to suggest that these problems could be solved through architecture. This invention included the working class as the new client for architecture, a new program of mass production, the welfare state as a new patron and a new role for architects as head of municipal building programs. This practise was born and inscribed under a specific historical condition. The new social democratic government in the Weimar Republic followed the fall of the Kaiser after World War I in Germany.[1] This context provided theories that brought about the evolution of the factory aesthetic that can be traced back to the Deutsche Werkbund, De Stijl in the Netherlands and the Bauhaus school in Germany.[2]

The focus of this research paper is on the work and the theories of the modern movement specifically in relation to energy conversation. The architecture of the modern world can be seen as the symbolic representation of ideological and political change. Kenneth Frampton writes that ideas have created buildings and ideas have destroyed them again.[3] For example in the 1920s Le Corbusier said that windows are for light and not for ventilation, but by the 1950s his architectural vocabulary had evolved and the “ventilation window” had become a standard element of his architectural work.[4] Another example is the Weissenhof Experiment

[1] Kim Tanzer and Rafael Longoria, *The green braid: towards an architecture of ecology, economy and equity*, New York, NY, Routledge, 2007, p.93.
[2] Alan Phillips, “Industrious architecture”, *World architecture*, n.54, 1997, p.120.
[3] Kenneth Frampton, *Modern architecture: a critical history*, London, England, Thames and Hudson, 1980, p.8.
[4] Kim Tanzer and Rafael Longoria, 2007, p.148.

in 1927. It was a model housing development built on a hill above Stuttgart as part of an exhibition entitled “Die Wohnung”. The choices of materials and techniques were in a few cases ideologically vital, but in others were more economic and pragmatic. The first visitors to the Weissenhof were struck by the departure from tradition. It looked radically new and different with features such as flat roofs, coloured facades and the lack of applied ornament.[5]

Research for this paper has been primarily literary, using books and journal articles which are held at the library of the University of Auckland. Secondary online media sources have also been successful, as have personal discussions with architects in both, New Zealand and Germany. The referencing is achieved by using the “Vancouver Method”, which is also known as the “Sequential Numbering Method”. The research paper itself is presented in three parts. Part one: comprises a literature review and relevant background material; Part two: the analysis of new building methods and techniques during the 1920s and early 1930s; and Part three: the conclusion.

Part one comprises one chapter which encompasses a literature review and looks at the historical conditions in the early stage of the 20th century in Germany, the development of the architectural ideas of the Deutscher Werkbund, De Stijl and the Bauhaus and finally the foundation of the Congrès Internationaux d’Architecture Moderne, or CIAM. Part two has three chapters. Chapter two addresses the theory of solar design. Le Corbusier wanted his houses be full of light and sun. Provided additional sources of energy were available, this could be achieved, even with his “single glass window”.[6] Chapter three explores the background and the evolution of the concept of ventilation in the architecture of Le Corbusier and the systems and elements through which it was implemented.[7] The “International Exhibition of Modern Architecture” is considered in Chapter four. The reconstruction in the economy, in housing, and in politics made possible the building of an experimental housing project at Weissenhof in Stuttgart, the “Weissenhofsiedlung”. The degree of structural change determined the character and the extent of the problems. They could not be solved with traditional methods and the issue of rationalisation and standardisation was only part of the real issue.[8] The conclusion, which is contained in Part three, is presents the final results and facts of this research report.

[5] Peter Blundell-Jones, *Modern architecture through case studies*, Oxford, Architectural Press, 2002, p.43.
[6] A. Ballantyne, *Architectures: modernism and after*, Malden, MA, Oxford: Blackwell, 2004, p.110.
[7] Kim Tanzer and Rafael Longoria, 2007, p.144.
[8] Karin Kirsch, *The Weissenhofsiedlung: Experimental housing built for the Deutscher Werkbund, Stuttgart*, 1927. New York, NY: Rizzoli, 1989, p.19.

1. THE MODERN ARCHITECTURE

The first part of this chapter contains a literature review that describes the main sources of literature, which were important for the research process of this paper. The second part of this chapter includes background information to the modern movement during the 1920s and early 1930s. It outlines the formation of the Werkbund, the Bauhaus, the De Stijl movement and the Congrès International d'Architecture Moderne (CIAM).

1.1. LITERATURE REVIEW

It is not surprising that there are a lot of books, articles and other resources available, which explore modern architecture. In this context, a serious selection of literature needs to be done, which gives a high quality of background knowledge in modern architecture and can be finally the most significant material in context to the scope of this research paper.

After all, the selection of books and articles is on the one hand general literature, which is important for the background knowledge, but does not generally give consideration to energy and does not give useful answers to the specific subject of this research report. On the other hand the selection contains key references as well, which are important in the context to the scope of this paper. This literature review is divided in two chapters, which explore general and specific literature of modern architecture.

1.1.1 GENERAL SURVEY TEXTS OF MODERN ARCHITECTURE

This section identifies the secondary key sources used to provide background information for this research report. Reyner Banham is one of the first serious writers, who is important in context to the topic and the scope of this research report. In *Theory and design in the first machine age* (1960), Reyner Banham describes the late years of the 1950s as an epoch that has often been called the Jet Age or the Second Industrial Revolution. Banham's writing is different to others during the 1960s in that he looks at the different aspects of the transformation of science and technology. Reyner Banham brings up the point that these transformations have powerfully affected human life, and opened up new paths to dealing with global ecological problems. He complains of the accessibility to almost unlimited supplies of energy in context to architecture, which is balanced against the possibility of making the planet earth uninhabitable.[1]

[1] Banham, Reyner. *Theory and design in the first machine age.* London, Architectural Press, 1960.

One of the most important background readings is *Modern architecture: a critical history* by Kenneth Frampton (1980). Frampton is well known for his writings about the architecture of the 20th century and achieved great prominence and influence in architectural education with his writings on modern culture. This book gives a look through the history of the modern movement and describes the changes of traditional building through new ideas and ideologies.[2] This is one of the main readings, which demonstrates the basis for the background knowledge on the history of the 1920s and early 1930s for this research report. However, Frampton does not give any information or attention to elements in the modern movement which relate specifically to green architecture.

In 1982, William J. R. Curtis published his book *Modern Architecture since 1900* that presents a second main resource of literature that gives background knowledge on modern architecture in relation to this research paper.[3] In his book, Curtis examines the background of modern tradition during the late nineteenth century. William J. R. Curtis discusses the development of tradition in a context that includes the changes of technical and social conditions within modern architecture. Like Frampton, Curtis does not give any information or attention to a development of a new kind of architecture, which can be linked with green architecture.

The books *Modern Architecture /1* and *Modern Architecture /2*, by Manfredo Tafuri and Francesco Dal Co (1986), are in a similar position in relation to this research report. Tafuri and Dal Co do not take a look on the development of green architecture in any context. Thus these two books were only used for background information to confirm Frampton's and Curtis's writings.[4]

The book *Modern architecture* by Alan Harold Colquhoun (2002), explores the motivations behind the revolutionary movement of the "international style". Colquhoun writes about the main architects of the movement such as Adolf Loos, Le Corbusier and Mies van der Rohe, and explores the evolution of the movement from Art Nouveau in the 1890s to the mega structures of the 1960s.[5] Colquhoun focuses on historical facts as Kenneth Frampton did, however, he takes the standpoint describing the different aspects of the garden suburbs before the First World War and the post-war Siedlungen afterwards in context to fresh air,

[2] Kenneth Frampton, *Modern architecture: a critical history*. London, England: Thames and Hudson, 1980.
[3] William J. R. Curtis, *Modern architecture since 1900*. London, England: Phaidon, 1996.
[4] Tafuri, Manfredo. Dal Co, Francesco. *Modern architecture / 1*. and *Modern architecture / 2*. New York, NY: Faber and Faber/Electa, 1986.
[5] Alan Colquhoun, *Modern architecture*. Oxford, New York: Oxford University Press, 2002.

natural sunlight and new facilities. His book gives limited consideration to energy and natural sunlight, and is not considered key literature in context to the scope of this research report.

Richard Weston focussed on regional interpretations of modern architecture, particularly in the Nordic countries. His book *Key buildings of the twentieth century: plans, sections and elevations*, which was published in 2004, contains a collection of twentieth century buildings and presents these buildings with plans, sections, elevations, and pictures. One of the problems during research for this paper was to understand the written descriptions of a particular building without any plans or sections. This collection of plans, sections, elevations, and pictures by Richard Weston addresses this gap of knowledge and make buildings, like the "Glass Pavilion" by Bruno Taut, the "Schröder-Schräder House" by Gerrit Rietveld as well as many other buildings more understandable.[6]

1.1.2 MODERN ARCHITECTURE AND ENERGY ISSUES

At the turn of the 20th century, more books were published, which addressed energy issues and material resources. James Wines's book is one of these which gives consideration to these issues. Wines is an American architect, who is associated with environmental design. His book *Green architecture* (2000) is intended as a general exploration of one of the most complex and problematic issues. This issue is about how to construct a human habitat in harmony with nature. The most important chapter for this research paper was "Nature's Revenge: A Brief Survey of 20th Century Green History", which is about the damage wrought by construction technology and the waste of resources during the last century.[7] It includes a history of ecologically oriented shelter as a review starting from the beginning of the 20th century to the present as well as a survey of architects, who are seeking to change the relationship between buildings and the environment.

Andrew Ballantyne discusses the role of energy since the 19th century in the "Introduction: Architectures in the Plural", which he published in 2006 as the editor in *Architectures: Modernism and After* (2006). The introduction gives consideration to the technologies of the 20th century and the problems, which arose through the development of new technologies.[8] Ballantyne proclaimed that modernism is concerned not with the transmission of a culture of approved building form, but with constant reinvention and experiment. He shows the permanence of buildings in this context and that the persistent repetition of particular built

[6] Richard Weston, *Key buildings of the twentieth century: plans, sections and elevations*. New York, W.W. Norton, 2004.
[7] James Wines, *Green architecture*. Köln, London: Taschen, 2000, pp.16-34.
[8] Andrew Ballantyne, "Introduction: Architectures in the Plural" in Andrew Ballantyne (ed.), *Architectures: modernism and after*. Malden, MA, Oxford: Blackwell, 2004, pp.1-32.

forms across time are no guarantee against the changing ways in which they are understood, from one time to another and in different cultural groups at the same time.

In addition to survey texts on modern architecture, there are articles of more direct relevance to the emphasis of this research report. An example is the article by Harris Sobin, "From l'Air Exact to l'Aérateur Ventilation and its evolution in the architectural work of Le Corbusier" (2007).[9] This research report includes work on Le Corbusier's development of energy related design and was one of the main resources for "Air Conditioning and Ventilation" in chapter 3 at this research paper. Harris Sobin is currently preparing a book length study provisionally entitled "From Science to Poetry: Le Corbusier and the Development of the New Environmental Envelope".[10]

1.2. NEUE SACHLICHKEIT IN THE WEIMAR REPUBLIC

The history of architecture is always a complex interplay between patterns of living, consideration of what good architectural form is and what technical means can be developed.[11] Architecture in the 20th Century began as a celebration of the age of industry and technology after the First World War in Europe.[12] In the wake of the revolution that followed the First World War, the German nation was confronted by the urgent need of a new constitution, which would maintain its political and cultural identity by setting its existence as a state on a new legal foundation. Only a few weeks after the revolution, the decree of 30 November 1918 was issued to provide for elections to a "National Constituent Assembly". This convened in Weimar on 6 February 1918.[13] Its purpose was to return to Germany, though it was delayed by political and economic crisis, and it implied a radical break with the national past and a search for alternative principles. Weimar was significant for many reasons political and social, but especially for the architecture that began to emerge in Germany around 1922. The development reflected a dramatic change of orientation in the visual arts. The architectural movement, known as "Neue Sachlichkeit" (New Objectivity),[14] was an art movement, which arose as an outgrowth of that development and in opposition to expressionism. The movement of the "Neue Sachlichkeit" ended in Germany with the fall of the Weimar Republic and the rise of the Nazis to power, in 1933.

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[9] Harris Sobin, "From l'Air Exact to l'Aérateur Ventilation and its evolution in the architectural work of Le Corbusier" in Kim Tanzer (ed.), Rafael Longoria (ed.), *The green braid: towards an architecture of ecology, economy and equity*. New York, New York: Routledge, 2007, pp.140-152.
[10] Harris Sobin, 2007, p.xiv.
[11] Andrew Ballantyne, 2004, p.1.
[12] James Wines, 2000, p.8.
[13] Karin Kirsch, *The Weissenhofsiedlung: Experimental housing built for the Deutscher Werkbund, Stuttgart, 1927*, New York, NY: Rizzoli, 1989, p.9.
[14] Alan Colquhoun, 2002, p.159.

It is a fact that Germany industrialised later than England and France and many critics said that improved design in craft and industry was important to the future wealthy. The opinion was that Germany, without any cheap material resources could only begin to compete at the world market with a high range of products of high quality. This argument was made by Friedrich Neumann in his 1904 essay "Die Kunst im Maschinenzeitalter" (Art in the Epoch of the Machine). There, he argued that such quality could only be economically achieved by an artistically cultivated people, oriented towards machine production.[15] The 1920s and 1930s were decades, in which it was not necessary to acknowledge ecological responsibility and "ecology" was not even a word in common use. [16]

1.2.1 THE FOUNDATION OF THE DEUTSCHER WERKBUND

The reform movement of education in applied art has been anticipated by Karl Schmidt's foundation of the "Deutsche Werkstätten für Handwerkskunst" (German Workshop for Manual Art) at Hellerau. In 1903, the whole movement gained considerable impetus with the appointment of Peter Behrens as principal of the "Düsseldorfer Kunstgewerbeschule". As a result of this movement in 1907, the Deutscher Werkbund was founded by thirteen independent artists and ten craft firms in Munich.[17] The individuals were Peter Behrens, Adelbert Niemeyer, Richard Riemerschmid, Jakob Julius Scharvogel, Theodor Fischer and others.[18]

The Deutscher Werkbund members dedicated themselves to the establishment of a centre for advancing the aims of their institution. The subsequent development of the Werkbund, particularly in its relation to industry, is inseparable from that phase of Peter Behrens's career. In 1907 he was the architect and designer of the "Allgemeine Elekticitäts Gesellschaft", or AEG, for whom he was to evolve a house style ranging from graphics to product design, industrial plant, and factory buildings. At AEG, Behrens was confronted with the might of industrial power. In exchange for his youthful visions of revitalizing German cultural life, he had to accept industrialisation as the manifest destiny of the German nation. The Turbine Factory that he built for AEG in 1909 was the result of his understanding of the composite issue of "Zeitgeist" and "Volksgeist". It was his duty as an artist and architect to give form to this new style of architecture as a conscious work of art and, as he said, to create a temple of industrial power.[19]

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[15] Kenneth Frampton, 1980, p.110.
[16] James Wines, 2000, p.232.
[17] Kenneth Frampton, 1980, pp.110-111.
[18] The others: Josef Hoffman, Wilhelm Kreis, Max Laeuger, Joseph Maria Olbrich, Bruno Paul, Paul Schultze-Naumburg, Fritz Schumacher and Peter Bruckmann
[19] Kenneth Frampton, 1980, p.111.

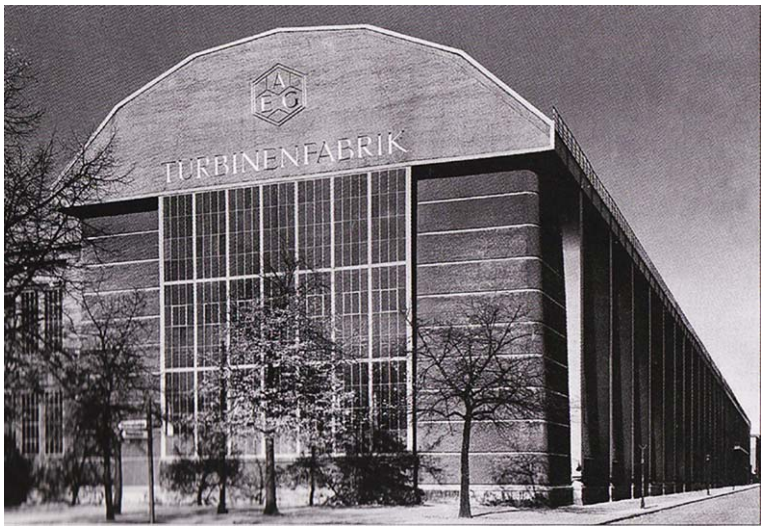

Plate 1.1
Peter Behrens, AEG Turbine Factory, Berlin, 1908-09

Between 1914 and 1929, the Deutscher Werkbund held several exhibitions in Germany including the Cologne exhibition (1914), the Berlin exhibition (1924), the Stuttgart exhibition (1927) which included the Weissenhof Siedlung, and the Breslau exhibition (1929). In 1914, after the Cologne exhibition and the presentation of the well known "Glass Pavilion" by Bruno Taut followed a split within the Deutscher Werkbund, between the acceptance of normative form (Typisierung) on the one hand, and the expressive "will to form" (Kunstwollen) on the other.[20]

The Weissenhofsiedlung in Stuttgart in 1927 was a significant exhibition of the Deutscher Werkbund. The first visitors to the Weissenhofsiedlung were struck by the departure from traditional forms. It looked new and different significantly from anything anyone had seen before, and as a result the exhibition in Stuttgart established the "International Style".[21] In 1938, the Deutscher Werkbund was closed by the National Socialists. However, after the end of World War II, in 1949, it was reestablished and celebrated its 100th anniversary in 2007 with a new planned Werkbund estate in Munich. Twelve architectural firms are currently involved in planning the new Werkbund estate "Wiesenfeld".[22]

1.2.2 THE MERGE OF THE ACADEMY OF FINE ARTS AND THE SCHOOL OF ARTS IN WEIMAR

The Bauhaus was the outcome of a continuous effort to reform the applied arts education in Germany. This movement of reform started with the establishment in 1898 of Karl Schmidt's German Workshop for Manual Art, in Hellerau. The next significant point during this period was the appointment in 1903 of Hans Poelzig and Peter Behrens to the directorship of the

[20] Kenneth Frampton, 1980, p.116.
[21] Peter Blundell-Jones, *Modern architecture through case studies*. Oxford, Architectural Press, 2002, p.43.
[22] Deutscher Werkbund Bayern e.V., "Werkbundsiedlung Wiesenfeld", Munich, Germany, Retrieved September 24, 2007 from the World Wide Web: http://www.werkbundsiedlung.com/

schools of applied arts in Breslau and Düsseldorf and, in 1907, the Deutscher Werkbund was founded in Munich. Walter Gropius became the director of the Weimar Academy of Fine Arts and the Weimar School of Arts and Crafts, in 1919, and as a merger of these two institutions, Gropius founded the Bauhaus.[23]

"Let us create a new guild of craftsmen, without the class distinctions which raise an arrogant barrier between craftsman and artist. Together let us conceive and create the new building of the future, which will embrace architecture and sculpture and painting in one unity and which will rise one day toward heaven from the hands of a million workers like the crystal symbol of a new faith."

Proclamation of the Weimar Bauhaus, 1919 [24]

The principles of the Bauhaus Proclamation of 1919 have been anticipated in Bruno Taut's architectural programme for the "Arbeitsrat für Kunst" (Workers Council for Art). Taut argues that a new cultural unity could be attained through a new kind of building, where each separate discipline would contribute to the final form. He wrote: "At this point there will be no boundaries between the crafts, sculpture and painting. All will be one: Architecture."[25]

Between 1919 and 1923, the Bauhaus began to absorb the ideas of "Neue Sachlickeit" and "De Stijl". The initial reaction came in 1921, when Van Doesburg came to Weimar in opposition to the Bauhaus and gave a series of lectures attended by many Bauhaus students. He advocated an approach to design diametrically opposed to the ideology of craftsmanship and artistic "intuition" that still dominated the Bauhaus. The real turning point came in 1923, when the Bauhaus organized its first exhibition. In line with the new technical emphasis, the stated theme of the exhibition was to be "Art and Technology: a New Unity". Gropius's architectural agenda was one, which would present, as he said, "International architecture from a completely pre-determined point of view, namely the development of modern architecture in the dynamic functional direction, without ornament or mouldings." [26] In 1925, the Thuringian State government withdrew its financial support and the Bauhaus moved to the town of Dessau. The municipality of Dessau funded a new school building, incorporating an existing trade school and a new staff houses. With the move, several of the existing staff resigned and their places were taken by a new generation of Bauhaus trained teachers, including Marcel Breuer, Joseph Albers, and Herbert Bayer. They had acquired a new aesthetic theory and a new set of technical skills different to the Bauhaus.[27]

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[23] Kenneth Frampton, 1980, p.123.
[24] L. Hirschfeld-Mack, *The Bauhaus*. Croydon: Longmans Green, 1963, p.4.
[25] Kenneth Frampton, 1980, p.123.
[26] Alan Colquhoun, 2002, pp.160-162.
[27] Alan Colquhoun, 2002, p.162.

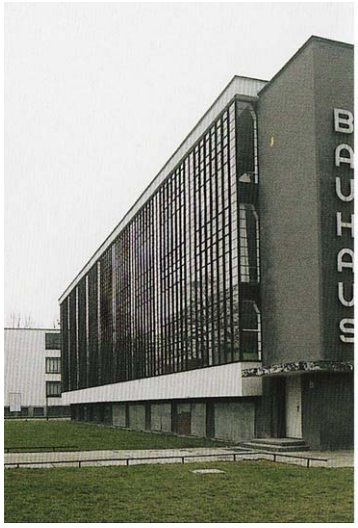

Plate 1.2
Walter Gropius, Bauhaus, Dessau, 1925-26

In 1930, as the last director of the Dessau Bauhaus Mies van der Rohe succeeded Hannes Meyer and remained in that position until the Bauhaus moved into an old warehouse on the outskirts of Berlin, in October 1932. It was forcibly closed by the National Socialist government nine months later in 1933.[28] The Bauhaus was not connected with any specific national or particular political beliefs and it was not a typically German school. However, it was an international school, which was dealing with problems that concerned all people. This was probably one of the reasons for its world wide success and the reason it was forcefully closed by the Nazis.[29]

1.3. DE STIJL MOVEMENT IN THE NETHERLANDS

The Dutch "De Stijl" movement was centered about the work of three men: the painters Piet Mondrian and Theo van Doesburg and the cabinet maker and architect Gerrit Thomas Rietveld. The other artists, who constituted the original formation, in 1917, under Van Doesberg's leadership, were the painters and architects Bart van der Leck, Georges Vantongerloo, Vilmos Huszar, J.J.P. Oud, Robert van't Hoff, Jan Wils and the poet Anthony Kok. However, they soon departed from the main line of the movement and went their various ways. All were signatories of the eight point manifesto, which was published in 1918 in the second issue of the magazine "De Stijl". This manifesto,which was the first of the De Stijl movement, called for a new balance between the individual and the universal. It stood for the liberation of art from both, the constraints of tradition and the cult of individuality.[30]

[28] Dirk Lohan, "Mies van der Rohe's Farnsworth House" in Paul Clemence (ed.), Mies *van der Rohe's Farnsworth House*. Atglen, PA: Schiffer Publishing, 2006, p.92.
[29] L. Hirschfeld-Mack, 1963, p.3.
[30] Kenneth Frampton, 1980, p.142.

The restriction to the primary colours yellow, blue and red came from Schoenmaekers. Yellow represents the movement of the ray (vertical), blue the contrasting colour to yellow (horizontal firmament) and red was the mating of yellow and blue. Van der Leck and Mondrian were in contact with Schoenmaekers in 1914, and were inspired. Schoenmaeker did not play a direct role in the aesthetic evolution of De Stijl. This part was left to Van der Leck and Mondrian.[31] In 1923, Gerrit Thomas Rietveld began to work on the design and detailing of the "Schröder-Schräder House" in Utrecht in the Netherlands. It was the first building to match the post-war dream of a new world built on new aesthetic, social and political principles.[32]

Plate 1.3
Gerriet T. Rietveld, Schröder-Schräder House, Utrecht, 1924

The "Schröder-Schräder House", built at the end of a late 19th century terrace, was in many respects a realisation of Van Doesburg's "Tot een beeldende architectur" (16 points of a Plastic Architecture). It fulfilled his prescription to be elementary, economic and functional, un-monumental and dynamic, anti-cubic in its form and anti-decorative in its colour. The main living level on the top floor, with its open "transformable plan", exemplified the traditional brick and timber construction and the postulation of a dynamic architecture liberated from the encumbrance of load-bearing walls. Finally, the 16 points of a plastic architecture by Van Doesburg can be read like an idealized description of the "Schröder Schräder House".[33] In 1931, Van Doesburg died in a sanatorium in Davos, Switzerland, and with him the De Stijl movement. Mondrian was the only one of the original De Stijl artists, who seemed to have remained committed to the strict principles of the movement, to the orthogonal and the primary colours, which were still the constituent elements of his mature work.[34]

[31] Kenneth Frampton, 1980, pp.142-143.
[32] Richard Weston, 2004, p.48.
[33] Kenneth Frampton, 1980, p.145.
[34] Kenneth Frampton, 1980, p.148.

1.4. THE CONGRES INTERNATIONAUX D'ARCHITECTURE MODERNE

In 1928, the secretary of the Swiss section of the Werkbund, Hélène de Mandrot, made contact with Le Corbusier, Pierre Chareau and Gabriel Guevrekian to arrange a meeting between the major European architects at La Sarraz in Switzerland. The timing was right for the foundation of the "Congrès Internationaux d'Architecture Moderne", or CIAM, which resulted from that first symposium. In coming to terms with the question of housing types, the CIAM was venturing on a terrain fraught with political implications. In a sense, the roots of the debate were still in the questions the Werkbund was to answer, but now the points of reference had changed. The problem of industrialisation was directly connected with the intervention being experimented with in Germany and the Netherlands.[35]

Plate 1.4
CIAM, "Congrès Internationaux d'Architecture Moderne", La Sarraz, June 1928

In 1930, a subgroup was formed within the CIAM, the "Comité International pour la Résolution des Problèmes de l'Architecture Contemporaine", or CIRPAC. CIRPAC was an operative body set up to work on the problem of urban analysis. The fourth congress, held in 1933, lost something of the concreteness of the first two congresses. It faced up to the overall problem of urban restructuring in new terms and resulted in the publication of the "Athens Charter" in 1943. The document adopted a functional concept of modern architecture and urban planning, which was unique and provocative. The Charter dealt with the themes discussed in the previous encounters and posed questions regarding new problems such as regional scale planning and the relationship between new and pre-existing constructions. After World War II, the ideas of the "Athens Charter" were adopted by architects and city planners to rebuild Europe. Le Corbusier himself left the CIAM in 1955 and the CIAM disbanded in 1959 as the views of the members diverged.[36]

[35] Manfredo Tafuri and Francesco Dal Co, *Modern architecture / volume 2*. New York, New York, Faber and Faber / Electa, 1986, p.219.
[36] Manfredo Tafuri and Francesco Dal Co, 1986, pp.219-220.

1.5. CONCLUSION

This chapter considers literature on modern architecture and provides background information to contextualise the research in subsequent chapters. Each scholar that is used as the basis for this research paper has a different point of view. This view is related to the personal opinion of the author and also to the time or epoch in which the author has lived or is living. Andrew Ballantyne says that there is no guarantee against the changing of views in which architecture and movements are seen in different cultural groups and from one time to another time.

This literature review tries to identify these different points of views and how they changed over time or evolving in relation to green architecture. One of the first writers, who realised an effect on human life and dwellings through changes in architecture, was Reyner Banham in 1960. Twenty years later, in 1980, Kenneth Frampton, published his wellknown book, but it does not discuss the development of a green architecture. The same can be identified in the literature by William J.R. Curtis in 1982 and Manfredo Tafuri and Francesco Dal Co in 1986. More literature resources, which were published around and after 2000, take a closer look on a green architecture development since the modern architecture. James Wines is one, who takes another view on this subject and explores this development. In 2000, Wines published *Green architecture* that includes a history of ecologically oriented shelter, from the beginning of the 20th century to the present. This book is part of the main background literature of this research report. Andrew Ballantyne was the editor for *Architectures: Modernism and After* in 2004, which is important for chapter 2. He proclaims that modernism is not concerned with the transmission of a culture of approved building form, but with constant reinvention and experiment.

Finally, this chapter considers the history and formations of the architectural groups Deutscher Werkbund, the Bauhaus and the De Stijl movement and shows that there was a need of changes in architectural culture in the first part of the 20th century. Now, that this development is explained, the research report can take a closer look on new techniques and ideas of the modern movement, which can possibly be linked to green architecture in the following chapters.

2. NATURAL LIGHT AND SOLAR DESIGN

This chapter explores the consideration to "natural sunlight and solar design" in modern movement. Three architects, Bruno Taut, Le Corbusier and Ludwig Mies van der Rohe, each with a significant project as an example will be the subject of this chapter. It explores the relation of architectural design in context to natural sunlight and solar design in modern architecture. These architects were significant for the modern movement and indeed, like Bruno Taut, Le Corbusier was not ignorant of the power of natural sunlight within residential buildings.[1] In the 1920s, there was no architect in like Ludwig Mies van der Rohe, to dominate the professional scene in Germany.[2]

The aim of this chapter is to explore if "natural sunlight" and "solar design" were generating interest within modern architecture during the construction and design process. This chapter shows that "Glass Architecture" and "Solar Design" were indeed a part of the architectural vocabulary of modern architecture.

2.1. THE DEUTSCHE WERKBUND EXHIBITION IN COLOGNE

In 1903, therapeutic light gained scientific validity when the Nobel Prize was awarded to Niels Finson for establishing the curative effects of light on tuberculosis. These practices did not only influence the design of buildings but the movement of modern architecture as well.[3]

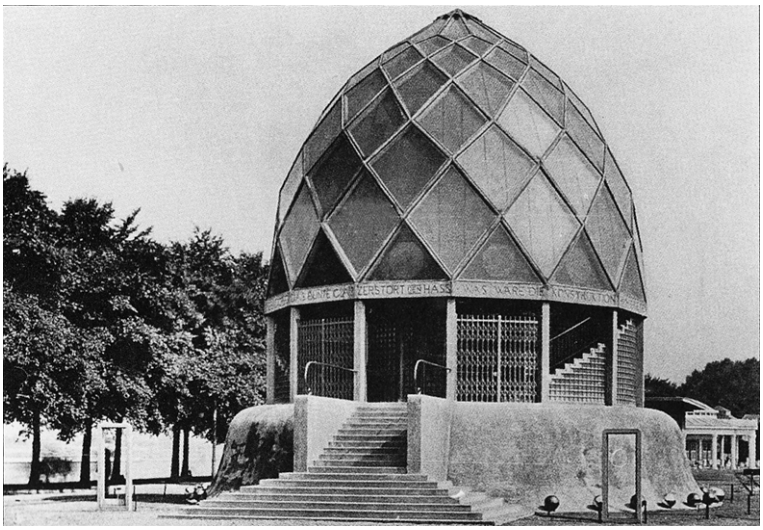

Plate 2.1
Bruno Taut, Glass Pavilion, Werkbund Exhibition, Cologne, 1914

[1] Brenda Vale and Robert Vale, "Steps Toward a Sustainable Architecture" in Andrew Ballantyne (ed.), *Architectures: modernism and after*. Malden, MA, Oxford: Blackwell, 2004, p.110.
[2] Alan Colquhoun, *Modern architecture*. Oxford, New York: Oxford University Press, 2002, p.170.
[3] Phillip G. Mead, "Unhealthy Energy Conservation Practices" in Kim Tanzer (ed.), Rafael Longoria (ed.), *The green braid: towards an architecture of ecology, economy and equity*. New York, New York: Routledge, 2007, p.154.

"In order to raise our culture to a higher level, we are forced, whether we like it or not, to change our architecture. And this will be possible only if we free the rooms in which we live of their enclosed character. This, however, we can only do by introducing a glass architecture, which admits the light of the sun, of the moon, and of the stars into the rooms, not only through a few windows, but through as many walls as feasible, these to consist entirely of glass – of coloured glass."

Poet Paul Scheerbart, Glasarchitektur, 1914 [4]

The text of Scheerbart's Glasarchitektur was dedicated to Bruno Taut, whose Glass Pavilion was inscribed with Scheerbart's aphorisms: "Light wants crystal", "Glass brings a new era", "We feel sorry for the brick culture", "Without a glass palace, life becomes a burden", "Building brick only does us harm" and "Coloured glass destroys hatred". These words dedicated the pavilion to the light that filtered through its faceted cupola and glass block walls to illuminate an axial seven tiered chamber.[5] On one hand, the Glass Pavilion presented a new type of architecture, an architecture that offered the possibility to use more natural sunlight inside a building than a traditional building design could offer. On the other hand, the construction of the Glass Pavilion made no concession to the climate. Ultimately it was not useful as a new design model of residential buildings, which could be offered for family living.

2.2. LE CORBUSIER AT THE VANGUARD OF EXPLORING

Like Bruno Taut, Le Corbusier was not an ignorant of natural sunlight within living space. For example, Le Corbusier's "*Manual of the dwelling*" suggests that the occupant should demand a bathroom facing south with a fully glazed wall leading to a balcony for sun and, providing additional sources of energy were available, this could be achieved, even with his single glazed windows. Corbusier's idea of facing the bathroom toward the sun also had many practical advantages. For example, the results were higher air temperatures, which could help to offset condensation problems and a sunny bathroom usually meant dry towels and air as well.[6]

In 1927, Le Corbusier published his "Five Points of New Architecture" to promote the modern movement. Modern architecture has never been just an aesthetic for Le Corbusier and his view of form has been described as dialectical: "On the one hand the imperative need to satisfy functional requirements through empirical form and on the other the impulse to use

[4] Kenneth Frampton, *Modern architecture: a critical history*. London, England: Thames and Hudson, 1980, p.116.
[5] Kenneth Frampton, 1980, p.116.
[6] Brenda Vale and Robert Vale, 2004, p.110.

abstract elements to affect the senses and nourish the intellect".[7] The Villa Savoye in Poissy represents the culmination of Le Corbusier's Purist style of the 1920s. The design exploited the possibilities of concrete frame construction to match the five points of his new architecture, in which he proclaimed: [8]

1. "Columns (pilotis) raise the house into the air, freeing the ground for people and vehicles"
2. "A roof garden on the flat roof replaces the ground lost by development"
3. "Extending the pilotis through as a structural frame enables partition walls to be freely arranged in what he called the "plan libre", or "free plan"
4. "Disposing windows as required by the interior facade" (free facade)
5. "Long horizontal windows, "fenêtres en longueur" (ribbon windows), give a more even distribution of light"

Plate 2.3
Le Corbusier, Villa Savoye, Poissy, France, 1928-30

The Villa Savoye was planned and built as a weekend house in the leafy Paris suburb of Poissy between 1928 and 1930. During the Second World War it fell into ruin, but was restored afterwards. The long horizontal windows, or "fenêtres en longueur", are located on the first floor to give a more even distribution of sunlight, as Le Corbusier proclaimed in his five points of new architecture. More natural sunlight inside the building should offer a proportionally higher quality of healthy life. Another relevant design is the roof garden that serves as a second terrace and solarium. The solarium is the ultimate expression of the healthy and open air life.[9] These benefits of healthy and open air life are some of the remarkable ideas in the design of the Villa Savoye and can be seen as a link to a new kind of architecture in relation to natural sunlight and solar design.

[7] Kenneth Frampton, 1992, p.152.
[8] Richard Weston, *Key buildings of the twentieth century: plans, sections and elevations*. New York, W.W. Norton, 2004, p.62.
[9] José Baltanás, *Walking through Le Corbusier*. New York, NY: Thames & Hudson, 2006, pp.55-57.

However enthusiastic Le Corbusier was about expansive glazing and experimenting with mechanical systems. During his life, he was also at the vanguard of exploring natural and passive solar designs, inspired by vernacular solutions.[10] Chapter 3, which explores ventilation and air-conditioning shows another example by Le Corbusier, the Salvation Army Building in Paris (1929-1933), which can also be linked to natural sunlight and solar design.

2.3. LUDWIG MIES VAN DER ROHE AND THE FARNSWORTH HOUSE

Le Corbusier was not the only great architect of that time, who was fascinated by the glass envelope. In the 1920s, Ludwig Mies van der Rohe dominated the professional scene of architecture in Germany, as Le Corbusier did in France.[11] Mies van der Rohe was one of the most important architects of the 20th century, and significant to the field of modern architecture. In Europe, before the Second World War was started, he emerged as one of the most innovative leaders of modern architecture. Mies van der Rohe produced visionary projects for glass and steel and executed a number of small but critically significant buildings. For example around 1920, he designed several projects for glass skyscrapers in central Berlin.[12]

The Farnsworth House is the only private home, which was designed and built in the United States of America by Ludwig Mies Van der Rohe. It is a one-room weekend retreat that is located in the floodplain of the Fox River near Chicago. The floor level of the Farnsworth House is raised above the ground to stay clear of the annual flooding of the river. Both, floor and roof plane are supported by wide flange steel columns. The edges of the roof, the floor and the terrace are framed with steel channels. Like Le Corbusier, Mies van der Rohe was also enthusiastic about expansive glazing. The windows at Farnsworth House are of clear plate glass that span from floor to ceiling. These windows provide a clear view and reduce the sense of enclosure to the barest minimum. Everything, the structure and the architecture, is made of steel and glass and is significant as the trademark of “Miesian design”.[13]

The Farnsworth House is seen as one of the highlights of modern architecture because of its spiritual rather than its functional qualities. For example, unlike other building types where the structure is hidden behind fireproofing and cladding, the Farnsworth House’s structural frame is fully visible. The house is so unconventional that every move and activity in it assumes an aesthetic quality, which is formed in different surroundings. The building

[10] Kim Tanzer and Rafael Longoria, *The green braid: towards an architecture of ecology, economy and equity*. New York, New York: Routledge, 2007, p.137.
[11] Alan Colquhoun, *Modern architecture*. Oxford, New York: Oxford University Press, 2002, p.170.
[12] Dirk Lohan, “The Farnsworth House” in Paul Clemence (ed.), Mies *van der Rohe's Farnsworth House*. Atglen, PA: Schiffer Publishing, 2006, p.92.
[13] Dirk Lohan, 2006, p.7.

provides for the use of a high range of natural sunlight, but the construction of the house makes no concession to the climate. Ultimately, the Farnsworth House cannot be used for family living or even as a residential building, just as the "Glass Pavilion" by Bruno Taut at the Cologne Exhibition, in 1914.

Plate 2.3
Ludwig Mies van der Rohe, Farnsworth House, Plano, Illinois, USA, 1945-51

In the architectural world, the Farnsworth House was widely regarded as the ultimate expression of both, the open plan and Mies van der Rohe's aesthetic ideal of "beinahe nichts" (almost nothing).[14] The concept, a country retreat from the big city, has been elevated to such abstraction that it demands complete acceptance of its rigour from the occupant. As Mies van der Rohe had said many times, materials and their details are the grammar of architecture:

"Unless you master the grammar you cannot speak a good prose,
and much less become a good poet."

Ludwig Mies van der Rohe [15]

2.4. CONCLUSION

Bruno Taut used a new material of glass bricks and tried to establish this material through a new kind of glass construction and design. His "Glass Pavilion" at the Cologne exhibition, in 1914, was an example of a building that provides a high range of natural sunlight inside the building. Although a good design presenting the use of natural sunlight in this context, it is not a useful example of a building that can be offered as a residential house. The same can be said about the "Farnsworth House" by Ludwig Mies van der Rohe. Mies van der Rohe

[14] Richard Weston, 2004, p.92.
[15] Dirk Lohan, 2006, p.8.

designed this building with expansive glazing that can be defined as a new kind of “Glass Architecture”. The design provides a high range of natural sunlight inside the building. This can be seen as a positive aspect, but on the whole there are more negative aspects in relation to the construction of the building. Like the “Glass Pavilion” by Bruno Taut, the construction makes no concession to the climate. As a result, it shows that this project cannot be used as an example of a building, which offers enough quality in terms of family living.

The last example in this chapter is the Villa Savoye by Le Corbusier. He showed how modern buildings can be designed to get the benefits of natural sunlight and solar design in modern architecture. He did not work with clear plate glass that spans from floor to ceiling to get a design of transparency like Ludwig Mies van der Rohe. Corbusier worked with his 5 points of new architecture to design the Villa Savoye and used long horizontal windows to give a more even distribution of natural sunlight inside the building. He gave more consideration to the aspect of health and fresh air. The result is that the Villa Savoye is an example that offers enough quality to be used as a residential building.

The literature resources that are used of this research report do not provide any information about problems in terms of overheating and interior temperatures, during the summer and winter time. This research report cannot give any statements in this regard, but it can be said that “Glass Architecture” and “Solar Design” have been a part of the architectural vocabulary in modern movement. The exploration of passive solar energy was not possible on a large scale due to the price of glass at the time. However as architecture from the modern movement experimented more with glazing, passive solar design began to explore.[16]

[16] Brenda Vale and Robert Vale, 2004, p.110.

3. AIR-CONDITIONING AND VENTILATION

This chapter explores how passive "Air-Conditioning" and "Ventilation" worked during the movement years and which benefits it brought to the building and the users, in the context of passive energy use. Le Corbusier was enthusiastic about the idea of natural and passive solar design. He was at the vanguard of exploring expansive glazing and experimenting with mechanical systems.[1]

This chapter looks at examples of Le Corbusier's buildings in the the development of passive "Air-Conditioning and Ventilation" during the modern movement. It shows the evolution of the idea to reduce the radiative transmission of solar heat into building interiors, which ends in new designs, like the "brise-soleil" concept.

3.1. WINDOWS ARE FOR LIGHT, NOT FOR VENTILATION

In 1929, Le Corbusier underlined his statement "la fênetre est faite pour éclairer, non pour ventiler" (windows are for light, not for ventilation).[2] By the end of the 1920s, for large scale projects, he advocated the use of two technically sophisticated mechanical systems: the "mur neutralisant" (neutralising wall) and "l'air exact" (respiration exacte). "Air Exact" was an elementary form of closed circuit air-conditioning, invented by French engineer Gustave Lyon and designed to provide correctly humidified air at exactly 18 degrees Celsius (64.4 degrees Fahrenheit) in all seasons. The former was adapted by Le Corbusier from double glazed systems traditionally used in areas of Europe with extreme winter weather, such as Switzerland or Russia. It consisted of a double layered cavity wall, which was filled with fast moving hot or cold air depending on the season. This moving air was to be blown vertically between the two layers of the double wall from a central machine room.

"To offset the effects of sedentary city life we need contrasts of various sorts – heat and cold, sun and shade, etc. – reaction to which provides an endless source of energy and vitality. Nothing is more dangerous than an absolutely uniform environment. Living in cotton wool…when you get up and open your door, you should be greeted by just that little shock of change, whether it be pleasant or unpleasant, which jolts you physically and mentally. Providing a natural reaction…"

Le Corbusier, The Marseilles Block, 1953 [3]

[1] Kim Tanzer and Rafael Longoria, *The green braid: towards an architecture of ecology, economy and equity*. New York, New York: Routledge, 2007, p.137.
[2] Harris Sobin, 2007, p.141.
[3] Harris Sobin, 2007, p.145.

Le Corbusier advocated these systems as the means for rendering the “glass box” habitable in all climates and seasons. He argued that this system provided the perfect machine age environment not only in Europe, but everywhere on the globe. This claim was clearly based on a thorough misunderstanding of the physical principles involved. For example, a double glazed wall with a flow of cooled air between its two layers could not have had any appreciable effect in reducing radiative transmission of solar heat into building interiors. Rather than detecting any flaws in these concepts, Le Corbusier proposed using the systems for two of his major large scale projects in the late 1920s. These projects were the “Centrosoyus Building” as a major governmental office building in Moscow (1929-1933) and the “Salvation Army Shelter” in Paris (1929-1933).[4] The clients for both projects balked at anything as radical or untried as the sort of totally manufactured indoor climate like Le Corbusier had in mind. One of the buildings, the “Centrosoyus Building” was built without incorporating either of the two mechanical systems, but included the double curtain wall.

The second building, the “Salvation Army Shelter” in Paris, was built without a second glass skin or the refrigerated cooling coils. As executed, the building retained its 10,500 square feet of south facing single glass however with only four very small openable sections to provide the possibility of ventilation. Nothing else was modified in the original design to compensate for the heat inside the building. The building appeared to be an environmental success during the particularly cold winter of 1933 to 1934. By the following summer, serious environmental difficulties had developed and the hermetically sealed all glass, south facing wall turned the building into an unventilated sauna. As a result of the construction it was impossible for the staff members to work inside the building, during summer time.

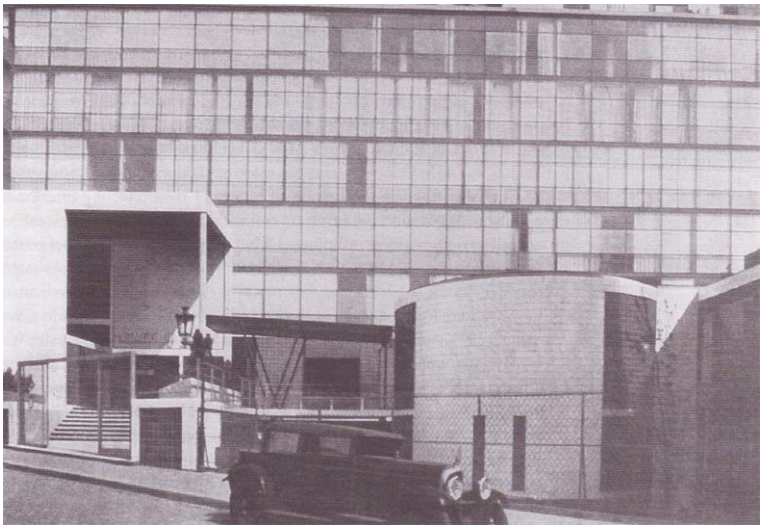

Plate 3.1
Le Corbusier, Salvation Army Building, Paris, 1929-1933

[4] Harris Sobin, 2007, pp.141-142.

After a long and bitter battle in front of the court with both clients and the Paris Préfecture, Le Corbusier was officially ordered, in March 1935, to incorporate forty-one more openable sections in the south façade. This experience undoubtedly encouraged him to accelerate his development of the "brise-soleil" device, known as "sun-breaker". It seemed that it also must have served as a reminder of the critical importance of ventilation in buildings. "L'air exact" and the "mur neutralisant" henceforth gradually disappeared from his writings and projects.[5]

3.2. LE CORBUSIER AND THE "WINDOW WALL"

Vernacular building traditions contain the knowledge of local strategies to deal with the influence of the sun, the wind and the rain. Technological developments led some twentieth century designers to believe that science could conquer the climate. Le Corbusier and Mies van der Rohe were interested in expansive glazing and experimenting with mechanical systems, but Corbusier was also interested in exploring natural and passive solar designs.[6] His theories were read in the Bauhaus design school in Dessau, Germany, but he actually never taught at the Bauhaus school. Le Corbusier argued that on one hand the Bauhaus school did not pay enough attention to architecture and on the other hand it paid to much attention to standardisation.

Plate 3.2
Le Corbusier, Villa La Roche, window wall at the entrance hall, Paris, 1923-1925

Le Corbusier was enthusiastic about air-conditioning when in 1933 he also introduced his idea of "man made weather".[7] This included the development of a building envelope system and a separate architectural solution for air-conditioning and ventilation. It was typical for him to break an overall architectural problem into its different parts. He then developed the design in which each element represented the solution to that particular part of the overall

[5] Harris Sobin, 2007, p.142.
[6] Kim Tanzer and Rafael Longoria, 2007, p.137.
[7] Kim Tanzer and Rafael Longoria, 2007, p.137.

problem. These solutions were generally additive objects and the solution of a prior time would persist into the next. At times, this led to direct conflict between a newly attained solution and one evolved during an earlier time.[8] Le Corbusier moved toward architectural solutions to the point of making ventilation an integral and visible part of his "window wall". He labelled this solution "l'aérateur" (aeration). The aeration is a series of tall, floor to ceiling slots that are narrow enough to be qualified as anti-theft. These slots provided passive ventilation inside the living room. In 1951, Le Corbusier designed a one-room vacation home in Paris for himself. He wanted to test his new design of passive ventilation on himself before it could be a part of his standard architectural design and vocabulary. It can be seen that the "High Court of Justice" of Chandigarh (1951-1954) was the first major building that was designed with the new "ventilation windows".[9]

Plate 3.3
Le Corbusier, High Court of Justice, Chandigarh, 1951-1954

"At this moment of general diffusion, of international scientific beliefs, I propose: only one house for all countries, the house of exact breathing…The Russian house, the Parisian, at Suez or in Buenos Aires, the luxury liner crossing the Equator will be hermetically sealed. In winter it is warm inside, in summer cool, which means that at all times there is clean air inside at exactly 18°."

Le Corbusier, Precision, in 1933 [10]

[8] Harris Sobin, "From l'Air Exact to l'Aérateur Ventilation and its evolution in the architectural work of Le Corbusier" in Kim Tanzer (ed.), Rafael Longoria (ed.), *The green braid: towards an architecture of ecology, economy and equity*. New York, New York: Routledge, 2007, p.140.
[9] Kim Tanzer and Rafael Longoria, 2007, pp.147-149.
[10] D. Michelle Addington, "Good-Bye, Wallis Carrier" in Kim Tanzer (ed.), Rafael Longoria (ed.), *The green braid: towards an architecture of ecology, economy and equity*. New York, New York: Routledge, 2007, p.160.

3.3. THE "UNITÉ D'HABITATION" AND A CHANGE IN THE DESIGN OF LE CORBUSIER

The "Unité d'Habitation" at Marseilles (1947-1952) was the first project Le Corbusier built after the Second World War. Aesthetically, it marked a radical break in his architectural style. The abstract plane, the smooth surfaces and the slender columns of his purist style were abandoned in favour of muscular and sculptural forms. The roughness of the raw concrete resulted from grainy and timber boarded formwork. The "Unité d'Habitation" was designed as an independent structural framework into which the individual units could be slotted. The basic idea of this design was the principle that these units could have been mass produced and a steel framed prototype was developed which proved this possibility.[11]

Plate 3.4
Le Corbusier, Unité d'Habitation, Marseilles, 1947-1952

The "Unité d'Habitation" also included a simple forced air heating system, which was used a simple type of smaller diffuser called the "Véga". The device is similar in concept and size to the type of adjustable small air nozzle that is used today in the dashboard of a car or in the cabin of a commercial jet. Le Corbusier even had a "Véga" installed in his personal work office. After his experience with the "Unité d'Habitation" in Marseilles, Le Corbusier started to experiment with larger scale cooling fans which also functioned at an architectural scale. They were used like a visible expression of natural airflow, passive ventilation and as a sign of quality in terms of human comfort.[12]

[11] Richard Weston, *Key buildings of the twentieth century: plans, sections and elevations*. New York, W.W. Norton, 2004, p.98.
[12] Harris Sobin, 2007, p.145.

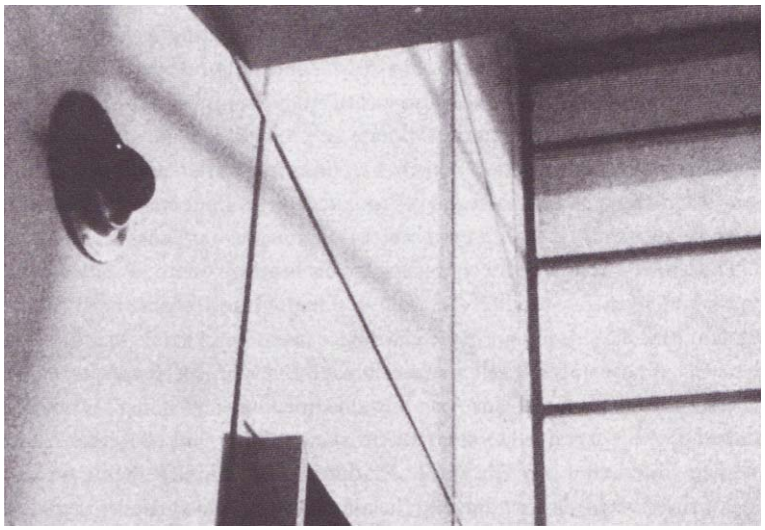

Plate 3.5
Le Corbusier, Diffuser type Véga, in typical use as supply unit, Unité d'Habitation, Marseilles, 1947-1952

The “brise-soleil” concept is another solution by Le Corbusier to protect a building against overheating through natural sunlight. Examples of the “brise-soleil” concept are the Ministry of Education in Rio de Janeiro (1943) by Lucio Costa, Oscar Niemeyer, Le Corbusier and other architects[13], and the “Unité d'Habitation” in Marseilles (1947-1952) by Le Corbusier. The “brise-soleil”, or “sun-breaker” solution refers to a permanent sun shading technique, like the simple patterned concrete walls popularized by Le Corbusier. The “brise-soleil” concept is used to prevent a heavily glazed facade from overheating during the summer. Its typical form employs horizontal projections extending from the sunside facade of the building. The sun-breakers generate shade to prevent the high-angle summer sun falling on the facade, but also allow the low angle winter sun to provide some passive solar heating. The “brise-soleil” concept was also integrated into the facade of the “Salvation Army Building” in Paris, after it was clear that it could not be used in its original design.

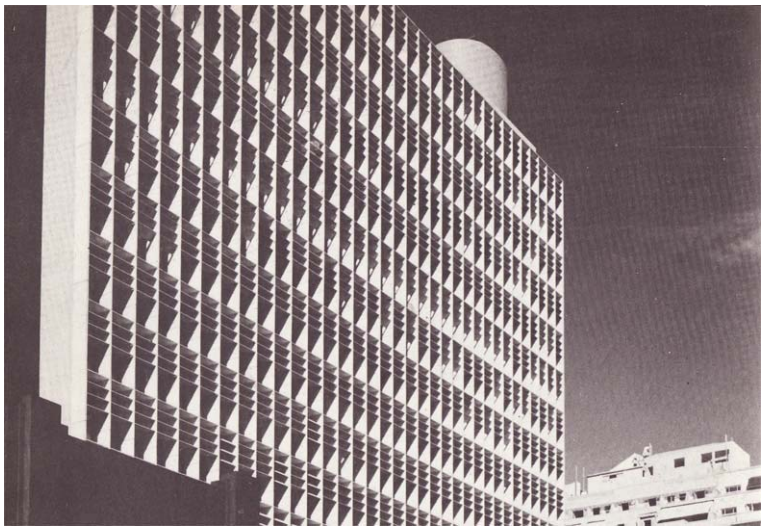

Plate 3.6
Lucio Costa, Oscar Niemeyer and others including Le Corbusier, Ministry of Education, Rio de Janeiro, 1943

[13] Reyner Banham, Age of the Masters: a personal view of modern architecture. London, Architectural Press, 1975, p.38.

3.4. CONCLUSION

In 1929, Le Corbusier said that “windows are for light, not for ventilation”. The “Salvation Army Building” in Paris (1929-1933) is a built example of this statement. This project utilises his double layered cavity wall, which was filled with fast moving hot or cold air, depending on the season. This idea was clearly based on a misunderstanding of passive solar design and the physical principles. Doubling a glass wall and a flow of cooled air between the two layers could not have had any effects to reduce the radiative transmission of solar heat into building interiors.[14]

The experiment at the “Salvation Army Building” failed but encouraged Le Corbusier to start the development of the “brise-soleil” concept.[15] For example, the “Ministry of Education” in Rio de Janeiro (1943) and the “Unité d’Habitation” at Marseilles (1947-1952) both use the “brise-soleil” concept. The “Unité” also marked a radical break in his understanding of aesthetic. The abstract planes, the smooth surfaces and slender columns were abandoned in favour of muscular, sculptural forms from timber boarded shutters.[16] The “Unité” also included the simple forced air heating system “Véga” which looked like a simple type of smaller diffuser.

By 1952, Le Corbusier came to the conclusion that a window could be seen as an element for ventilation. The “High Court of Justice” building in Chandigarh (1951-1954) was the first major project that was planned with the “ventilation window”. Able to open, the window could provide passive ventilation to building interiors and as being a solid element. It was not only a light giver. This design exemplifies Le Corbusier’s philosophy to separate each function of architecture as an independent element and to provide different solutions.

In relation to Ludwig Mies van de Rohe, the research process clarified that Mies van de Rohe was more interested in the aesthetic side of modern architecture. As shown in chapter 2, he was enthusiastic about expansive glazing to minimise the sense of enclosure. He experimented with glass to achieve a high range of transparency in his designs of buildings, while Le Corbusier was at the forefront of exploring new techniques and solutions of ventilation and air-conditioning.

[14] Harris Sobin, 2007, pp.141-142.
[15] Harris Sobin, 2007, p.142.
[16] Richard Weston, 2004, p.98.

4. THE DEUTSCHE WERKBUND EXHIBITION IN STUTTGART

This chapter considers the problems of a building's construction and design in the 1920s and the early 1930s. The degree of structural changes by the departure from traditional forms determines the character and the extent of the problems in modern architecture. In 1927, the Weissenhof experiment played an important part of the Deutscher Werkbund exhibition in Stuttgart which in turn lead to the establishment of the "International Style".[1]

The aim of this chapter is to discuss whether these new design and construction methods in modern architecture provided any possibilities in reducing wasted energy and material resources during the construction process. This chapter shows how the Deutscher Werkbund exhibition offered a number of possibilities in the design and construction of the buildings at the Weissenhofsiedlung.

4.1. SIXTEEN DIFFERENT ARCHITECTS ON ONE PROJECT

After the First World War, there were a great number of technically competent, ideologically progressive architects in Germany, many of whom were put in charge of city programmes between 1924 and 1931, such as Otto Haesler in Celle, Max Berg in Breslau, Fritz Schuhmacher in Hamburg, Ernst May in Frankfurt am Main and Martin Wagner in Berlin. Like the "Garden Suburbs" before the First World War, the post-war Siedlungen consisted of enclaves of new housing on the outskirts of existing cities. They were built to higher densities and consisted mostly of apartment blocks of up to five storeys. These were generally laid out on the "Zeilenbau" principle of parallel blocks from north-south at right angles to the access street. This gave fresh air to each apartment and provided natural sunlight. At the aesthetic and symbolic level, they followed the rules of the "Neue Sachlichkeit".[2]

The "Weissenhofsiedlung" in Stuttgart was a symbol of the new German economy after the end of the economic chaos of the early 1920s. The Siedlung expressed the progressive optimism of the Weimar Republic. The inclusion of leading architects from France, the Netherlands, Belgium and Austria showed the solidarity of modernists across Europe. It was a sign that the Weimar Republic would like to be seen as a part of Europe and the world after the First World War.[3]

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[1] Peter Blundell-Jones, *Modern architecture through case studies*. Oxford, Architectural Press, 2002, p.45.
[2] Alan Colquhoun, *Modern architecture*. Oxford, New York: Oxford University Press, 2002, p.165.
[3] Peter Blundell-Jones, 2002, p.11.

Plate 4.1
Poster design for Werkbund exhibition "Die Wohnung", 1927

The Weissenhof experiment was a model housing development which was built on a hill above Stuttgart in 1926-27 as part of an exhibition. This exhibition was entitled "Die Wohnung" (The Residence) and was organized by the Deutscher Werkbund.[4] Ludwig Mies van der Rohe, who was the last director of Bauhaus, was the architectural director of the Deutscher Werkbund and the artistic director of the Weissenhofsiedlung.[5] The project was funded by the city on the basis that the houses and flats would be rented after the exhibition. Although it was supposed to be a demonstration of social housing, the site and budget restricted many architects to build a single unit and most produced work which was closer to bourgois villas than houses for the working class. Indeed, many had a maid's room and one even had a garage. The site was controlled by the Stuttgart architect Richard Döcker, who also designed two houses of the exhibition. However, the budget was tight and he had difficulty to get information from the other architects, including Mies van der Rohe.[6]

The history of the Weissenhofsiedlung is also a story of sixteen individual architects. For many, their part in this exhibition project was a decisive event in their careers.[7] The participating architects were Peter Behrens, Le Corbusier and Pierre Jeanneret, Walter Gropius, Ludwig Mies van der Rohe, Hans Scharoun, Bruno and Max Taut and others.[8] Not all but most, who were involved in the experiment, were also members of the Deutscher Werkbund.[9]

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[4] Peter Blundell-Jones, 2002, p.11.
[5] William W. Braham, Jonathan A Hale and John Stanislav Sadar, *Rethinking technology: A reader in architectural theory*. Abingdon, Oxon, New York: Routledge, 2007, p.113.
[6] Peter Blundell-Jones, 2002, p.11.
[7] Karin Kirsch, *The Weissenhofsiedlung: Experimental housing built for the Deutscher Werkbund, Stuttgart, 1927*, New York, NY: Rizzoli, 1989, p.10.
[8] The others: Victor Bourgeois, Richard Döcker, Josef Frank, Ludwig Hilberseimer, Jacobus Johannes Pieter Out, Hans Poelzig, Adolf Rading, Adolf Gustav Schneck, Mart Stam
[9] William W. Braham, Jonathan A Hale and John Stanislav Sadar, 2002, p.113.

Plate 4.2
Weissenhofsiedlung, view north-east, Scharoun's house in the foreground, Taut's with rounded corner, Mies van der Rohe's block crowns the hill, 1926-27

4.2. AN INTRODUCING OF NEW POSSIBILITIES IN CONSTRUCTION

The first visitors to the Weissenhofsiedlung in Stuttgart were struck by the departure from tradition. It looked radically new and radically different to the visitors because nearly all new buildings in European cities were still covered in sculptural ornament, which was based on some variant of historical style. Load bearing wall constructions with visible pitched roofs, cornices, string courses, rustication and other elements that dominated the method of teaching in architectural schools, were the norm. Previously they assumed that the building would take a symmetrical form with a central entrance and plans were set up on axes according to the "Beaux Arts" method, however these principles changed during the modern movement.[10]

Ludwig Mies van der Rohe was always interested in generic types and in universal architectural solutions.[11] Like many other colleagues, who were working on the Weissenhof project, he was an enthusiastic reader of Henry Ford's recently published autobiography and an enthusiast of mass production. These architects understood the economies of the production line and considered its application to the building site. They had imitated these kinds of forms by hand, which they thought the machine might later produce in mass. For example, traditional joiners in small workshops made endless identical windows which could have easily all been different. Old fashioned brickwork was concealed with render and paint to give it a seamless surface. It was called the "machine aesthetic" and a model in terms of size and technical efficiency. Walter Gropius was the only one of all Weissenhof architects who went substantially further with mass production. Gropius developed a pair of two storey houses using a dry panel system with a steel skeleton of small sections placed at one metre intervals and a single central column in plan. This was intended to minimise building time and

[10] Peter Blundell-Jones, 2002, p.43.
[11] Peter Blundell-Jones, 2002, p.14.

site work. His idea was to transfer a part of the construction process to the more secure and predictable conditions of the factory, which also offered the possibility of reducing the waste of material and resource to a minimum. Walter Gropius was the only architect at the Weissenhofsiedlung who devised a construction prototype which was completely prefabricated. Several other architects, like Ludwig Mies van der Rohe and Le Corbusier, were interested in the rationate of mass production and its implications for housing at a large scale.[12]

The houses of Jacobus Johannes Pieter Oud were standard types of buildings which included the more traditional form of terrace. Like the German economy did, the Dutch economy did not suffer as a result of the First World War and modernist architects received commissions to design important buildings much earlier. Peter Oud definitely had mass production in his mind. He used a type of standard casement window which could be bracket together in groups of two, three and six casements. His main effort went into planning the interior to produce the most efficient house with the smallest possible volume. For example, Pieter Oud's design of the kitchen with its integrated worktops was in the forefront of development and a predecessor to the famous "Frankfurt Kitchen".[13]

Plate 4.3
The houses by Jacobus Johannes Pieter Oud, street side with small yards, 1926-27

Le Corbusier's houses are the best known works of the Weissenhofsiedlung in Stuttgart and they marked a significant advance in his reputation. Le Corbusier used the Weissenhof experiment as a chance to exemplify his five points of new architecture, and would in turn use these for the Villa Savoye project in Poissy in 1928-30 (chapter 2.2:p.16). The flat roof of his project in Stuttgart was a new kind of construction and significant for all buildings at the Weissenhofsiedlung.

[12] Peter Blundell-Jones, 2002, pp.16-18.
[13] Peter Blundell-Jones, 2002, pp.21-22.

Plate 4.4
Le Corbusier's buildings seen from the street, 1926-27

For Le Corbusier the roof became a habitable space, thus replacing the ground which the building covered. By 1927, the implications of the new structural system were well known, but it was ultimately Le Corbusier who gave them visual drama and brought them into modern architecture. Indeed, Le Corbusier intended to show a simpler, more direct form of life stripped of clutter and sentimentality. His idea was to stop wasting space and especially to stop wasting too much energy on rooms, which were used only half the time.[14]

"It is no longer everybody's wish only to have a temporary bed situation at night, and by day to box it away… Many want a closed bedroom in which they not only rest and dream, but make love, conceive, give birth, and die."

Edgar Wedepohl, 1927 [15]

4.3. THE INTERNATIONAL STYLE WAS ESTABLISHED

The issue of rationalisation and standardisation in the building process was part of the real issue during the Weissenhof experiment.[16] Choices of materials and techniques were ideologically in some cases, but economic and pragmatic in others.[17] In fact, the buildings as a whole gave rise to the view that the Deutsche Werkbund tried to establish a functionalist aesthetic. In this case, one of the first critics was the functionalist Herman Muthesius, who was chairman of the Werkbund from 1910 until 1916. Overall he welcomed the exhibition as a significant experiment, but argued that the solutions offered were not the product of functional consideration at all. Instead he believed that they reflected a new formalism in

[14] Peter Blundell-Jones, 2002, pp.24-27.
[15] Peter Blundell-Jones, 2002, p.27.
[16] Karin Kirsch, 1989, p.19.
[17] Peter Blundell-Jones, 2002, p.11.

which consideration to rationality, economy and construction requirements had been ruthlessly subordinated.[18]

It needs to be noted that there are also misunderstandings and fallacies in relation to the Weissenhof experiment. One of these misunderstandings is the assumption regarding "The White Architecture" at the Weissenhof.[19] This assumption is based on black and white photography which played a major role in consolidating the white image as the colours were bleached out in the photographic reproduction. Another reason for the white image can be the name "Weissenhof" itself, which contains the German word for white: "Weiss". Mark Wigley brings up the English translation "white court" for the German name "Weissenhof" as an uncannily prophetic name.[20] However the German name "Weissenhof" was just a name and not a combination of words to describe a white court and should not be translated as such. Bruno Taut, among others, experimented with strong colours, however this was concealed by the use of black and white photography of the time. For example, the houses by Mart Stam were vivid blue, the building by Peter Behrens ochre yellow, and the double houses by Le Corbusier were blue and green in colour.

Plate 4.5
During the Third Reich, the "Weissenhofsiedlung" and its whiteness were referred to through a photomontage as an "Arabian Village" provided by the Nazis

"It is an essential moment of the new interpretation of form that certain colourfulness is appropriate to it …. The new architecture needs colour, needs it as a means of design, in order to articulate the plain surfaces of its walls, and it needs it further in a functional sense,

[18] Joan Campbell, *The German Werkbund: the politics of reform in the applied arts.* Princeton, N.J.: Princeton University Press, 1978, p.187.
[19] Peter Blundell-Jones, 2002, p.44.
[20] Mark Wigley, *White walls, designer dresses: the fashioning of modern architecture*. Cambridge, Mass.: MIT Press, 1995, p.303.

in that it uses colour values, to express, with the gradation of these values, the potential relations of the spatial organism."

Le Corbusier [21]

Another point is a fallacy in context to the slogan "honesty of expression", which is related to the new definition of "Zeitgeist". Architecture should "express it's time" to be "honest", but the architects of the Weissenhofsiedlung have not always shown honesty in their selection and use of building materials. One example of this is the project by Ludwig Karl Hilberseimer at the Weissenhofsiedlung. The original building and construction plans show that a steel frame system was intended, but delivery problems precipitated a change to the cheaper zig-zag timber system rather like scaled-up corrugated cardboard. With render outside and plaster within, this could have been any material.

Another example is the project by the Dutchman Mart Stam at the Weissenhofsiedlung. A frame construction was intended as well, but they were built largely of blockwork for economic reasons. Not clear from published material is the construction of the curved wall in the lower house of Max Taut's project. Taut used rendered surfaces, which he seems to have used both to provide a contrast with the texture of the panelled walls and to allow some relaxation from the strictness of their insistent rhythm.[22] The house by Hans Poelzig's was constructed using timber frame clad on the outside with Fornitram, which was an early form of woodwool slab. Hans Poelzig had planned to display the joints, but they were rendered and painted grey. Architects such as these started to manipulate plain surfaces until they achieved a decorative effect which replaced that of ornament and colour which had been removed. The white wall takes over the role of these elements, whose removal it advertises. This transformation of the surface can be understood in terms of cladding.[23]

In fact, many similar examples in terms of material imitation at the Weissenhofsiedlung can be found. These examples show that "honesty of expression" was not always given. Mark Wrigley argued that the look and the effect of a building in modern architecture were more important than the choices of the materials. In some cases these decisions had a negative influence on the physical facts of the construction. For example proper insulation was neglected and the buildings did not reduce energy usage, which was extremely high in comparison to today's standards.

[21] Mark Wigley, 1995, p.320.
[22] Peter Blundell-Jones, 2002, p.39.
[23] Mark Wigley, 1995, p.327.

4.4. CONCLUSION

The Weissenhof introduced a new era of architecture to the public. Traditional architecture was about symmetrical forms with central entrances, load bearing wall constructions, pitched roofs and other such elements. Modern architecture was about the significance of flat roofs, white walls, long horizontal windows to provide transparency, and other new types of construction techniques. The choices of materials and techniques were ideological, but in others more economical and pragmatic. The Weissenhof exhibition established a range of these new possibilities in construction and design in modern architecture.

Rationalisation and standardisation in the building process were part of the real issues of the Weissenhof experiment. [24] Walter Gropius' construction at the exhibition was supposed to minimise building time and site work. To achieve these benefits he experimented with mass production. Gropius tried to transfer the construction process to the factory and devised a construction prototype, which was completely prefabricated. This new method of mass production minimised building time and site work and provided the possibility of lowering the environmental impacts and reducing the waste of building materials on site. Other architects at the Weissenhofsiedlung, like Ludwig Mies van der Rohe and Le Corbusier, were also interested in the rationale of mass production. Le Corbusier was also interested in stopping the waste of space and waste of energy on rooms, which were used only part the time. [25] The new type of a flat roof made use of unusable space, which was a result of the traditional pitch or double pitch roofs. The flat roof saved space and energy by reducing unnecessary heating during the winter and started to be a standard element in the projects of Le Corbusier.

One of the major problems was in choosing to overemphasise the technological advantages and undervalue the social and aesthetic aspects. [26] It could be included that the look and the effect of a building in modern architecture were more important than the choices of the materials, as Mark Wrigley argued. It had been detrimental that construction as proper insulation were neglected and therefore did not reduce energy usage. On the other hand the numbers of structural changes and construction methods defined the character and the complexity of problems faced during modern architecture. The Weissenhofsiedlung in Stuttgart is acknowledged as a historical milestone and it is commonly agreed that it established a new style of architecture, known as the "International Style". [27]

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[24] Karin Kirsch, 1989, p.19.
[25] Peter Blundell-Jones, 2002, pp.24-27.
[26] James Wines, *Green architecture*. Köln, London: Taschen, 2000, p.64.
[27] Peter Blundell-Jones, 2002, p.45.

5. CONCLUSION

This paper explores different literature resources on modern architecture and has provided background information to contextualise the research in subsequent chapters. In the 1980s, authors like Kenneth Frampton, William R.J. Curtis, Manfredo Tafuri and Francesco Dal Co described the architectural movement and offered a high range of background information of modern architecture. They did not look to see if the architects had provided a range of solutions or construction developments that could be useful to solve the problem of wasting energy and material resources in modern architecture. On the other hand, other writers like Reyner Banham realised the effect on the quality of human life and the environment through changes in architecture in 1960, but he did not discuss any architects who successfully reduced this effect.

James Wines is a more recent writer who in 2000 started to publish his ideas and thoughts on the development of green architecture since modern architecture. Another critical writer is Andrew Ballantyne, who proclaims that modern architecture is concerned not with the advancement of perceived building forms, but with constant reinvention and experiment. Research of the history of modern architecture indicated that there was a need for change in architectural culture in the first part of the 20th century. It shows that each scholar has a different point of view and that this view is related to personal opinion and to the time or epoch. In reverse, it exemplifies that there is no guarantee against the changing of views in which the modern architecture is viewed in different cultural groups and from one time to the next time.

Today people are still talking about “Green Architecture”, “Sustainable Buildings”, “Solar Design”, Energy Conversation” and other ideas and techniques. During the 1920s and early 1930s there was not even a word or a name for it. This research report shows that architectural design in relation to natural sunlight and solar energy was more likely a bonus than a need in the construction of a building. These developments were more concerned with a positive effect on health, life and comfort. This paper considers the opportunity to use natural sunlight and solar design in modern architecture and it comes to the conclusion that “Solar Design” has been a part of the architectural vocabulary during this time. As architecture from the modern movement experimented more with glazing, passive solar design began to explore.[1] However the exploration of passive solar energy was not possible on a large scale due to the price of glass at the time.

[1] Brenda Vale and Robert Vale, 2004, p.110.

For example, some projects in modern architecture, which can be defined as “Glass Architecture”, used natural sunlight but not in the context of saving energy. A significant example of this is the “Glass Pavilion” by Bruno Taut. He used the new glass brick material in his design, which provides a high range of natural sunlight inside the building. Another example is the “Farnsworth House” by Ludwig Mies van der Rohe. His ideas were to achieve an unobstructed view and to reduce the sense of enclosure to a bare minimum. As a result, the idea of using natural sunlight was advantageous, but the construction of these two examples made no concession to the climate and did not offer a good interior environment which could be used residentially. Only the example of the Villa Savoye by Le Corbusier, with its long horizontal windows gives a more even distribution of natural sunlight inside the building and could be successfully used for family living.

In 1929, Le Corbusier proclaimed that windows are for light, and not for ventilation. Afterwards, he started to work with a double layered cavity wall, which was filled with fast moving hot or cold air depending on the season to provide air conditioning. His idea was clearly based on a misunderstanding of passive solar design and tits physical principles. For example, he doubled a glass wall and provided a flow of cooled air between its two layers, but it did not have any appreciable effects in reducing the radiative transmission of solar heat into the building’s interior.[2]

The experiment failed and as a result he started to develop the “brise-soleil” concept. The “Ministry of Education” building in Rio de Janeiro (1943) is an example of the “brise-soleil” concept that utilises a permanent sun shading technique. The idea is that the sun breakers are incorporated into the shade to prevent the high-angle summer sun falling on the facade, but to also allow the low angle winter sun to provide some passive solar heating. It is used to prevent a heavily glazed facade from overheating during the summer and actually saves energy on additional air-conditioning. By 1952, Le Corbusier introduced the “Ventilation Window”, which indicated a change in his principles and allowed him to use a window as an element ventilation. The “High Court of Justice” building in Chandigarh and the “Unité d’Habitation” in Marseilles are examples that established this new element of his architecture to provide passive ventilation and light.

Milestones for modern architecture in terms of establishing new techniques and new design solutions are the Deutscher Werkbund exhibition in Cologne (1914) and the Weissenhofsiedlung in Stuttgart (1926-27), which were a part of the exhibition “Die

[2] Harris Sobin, “From l’Air Exact to l’Aérateur Ventilation and its evolution in the architectural work of Le Corbusier” in Kim Tanzer (ed.), Rafael Longoria (ed.), *The green braid: towards an architecture of ecology, economy and equity*. New York, New York: Routledge, 2007,pp.141-142.

Wohnung". The Weissenhof experiment and its architects established new techniques and forms, like the significant flat roofs, white walls, long horizontal windows which provided transparency and other new types of construction techniques. The choices of materials and techniques were in a few cases ideological, but in others they were more economical and pragmatic. The Weissenhof exhibition proved it was possible to experiment and to transfer the construction process to the factory. The solution was shown to be "mass production" and completely prefabricated construction types. These techniques aimed to minimise the time of construction and site work, which therefore minimized environmental impacts, including the waste of building materials and resources. Therefore, the issue of rationalisation and standardisation in the building process was part of the core issue during the Weissenhof experiment.[3]

One of the major problems many architects of this time faced was a choice to overemphasise the technological advantages and to undervalue the social and aesthetic aspects at the Weissenhof experiment.[4] It might be that the look and the effect of a building were more important than the choices of the materials as argued by Mark Wrigley. And it is a fact, that this choice was detrimental to the construction as proper insulation was neglected and therefore the building did not reduce the energy usage. But the numbers of structural changes and construction methods has defined the character and also the complexity of the problems. In this case, the Weissenhof exhibition in Stuttgart has established a new style of architecture, the "International Style".[5]

Overall, this research report shows that there have been many new ideas and developments during modern architecture which were established and began to indirectly challenge the waste of energy and material resources. It can be called the beginning of a remarkable change in the theory and practice of architecture, but it cannot be called the beginning of a "Green Architecture". This research paper attempts to explain these ideas, which were not fully evolved enough to reduce the level of energy wasting. However the many changes in both the construction and design process have led to other developments and ideas, which have been pursued in architectural developments after the modern movement. Overall, this report is useful to help understand how the changes in architectural thinking began during the modern architecture and to understand the past, and the challenges of what we now regard as "Green Architecture".

[3] Karin Kirsch, 1989, p.19.
[4] James Wines, *Green architecture*. Köln, London: Taschen, 2000, p.64.
[5] Peter Blundell-Jones, 2002, p.45.

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