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THE GREEN LIBRARY

The challenge of environmental sustainability

DIE GRÜNE BIBLIOTHEK

Ökologische Nachhaltigkeit in der Praxis

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Going green: Free University Philological Library, Berlin

An evolutionary concept development – from a box to "The Brain"

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Abstract: Active as well as passive constructional strategies and innovations were realized within a dynamic design process to guarantee sustainability at the Berlin Philological Library.[1] Besides a reduction of the enveloping skin area in relation to its volume, the use of special building materials is noteworthy. This and the use of daylight and an innovative heating and ventilation system ensure the intended sustainability. There are also numerous other strategies supporting this goal. Encompassed within this approach, the needs of the users take centre stage. Awarded with the Deutscher Architekturpreis and the Contractworld.award in 2007, the Philological Library is a notable example of a sustainable library and an architectural highlight.[1]

Zusammenfassung: In einem dynamischen Design-Prozess konnten bei der Philologischen Bibliothek der Freien Universität Berlin[1] grundlegende aktive wie auch passive bautechnische Neuerungen verwirklicht werden, um Nachhaltigkeit sowohl im Hinblick auf die Nutzerfreundlichkeit als auch auf den Schutz des Bestandes zu garantieren. Dazu zählt neben einer Verkleinerung der äußeren Hülle in Relation zum Raumvolumen auch die Verwendung der richtigen Baumaterialien. Dies sowie die Nutzung von Tageslicht in Verbindung mit einem innovativen Heiz- und Lüftungssystem sorgen neben weiteren Strategien für die angestrebte Nachhaltigkeit. Neben diesen Aspekten stehen zudem die Anforderungen zur Benutzbarkeit der Präsenzbibliothek durch die Leser im Focus. Für ihr Design wurde die Philologische Bibliothek u.a. 2007 mit dem Deutschen Architekturpreis sowie dem Contractworld.award ausgezeichnet.

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1 www.fu-berlin.de/sites/philbib/index.html. Accessed on 26 January 2013.

1 Introduction

For about 5,000 years now, people have tried to preserve their knowledge, tales and information by putting them down in intelligible code on portable media, to secure and to sustain this information for their own use and for those of others. The purpose of this extends from simple day-to-day noting and reporting, to communication and ultimately to teaching and conveying knowledge to future generations. Whereas putting information on solid media like stone and, to a lesser degree, murals makes it endure for a very long time and largely irrespective of changing climatic conditions, portable media are prone to decay and ultimately to the loss of the very information they are containing, if not carefully sheltered and maintained. Therefore, building structures which provide optimized conditions, i.e. protection from the elements, keeping humidity and temperature at tolerable levels, allowing for daylight but keeping out destructive direct sunlight, were the obvious next step. It sounds all so simple – and in fact has been carried out to great success over millennia and centuries. Since preserving knowledge used to enjoy the highest priority and great esteem, it was down to rare and extraordinary events like wars and natural catastrophes to seriously harm libraries. Examples in very recent times include the devastating fire at Herzogin Anna Amalia Library at Weimar[2] in 2004, and the notorious collapse of Cologne City Historic Archive[3] in 2009 due to inadequate adjacent groundworks.

2 Books vs users – different requirements

Endorsing sustainability criteria seems obvious in the keeping of books – however, things get more complicated with the users of written material frequenting the libraries. To preserve books appropriately and sustainably, it would be sufficient to shelter them in solid building masses, limiting daylight impact and providing constant levels of temperature and humidity over the course of the seasons. A skilful selection of building materials, suitable fire protection and limited consumption of energy supply should make it easy to profile for advanced building sustainability criteria.

Accessing the stored information, however, is setting up an entirely different array of criteria, and ultimately the right choice of combining and overlapping antagonistic requirements is the key to creating a sustainable library successfully.

2 www.klassik-stiftung.de/haab. Accessed on 26 January 2013.

3 www.stadt-koeln.de/5/kulturstadt/historisches-archiv/. Accessed on 26 January 2013.

Historically, access to libraries has always been limited to a few privileged persons, thus limiting the need to provide space for reading and working adjacent to the books. Removing books for lending purposes was a rare option. Most libraries were organized as reference libraries, with the books either locked behind protective glazed doors or even chained to shelves and desks, like in medieval monastic libraries. This has been radically changed since the age of enlightenment, and especially since the arrival of large publicly accessible libraries at universities, but also at state-run and independent research organizations and archives.

For readers and users of books, optimal reading and desk-working conditions matter most; this includes high levels of daylight and supportive artificial lighting, ergonomic desks and chairs and all the support functions like cloakrooms, bathrooms and refreshment facilities. More importantly, and benefiting from central European mild climate conditions, office-style working with books would allow for a much wider range of tolerable temperature and humidity scales than conservation criteria would accept including natural ventilation by opening the windows. In summer, you could even work outside, sitting on the grass in the charming little "Rustbucket" (so-called *Rostlaube*) courtyards.

So one of the keys to designing a sustainable library building successfully is identifying the right combination of these requirements, which at first sight seem incompatible with each other. Historically, the sheer masses of printed information accumulated in a library called for large, often double or even triple-height spaces, lined with bookcases along external and internal walls. Additional shelves, accessible via galleries, enlarged storage capacities. Reading areas naturally found their place in the middle of these rooms, brightly lit via penetrations in the external walls or via skylights, giving priority to user requirements and the sensation of space. This archetypical arrangement is ubiquitous, from early monastic libraries to 18th-century manor houses and university libraries. These large, almost ceremonial spaces are still very much favoured by many architects, as very recent examples in Berlin,[4] Dresden,[5] and Stuttgart[6] prove. Their vast airy volumes, however, are expensive to build and require extensive air-conditioning to serve a rather limited usable area, set in relation to the massive volume.

Once the storing of books in larger quantities is separated from working with them, optimal conditions for both reading and conservation can be more easily

4 Humboldt-Universität zu Berlin, Jacob-und-Wilhelm-Grimm-Zentrum. www.grimm-zentrum.hu-berlin.de. Accessed on 25 April 2013.

5 SLUB Sächsische Landesbibliothek – Staats- und Universitätsbibliothek Dresden. www.slub-dresden.de. Accessed on 25 April 2013.

6 Stadtbibliothek Stuttgart am Mailänder Platz. www1.stuttgart.de/stadtbibliothek/. Accessed on 25 April 2013.

addressed. The downside, however, is the loss of visual connection to the books, i.e. the unique atmosphere they create, and certainly easy and quick access to them. Stockholm's city library[7] is an interesting example of how to protect books in a central position, providing both thermal protection and restricting harmful daylight levels by limiting openings to a row at the top of the cylindrical room, and wrapping smaller and better lit reading rooms around. Often misinterpreted as a central reading room,[8] the stunning circular space lined with three-tiered book shelf galleries serves only for storing books, with a central lending service desk. For reading the books and working with them, generously lit reading rooms frame the central space, like a protective layer.

3 The new Philological Library

In contrast to the libraries mentioned above, the Free University Philological Library[9] is a reference-type library, where any reading and studying has to be done on the premises, with no lending facilities save overnight. Therefore, 650 work-

Fig. 14.1: Central perspective view towards entrance and information desk.
© Reinhard Görner, www.goerner-foto.de.

7 https://biblioteket.stockholm.se/. Accessed on 22 February 2013.
8 Prof. Eckhard Gerber, talk at LIBER Seminar, Paris, January 1996.
9 www.fu-berlin.de/sites/philbib/architektur/fakten/index.html. Accessed on 26 January 2013.

desk positions were required, with flexible storage possibilities for about 700,000 books. Bookstacks are openly accessible to all users, only a very small number of rare and fragile books are locked away with access limited to authorized persons only. While priority reading facilities like carrels were asked for initially, this was turned down later in favour of simple book carts for private use. This is a much more flexible way to lock away personal books and items for people like visiting academic staff and post-doctorate students. All library administration, group study rooms and the small closed stacks would not be part of the new building, but were accommodated within the existing *Rostlaube* offices.

4 Design process

With their competition entry, *Foster + Partners*[10] supplied two alternative plans. As requested by the client, a solution integrated into the Rostlaube structure was proposed, using four of the existing courtyards. Right at the outset the width of the existing floor plates turned out to be too narrow to organize and manage a library of the required size efficiently. Moreover, respect for the integrity of the structure, designed by *Candilis Josic Woods* architects in 1963, led to a second alternative, a freestanding new library building on the site of an adjacent car park. This solution was much favoured by the Free University, since capacities for institute space would not have to be reduced. However, a new building did not seem feasible within the Berlin Senate budget plan, and the alternative was subsequently dropped.

5 Massive core – light enclosure

The integrated design approach started with a rectangular, table-like concrete structure, spanning from central K-street to northern L-street main circulation. A central stair allowed access to the new floor slabs, and at this early point the strategic decision was already made to keep books in a spinal central array. Reading-desk positions aligned the sides, each floor plate slightly staggering inward. By keeping the books in the centre, they are protected from high levels of daylight and, in a sandwich-like array, are enclosed by the massive floor slab layers. Inverting the classic layout, reading positions now occupy the edges and enjoy ample daylight levels and views into the adjacent courtyards. The new structure

10 www.fosterandpartners.com/. Accessed on 26 January 2013.

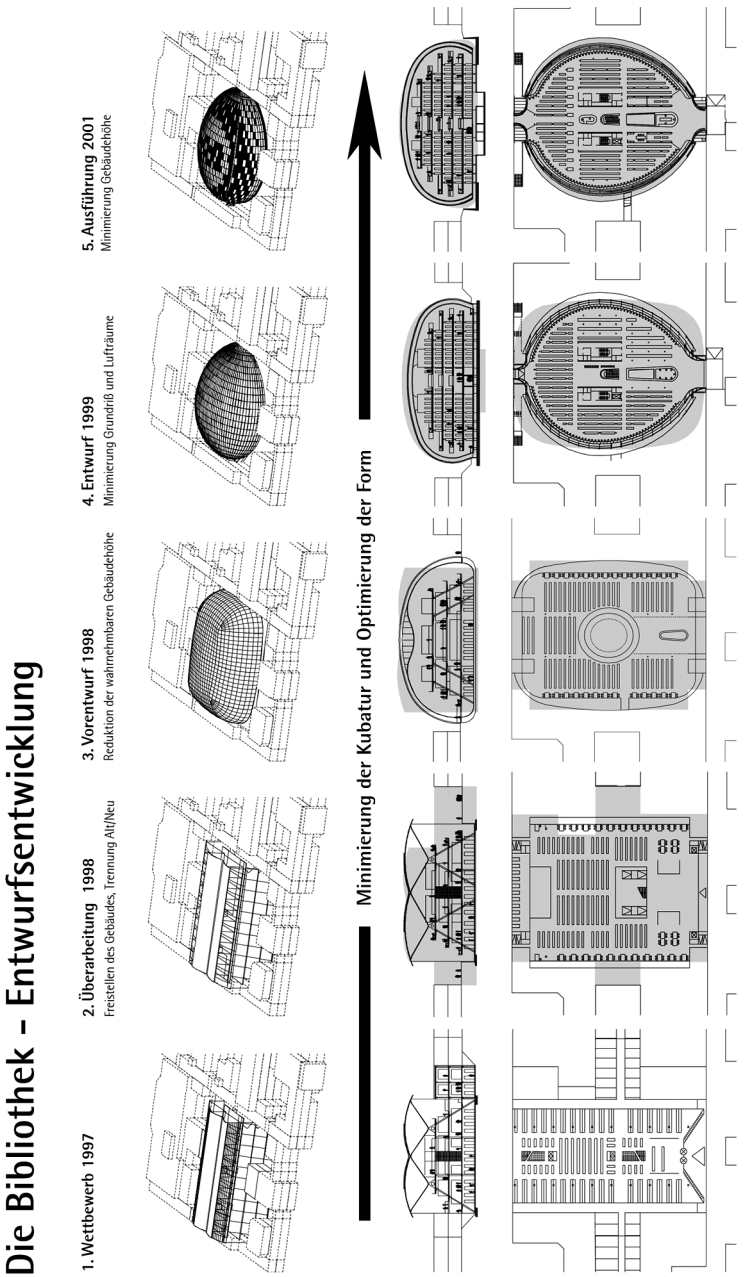

Fig. 14.2: Design development stages diagram. © Foster + Partners.

would be covered by twin barrel-vaulted light steel roofs, generously lighting the reading desks. While further exploring this early version, defining the edges and numerous interfaces with the existing structures proved to be complicated. At the same time worries started about the large air volume this generous enclosure would create. This lead to a number of evolutionary studies and variants, which were tested and evaluated via conventional 2D and 3D drawings, but also by applying advanced specialist modelling software, climatic modelling and sketch models.

6 Usability

Being a reference library, great efforts were made to create best possible workplace conditions and easy access to all information and research facilities. In order to accommodate the 650 reading positions required, floor-plate edges were designed undulating in wave-like shapes to create a longer line of continuous work desks. Bending inwards and outwards, and being shifted by half a phase each floor, it was possible to create small double or even triple height aisle spaces. These create a sense of spatial experience while still keeping close to the inner skin of the enclosure, sometimes almost within touching distance.

Right at the entrance, computer terminals are situated for checking the availability of books required. After leaving personal items in two locker aisles, users find a central information and lending desk within the atrium space, which carves out a deep cut into the floor plates. A second information desk for detailed research assistance is located at the end of the atrium on the ground floor. Reading desks continue along the atrium, providing views into the active part of the space. Each user will be able to locate an identifiable, unique space close to his/her preferred study subject. The user experience should be easy, intuitive and non-hierarchical – hence the total absence of ceremonial spaces, carrels and any other privileged separate rooms. It is only at the top level where, rather unexpectedly, lounge chairs are positioned to enable students to read larger volumes in a more comfortable and relaxing position.

Fig. 14.3: View along internal glass-fibre skin and work desk balustrades. © Reinhard Görner, www.goerner-foto.de.

Fig. 14.4: Reading positions at top level. © Reinhard Görner, www.goerner-foto.de.

7 Cut volumes

Once the direct link to the adjacent main circulation was reduced to small docking stations, this move liberated the way to the free formation of the library's structural shape in many ways. Free-shaping the building's external profile started a process to minimize the enveloping skin area in relation to its volume. In nature, this is an evolutionary effect called Allen's Rule, helping arctic animals like the polarfox with bigger body masses to minimize energy losses and, conversely, assisting desert inhabitants like the North African fennec to provide more surface to control their temperature. Theoretically, this process would end up in a globe – the perfect surface to volume relation – not unlike the "Memorial to Newton" by Étienne-Louis Boullée, who also presented a grand scheme for the French National Library in 1785.[11]

11 Étienne-Louis Boullée, "Newton's cenotaph." www.wdl.org/en/item/2825/; "Marcella Durand on the infinite library". www.nyfa.org/nyfa_current_detail.asp?id=17&fid=1&curid=677. Accessed on 22 February 2013.

Fig. 14.5: Polar Fox. © Lisa Spreckelmeyer_ pixelio.de.

Fig. 14.6: Fennec. © Thomas Ilchmann_ pixelio.de.

Ultimately, the enveloping skin of the library, after much fine-tuning and testing, was closely wrapped over its sculptured form, like shrink-wrapping a fragile machine.

8 The skin

Usually, the first element towards designing sustainability is to take a look at the optimal alignment of the building to local sun-path diagrams. However, here, locked within the given building grid, alignment was not available as a creative tool. New challenges like micro-climatic differentiation within the existing courtyards came up and had to be taken into consideration. Since the Free University did not ask for full air-conditioning, but only limited temperatures above 25°C up to ten days a year, it was seen as a challenge to develop a natural-ventilation-based scheme despite the Library's deep plan diagram.

To enable this strategy, the entire building is wrapped in a double-skin envelope, including a hollow floor at the bottom to act as air ducts for fresh and exhaust air. The outer skin layer consists of a pattern of highly insulated metal panels, double-glazed elements and openable solid metal flaps, supported by a three-dimensional all CAD-CAM-manufactured and patented MERO-steel structure. As an inner layer, a much lighter and softer cover consisting of silicon-coated glass-fibre fabric was chosen. With its translucent appearance, it acts both as a filter and distributor of daylight and a projection screen for artificial lighting at night. Occasional ETFE-foil elements, sewn into the panels, provide glimpses of the sky and adjacent building corners. A specially designed transmission rate prevents airstream losses inside the cavity but provides acoustic absorption to

Fig. 14.7: External envelope with ventilation flaps. © Reinhard Görner, www.goerner-foto.de

calm down unwanted noises and reflections inside the library. Fine wire-mesh openings disguise standard air vents either to provide fresh air or to take out waste air at the higher levels.

The skin cladding is given a silvery shine, as a contrast to the warm and dark bronze cladding of the Rostlaube. The entrance docks, brokering both worlds, are bright melon yellow. The colour crawls under the skin, revealing occasional glimpses only and secretly re-appears at transitory spaces like corridors and connections to the existing building pattern.

9 The body

Below the freestanding curved skin, a stack of five floor plates on circular columns is situated. Made of 30-cm-thick concrete, it provides the necessary passive storing masses but also gives room for an integral concrete cooling / heating system and for pre-stressed reinforcement bars to allow for the curved cantilevering edges. Two solid concrete cores work as stiffening elements, containing large air ducts to distribute fresh air into the centre of the building and complementing the skin outlets. A narrow atrium space cuts deep into the centre, containing the main circulation stairway.

Fig. 14.8: Central atrium view. © C. Hallmann.

10 A solar motor

It was decided that the lowest floor level should be carved and moated into the ground, aligned with air intakes to suck in fresh air at low temperature. In a summer-type scenario, with average temperatures above 20°C, air will flow both into the skin and into the bottom cavity, evenly providing all floors with fresh air. Waste air will get extracted through air vents at the top. In order to sustain this airflow even at inversion weather scenarios, the skin cavity is divided into four sections while a centre section will be able to interconnect sections diagonally, tracking the NW / SE geographic direction of the Rostlaube building. In addition to this, the central section acts as a waste air or smoke extraction pool. Heated up by an increased number of glazed panels on the southern side, constant airstream flow and air extraction at the top is ensured. Additionally, wind-pressure differentiation on south-eastern and north-western faces of the curved skin is being used to further sustain the airstream. To double-check and to ensure this vital component of the sustainability strategy would work satisfactorily within the fixed conditions and limitations of the existing courtyards, extensive computer modelling and wind tunnel tests on models were executed and carefully analysed.

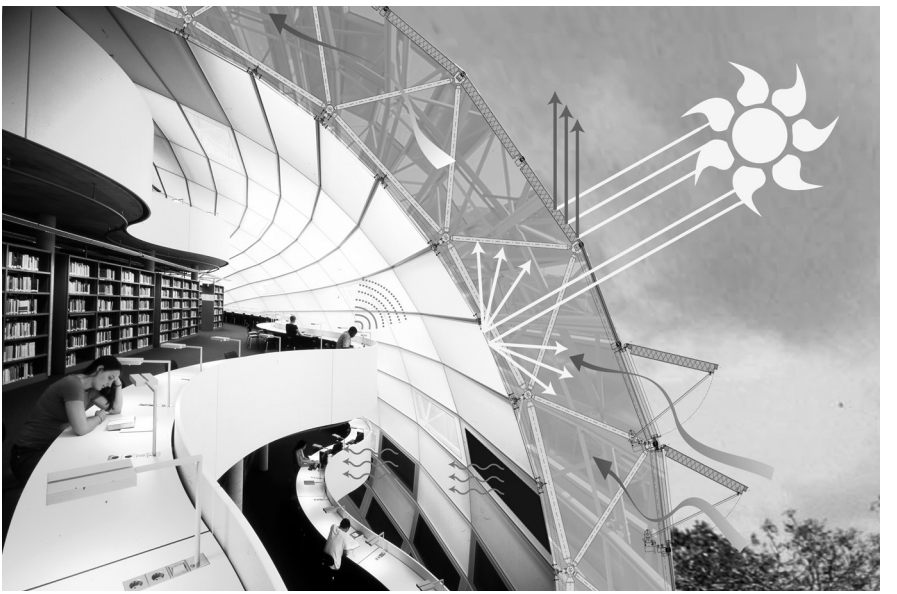

Fig. 14.9: Building envelope functionality diagram. © Foster + Partners.

In spring and autumn, when temperatures exceed 16°C, natural ventilation is maintained but fresh air from the bottom cavity gets heated and distributed via the central cores.

In a winter scenario, and on extraordinarily hot summer days, all skin flaps close and pre-heated or cooled air is supplied via the central core air outlets. Residual energy in waste air gets recovered by being pumped down into the central plant room. There is no conventional heating system planned, but all floors are tempered via integral fluid-based piping systems.

11 Slow tech + low tech

All in all, the sustainability strategies at the Free University Philological Library are not sorcery and witchcraft, but a careful selection of rather simple passive strategies as described. These are combined with a number of active components like the concrete cooling / heating and active control of the various air vents and flaps of both the external and internal skin. Concrete cooling / heating is operated on the basis of low temperature differentiation, so existing district heating can be tapped, as well as residual capacities of existing compression coolers being used.

Control of the numerous flaps and vents is based on relatively simple database software.

Nevertheless, the interaction of all systems and components needs to be meticulously monitored and fine-tuned to work to full user satisfaction. Despite the fact buildings are still largely constructed manually and in a traditional way, they need to be seen as technical products which, like any car rolling off the conveyor belt, require testing and approval procedures before being handed on to the client. A monitoring process was carried out during the first year in operation, to observe technical parameters and performance.

12 Economy vs ecology?

By no means all economically favourable solutions are equally strong in terms of ecology, and vice versa. However, most economic common sense and the design solutions derived from these principles have great potential to turn out ecologically sound, if a few additional attributes like materials' eco-balances, contamination and low carbon emission are respected and integrated into the decision-making process. Cutting volumes, for example, had a twin effect on reducing cladding costs as well as on reducing the volumes to be conditioned, thus saving both on investment and on running cost. Calculations and comparisons of standard technology and the new systems as proposed revealed a draw after 7–8 years, well undercutting standard life expectancy of their components.

All in all, free natural ventilation can be used at the Free University Philological Library over about 60% of the course of a year, reducing average running costs by 35% as compared to standard fully air-conditioned libraries. Total building costs, compared to German university libraries erected about the same period, proved to be 10% lower than the average cost, despite the building's advanced concept.

13 Seven years later

Officially inaugurated in September 2005 by the mayor of Berlin, Klaus Wowereit, the Free University President Prof. Dieter Lenzen and Lord Foster, the library quickly attracted students of all faculties, sometimes even more than it was designed for, so temporary limitations had to be introduced.

The Free University Philological Library has been awarded a number of architectural prizes, among them in 2007 the Deutscher Architekturpreis

(Auszeichnung),[12] the Architekturpreis Berlin,[13] the Contractworld Award (Auszeichnung)[14] and in 2006 Deutschland – Land der Ideen.[15] Its unique shape and moniker, "The Berlin Brain", has elevated the library into a promotional icon for the Free University's ambitious "Excellence Campaign", and images of it are widely used in the Free University's publications and on its website.

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12 www.bbr.bund.de > Baubereich > Wettbewerbe und Preise. Accessed on 26 January 2013.

13 www.architekturpreis-berlin.de/. Accessed on 26 January 2013.

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