BRAIN WORK AND HANDWORK: THE CONSERVATOR-RESTAURATOR AS RESEARCHER. METHODOLOGICAL AND TECHNOLOGICAL ASPECTS OF THE PRESERVATION OF HISTORICAL ARCHITECTURAL SURFACES INCLUDING THE MODERNISM

(Englische Fassung, die Grundlage war für die Polnische Publikation, 2023)

Mózg i ręka: konserwator-renowator zabytków jako badacz i pracownik fizyczny. Metodologiczne i technologiczne aspekty ochrony zabytkowych powierzchni architektonicznych - w tym modernizmu (Brainwork and handwork: the conservator-restaurator as researcher and manual worker. Methodological and technological aspects of the preservation of historical architectural surfaces including the modernism), in: Maria Jolanta Sołtysik, Marek St□pa (eds.), Modernizm w Europie – Modernizm w Gdyni 8/ Modernism in Europe – Modernism in Gdynia 8. Industrial, port and urban architecture of the 20th century, Gdynia – Gdańsk 2023, p. 298-315 (Polish, with English abstract). https://www.gdynia.pl/modernizm/cykl-modernizm-w-europie-modernizm-w-gdyni,7219/nr-8-pl-en-architektura-przemyslowa-portowa-i-miejska-xx-wieku-industrial-port-and-urban-architecture-of-the-20th-century,571641

Ivo Hammer, Vienna / HAWK Hildesheim

ABSTRACT

The history of the preservation of modernist architecture can largely be described as a history of disregard for the materiality of its surfaces, often also as the destruction of surfaces. The historical technologies of the monuments are often no longer known to the craftsmen. Among the many reasons for this situation, we include above all the radical economic and technological changes in construction technology over the past 60 years, but also the stereotypical aesthetic ideas shaped by black and white photography and modern visual media, and the aspiration according to product-aesthetic novelty values.

The prevailing modern preservation of monuments is still based on design, on what is considered to be the original intention, the conception of the architect and often only presents diagrams, ultimately surrogates, Potemkin villages, so to speak. A preservation of monuments worthy of the name aims to preserve the authenticity of the monuments, which is embodied in their materiality. Authenticity includes not only the original historical substance, but also the materiality of significant later aesthetic changes and sometimes also traditional repairs, provided they are compatible with the original and have proven themselves on the object. The principles of preserving historical architecture also apply to the architecture of modernism, the contradiction between practical values and historical values is always virulent, largely independent of the age of the architecture.
Studies in conservation-science, which include all areas of knowledge, are a prerequisite for knowing and understanding the materiality.

In the international discussion, the preservation of modernist architecture is referred to as a multidisciplinary activity and also recognized that physical research into the buildings themselves is just as necessary as the exploration of archives (Keupers-de Jonge 2017). Nevertheless, the profession of restorer-conservator is still largely neglected by architects and art historians, and sometimes also by those who work in the preservation of monuments, and in the practice of preserving modernism it is often only used for color analysis.
University training in the preservation of historical architecture is still left almost exclusively to architects. Internationally, only a few university institutes that educate conservators-restorers have begun to expand the concept of culture and have made the preservation of architectural surfaces the subject of specialization courses.

In this situation, it is necessary to describe the specific tasks of the conservator-restorer within the multidisciplinary activity dealing with the preservation of historical architecture, including modernist architecture. The conservators play a special role in the interdisciplinary concert of cooperation

between architects, art historians, natural scientists, technicians and other specialists involved in building preservation. Similar to e. g. surgeons the conservators-restorers are concerned with the subject both scientifically-theoretically and practically-manually.
The scientific-theoretical examination of the built monuments by the conservators-restorers has a transdisciplinary and exploratory character, their practical-manual interventions serve the purpose of investigation and preservation
The conservators-restorers examine the architectural monuments using all historical, scientific, technological, phenomenological and empirical methods, they examine with all the senses (organoleptic). Thanks to their scientific and technological knowledge and their experience, the conservators-restorers are able to generate relevant information in these exploratory investigations, even if the detailed results are often only of statistical significance. However, further data from scientific and technological specialists must also be interpreted in a material and aesthetic context. Only by linking the various areas of knowledge can one do justice to the complex historical and technological reality of the monument. The conservators-restorers have before them the undivided material and aesthetic unity of the object, must recognize it and intervene in it with the aim of preservation.
The scientific nature of the investigation cannot only be determined by the use of the so-called exact sciences. No discipline is ancillary to the other. Each discipline has its specific responsibility for the whole of the monument (Giovanni Urbani). However, cooperation is only possible if the experts involved in the knowledge process are at least familiar with the specific methods and criteria of the other disciplines and are always aware of their own limitations.
In order to do justice to the dual task of preserving the monument and designing the re-use, i.e. the restoration of the utility value, cooperation between architects and conservators-restorers is particularly necessary.

Introduction: Surfacing materials matter!

As part of the 2019 conference *Modernism in Europe – Modernism in Gdynia 7: Architecture of the 20th century. Preservation of its authenticity and integrity in Gdynia and Europe* I got the opportunity to talk about the importance of the materiality of the surfaces of historical architecture.[1] I tried to show that the materiality of historical architecture, which is part of the cultural heritage, is not an aspect of a monument that can be assessed on a case-by-case basis,[2] but is the actual basis of its existence.

The values attributed to the architectural heritage, the form, the function and the cultural attributions are inextricably linked to the physical base, to the fabric. A built monument cannot be authentic without its material existence.[3] The practice of preservation and adaptation to the requirements of modern use forces compromises – as is always the case in the preservation of architectural monuments – even when preserving monuments of modernism. But if the original materiality is not examined, recognized and respected in a project for the re-use of an architectural monument, the adaptation to modern requirements and the corresponding design, the interventions lead to a falsification of the monument, to the damage or even the loss of its 'skin', the monument - in its appearance - becomes a surrogate. (figs 1,2)

[1] Hammer 2020 (Gdynia)
[2] Henket-de Jonge 2010, p. 100; Keupers-de Jonge 2017; John Allan, Materiality and Mythology, in: Černá-Hammer 2008, pp 50-56
[3] Hammer 2019, p.32

1. Brno, Tugendhat House, 1930, Ludwig Mies van der Rohe, 2nd floor, terrace, north-west corner, north facade, detail; (right, light stripe): Removal of the whitewash using a micro chisel, carried out by a conservator-restorer, 2004; Remaining surface: damage to the original facade surface due to lack of care during manual cleaning by a craftsman using a pneumatic needle hammer, 2011. Photo Ivo Hammer 5/2011

2. Alfeld, Fagus Werk, 1911, Walter Gropius / Adolf Meyer, plaster detail, with a yellowish color of the surface, which matched in color to the facing bricks of the facade. Damage caused by careless sandblasting. Photo Ivo Hammer 1999

From Henry-Russel Hitchcock's and Philip Johnson's book The International Style: Architecture since 1922, which appeared at the same time as the famous landmark exhibition at MoMA in 1932[4], we can gather that the reception of modernism in this pioneering period showed a sensitivity to the meaning of the materials and surfaces that is extraordinary for us today.

Up until after World War II, the historical tradition of periodic maintenance by hand was still alive in modern buildings in many countries. The admirable reconstruction of cities in Poland destroyed by the German Nazis testifies the outstanding achievements of Polish craftsmanship, which were also used and appreciated outside the country, for example in the preservation of monuments in Germany and Austria. (fig. 3)

3. Olsztyn / Allenstein. Reconstruction of the Sixties of 20ieth c. Traditional lime surfaces, polish craft tradition was still alive.

4. Warszawa /Warzaw 2010, Academy of Fine Arts, rectorate. Modern garish colours containing artificial resin and titan-white. Photo Ivo Hammer: 2010

[4] Modern architecture: international exhibition, New York, Feb. 10 to March 23, 1932, Museum of Modern Art, 1932

Photo: google maps streetview	

Modern replacement materials, manufactured in the laboratories of building material companies, have been gaining ground since the 1960s, displacing the tradition of craftsmanship and serving a building activity that is aligned on short-term calculations, rapid wear and tear, high consumption of resources and commodity aesthetic uniformity.[5] (fig. 4-6)

5 Sanatorium Dr. Barner, Albin Müller 1914. Yellowish natural plaster, scratched, with later repairs using Portland cement. Photo Ivo Hammer 2004

6. Helsinki, Malmi Airport / Malmin lentoasema, Dag Englund, 1935 - 1938. Joint damage due to joint repair with waterproof material (Portland cement?). Photo: Ivo Hammer 2012

The awareness of the importance of materiality in the preservation of historical monuments but also in new buildings was lost and led to irreplaceable losses, especially in the area of wall surfaces. Stereotypes, nourished among other things by iconic black and white photographs, led to garish white or gaudily colored coatings containing synthetic resin.

Scientific conservation studies of major works of modernism, carried out by conservators-restorers in interdisciplinary cooperation with art and architectural historians, architects, scientists and technologists have led to new findings regarding the materiality of the buildings over the last 20 years, which have changed our image of the architectural surfaces of modernity. That softness and liveliness of the original wall surfaces, very often executed using the traditional lime technique, which an attentive observer can also recognize in the contemporary black-and-white photos, is an essential element of the beauty of the buildings of modernism. In view of the straightforward rationality of their design language, it is particularly eye-catching. (fig. 7)

[5] Hammer 2003, p. 193

	7. Brno, Tugendhat House, 1930, 2nd floor, terrace, east facing. In the upper part of the eastern wall there is an archaeological window with the original surface. The facade is painted with lime paint pigmented with fine yellowish sand, in the spirit of the historical tradition of periodic manual maintenance (2011). The brass sheets covering the steel pillars bear the original patina. Photo Jong Soung Kimm 2012

Using the example of the preservation of wall surfaces, in this paper I would like to discuss the interdisciplinary cooperation of architects, natural scientists, technicians, conservators-restorers and craftsmen and the specific role of the conservator-restorer, which is still hardly noticed in architectural circles. I assume that - in principle - the same criteria apply to the preservation of modernist monuments as to the preservation of earlier architecture, even if there are some new technical problems.[6] The contradiction between the preservation of utility values and the preservation of cultural source values is always virulent in the preservation of built heritage.

The conservator-restorer as researcher

An investigation of a monument cannot be assessed as sufficiently 'scientific' if just material sciences are applied. The complex cultural and technological reality can only be comprised by the entanglement of the different ways of gathering knowledge and understanding. No discipline is an ancillary science to the other.[7] Every discipline has its specific responsibility concerning the monument as a whole. An interdisciplinary cooperation is possible only if the specialists in one field have at least an idea of the specific criteria and investigation methods of the other domains. Accepting the limits of cognition in one's own discipline is not a question of humility when facing complex problems only, but is a fundamental attitude also for an efficient cooperation of different disciplines. In each discipline there are limitations of knowledge according to the historical level of development with regard to the historic and scientific studies.[8]

In the international discussion about the conservation studies of modernist architecture, "*multidisciplinary activity*"[9] is mentioned here and there. It is also acknowledged that "*physical research into the buildings themselves is just as necessary as the exploration of archives*"[10] and also in connection with the well-known restoration of the Sanatorium Zonnestraal admitted a cognitive process: "*At first the historical color research was usually a secondary consideration, but now it is often conducted in direct conjunction with the historic building survey. … That the physical object is*

[6] Hammer 2017 (Materialität)
[7] Torraca, Giorgio, *The scientist's role in historic preservation with particular reference to stone conservation (1982)*, in: Nicolas Stanley Price, M. Kirby Talley Jr. & Alessandra Mulucco Vacaro (eds), *Historical and philosophical issues in the conservation of cultural heritage* (Readings in Conservation), Los Angeles (Getty Conservation Institute) 1996, pp 439-444
[8] Hammer 2015, 177 ss
[9] Macdonald and Arato Gonçalves 2020, p. 14
[10] De Jonge and Henket 2010, p. 101

another indispensable source of information, thus acknowledging the materiality of modern heritage also posesses an historical value, dawned only later."[11] On the other hand, a 2017 Handbook on Strategies of Conservation and Conversion written for architectural education and conservation along the descriptive title *Design from* (sic!) *Heritage*, which is enthusiastically linked in the foreword to Vitruvius's Libri Decem[12], does not mention precisely that profession that deals in a special way - both scientifically-theoretically and manually - with the materiality of heritage, namely the profession of conservator-restorer.

First, a definition of the image of the profession *conservator-restorer*. Why is the somewhat cumbersome double term necessary?
The job title, colloquially in many countries is *restorer*, in English the term *conservator* is unclear, an umbrella term.[13] It refers to other professions involved in the preservation of monuments, from architects to craftsmen repair. The essential goal of preserving a monument today is no longer the restoration of things that no longer exist or the refurbishment of an alleged historical state, but the preservation of the historical substance, the conservation of the material substrate and the cultural values associated with it.
At the suggestion (1978) of Countess Agnes Ballestrem, the International Council of Museums, Committee of Conservation ICOM CC in Copenhagen, in 1984, adopted the dual designation of the profession valid for all languages, namely conservator-restorer. The double name is not only a linguistic precision of the job title, but is also a helpful basis for a cooperative partnership with architects, with other specialists and the craft. [14]
The European umbrella organization ECCO defined the profession as follows in 2002: *The Conservator-Restorer is a professional who has the training, knowledge, skills, experience and understanding to act with the aim of preserving cultural heritage for the future, ... The Conservator-Restorer undertakes responsibility for, and carries out strategic planning; diagnostic examination; the drawing up of conservation plans and treatment proposals; preventive conservation; conservation-restoration treatments and documentation of observations and any interventions.* [15]
Today, no one would commission an artist (because of his special proximity to the artistic process) or an art historian to examine and "restore" a precious canvas painting, but rather a suitably trained conservator-restorer. Internationally, a distinction is made between traditional art restoration and building restoration.[16] This distinction is even reflected in international training courses for restorers — be they in Krakow, Philadelphia or Tallinn — leading to different career paths: Building restoration is primarily geared to architects.[17] But why should a methodical difference be made between preserving the surfaces of a medieval fresco and the handcrafted wall plaster of a building, especially when public interest in its conservation is evidenced by the fact that it is listed as a heritage site? Is the „*inspired creativity and ingenuity of the designer*" really the "*first and most important requirement*"[18] for the conservation, adaptive use and transformation of a heritage building?

[11] De Jonge and Henket 2010, p. 102
[12] Keupers-de Jonge 2017, p. 5
[13] Macdonald and Arato Goncalves 2020, p. 26 (ICOMOS Australia 2013)
[14] Hammer-Tugendhat et. al. 2020, p. 248.
[15] Professional guidelines, ECCO, Brussels (The profession: 2002, Code of Ethics: 2003; Education: 2004) www.ecco-eu.org
[16] Hard to believe, but indicative of architects' disregard for the profession of conservator-restorer: In the Getty Conservation Institute's recent international overview of *Education and Training for the Conservation of Twentieth-Century Built Heritage* (Pedroni et al. 2020), the university institutes for conservation-restoration are not mentioned; for example, the *Department of Mural Painting / Architectural Surfaces* of the *Institute for Conservation and Restoration* of the Academy of Fine Arts Vienna is missing
[17] See Hammer-Tugendhat et. al. 2020, pp. 166
[18] Keupers-de Jonge 2017, p. 26 (WdJ); see also Meurs 2016 (*Heritage based* (sic!) *design*)

I think it's time for architects to get off their high horse of absolute leadership and embrace the study, conservation, and design of adaptation as an interdisciplinary task that they are responsible for coordinating.
Already the stage of the investigations is to be understood as a dialectic process in which decisions have to be made again and again, which may exceed the professional competence of the architect, e. g. statics, building physics, safety, materials science or the interests and concerns of other stakeholders, e. g. owners, preservation of monuments, social institutions. Conservator-restorers are not only "*useful link between architects and craftsmen*"[19], and also not only researchers of *historical polychromy*, but responsible for the investigation, definition, evaluation and practical preservation of the materiality of the monument. Conservators-restorers must be active from the beginning of the planning, with the first survey investigations.[20] The planning of the conservation and the re-use only gets a rational basis on the basis of the results of the conservation-science investigation.[21]
It is a fact that internationally there are not enough conservators-restorers who have a lot of experience beyond mural painting in the field of undecorated architectural surfaces, which is not least typical of modernist architecture. In this respect, more training courses for conservators and restorers at universities are needed internationally, and the existing courses need an expanded concept of culture.[22] However, a solid university education in the material area of porous building materials (wall, stone), metal objects and wooden surfaces also enables the conservator-restorer to methodically examine and preserve modernist buildings; it is about the materiality, not questions of style.[23]

Interdisciplinary process.

The following checklist of the methodological process of interdisciplinary planning and implementation assumes that the same criteria apply to the preservation and adaptation of modernist architecture as to the preservation of older historical architectural heritage, even if there are new technical problems. Due to the given occasion, a special focus is the proportion of conservators-restorers in this interdisciplinary concert.
The image examples focus on facade surfaces.

Table

Model of the interdisciplinary process of study, conservation and adaptation of historic architecture The term historic architectural heritage refers to all older monuments of built heritage, including modernist architecture. For all planning steps and interventions in the monument, the consent of the owner and the state monument preservation must always be obtained. The respective main actors are highlighted. For larger projects, an (international) scientific advisory board is recommended. All surfaces, states and work steps should be professionally documented with photographs, drawings (mapping) and in writing.			
abbreviations			
O A H	Owner, builder, investor Architect (coordination, planning, construction supervision), Art historian, architectural historian	L: F SC:	landscape planning, Specialist planner (electrical, security, heating, ventilation),

[19] Macdonald and Arato Gonçalves 2020, p. 14
[20] See Hammer 2020. The ongoing planning for the conservation of Josef Frank's main work, the Villa Beer in Vienna (1930) and its adaptation as a museum could be considered an example of best practice based on what has happened so far, see https://blog.villabeer.wien/2022/02/14/14-02-2022-die-restauratorische-untersuchung-hat-begonnen/
[21] See also Hammer-Tugendhat et. al. 2020, pp. 164-168
[22] The first international Master of Arts course for the conservation and restoration of architectural surfaces was introduced in 2005 at the HAWK University in Hildesheim. Hammer 2017
[23] Pedroni et. al. 2020, pp. 33-38

ST P C-R: CC S PA	Structural engineer Building physicist Conservator-Restorer (wall/stone, metal, wood, wooden surfaces) Building climatologist, Materials scientist (chemist, physicist, microbiologist, mineralogist, etc.) Planning Authority		Craft specialists (e.g. construction site equipment and safety, model making, scaffolding, construction companies, glass, plaster, painters, varnishers, carpenters, metal construction, flooring, electrical, lighting, heating, ventilation, plumbing, roofers, plumbers, lightning protection, locking technology, landscapers , gardener, cleaning)

	task	Main actors
1.	URGENT SECURITY MEASURES: Planning and implementation, e.g. B. drainage, static protection, crash protection, protective roof, barriers.	O, A, ST, C-R, S, C
2.	DOCUMENTATION FILES: Plans, outlines, photos that are as accurate as possible with regard to dimensions	A, H, C-R, L
CONSERVATION-SCIENCE STUDY (3-10) [24]		
3.	GENERAL INFORMATION: object definition, framework conditions of the project, scope, methods and documentation of the investigations,	O, A, H, C-R, S, CC, P, L, F
4.	HISTORICAL DATA: photos, drawings, plans, written sources, publications, literature, form and content of the design, history of reception, dating, concordance of dates from various sources,	A, S, H, C-R, L
5.	MATERIALS, TECHNIQUES, SURFACES: Wall, coating, structure, colors, patina (original and later, anthropogenic changes, construction phases, repair layers. Sampling by conservatos-restorers	C-R, A, S, H
6.	CONDITION, DAMAGES: well-preserved parts, extent of preservation, normal weathering, dramatic damage (localization and intensity), dynamics of damage processes (time definition, speed), characterization of damage phenomena, e. g. cavities (lack of adhesion), cracks, defects, strength (state of cohesion), salt efflorescence, crusts, microorganisms (original and later anthropogenic changes). Sampling by conservators-restorers	C-R, A, S, CC, P
7.	TECHNICAL DATA: statics, roof, windows, doors, drainage system, security (survey also of C-R)	A, S, CC, P, C-R,
8.	BUILDING PHYSICAL DATA: climate (temperature, relative humidity RH, wind direction, solar radiation, humidity (infiltration, thermal condensation, hygroscopicity), electrical conductivity of the surface, capacitance measurement in terms of wall moisture, heating, use, etc. If necessary, these data can be collected by conservators-restorers for an initial overview	A, ST, CC, P, S, C-R,
9.	SCIENTIFIC INVESTIGATIONS: Samples, incident light, cross section, thin section, stratigraphy, binding agent, mineralogical and chemical analysis, staining, UV, X-ray diffractometry (XRD), thermal analysis (TG-DTA), infrared spectroscopy (FT-IR), scanning electron microscope (REKM -EDX) etc..[25]	S, C-R, CC, P
10.	9RESULTS / INTERPRETATION / EVALUATION: Building history, original appearance, history and appearance of later changes, historical significance of the time layers (evaluation); Damage processes, causes of damage (anthropogenic, weathering), conservation perspective	O, A, ST, H, C-R, S, P, CC
DESIGN OFT HE PROJECT OF CONSERVATIONA AND RE-USE (11-14)		
11.	USAGE SPECIFICATIONS, FEASIBILITY, FINANCING (framework project)	O, A, PA
12.	PROPOSED MEASURES FOR STRUCTURAL SECURITY	A, S, C-R
13.	PROPOSALS FOR CONSERVATION (necessary for conservation, aesthetically desirable), sample, pilot work	C-R, A, C
14.	PROPOSED ACTION RE-USE (ADAPTION TO MODERN UTILITY VALUES) (repair, conversion, new construction)	A, S, C-R, C, PA
CONSERVATION, REPAIR, ADAPTION (CONVERSION AND ADDITION) *WHO DOES WHAT??*		

[24] Hammer 2000, 2015; Hammer-Tugendhat et. al. 2020, 164-168

[25] Stefan Simon, Historische Mörtel und Putze. Möglichkeiten und Grenzen der wissenschaftlichen Analytik, in: Pursche 2003, pp. 178-182

15. CONSERVATION of historically significant original parts that would not be preserved by craft repair	C-R
16. REPAIR (of the existing building fabric): Development of methods and techniques by conservationists-restorers, supervision of the craft by conservators-restorers	A, C, F, C-R,
17. MODIFICATION (structural modification of the existing building structure and adaption to modern needs). Supervision of the craft by conservators-restorers	A, C-R, C, L
18. NEW BUILDING (addition to the existing building stock)	A, L, C

Security measures:

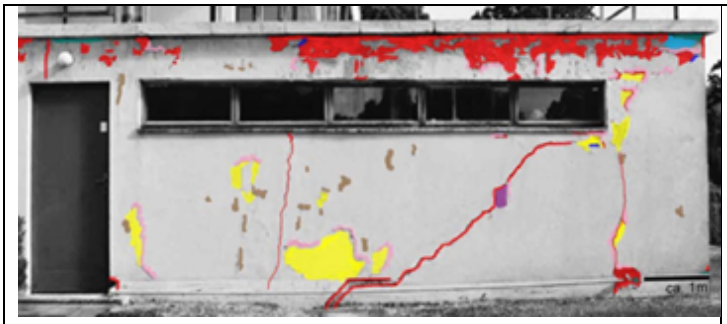
If a porous masonry z. B. has been soaked through damage to the roof and drainage, it should be noted that harmful salt efflorescence usually occurs on the surface during drying. In this case, sensitive surfaces need to be protected with disinfection and compresses. (figs. 9, 9)

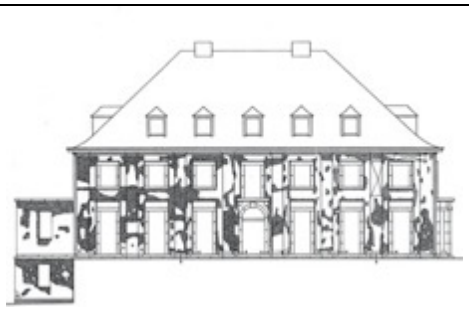
8. Brněnec / Brünnlitz, Löw-Beer wool spinning and weaving factory, former laboratory building (SS building of Oskar Schindler's Concentration Camp 1944-1945), listed heritage since 2020. Lack of roofing. Temporary cover example as an emergency measure to secure the preserved part of the building. Photo Daniel Low Beer 2021

9. Forchtenstein, ancestral seat of the Esterhazy princes, courtyard. Emergency protection of the facade painting from 1687 (?) using a cellulose compress stabilized with lime mortar. Photo Ivo Hammer 1991

Documentation

Before the start of the examination of the object - in addition to the usual floor plans and elevations - orthogonal, dimensionally accurate photos of all surfaces are required as a basis for the visual documentation of the specialists involved in the planning process (i. e. architects, art historians, structural engineers, building physicists, conservators-restorers, building climatologists, materials scientists and landscape planner) makes sense. Phenomena observed and the localization of findings can often be entered more quickly on photos than on plans. (figs. 10, 11)





11. Potsdam-Neubabelsberg, Urbig House, Ludwig Mies van der Rohe 1915-

10. Brno, Tugendhat House (1930), Ludwig Mies van der Rohe, garden stairs, west wall, mapping of the condition of the architectural surface based on a photo. HAWK/Hitzler 2004	1917. Façade elevation (S-W) with graphic documentation of the plaster damage. Alexandra restoration 1991 (HAWK / Danneberg, Knappe 2005)

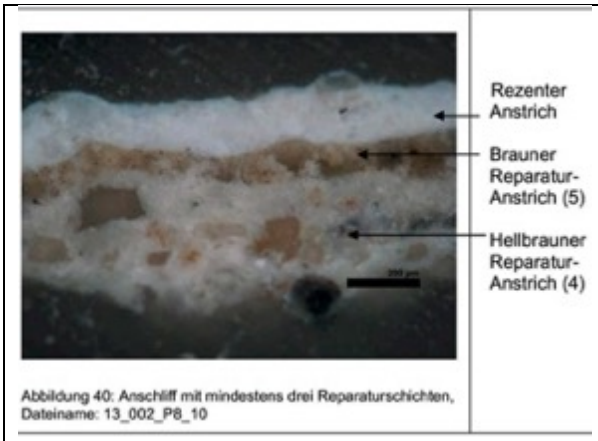
Historical data:

12. a. Brno, Fair grounds, Exhibition on the 10th anniversary of Czechoslovakia, Pavillion of the Prague Academy of Applied Arts, Pavel Janák, 1928. The underside of the loggia is designed in color with a flat decorative painting. (left). 12. b. Pavel Janák, Color scheme of an interior, ca. 1930 (right). Photos: courtesy of National Museum of Technology NTM Prague

Naturally, art historians, architectural historians and researchers specializing in building history play a vital role in the study of visual and written historical data, including oral tradition, of photos, plans, drawings, archive documents, publications, of comparative objects, also with regard to phenomenological investigation of the historical building. But the other disciplines involved in the planning process should also use the historical sources in order to question the source material from their specific point of view. Conservators-restorers, for example, reveal phenomena in black-and-white photographs relating to the surface design that architectural historians would probably not even notice. (fig. 12)

Materials, techniques, finishes, colors, state of preservation

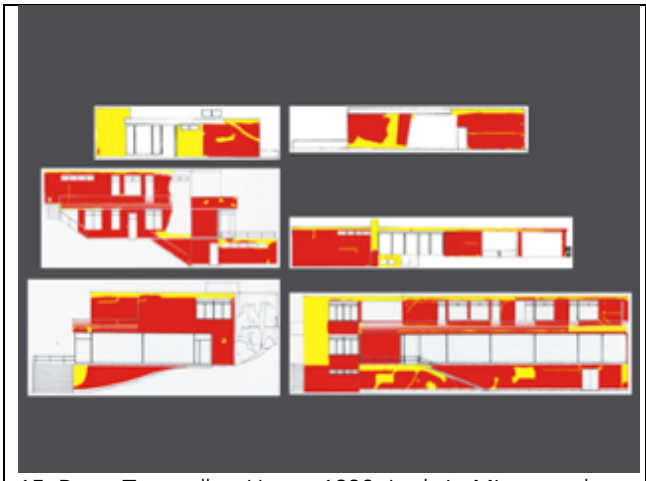
Exploring materiality is the domain of conservators-restorers in a special way. They study the cultural monument in a transdisciplinary manner with all appropriate historical, scientific, technological and empirical methods. They define, on the basis of historical knowledge, the materials, techniques, surface materials and colors of cultural monuments covering all historical periods, original as well as later phases of renovation. (fig. 13, 14)



13. Brno, Tugendhat House (1930), microsection of the upper part of façade surface coating. Three renovating layers, two of them lime paints, altered du to sulfate pollution: light brown (4), 1945?; brown (5), 1967?; recent whitish paint containing artificial resin, 1985. HAWK/Hitzler

14. Brno, Tugendhat House (1930), South façade, 2nd storey, surface during cleaning performed by a conservator-restorer, using a pneumatic micro-chisel: original surface of hydraulic lime plaster smoothed with a wooden board and washed with a very thin lime paint pigmented with silt grain sand; three brownish limewashes, altered; recent cement-resin wash of 1985. Photo: Ivo Hammer 2011

Conservators-restorers investigate and document the condition and damage (fig. 15), they register those parts that are well preserved and so develop a benchmark for assessing the aging effect, they search for the damaging factors and finally develop methods for conservation and restoration, as well as the skills required for repair and maintenance (fig. 16, 17). An indispensable part of the research method is the interdisciplinary cooperation between architects, structural engineers, art historians, conservators, material scientists, chemists, physicists, building climate control engineers etc. The aim of these studies is the preservation of the technical and aesthetic authenticity of the monument and its value as a source of history.[26]



15. Brno, Tugendhat House 1930, Ludwig Mies van der Rohe. Mapping of the extent of the preservation of the plastering of the façade, HAWK 2004

16. Leiben / Lower Austria, castle, 17th c., courtyard, eastern façade. Mapping of damage phenomena classified in 4 steps according to the state of preservation and the amount of work for repair. Federal Monuments Office BDA/ Tinzl 1996.

[26] Hammer-Tugendhat 2020, p. 167

17 a. Brno, Tugendhat House, 1930, Ludwig Mies van der Rohe; (left): West facade, 1st floor, detail. In the sampling area (1 cm2), part of the surface is slightly yellowish, caused by air pollution with sulphates (conversion of lime into gypsum); 17 b. (right): Microsection of the sample, in UV light. The upper half of the limewash is clearly glassy, caused by the transformation of the lime into gypsum. HAWK / Hitzler 2004

Exploratory investigation

Often conservators/restorers are forced to rely on their own resources and some of these preliminary investigations can be executed by the conservator-restorer alone, including survey measurements and finally organoleptic methods, the examination with all human senses.[27]
In this context we refer to preliminary investigations which serve as indicative orientation with respect to the main parameters of the monument, its ambience, its materials, its surface and aesthetic appearance.[28]
The conservators-restorers have an indispensable role already in the first appraisal of a built monument. On the other hand, the disregard of scientific methods of investigation and of interdisciplinary cooperation may lead to subjectivism and even dilettantism.

Sources of moisture

Every handbook refers to moisture as the most important factor of degradation in a building. In fact, the presence of water is a prerequisite for most of the degradation processes: chemical and biological degradation processes as well as many physical processes.
It is known that the moisture in historical buildings, which consist of porous, hydrophilic building materials, has three causes:

- Infiltration into the porous system (soil moisture, deficiencies in the roof and water drainage (drainage), defective sewers, driving rain)
- thermal condensation (dew point) mostly beneath the surface, and
- moisture generated by hygroscopic salts.

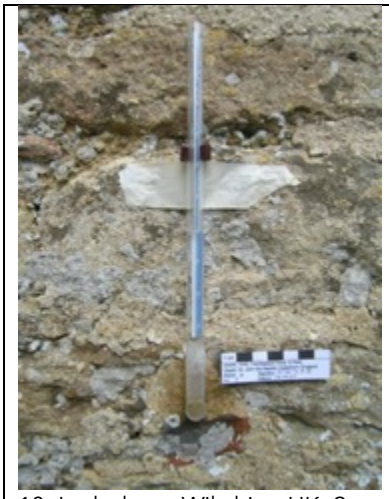
However, the importance of infiltration of water into the porous, hydrophilic building material as a normal factor of decay is often overestimated.[29]
'What is called "rising damp" is a capillary transport of soil moisture in all directions through the porous system. The highly porous brick walls of Venice stand directly in salt seawater, yet one can live in the buildings of that city. Provided there is a balance between the quantity of moisture transported through the capillary system of the Venice brick walls and the quantity of evaporation, moisture will not advance by capillary transport beyond ca. 50 cm water level under normal conditions.
Moisture always occurs on a façade. Even if we try to 'protect' the surface of a façade against infiltration of water with protective roofs or hydrophobic coatings, there is always moisture on facades due to thermal condensation and hygroscopic salts.

[27] See also Keupers-de Jonge 2017, p.33: „Observation is more than just looking. This experience, which is time-bound, is generated by all the human senses (sight hearing, touch, smell and taste." (MK)
[28] Hammer 2015, p. 178
[29] See e.g. Massari, Giovanni and Massari, Ippolito, Damp buildings, old and new, ICCROM, Rome 1993; Hammer 2015, p. 182; Hammer 1996, p. 84 s

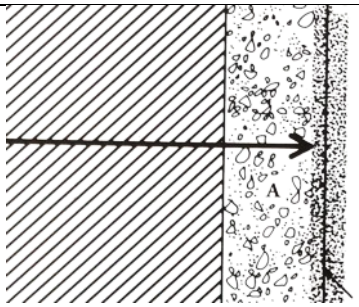
Investigations on behalf of the Bundesdenkmalamt have proved that thermal condensation is a substantial, if not the main source of humidity on façades. Thermal condensation develops nearly every night, especially after precipitation.[30]
Although the hygroscopic behavior of soluble salts – and salt mixtures – is known, of course, its importance for the deterioration of architectural surfaces was not adequately recognized in the literature for a long time and it is still underestimated.
We must distinguish between the normal humidity (which is even useful for the preservation) and moisture that is present in an amount and to a degree of contamination that are harmful.

Velocity of evaporation

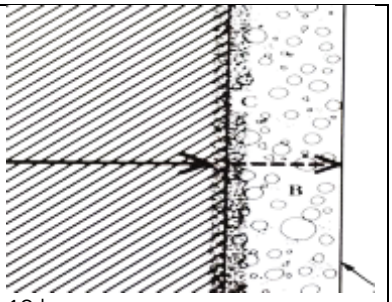
The resilience of these of these mineral systems, their technological 'intelligence' is very much linked with the fact that moisture can evaporate quickly, because the moisture reaches the surface of the porous building material in liquid form. Imagine: 1 l of water equals approx. 1 m^3 water vapor under normal conditions of temperature and pressure. If a certain amount of water can reach the surface directly and evaporate there, drying is 1000 times faster than if the same amount of water has to diffuse through a hydrophobic pore system in vapor form. Soluble salts can bloom on a hydrophilic surface, fall off in the wind or even be washed away by rain, and finally can be reduced mechanically or by compresses. Rapid evaporation through a hydrophilic surface reduces the temporal possibility of developing those damaging factors related to moisture: swelling, ice formation, chemical and biological processes. What is commonly referred to as the misleading metaphor "*breathing activity*" ('*Atmungsaktivität*') of facades is usually only a permeability of water in the form of vapor, with a corresponding thousandfold lower evaporation rate. (figs. 18, 19)



18. Inglesham, Wiltshire, UK, St. John the Baptist, Chancel, façade, south wall, detail, survey measurement of porosity using test tubes after Ryszard Mirowski (patent 125 504). HAWK / Teeken / Wander / Rutherfoord / Hammer 2007



19 a. Diagrams showing how the application of a layer of hydrophobic plaster will prevent soluble salts from being transported to the wall surface by liquid water:



19 b.
⇾ liquid water, ⇢ water vapor
A: lime plaster
B: hydrophobic plaster
C: zone of crysallisazation
Ex: Arendt, Claus, *The role of archtectural fabric in the preservation wall paintings*, in Cather 1991, p. 34

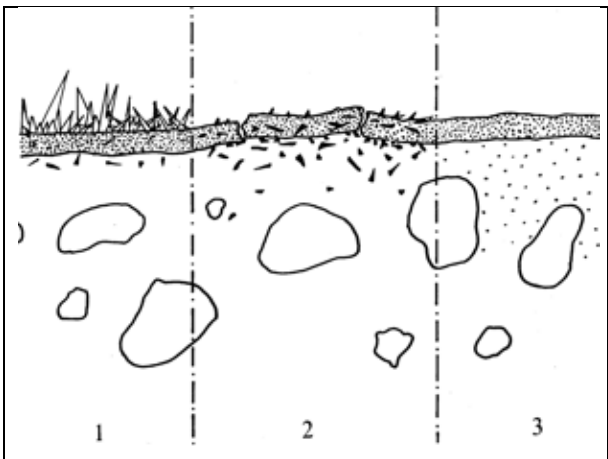
Soluble salts[31]

[30] Bogner 1996
[31] Hammer 2015, p. 182

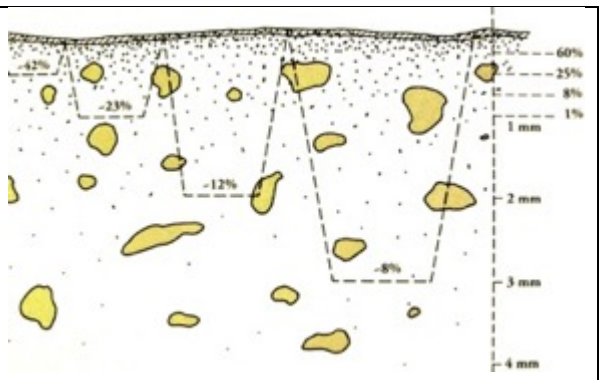
The concentration of soluble salts at the surface is caused by evaporation of 'normal' humidity in the long term, but also by humidity which has infiltrated accidentally. Because of their hygroscopic character, the soluble salts concentrated at the surface cause capillary expansion of humidity even if the original source of dampness no longer exists. The dissipation of moisture due to hygroscopic salts can sometimes lead up to a height of some 3-5 m. This dissipation is often interpreted and misunderstood as 'rising damp'. Therefore, methods of "drying out" walls ("Trockenlegung"), for example using a vapor barrier or horizontal insulation, which are often touted by more or less reputable companies, are not only expensive but also largely pointless and useless.
Given the known damaging effects of soluble salts which are concentrated on the surface, the fluctuation of the room climate around the equilibrium moisture content of the salt mixtures, is of particular importance. According to observations in Switzerland, Austria und UK, the Rheq of the salt mixtures was often between approx. 60% and approx. 70% RH, depending reciprocally also to higher or lower temperatures.[32]
If the surface is impermeable to water in liquid form, e. g. due to a crust or a hydrophobic coating, the soluble salts crystallize at the evaporation border, i. e. at the interface between the layers of different porosity, and thus behind the hydrophobic layer and creating the scaling of the hydrophobic coating.
Salts also crystallize at the interface between different layers of original coating, thereby creating the separation of these layers.
It is advisable to have the nature and distribution of the salts examined by a professional laboratory.

Damage factor: gypsum

Gypsum, the conversion product of lime from air pollution with sulfates, is a particularly dangerous salt. It is sparingly soluble, but about 100 times more soluble than lime; (fig. 19 a) As Mauro Matteini has shown, Gypsum does not crystallize on the surface like the easily soluble salts, but in the matrix near the surface; it is therefore important to only remove a thin surface layer when taking samples in order to obtain an analysis result that makes a realistic statement about the damage relevance of the gypsum content. (fig. 19 b)



19 a. Schematic illustration of the damaging effect of the soluble salts in relation to their solubility: 1) easily soluble salts, 2) slightly soluble salts (e.g. gypsum) and 2) almost



19 b. As the distribution of gypsum is heterogeneous, sampling at varying depths gives results that are misleading with respect to the state of conservation. At right, percentages of gypsum at arbitrary intervals of 0,25 mm are

[32] Arnold, Andreas and Zehnder, Konrad, Monitoring Wall Paintings Affected by Soluble Salts, in: Cather 1991, pp. 103-135

insoluble salts (e.g. calcium carbonate), ex: ibidem fig. 2	given. At left are analytical results that would be obtained by different sampling depths of 0,5-3 mm. Ex: Mauro Matteini, In Review: An Assessment of Florentine Methods of Wall Painting Conservation Based on the Use of Mineral Treatments, in: Sharon Cather 1991, figs. 2, 3

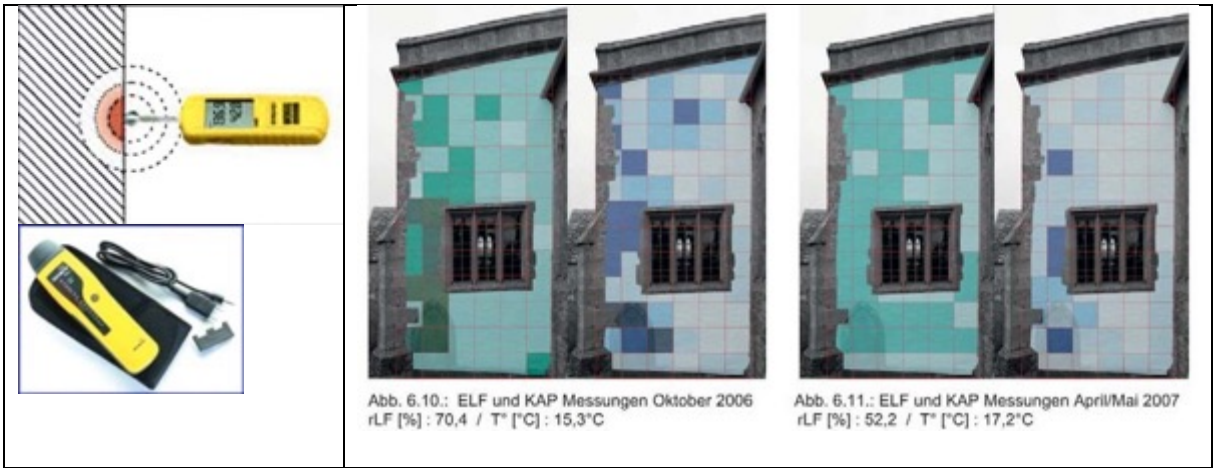
Understanding the physical character of the porous building materials

We can understand the porous building materials of historic architecture and their surface as a sustainable system that is resilient to normal weathering conditions and - provided periodic care - ages slowly.

The most important question is not: What are the damaging factors? The most important question is: Why was the building preserved at all? What are the factors favorable for further conservation? These factors must be understood and strengthened in the interventions for the preservation of the building.

A lime plaster could only resist degradation processes (e. g. thermal dilation, breakdown due to frost and thaw, vibration, salt crystallization and hydration) for a short time if the system would not 'heal' itself through the process of transformation and recrystallisation of calcium carbonate triggered (under normal conditions) by the impact and (quick) evaporation of humidity and re-carbonization with carbon dioxide.[33]

Survey Investigation of Moisture and Salts



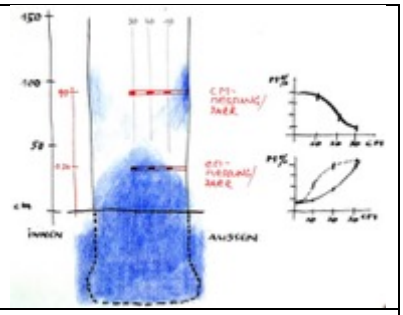
20. (left): Devices to measure the electric capacity CAP, with ball head and the electric conductivity ELC with a two needles head; (right): Inglesham, Wiltshire, UK, St. John the Baptist, southeast wall; the graphical representation of measurement of the ELC (green) and the CAP (blue). The comparison of the measurement of October 2006 (15 ° C, **70% RH**) and by April 2007 (17 ° C, **52% RH**) indicated hygroscopic moisture as the cause of the measured values: The ELC measurement of October shows significantly higher values than the CAP-measurement. HAWK / Teeken / Wander / Rutherfoord / Hammer.

ELC (Electric conductivity Measurement) is a statistical survey method, originally developed for testing wood, to obtain information on areas where certain processes connected to humidity and salts may occur. Surface type, temperature, RH and time must always be recorded when taking these measurements. Applied by practiced hands, the small needle head does not damage the surface.

[33] Paschinger, Hubert, *Fassadenanstriche*, in: *Probleme und Konservierungstechniken in der Baudenkmalpflege*, „Restauratorenblätter" 4, Vienna 1980, pp. 99-108

CAP (Electric Capacity Measurement) is a fairly well-known method of surveying humidity, although surface irregularity and the non-homogeneous nature of the materials mean that readings for absolute moisture content are not very precise. (fig. 20)
Using these statistical survey methods, we can distinguish between actual infiltration and hygroscopic humidity caused by soluble salts, which are concentrated at the surface. We can also determine if there is moisture under a surface that is impervious to water in liquid form.[34]
The CCM (Calcium Carbide Measurement) measures the absolute content of moisture in samples taken from different depths. In our work this method proved to be much quicker than the method of drying out samples in the laboratory, and it turned out to be precise enough.
A hole of 10-20 mm diameter is drilled into the wall with a rotary hammer. Samples are taken from different depths, mostly 10-20 g, according to the estimated moisture content. The first sample is always taken from the surface area. The next sample is taken from a depth of about 10-13 cm, and the next from a depth of about 20-23 cm. No more than four samples from different depths normally are required. The sample is quickly crushed in a mortar, weighed and placed in a sealable metal bottle. The bottle is closed with a pressure gauge. Along with this sample a defined amount of calcium carbide is placed (e. g. as a vial) into the bottle. The water adsorbed by the material of a sample reacts with the calcium carbide, forming acetylene gas. The pressure of the gas is measured and indicates the percentage of water content of the sample. The relationship between pressure, volume and water content of the sample is read in a table. For the interpretation of results, it is important to register the type of drilling dust, which allows conclusions about the nature of the masonry. Obviously the moisture content of the porous bricks should be assessed differently from that of a granite stone. (fig. 21)





21 a) CCM measurement equipment; b) form to document CCM; c) 2 types of different results: of CCM and the related diagrams.

Conservation and Repair of historic monuments: New Tasks

Compared to the historical tradition of repairing historical architectural surfaces, including plastering, the following new tasks arise in modern monument preservation, which are a specific field of work for conservators-restorers:

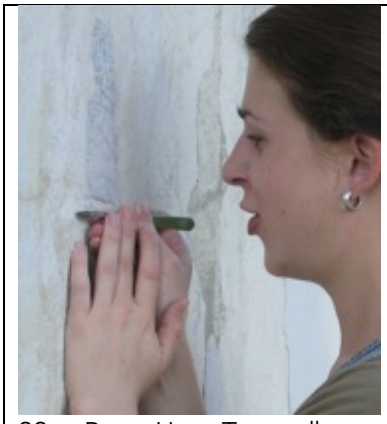
1. Evaluation of plastering and paint as an integral part of the cultural value of the monument.
2. Preservation, i.e. preservation, of those plaster parts that would have to be removed and renewed according to technical criteria (consolidation, re-adhesion of detached layers).
3. Treatment not only of the symptoms of changes that qualify as damage, but also of the causes of the damage (e. g. decreasing salts using compresses, reconversion of gypsum, crusts, construction defects).
4. Treatment of the consequences resulting from the disruption of the repair tradition and also from the increase in air pollution since the 19th century.
5. Removal of incompatible restoration and repair materials (cement plaster, film-forming paints).

[34] Hammer, 1996; Hammer 2015, p. 186 for further information

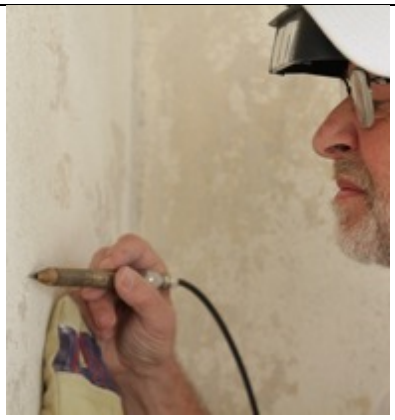
6. Development of the repair method and repair material, which is aesthetically adapted to the specific object and is technically compatible and to supervise the craft execution of the repair.

In the last 150 years, economic factors in particular have led to drastic changes in construction technology with the development of industrialization in terms of materials, techniques, aesthetic preferences and, last but not least, the loss of sustainability. The craft lost the knowledge of its traditional techniques. In this situation, the conservator-restorer also has the task of developing the methods and techniques of repair together with the craft and of supervising the execution of the work.[35]

Cleaning methods



22 a. Brno, Haus Tugendhat, 1930. Manual examination of the historically significant layers by the conservator-restorer using a scalpel. HAWK / Schaack. Photo: Ivo Hammer, 2004

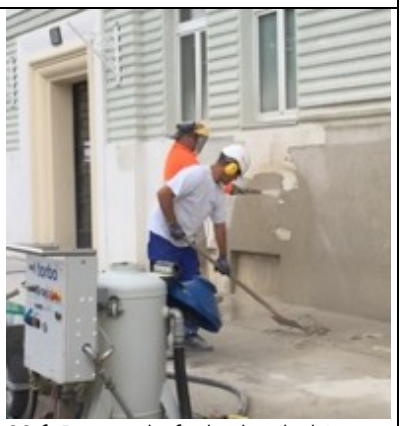


22 b. Brno, Tugendhat House, 1930. 'Uncovering' (removal of later whitewash and recent synthetic resin paint) using a pneumatic micro-chisel by the conservator-restorer. Photo: Dieter Reifarth 2011

22 c. Brno, Haus Tugendhat, 1930. Rationalization of the 'excavation' method using a pneumatic needle hammer, with accountable collateral damage provided the device is used responsibly. UPCe Litomyšl / Červinka. Photo: Ivo Hammer 2010

22 d. Brno, Tugendhat house. ‚Uncovering test' (removal of whitewashing) using water-sandblast (JOS). UPC Litomysl / Červinka. Photo Ivo Hammer 2004

22 e. Brno, Tugendhat house. In this case, uncovering test' (removal of whitewashing) using a cryo jet (ice crystals) did not bring the desired success, CIC, 2005. Photo: Ivo Hammer



22 f. Removal of a hydrophobic coating in the base area. Large-scale water-sandblasting, Vienna 3rd district, Rechte Bahngasse 28. Photo: Ivo Hammer 2018

[35] In the following I would like to provide some hints only, for further information see Hammer, 1996, 2003, 2015, 2020

22 g. Braunlage, Sanatorium Dr. Barner, central building, west facade, Albin Müller 1915, uncovering test (removal of a recent synthetic resin paint, approx. 1970) using a steam pressure jet. HAWK / Vogler, Wellner 2004. Photo: Ivo Hammer

22 h. Braunlage, Sanatorium Dr. Barner, central building, west facade, Albin Müller 1915, uncovering test (removal of a recent synthetic resin paint, around 1970) using hot air. HAWK / Vogler, Wellner 2004. Photo: Ivo Hammer

22 i. Braunlage, Sanatorium Dr. Barner, central building, west facade, Albin Müller 1915. Cleaning tests using compresses made from beech pulp and water (+ ammonium carbonate). HAWK / Vogler, Wellner 2004. Photo: Ivo Hammer

The cleaning methods must be developed by the conservator-restorer according to the findings of the examinations and the evaluation of the surfaces. (fig. 22, a-i) If the cleaning is not carried out by the conservator-restorer himself, but by craftsmen, the cleaning must be carried out under the supervision of the conservator-restorer.

Treatment of salts

23 a. Brno, Tugendhat house, 1930, driver's apartment, gallery parapet, uncovering test' with micro chisel and subsequent compresses with ammonium carbonate with a neutral edge, HAWK 2004. Photo: Ivo Hammer

23 b. Brno, Tugendhat house, 1930, driver's quarters, gallery parapet, 'rehearsal'. Effect of the compress with ammonium carbonate: purification and conversion of the plaster into lime, salt reduction. HAWK, Photo: Ivo Hammer 2004

23 c. Brno, Tugendhat House, 1930, upper terrace, north wall. Rapid application of a compress to clean and reconvert the plaster with a trowel. Composition of the compress: 1 kg of ammonium carbonate, beech pulp ARBOCEL BC 200 0.5 kg, kaolin (China clay) 0.5 kg, water demineralized 4.5 -5 l. Art KODIAK / Michal Pech. Photo: Ivo Hammer 2011

23 d. Brno, Tugendhat House, 1930, upper terrace, north wall. Rapid removal of the cellulose kaolin ammonium carbonate compress with the spatula. Art KODIAK / Michal Pech. Photo: Ivo Hammer 2011

The treatment of salts, i.e. their reduction and their transformation (reconversion of the lime transformed into gypsum by air pollution) is a task that must generally be carried out by the conservator-restorer himself, or at least under his supervision. (fig. 23, a-d)

Consolidation

24 a. Samples of a slightly hydraulic lime plaster. attempts at consolidation. Li: Penetration behavior of lime putty with water (not dispersed); Wed: Penetration behavior of lime putty in 1-propanol (not dispersed); Re: Hydrated lime suspension dispersed in 1-propanol with a hand mixer. phenolphthalein test. HAWK/ Vogler 2005

24 b. Hand mixer with dispersing discs

24 c. Vienna, facade from 1880, consolidation with hydrated lime dispersed on site

The consolidation of stones or plasters that are part of the historical fabric of the building heritage and whose cohesion is reduced or the fixing of layers of plaster and paint that have lost their adhesion to their support are typical tasks of the conservator-restorer. (A precise craftsman would have to remove and replace these parts). Our attempts at consolidation with "nano" lime produced on site have been successful, often eliminating the need for expensive and sometimes toxic materials (such as silicic acid esters or barium hydroxide) and also avoiding the risk of over-consolidation.

Mortar, Limewash

Washed sands are very problematic in historical lime technology. We need the natural fine grains - about the size of silt (Schluff)[36] - as a hydraulic factor, and also as a pigmenting factor. It is worthwhile to visit the nearby sand pits at the beginning of conservation work, or to look at the sands used by surrounding construction companies and take samples with you. (fig. 25, a-b) With these natural materials, it is usually possible to produce a plaster mortar that corresponds to the historical stock in terms of color and grain size, usually without additional pigments.
Preparing the supplementary mortar and the subsequent whitewash of built heritage is one of the conservator-restorer's tasks, because it is about the aesthetic and technological adaptation to the historical substance and the craft usually no longer has the traditional technical knowledge.

25 a. Sand quarry near Inglesham / UK. Photo: Ivo Hammer 2007

25 b. Different sand colors from the sand pit near Inglesham / UK. Photo: Ivo Hammer 2007

25 c. Weißenkirchen in der Wachau, parish church, large west tower, east facade, plaster from 1502. The plaster is supplemented by 2 bricklayers: one applies the slurry, the other applies the supplementary mortar. Photo: Ivo Hammer 1990

25 d. Weißenkirchen in der Wachau, parish church, large west tower, east facade, plaster from 1502. The filling mortar (still wet) contains non-washed local sand and fits perfectly to the original mortar. (6 pv slaked lime, 1 pv TRASSIT Plus, 10 pv yellow sand 0-3 mm, 10 pv local sand o-5 mm, some ochre pigment Siena nat., ¼ pv brick powder, ¼ pv dried particles of slaked lime.

The production of good adhesion of the supplementary mortar is decisive for the quality of the filling of gaps. This is not achieved by a non-hydrophilic cement slurry found in the modern industry norm

[36] 0,02 – 0,0063 mm approx.

('pre-splash'). The secret of good adhesion of the supplementary mortar is the calcite crystals clinging to the wall or rough plaster. It is important to prevent the supplementary mortar from becoming thin in the contact zone. This is done by prewetting sufficiently long beforehand or only by moistening, by applying a slurry consisting of diluted plaster mortar enriched with a little binding agent and applying the supplementary mortar to the still wet slurry. It is therefore advisable that two masons work hand in hand, one applying the grout, the other applying the supplementary mortar and dressing the surface. (fig. 25, b-c) At least initially, this repair work requires the craftsman's supervision by the conservator-restorer.

26 a. Sand from Bratčice, south of Brno, not washed. The glacial siliceous sand has very different colored grains, the overall color is yellowish brown. The sand was most likely used for the plaster mortar of the Tugendhat house (1930) in Brno. Bottom of the phot approx. 10 cm. Photo: Ivo Hammer 2011

26 b. Brno, Tugendhat House, 1930, lime swamp, the base of a lime wash, composed according to the historical tradition of care, before dilution with water, made by conservators-restorers (Michal Pech and Ivo Hammer): Lime putty (ALTMANNSTEIN) 30 kg, 150 g linseed oil, lemon yellow 300 g, white marble powder (2 µ) 150 g, very fine sand mud (0-0.5 mm) bon Bratčice 3 kg, Bratcice Sand 0-2 mm 2 kg). Photo: Ivo Hammer

For technical and aesthetic reasons, fine sand of the size of silt must be added to a whitewash, at least on the facade. The fine sand has a hydraulic effect and also acts as a pigment. This fine sand is made by slurring the unwashed sand, the same kind that was already used to make the mortar. In the case of larger objects, this can even be done directly in the washing plant of the sand pit by catching the washed-out material. The color differentiation of the sand grain usually leads to a precise color adjustment to the historical substance. (fig. 26, a-b) The whitewash has to be a little lighter, as it darkens with age as the calcite crystals become larger. (fig. 7) This addition of mortar and limewash follows a historic tradition of artisanal repairs. The surface appearance of the historic buildings also changes in accordance with this sustained maintenance process, oscillating between the novelty value of the repair and the beauty of the aging that is appropriate to the materiality of the historic object.

Summary

In the international discussion, the preservation of modernist architecture is referred to as a multidisciplinary activity and also recognized that physical research into the buildings themselves is just as necessary as the exploration of archives (Keupers-de Jonge 2017). Nevertheless, the profession of restorer-conservator is still largely neglected by architects and art historians, and sometimes also by those who work in the preservation of monuments, and in the practice of preserving modernism it is often only used for color analysis.

University training in the preservation of historical architecture is still left almost exclusively to architects. Internationally, only a few university institutes that educate conservators-restorers have begun to expand the concept of culture and have made the preservation of architectural surfaces the subject of specialization courses.
In this situation, it is necessary to describe the specific tasks of the conservator-restorer within the multidisciplinary activity dealing with the preservation of historical architecture, including modernist architecture. The conservators play a special role in the interdisciplinary concert of cooperation between architects, art historians, natural scientists, technicians and other specialists involved in building preservation. Similar to e. g. surgeons the conservators-restorers are concerned with the subject both scientifically-theoretically and practically-manually.
The scientific-theoretical examination of the built monuments by the conservators-restorers has a transdisciplinary and exploratory character, their practical-manual interventions serve the purpose of investigation and preservation. The conservators-restorers examine the architectural monuments using all historical, scientific, technological, phenomenological and empirical methods, they examine with all the senses (organoleptic). Thanks to their scientific and technological knowledge and their experience, the conservators-restorers are able to generate relevant information in these exploratory investigations, even if the detailed results are often only of statistical significance. However, further data from scientific and technological specialists must also be interpreted in a material and aesthetic context. Only by linking the various areas of knowledge can one do justice to the complex historical and technological reality of the monument. The conservators-restorers have before them the undivided material and aesthetic unity of the object, must recognize it and intervene in it with the aim of preservation.
The scientific nature of the investigation cannot only be determined by the use of the so-called exact sciences. No discipline is ancillary to the other. Each discipline has its specific responsibility for the whole of the monument (Giovanni Urbani). However, cooperation is only possible if the experts involved in the knowledge process are at least familiar with the specific methods and criteria of the other disciplines and are always aware of their own limitations.
In order to do justice to the dual task of preserving the monument and designing the re-use, i. e. the restoration of the utility value, cooperation between architects and conservators-restorers is particularly necessary.

KEY WORDS
Architectural heritage, Modernism, interdisciplinary cooperation, conservator-restorer, survey, conservation-science study, project design, documentation, materiality, damages, moisture, treatment of salts, conservation and repair

BIBLIOGRAPHY

Allan, John, From Sentiment to Science – DOCOMOMO Comes of Age, in: Proceedings oft he 12th International DOCOMOMO Conference, Espoo 2012,

Arnold, Andreas, Salzmineralien in Bauwerken, in: Schweizeriche mineralogische und petrographische Mitteilungen 61, Zürich 1981, pp. 147-166

Boito, Camillo, *I nostri vecchi monumenti. Conservare o restaurare?* In: „Nuova antologia di scienze, lettere ed arti", Jg. 21 = vol.. 87 = Serie 3, vol.. 3, 1886, pp. 480–506.
https://archive.org/details/nuovaantologiadi87unse/page/480/mode/2up

Bogner, Manfred, *Zum Einfluss meteorologischer Parameter auf den Verwitterungsprozeß an Fassadenoberflächen: Temperaturverwitterung und Feuchteverwitterung an der Fassadenfläche des Landschlosses Parz (Grieskirchen, Oberösterreich)*, in: *Fassadenmalerei/Painted Facades, Forschungsprojekt EUROCARE, 492 Muralpaint*, „Restauratorenblätter" 16, Vienna, 1996, pp. 77-82

Brand, Steward, *How Builidngs Learn. What happens after they're built*, NKew York 1994

Cather, Sharon (ed.), *The Conservation of Wall Paintings*, (Proceedings of a Symposium organised by the Courtauld Institute of Art and the Getty Conservation Institute London, July 13-16,1987), Los Angeles 1991

Černá, Iveta and Hammer, Ivo (ed.), *Materiality, Materiality (Sborník příspěvků mezinárodního symposia o ochraně památek moderní architektury / Proceedings of the International Symposium on the Preservation of Modern Movement Architecture / Akten des internationalen Symposiums zur Erhaltung der Architektur des Neuen Bauens, Brno / Brünn 27.-29.04.2006),* Muzeum města Brna / Museum of the City of Brno and Hornemann Institut of HAWK in Hildesheim 2008

Cramer, Johannes and Sack, Dorothée, *Mies van der Rohe. Frühe Bauten. Probleme der Erhaltung. Probleme der Bewertung*, Petersberg 2004

Danzl, Thomas, *Rekonstruktion versus Konservierung? Zum restauratorischen Umgang mit historischen Putzen und Farbanstrichen an den Bauhausbauten in Dessau*, in: "Denkmalpflege in Sachsen-Anhalt" vol. 7/1, 1999, pp. 100-112

Danzl, Thomas, *Kunstputz (Edelputz) – Kunststein (Betonwerkstein) – Kunststeinputz (Steinputz). Die Bedeutung und Erhaltungsproblematik materialfarbiger Gestaltungen an Putzfassaden des 19. und 20. Jahrhunderts*, in: Pursche (ed.) 2003, pp.146-159

De Jonge, Wessel and Henket, Hubert-Jan, *Historic building survey on Modern Movement buildings. Zonnestraal as a touchstone*, in: Meurs and Van Thor 2010, pp. 101-109

Wim F. Denslagen, *Architectural Restoration in Western Europe: Controversy and Continuity*, Amsterdam 1994

Douet, James, Industrial Heritage Re-tooled: Thke TICCIH Guide to Industrial Heritag Conservation,

Gebessler, August (ed.), *Gropius. Meisterhaus Muche / Schlemmer. Die Geschichte einer Instandsetzung*, Stuttgart / Zürich 2003 (Review: Hammer, Ivo, *Instandsetzung der Geschichte?* In: *Dokumentation in der Baurestaurierung*, „Restauratorenblätter" 28, 2009, pp. 228-230)

Glendinning, Miles, *The conservation movement: A history of architectural preservation: Antiquity to modernity*, London 2013

Götz, Marko and Hammer, Ivo, *Erhaltung, Konservierung und Reparatur von Betonwerkstein, Steinputz und Edelputz am Beispiel der Fassadenoberflächen der Lessing-Loge in Peine von 1926*, in: Vereinigung der Landesdenkmalpfleger in der Bundesrepublik Deutschland (eds.), *Denk-mal an Beton! Material, Technologie, Denkmalpflege, Restaurierung*, „Berichte zur Forschung und Praxis der Denkmalpflege in Deutschland" 16, Petersberg 2008, pp. 203-212

Hammer, Ivo, *Historische Verputze. Befunde und Erhaltung*, in: „Restauratorenbla□tter" 4, Wien 1980, pp. 86-97

Hammer, Ivo, *Organique ou minéral? Problèmes de consolidation et de fixage des peintures murales*, in: SCR-Association Suisse de Conservation et Restauration (ed.), *Produits synthétiques pour la conservation et la restauration des oeuvres d'art. 3e partie. Utilisation des produits synthétiques*, 2. Séminaire 19./20./21. novembre 1987 à Interlaken , Bern (Haupt) 1988, pp. 62-76.

Hammer, Ivo, *Salze und Salzbehandlung in der Konservierung von Wandmalerei und Architekturoberfläche (Bibliographie gemeinsam erstellt mit Christoph Tinzl)*, in: *Salzschäden an Wandmalereien*, „Arbeitshefte des Bayerischen Landesamts für Denkmalpflege", Band 78, München 1996 (Tagungsberichte vom 28./29.11.1988), pp. 81-106

Hammer, Ivo, Ivo Hammer, *Symptome und Ursachen. Methodische Überlegungen zur Erhaltung von Fassadenmalerei als Teil der Architekturoberfläche*, in: „Zeitschrift für Kunsttechnologie und Konservierung", Jg. 10/1996, 63-86.

Hammer, Ivo, *Die malträtierte Haut. Anmerkungen zum Umgang mit verputzter historischer Architekturoberfläche*, in: „Beiträge zur Erhaltung von Kunstwerken" 7, Restauratoren Fachverband RFV, der Hochschule für Bildende Künste Dresden und dem Restauratorenverband Sachsen (eds.), Berlin 1997, pp 14-23

Hammer, Ivo, *Zur Nachhaltigkeit mineralischer Beschichtung von Architekturoberfläche. Erfahrungen mit Kaliwasserglas und Kalk in Österreich*, in: *Mineralfarben. Beiträge zur Geschichte und Restaurierung von Fassadenmalereien und Anstrichen* (Weiterbildungstagung des Instituts für Denkmalpflege an der ETH Zürich „Erfahrungen mit der Restaurierung von Mineralfarbenmalereien", 20-22.März 1997), Marion Wohlleben und Brigitt Sigel (eds.), Zürich 1998, pp. 191-203.

Hammer, Ivo, *Inhalte und Methoden der restauratorischen Befundsicherung,* in: *Der Kreuzgang von St. Michael in Hildesheim. 1000 Jahre Kulturgeschichte in Stein* (Schriften des Hornemann Instituts, Bd. 2; Niedersächsisches Landesamt für Denkmalpflege in Niedersachsen, Bd. 20), Hameln 2000, pp. 115-117

Hammer, Ivo, *Zur Erhaltung der Materialität der Oberflächen von Bauten der Moderne am Beispiel der Werkbundsiedlung in Wien*, in: Stiftung Bauhaus Dessau (Hrsg.) *Umgang mit Bauten der klassischen Moderne 2. Sanierung von Oberflächen*, Akten des Kolloquiums am 15.12.2000 in Dessau, Dessau 2001, pp. 51-61

Hammer, Ivo, *Kalk in Wien. Zur Erhaltung der Materialita□t bei der Reparatur historischer Architekturoberfla□chen*, in: „Restauro. Zeitschrift fu□r Kunsttechniken, Restaurierung und Museumsfragen", 6, 2002, pp. 114-425

Hammer, Ivo, *Bedeutung historischer Fassadenputze und denkmalpflegerische Konsequenzen. Zur Erhaltung der Materialität von Architekturoberfläche (mit Bibliographie und Liste von Konservierungsarbeiten)*, in: Pursche (ed.) 2003, pp. 183-214

Hammer, Ivo, *Attitudini discordanti. Zur Aktualität von Alois Riegl und Cesare Brandi in der Theorie und Praxis der Restaurierung von Wandmalerei/Architekturoberfläche in Österreich*, in: Giuseppe Basile (ed.), *Il pensiero di Cesare Brandi dalla teoria alla practica / Cesare Brandi's thought from theory to practice,* (Atti dei Seminari di/ Acts of the Seminars of München, Hildesheim, Valencia, Lisboa, London, Warszawa, Bruxelles, Paris), Saonara 2008, pp. 63-68.

Hammer, Ivo, *The Original Intention – Intention of the Original? Remarks on the Importance of Materiality Regarding the Preservation of the Tugendhat House and Other Buildings of Modernism*, in: Dirk van den Heuvel-Maarten Mesman – Wido Quist – Bert Lemmens (eds.), *The Challenge of Change. Dealing with the Legacy of the Modern Movement*, Proceedings of the 10th International DOCOMOMO Conference, Amsterdam 2008, pp. 369-374.

Hammer, Ivo, *Lime Cannot be Substituted! Remarks on the History of the Methods and Materials of Painting and Repairing Historical Architectural Surfaces*, in: Karol Guttmeyer (ed.), *Colour on historical facades from the Middle Ages to modern times: History, Research and Conservation issues*, (September 22-24 2010, Królewski Castle, Warsaw), Warsaw 2010, pp. 317-355 (English and Polish)

Hammer, Ivo, *Zur Restaurierung der Wandoberflächen des Innenraums der Ev. Pfarrkirche St. Marien in Salzwedel. Untersuchungen und Konzepte der HAWK Hildesheim*, in: „Denkmalpflege in Sachsen-Anhalt, Zeitschrift des Landesamtes für Denkmalpflege und Archäologie Sachsen-Anhalt", Nr. 2 / 10 (Halle 2011), pp.. 44 - 63

Hammer, Ivo, *The material is polychrome! From interdisciplinary study to practical conservation and restoration: the wall surfaces of the Tugendhat House as an example*, in: *La conservazione delle policromie nell'architettura del XX secolo / Conservation of Colour in 20th Century Architecture*, Giacinta Jean (ed.), Lugano 2012, pp. 234-249

Hammer, Ivo, *Exploratory Study of Condition and Factors of Decay of Architectural Surfaces Carried Out by Conservators-Restorers*, in: Anna Bergmans, Ilona Hans-Collas (eds.), *Muurschilderkunst, Wandmalerei, Peinture Murale, Wall Painting. In Honour of Walter Schudel*, in: „Gentse Bijdragen tot de Interieurgeschiedenis/Interior History", vol. 38, 2012-2013, Leuven 2015, pp. 177-194

Hammer, Ivo, *Modern Movement Materiality. Remarks to Meaning and Methods of Preservation*, in: SCHUNCK Heerlen (ed.), *Preservation of Monuments and Culture of Remembrance, using the example of Luwig Mies van der Rohe*, Heerlen 2016, pp. 54- 61

Hammer, Ivo, *Ausbildung und Praxis in der Konservierung von Wandmalerei/Architekturoberfläche - ein Resümee*, in: *Retrospektive und Perspektive: Methoden und Techniken in der Wandmalereirestaurierung, „*Inhalte - Projekte - Dokumentationen / Schriftenreihe des Bayerischen Landesamtes für Denkmalpflege" Nr. 17, München 2017, pp. 45-55

Hammer, Ivo, *Zur Materialität des Neuen Bauens. Bedeutung und Methode der Erhaltung*, in: „Beiträge zur Erhaltung von Kunst- und Kulturgut" 1/2017, VDR Verband der Restauratoren (ed.), pp. 88-96

Hammer, Ivo, *Materialität und Konservierungswissenschaft. Anmerkungen zu einem kulturwissenschaftlichen Problem / Materiality and Conservation-Science. Notes on a culture studies*

problem, in: „im_material_ita□t / im_material_ity, Restauratorenbla□tter / Papers in Conservation" vol. 36, 2019, pp. 23-44

Hammer, Ivo, White, everything white? Josef Frank's Villa Beer (1930) in Vienna, and its materiality in the context of the discourse on 'white cubes', in: Built Heritage 4:12, 2020, https://doi.org/10.1186/s43238-020-00011-9

Hammer, Ivo, *Materiały powierzchniowe mają znaczenie! Wykończenia elewacji wybitnych dzieł architektury modernistycznej lat dwudziestych i trzydziestych XX wieku w Europie. Hitchcock-Johnson i ostatnie badania / Surfacing materials matter! Facade finishes of outstanding modernist architecture in the 1920s and 1930s in Europe. Hitchcock-Johnson and Recent Studies*, in: Maria Jolanta Sołtysik and Marek Stępa (eds.), *Architektura XX Wieku. Zachowanie Jej Autentyzmu I Integralności W Gdyni I W Europie. Modernizm W Europie – Modernizm W Gdyni 7 / Architecture of the 20th Century. Preservation of its Authenticity and Integrity in Gdynia and Europe. Modernism in Europe – Modernism in Gdynia 7*, Gdynia, Gdańsk 2020, pp. 43-56. https://www.gdynia.pl/zabytki/cykl-modernizm-w-europie-modernizm-w-gdyni,7219/nr-7-pl-en-architektura-xx-wieku-zachowanie-jej-autentyzmu-i-integralnosci-w-gdyni-i-w-europie,555426

Hammer, Ivo (with contributions of Goetz, Marko), *Techniques, damage processes and Conservation of Concrete Stone and Cement plaster,* in: Preservation technology. DOCOMOMO Dossier, 2022, in print.

Hammer, Ivo and Peter Szalay), *Exemplárny prieskum. Reštaurátorská kampaň vo vile tugendhat / exemplary exploration. Tugendhat House restoration campaign*, in: „Architektúra & Urbanizmus. Časopis pre teóriu architektúry a urbanizmu / Journal of Architectural and Town-Planning Theory", ROČNÍK / Volume XLIV, 2010, ČISLO / Number 1-2, St. / pp. 150-161

Hammer, Ivo, *The Tugendhat House: between artisan tradition and technological innovation. Preservation as sustainable building policy*, in: *Modern and Sustainable*, „Docomomo International Journal" 44, 2011/1, pp. 48-57

Hammer, Ivo, *Ausbildung und Praxis in der Konservierung von Wandmalerei/Architekturoberfläche - ein Resümee*, in: *Retrospektive und Perspektive: Methoden und Techniken in der Wandmalereirestaurierung* , „Inhalte - Projekte - Dokumentationen / Schriftenreihe des Bayerischen Landesamtes für Denkmalpflege" Nr. 17, München 2017, pp. 45-55

Hammer-Tugendhat, Daniela / Hammer, Ivo / Tegethoff, Wolf, *Haus Tugendhat. Ludwig Mies van der Rohe*, Basel/Berlin/München/Boston 2020 (revised edition: print and e-book)

Henket, Hubert-Jan and de Jonge, Wessel, *A restoration concept for Modern Movement architecture*, in: Meurs and Van Thor 2010, pp. 98-101

Henket, Hubert-Jan, *When the Oppressive New and the Vulnerable Old Meet; a Plea for Sustainable Modernity*, in: „Docomomo International Journal" 52, 2015/1, pp. 14–19

Hirsch, Robert, *Exterior Plasterwork in Gdynia's Modernist Architecture and its Preservation*, in: Jolanta Sołtysik and Robert Hirsch, (eds.), *20th Century Architecture until the 1960s and its Preservation, Modernism in Europe. Modernism in Gdynia*, Gdynia 2015, pp. 251-258

Hitchcock, Henry-Russel Jr. and Johnson, Philip, *The International Style: Architecture since 1922*, New York 1932

ICOMOS (International Council of Monuments and Sites), Guidlines on the Education and Training on the Conseration of Monuments, Ensembles and Sites, 1993 (adopted in Colombo)

Keupers, Marieke and de Jonge, Wessel, *Designing from Heritage. Strategies for Conservation and Conversion*, TU Delft, Faculty of Architecture (IHeritage & Architecture) and Rondeltappe Bernoster Kemmers Foundation, Delft 2017

Kobler, Friedrich and Koller, Manfred, *Farbigkeit der Architektur*, in: *Reallexikon zur Deutschen Kunstgeschichte*, Bd. VII (Lieferung 1974/75), Sp. 222-225

Macdonald, Susan and Arato Gonçalves, Ana Paula, *Conservation Principles for Concrete of Cultural Significance*, The Getty Conservation Institute, Los Angeles/CA 2020
www.getty.edu/conservation/publications_resources/pdf_publications/pdf

Macdonald, Susan and Ostergren, Gail (eds.), Conserving Twentieth-Century Built Heritage: A bibliography, Second edition, The Getty Conservation Intitute, Los Angeles 2013
www.getty.edu/conservation/publications_resources/pdf_publications/twentieth_century_built_heritage.html
Meurs, Paul, *Heritage-based Design*, Delft 2016

Meurs, Paul and van Thoor, Marie Therèse (eds.), *Sanatorium Zonneastraal. History and Restoration of a Modern Monument*, (with contributions – among others - of Hubert-Jan Henket, Wessel de Jonge, Mariël Polman and Matijs de Keijzer), Amsterdam 2010

Pedroni, Margarita / Bargues Ballester, Cesar / Canziani, Andrea / de Jonge, Wessel / McCoy, Chandler, *A Global Survey on Education and Training for the Conservation of Twentieth-Century Built Heritage*, GCI and docomomo International, Los Angeles 2020, www.getty/conservation
www.getty.edu/conservation/publications_resources/pdf_publications/global_survey_on_education_and_training.html

Pursche, Jürgen, *Mittelalterliche Putze – Bemerkungen zu Befunden in Regensburg*, in: Michael Petzet (ed.), *Farbige Architektur. Regenburger Häuser – Bauforschung und Dokumentation*, „Arbeitshefte des Bayerischen Landesamts für Denkmalpflege", Bd. 21, Munich 1984, pp. 10-28

Pursche, Jürgen (ed.), *Historische Architekturoberflächen Kalk - Putz - Farbe / Historical Architectural Surfaces Lime - Plaster – Colour*, in: ,''ICOMOS Journals of the German National Committee; XXXIX" / „Arbeitshefte des Bayrischen Landesamts für Denkmalpflege, Band 117" (International Conference of the German National Committee of ICOMOS and the Bavarian State Department of Historical Monuments - München, 20. - 22. November 2002), München 2003

Reichwald, Helmut F., *Surfaces and Colour Treatment of the Interior and Exterior of the Double House by Le Corbusier and Pierre Jeanneret*, in: Cerna, Iveta / Hammer, Ivo (eds.) 2008, p. 58-66

Ruchniewitz, Silke, *Zur Theorie des Materials in der Klassischen Moderne. Überlegungen anhand der Architektur von Ludwig Mies van der Rohe*, unpublished diploma thesis, HAWK Hildesheim, Conservation and Restoration of Wall Paintings / Architectural Surface course, examiners: Prof. Dr. Ivo Hammer und Prof. Dr. Thomas Danzl, Hildesheim 2008

Urbani, Giovanni (ed.), *Problemi di conservazione*, Bologna (s.d.) 1973

Wagner, Monika; Rübel, Dietmar; Hackenschmidt, Sebastian (eds.): *Lexikon des künstlerischen Materials. Werkstoffe der modernen Kunst von Abfall bis Zinn*, München 2010

THE AUTHOR:

Ivo Hammer,
Prof. Dr. phil., Conservator-restorer, art historian, Fellow of IIC, member of ICOM, ICOMOS, VDR, DOCOMOMO International – ISC technology. Conservator-restorer in the workshop of his father Walter Hammer. 1976-97 Austrian civil servant: Head of mural painting/architectural surface in the Conservation Institute of the Federal Office of Heritage Preservation, Vienna (Bundesdenkmalamt). 1997-2008: Full professor at HAWK University, Hildesheim. 2003-2010: Conservation-science study of the Tugendhat House, Brno (1930, UNESCO-WH). 2010-2012: Chair of the International Expert Commission THICOM (Tugendhat House). 2016, together with Daniela Hammer-Tugendhat: Price of the City of Brno. Nominated in 2017 by the German VDR (Association of Conservators) for the Karl Friedrich Schinkel Ring of the German National Committee for Heritage Protection. Contact: mobile: +43 650 224 50 58, e-mail: ivohammer@me.com; www.ivohammer.at