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Bauhaus Building in Dessau: Introduction to the General Concept for the Improvement of Energy Efficiency in the Building, Incorporating Aspects of Monument Conservation

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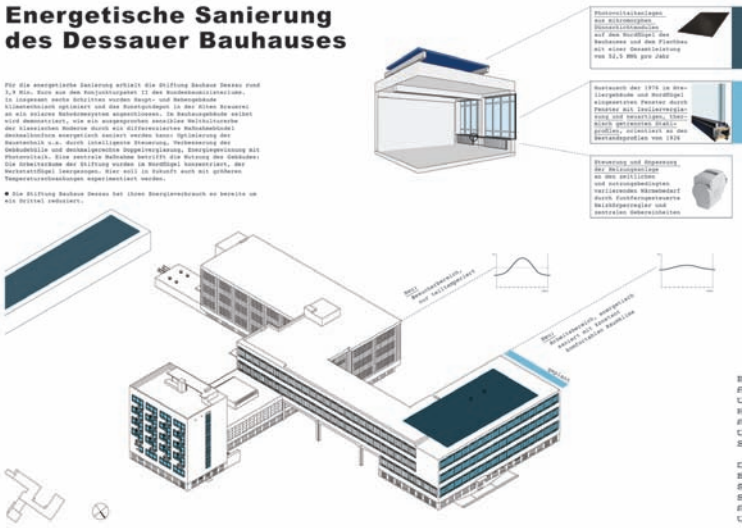
The Bauhaus building in Dessau (Fig. 1), built in 1926 to plans by Walter Gropius and furnished in conjunction with the Bauhaus workshops, is a key work in the development of modern architecture in the early 20th century. The inclusion of the Bauhaus sites in the UNESCO list of World Heritage sites documents this importance and underlines the necessity of proceeding with the utmost care and sensitivity when dealing with changes and interventions in the building.

Modern architecture is still at particular risk today from structural changes that damage its integrity or adaptations made in order to meet present-day standards for usage and comfort. As we know, successful renovation of Modern Movement buildings depends on a precise knowledge of the buildings including especially the cultural value, an evaluation of the measures taken as part of a general concept, careful detail planning and the sensitive implementation of building measures. This methodology was also applied to the measures for the improvement of energy efficiency in the Bauhaus building, which were implemented in 2010 and 2011.

In recent years, the debate about energy consumption at the Bauhaus building has intensified due to the extremely high operating costs. The Bauhaus Dessau Foundation has therefore planned and implemented measures in order to reduce energy consumption and operating costs, improve convenience of use, and contribute to climate protection by lowering CO_2 emissions. The further aim is to promote innovative and high-end solutions that ultimately stimulate improvements in energy management in other buildings, too. The project involved the development of a general concept and the implementation of specific measures within this overall context. All in all, these should reduce energy consumption by around 30 per cent.

As the International Council on Monuments and Sites ICOMOS stated during its supervision of the project, the planning, assessment and implementation of the measures should "accommodate the concerns of current operating costs for energy and convenience of use and, moreover, focus on the overall cultural and ecological balance with a view to sustainability." Priority was therefore given to the protection and conservation of the original building substance and the cultural values of the building. In an intensive process involving specialist engineers (e.g., structural engineers, construction physicists or heating specialists), users and representatives of the monument conservation authorities, all steps and decisions could be consistently reviewed.

1. *Bauhaus building from the west, 2009. Bauhaus Dessau Foundation, Martin Brück, 2009*



2. *Measures for the improvement of energy efficiency in the Bauhaus building, 2011. Bauhaus Dessau Foundation, Stefanie Schneider und Yvonne Tenschert 2011*

1.

It was possible to clarify relatively quickly that some measures are compatible with the Bauhaus building (Fig. 2). Improvements were therefore made to the heating system. With the use of radio-controlled thermostats now it is possible to heat the individual rooms independently from another. In an adjoining building on the site, it was possible to completely disconnect the heating by reorganising storage spaces. The Bauhaus Dessau Foundation's collection was moved to the 19th century industrial building, where the climatic conditions, required to preserve the objects, are maintained by an innovative solar heating and cooling system. Over the course of the evaluation process, agreement was reached on the temporary installation of a photovoltaic system, situated partly on the roof of an adjoining building and partly on the roof of the Bauhaus building. The change to the roof constitutes only a limited intervention in the building substance and is, as such, reversible. The system is made up of horizontal elements and is only visible from the multi-storey part of the Bauhaus (the Studio building), but not from the surrounding area or from other parts of the building.

2.

The extensive glass façades of the Bauhaus building (Fig. 3) were analysed with particular diligence, partly because a great deal of heating energy is lost through these surfaces: they account for 50 per cent of the transmission heat loss. On the other hand, the glass façades of the Bauhaus building not only fill a practical function, but also fundamentally determine the character and aesthetic of this architecture. It was therefore necessary to precisely understand and assess the cultural value of the windows in order to ascertain the scope for action. Moreover, different approaches for changes to the windows had to be outlined and evaluated, such as the use of insulating curtains, the timely installation of outer windows (for winter only) or the substitution of glass in selected areas.

In the early 20th century the design potentials of the new steel, concrete and glass building materials held a great fascination for architects. The glass façades became essential components of the building and contributed to a new understanding of space. Naturally, Walter Gropius was equally impressed and moreover very conscious of the impact of this architecture: "[...] the works of the modern, influential architects demonstrate a new awareness of space [...] that annihilates the enclosing wall and seeks to preserve the correlation between the interior and the exterior."[1]

The spatial layout of the Bauhaus building (Fig. 4) and the opening up of the rooms with large expanses of glass facilitates complex connections between interior and exterior by transparency and reflection. The interface between inside and outside is articulated by the exceptional windows, which thereby gain an added relevance in the spatial and aesthetic concept.

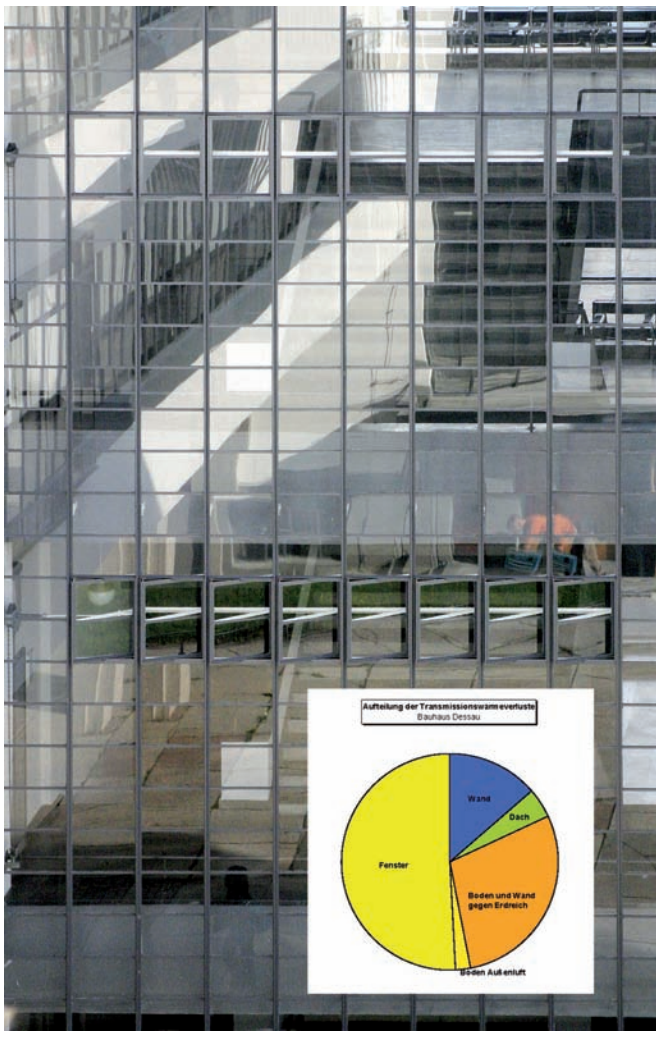
At the Bauhaus building, the glass panels were held in place by "double-rebated steel frames". Crystal plate glass was chosen for the glazing. "(Crystal) plate glass is a rolled glass which is then ground and polished, or a drawn thick glass which is treated in the same way; with its complete transparency and its entirely smooth and brilliant surfaces, it is the best sheet glass of all. The smoothness prevents all optical distortions, even to the roaming eye or through several sheets set at angles to one another."[2]

In 1926, different kinds of steel windows were fitted in the Bauhaus building. The analysis of the windows currently fitted in the building shows that only very few of the 1926 windows are still in place. The few preserved original windows in the building are therefore especially important, because they document both the technological standard at the time of construction and the aesthetic effect that was originally aspired to, and therefore should be retained without alteration as building components that are particularly worth preserving. Preserving the original building substance has a high priority because, above and beyond any historic, artistic and architectonic-aesthetic significance, it presents unique, irreplaceable testimonies to the building's technology and construction, which must be conserved. As a result of the accumulating losses of the material substance of the historic buildings of Modern Movement Architecture, it became essential to carefully protect and preserve the

1. Gropius, Walter: *Glasbau*, in: "Die Bauzeitung", 25.05.1926.

2. Völckers, Otto: *Bauen mit Glas*, Stuttgart 1948.

3. *Transparency and light reflection on the glass façades of the Bauhaus building vs. Transmission losses through the building shell. Bauhaus Dessau Foundation, Martin Brück, 2006 and Transsolar, 2011*



4. *Glass façades of the Bauhaus, 2010. Bauhaus Dessau Foundation, Martin Brück, 2010*

remaining substance and to view the buildings not only in the light of their artistic impact, but also to focus attention on their importance as historical testimonials, including their materiality and signs of age. "If we are not prepared to accept aged surfaces, modifications and a lower utility value in modern buildings, then soon we will have no more historical monuments, no authentic evidence, only reconstructions similar to the original..."[3]

This appreciation of the original substance is also shown in the recent discovery of original windows from 1926, which were believed to be lost. In 1976 these were considered beyond repair, were removed and then built into a greenhouse (Fig. 5). After documenting and dismantling the greenhouse, the original windows assimilated into its structure were documented in photographs and drawings and re-installed in the building.

At first glance the reproduction windows made for the reconstruction of 1976 comply with the historic example. At a second glance, the steel frames show a different construction principle, different opening functions and an altered appearance in detail. The reproductions of 1976 are worth preserving from a monument conservation perspective. However, unlike the curtain wall, they do not satisfy the conditions for protection. They are therefore maintained with simple resources, but could be replaced if necessary.

The curtain wall of the workshop wing (Fig. 6) is a particularly notable feature of the Bauhaus. Today, the building features a complete reconstruction, dating from 1976, of the curtain wall destroyed in World War II. In monument conservation terms, the 1976 reconstruction of the curtain wall of the workshop wing satisfies the conditions for protection. The façade, which was painstakingly reconstructed according to the standards of the day, is, beyond the special spatial and aesthetic effect of the wafer-thin glass membrane, an important historic document for the history of the Bauhaus. It also marks a general shift in the appreciation of modern architecture, which is now increasingly acknowledged as a cultural monument and treated with great care and attention to detail during renovations. For these reasons, the reconstructed façade with its single-glazed windows should be preserved.

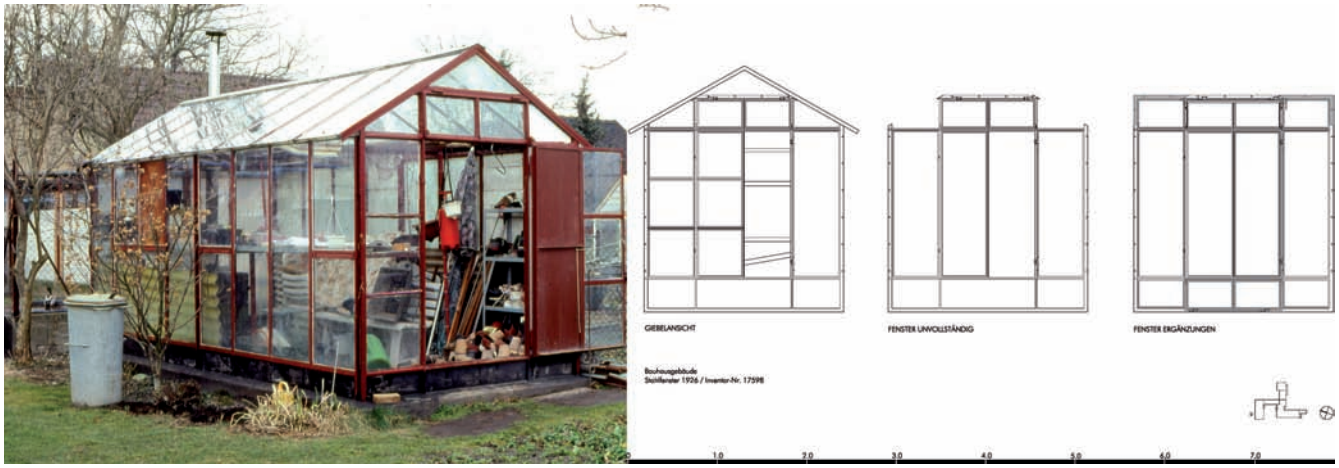
The spatial layout of the Bauhaus building is what enables the interaction and impact of the glass façades in the first place. The lines of sight between the workshop wing, bridge and north wing and between the Studio building and the bridge thereby allow fascinating views through numerous glass layers and different indoor and outdoor spaces. The experience is not only characterised by the transparency of the glass panes and the simultaneous perception of different spaces – the public street, the semi-public staircases and corridors, the private workspaces; the reflections from the glazed panels, with which areas outside the field of vision are perceived and also transformed by the refraction of light, are just as important. When moving through the building, the viewer's perception of the complex and eclectic architecture is heightened once again. In these areas, changes would have a negative impact on the artistic-aesthetic and historical values of the building.

The extraordinary atmosphere at the Bauhaus is still inspiring, even today. The aesthetic is generally perceived as "timeless" or even "contemporary", even though the amenities and standards reflect the ideas of the 1920s. For precisely this reason it is important that, for the present-day perception of the building as a historic cultural monument, the passage of time since its construction is perceived, that is, that the Bauhaus with its architectural surfaces, furnishing and fittings is recognised as being "not of the present". As such, the staircase steps worn by intensive use, the painstakingly repaired floor or the seemingly "archaic" and noisy window opening mechanisms are not flaws, but important aspects of the architecture which first facilitates the sensory perception of the building's age and, by association, the pioneering cultural achievement of the day. Future generations should also have an opportunity to experience this unique building.

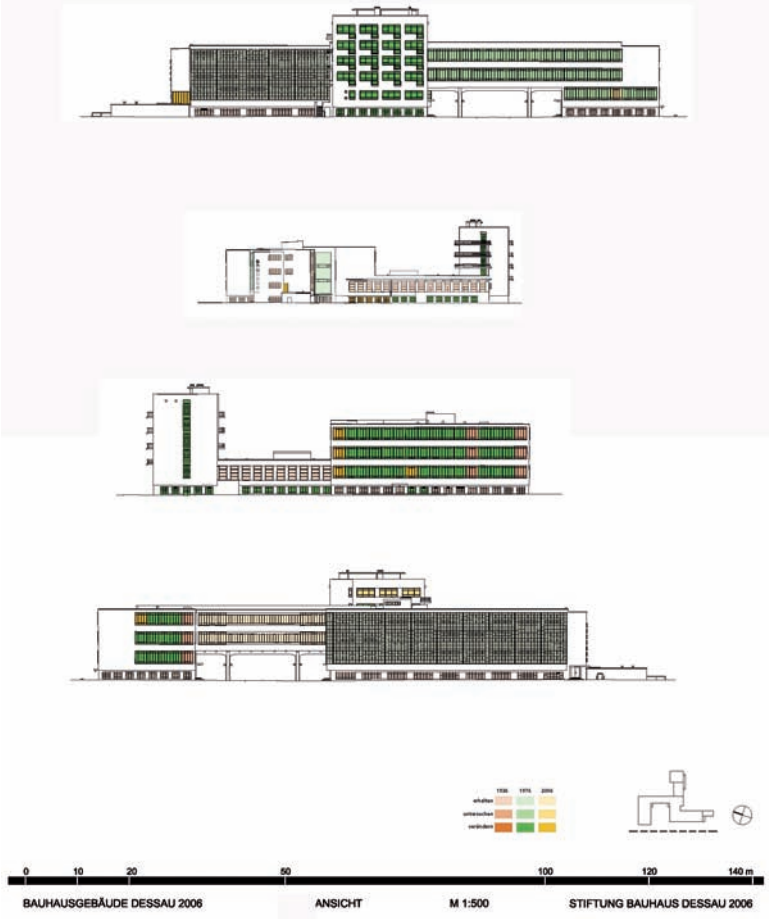
The analysis and evaluation of the existing windows led (Fig. 7) to the development of scientific conservation priorities, based either on their location in the building or their date of construction, that is, according to their aesthetic or architectural and historical importance. Accordingly, the

3. Schmidt, Hartwig: *Der Umgang mit den Bauten der Moderne in Deutschland*, in: *Konservierung der Moderne?* Conference of the German National Committee of ICOMOS in collaboration with "Denkmal '96", ICOMOS Journals of the German National Committee XXIV, Munich 1998.

5. *Transitional stages of an original window from the Bauhaus building, 2004. Bauhaus Dessau Foundation, Roland Zschuppe, 2001, Petra Welhöner, 2004*



6. *Interior view of the workshop wing, 2006. Bauhaus Dessau Foundation, Jutta Stein, 2006*



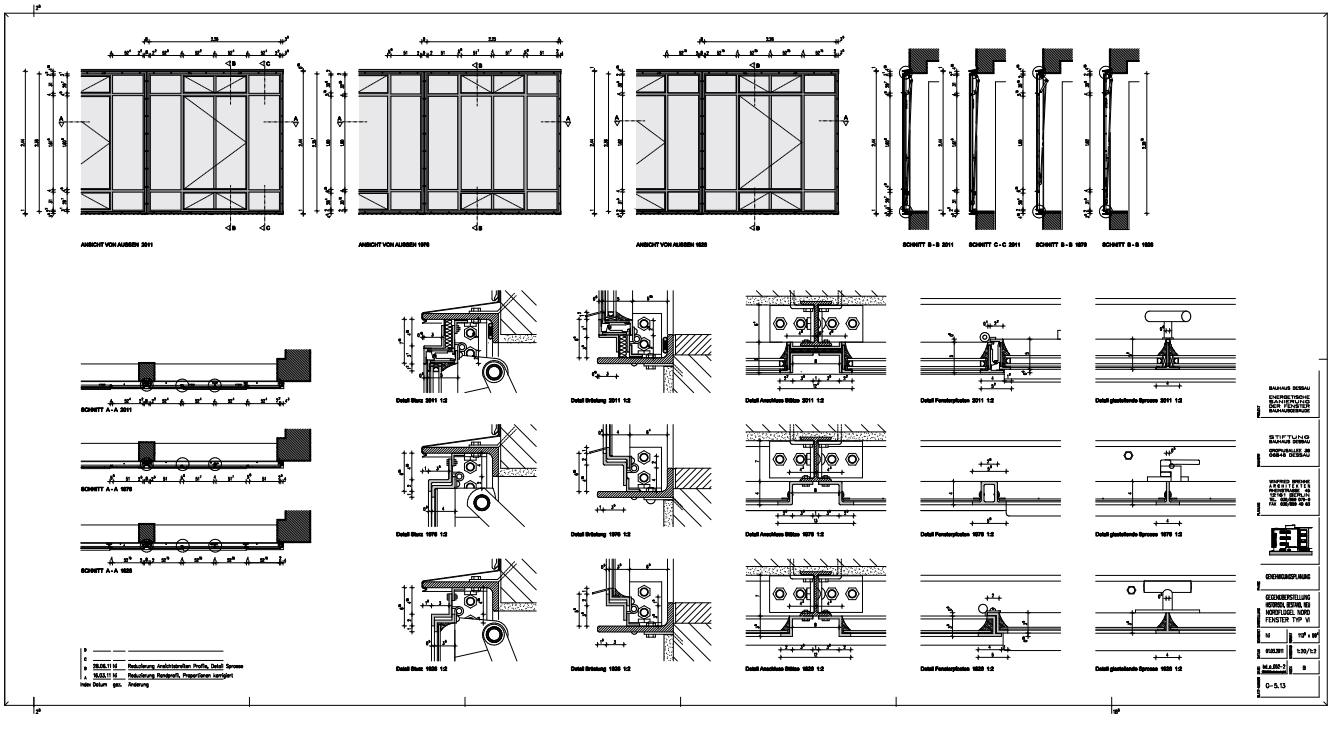
7. *Representation of the years of construction and the potentials for changes to the glass façades, 2009. Bauhaus Dessau Foundation, 2004-2009*

original windows, the curtain wall and the areas characterised by complex interpenetrations were to be left unchanged. For the energy-efficient optimisation of the Bauhaus building through the installation of thermally separated window frames and insulated glazing, the windows reconstructed in 1976 with different frames and simplified opening mechanisms, in which the complex interpenetrations or the historic significance play a less important role, offered a solution. In this way, precedence was still awarded to the conservation of the original building substance and the building's cultural values.

The east side of the Studio building and the north and west sides of the north wing proved to be ideal areas to work on the development of suitable windows. Remarkable savings in heating energy were to be expected and restricting the planned alterations to selected areas will ensure the long-term preservation of the historic glass façades in other areas.

In a time-consuming process, the Winfried Brenne Architekten and the Netherlands-based manufacturer MHB developed thermally separated window frames made from hot-rolled steel (Fig. 8), which take account of both monument conservation concerns and structural requirements. The frames are similar to the original steel frames in both appearance and width, the glass is held in place by thermally insulated silicone gel and the original casements were reconstructed. The hinges and opening mechanisms were reconstructed based on the historic example and painted in the original colour. Rubber seals in a matching colour were affixed to the rebates.

8. *Windows in the north façade of the north wing 2011-1976–1926. Winfried Brenne Architekten, 2011*



9. *North façade of the north wing after the installation of new windows, 2012. Bauhaus Dessau Foundation, Yvonne Tenschert, 2012*

Special interest concentrated on the glazing. The historical Crystal Glass is no longer produced, but present-day float glass is very similar to it (Fig. 9). Another thing is today's energy-efficient glass which consists of two or three sheets and coating systems based on metal oxides. These glasses look very different from the original glass and they produce a complete change to the impact of the building. This was reason that several samples were fixed to the building. Taking into account all aspects from energy-saving to cultural value the decision was to use not a coated product with Ug value 1.0 W/m²K and Ug 1.6 W/m²K, but a glass with a less favourable Ug value of 2.6 W/m²K.[4]

The building today therefore has four time layers side by side: windows from 1926 and 1976, reconstructions of the 1926 windows made in 2006, and new windows with thermally insulated frames and insulated glazing based on the 1926 windows.

For all other glazed surfaces, alternative means of reducing energy consumption were sought. These range from the improved control of external doors by way of door closers and the optimisation of ventilation management to the use of thermally insulated curtains and small measures which improve comfort in the workplace, such as the installation of room-dividers to retain or exclude heat or the addition of temporary in-built heaters.

4. Find more details about the windows in: Brenne, Winfried. Nickmann, Ulrich. Weller, Bernhard. Reich, Stefan. Mathijssen Mark: *Innovative Stahl-fensterkonstruktionen für das Weltkulturerbe Bauhaus Dessau*, in: Weller, Bernhard und Tasche, Silke (Hrsg.): Glasbau 2012, Dresden 2012.

3.

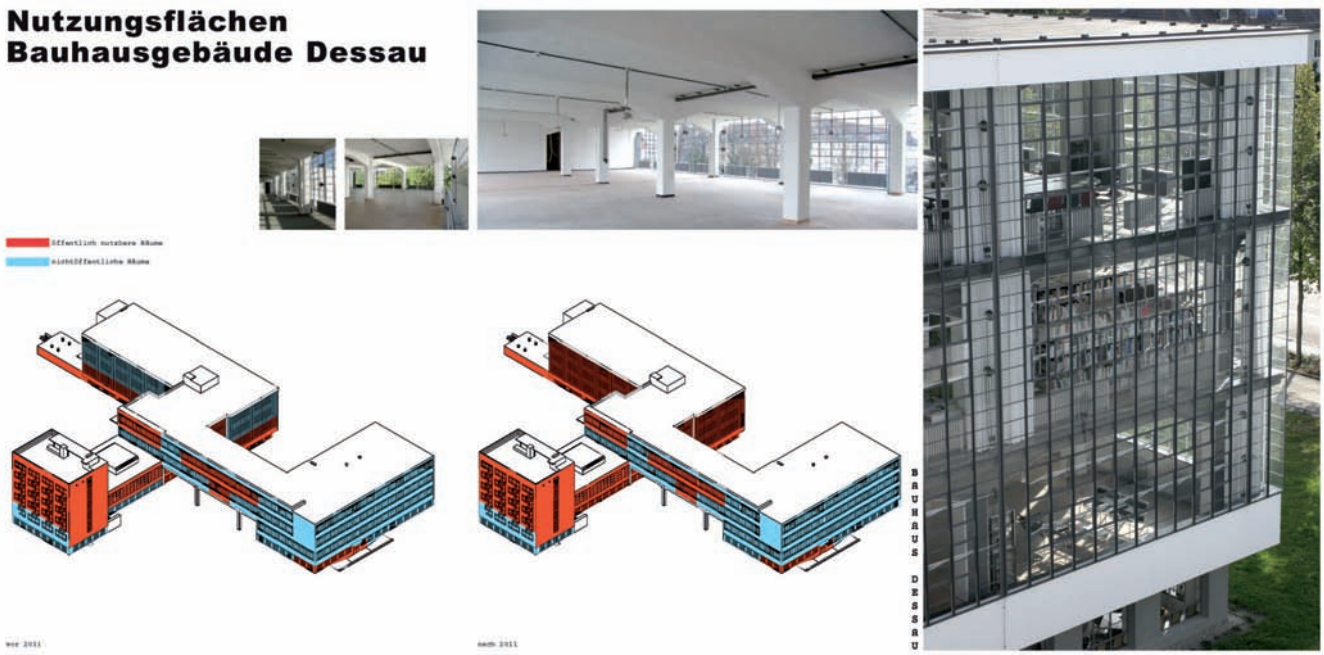
The most important part of the general concept for energy management at the Bauhaus building (Fig. 10) was the exploration of options to reduce energy losses by making changes to the usage concept. The first steps involved moving the art collection and library out of the building and disconnecting a storage building from the heating system.

The Bauhaus Dessau Foundation also concentrated its office space in one part of the building. By locating all the office spaces in the rooms in the north wing, which are equipped with new windows, the use of heating energy is optimised by utilising the radiation from the adjoining rooms, and the structural and technological interventions geared to an improved energy management are bundled in areas where such procedures are acceptable from a monument conservation perspective. Grouping the workstations together also results in a practical concentration of technical equipment and to short journeys from one workplace to the next. This reduces the need for interventions in other areas.

With the relocation of the office work places and features such as the library, it becomes possible to open up other areas in the workshop wing of the Bauhaus building for visitors. This means that visitors have an unique opportunity to experience with all their senses an authentic testimony to the Bauhaus' history, that extraordinary space behind the thin glass membrane, the curtain wall.

As a cultural monument of great significance the Bauhaus can adopt a useful social role in that it provides

10. *Changes of use in the Bauhaus building, 2012. Bauhaus Dessau Foundation, Martin Brück 2006, Yvonne Tenschert, 2012*



11. *Workshop wing, open for visitors. Bauhaus Dessau Foundation, Jutta Stein Brück, 2006*

a cultural, aesthetic and historic point of orientation. While the building has always been an object of exposition as the "built manifestation of the Bauhaus' ideas", today the building's role has changed, not just in view of the visitors who wish to be guided and provided for, but also in view of the changing appreciation of the building. The building's importance as a shell for a specific use is increasingly giving way to its importance as a place of public interest.

Through the use of these rooms in the workshop wing for viewings, presentations, workshops or seminars, they can as a rule be presented without excessive development or equipment. Because they are no longer heated for constant use as office workplaces, it is possible to significantly reduce the room temperature. In this way, the energy consumption and operating costs in this area are reduced notably. Moreover, the moderate temperature also minimises problems arising from the building's structure and design, such as the development of condensation, thereby safeguarding the building substance for the long term.

4.

The example of the Bauhaus building shows how the implementation of specific measures as part of a general concept can lead to solutions that reduce energy consumption while conserving and safeguarding the historical monument's cultural value for the future.