Building System Design for an intelligent building

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Building System Design offers intelligent solutions using the example of the DIAL headquarters in Lüdenscheid

At the DIAL headquarters, an intelligent building was created with the help of modern technology. The aim was to find solutions that satisfy the needs of people, employees and visitors, without staging technical solutions as an end in themselves. Technology and architecture go hand in hand in a holistic concept. The result is an energy-efficient building with the highest standards of comfort and aesthetics.

The project

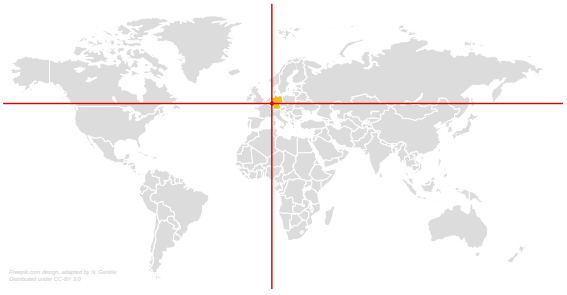
DIAL GmbH sees the future in intelligent, fully automated buildings that are geared towards the needs of their users. That is why the architecture and the overall technical concept for the company's own headquarters in Lüdenscheid were also designed in-house and managed until the move in 2013. Since then, the software-controlled building has been continuously developed.

On a construction site of around 5,000 square meters on a former train station site, DIAL realized a striking new building complex that set new standards, particularly with regard to the integral planning of the technical building equipment - the building system design. One of the results is the high energy efficiency of the new building, which is

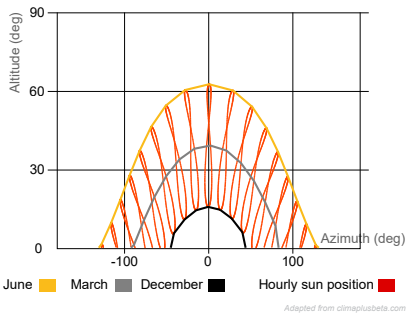
Figure 1. DIAL Headquarter Lüdenscheid. The windows are floor-to-ceiling and lintel-free.

almost built using a passive house design and does not require a conventional heating system. Around 2,000 square meters of usable space will be available on three floors. The complex space program includes a central foyer with bistro and catering, offices, conference rooms and several laboratories for measurement, lighting experiments and training.

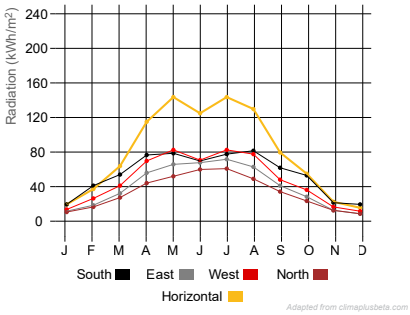
DIAL is a rapidly expanding company with currently 90 employs, but the new building is designed for up to 100 workplaces. If even more space is required in a few years, there is an adjacent option area available, which provides



Location: Lüdenscheid, Germany
51.22°, 7.63°



Sun path for
Lüdenscheid, Germany



Global horizontal and vertical radiation for
Lüdenscheid, Germany

IEA SHC Task 61 Subtask D
Monitored by **DIAL GmbH**

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Figure 2. The DIAL Headquarter and sorrounding

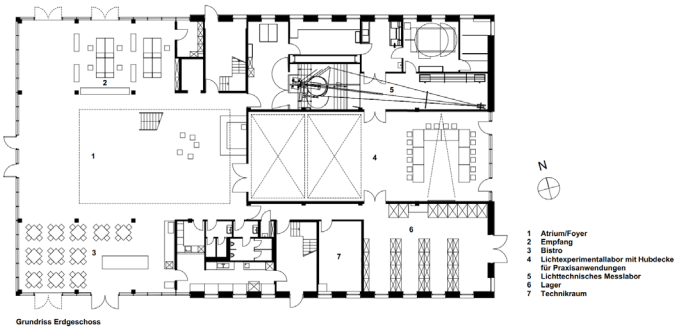

Figure 3. Plan of DIAL Headquarter

Figure 4. The atrium at daytime

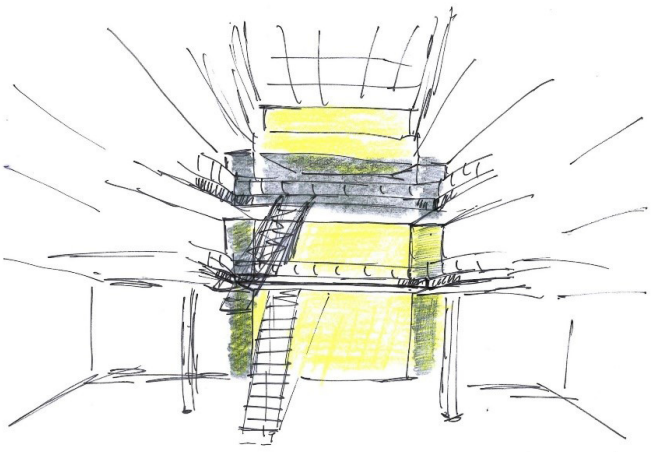

Figure 5. Concept study for the atrium

a further 3,000 square meters for a second construction phase.

Monitoring

From the beginning, thermal, lighting and energetic simulations were the focus of the design.

The technical systems were planned as a co-working function and run in a complex interplay. All trades are networked with one another, which means that no system works independently. An operating software controls and regulates the functions of the building on the basis of the information available. In order to operate the building in an energy-efficient and comfortable way at all times, it is necessary to implement dynamic operating strategies with the help of building automation.

The installation of the technical equipment is therefore largely carried out in a raised floor, to be able to update the installation at any time

From here, the supply air is introduced into the room and the exhaust air is discharged from the room. Since this arrangement does not conform to the textbook, it was simulated in terms of flow technology beforehand.

Energy

In order to balance daylight and artificial light as efficiently and ergonomically as possible, a dynamic light manage-

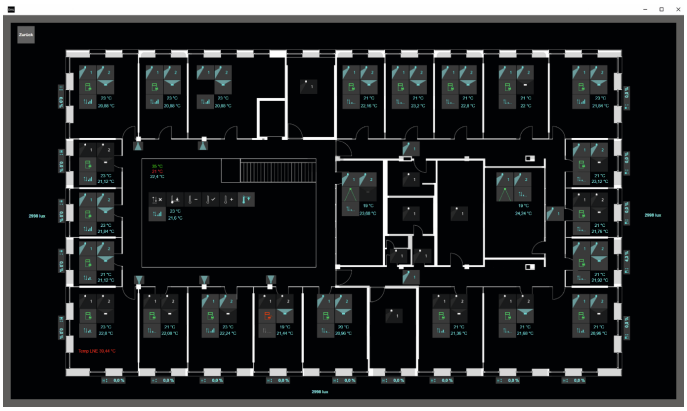

Figure 6. Overview interface for the building management system

Figure 7. The atrium at night

ment of the external sun protection and the artificial lighting is required. In principle, all application functions are controlled by the building operating system as required (Figure 6). Nevertheless, great importance was attached to providing the user with individual influence. Conventional switches cannot be found in most rooms. Individual settings are made via PC app or smart phone (Figure 8).

Solid concrete ceilings and outer walls are integrated as thermal storage masses into the energy and climate concept, which is based on an extensive thermal simulation. Above all, automatic functions of ventilation and air conditioning systems such as night-time operation or free cooling should be mentioned here. In order to be able to use the storage mass of the building as effectively as possible, it must be freely accessible.

"The intelligent building serves the user"

The use of software-based technical building management is crucial for the successful operation of the intelligent building. On the one hand, the central display of the operating status and the operation of the technical systems of the building take place, on the other hand, the recording and continuous evaluation of the operating data with the aim of maintaining and optimizing the building's performance. The entire building is hybrid automated and based on KNX IP. At field level, in addition to KNX, DALI (lighting) is also used.

Figure 8. Interface of the PC-App used for the individual user settings

Lighting design

The lighting design is based on the natural effect of daylight and its dynamic course. The principle is: learning from daylight. It includes on 3 components:

1. Basic lighting

The basic lighting is used to create sufficient horizontal illuminance and illuminance on the eye. The direct view into the light sources is taboo, which is why indirect lighting is necessary. The light colour is uniform in all offices 6500 K and creates the impression of a clear sky without intrusive blue tones (Figure 9). The lighting is not switched on suddenly, but always gently dimmed up and down. It can also be used to achieve high lighting levels of up to 2000 lx. The floor-to-ceiling and lintel-free windows and lightsabres between the individual offices ensure that there is sufficient supply of daylight.

The basic lighting follows the brightness of natural daylight, whereby the user can choose between three different dynamic brightness gradients depending on his personal inclination (Figure 10). This corresponds to the philosophy of lighting planning at DIAL, as it is also taught in the training courses. It feels like artificial daylight.

Figure 9. Renderings of the individual light scenes

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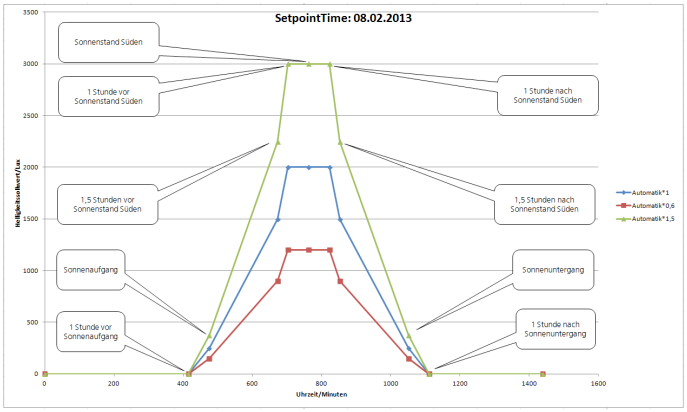

Figure 10. Set-points for basic artificial lighting. Three different luminous levels can be set by the user

2. Accent lighting

The accents give the feeling of direct sunlight and consciously rely on the positive effects of light and shadow, light and dark. They set logical perceptual focuses on objects in space. The light sources are arranged completely without interference and can be adapted to new conditions. Warm white was chosen as colour temperature corresponding to the sunlight.

"Basic lighting follows the brightness level of natural daylight"

3. Vertical lighting of the external walls

Positioning of the lights close to the wall (grazing light), continuous illumination of the entire outer wall. Its colour was a matter of controversy. Now it is either individually adjustable or fixed with a given light colour.

Following this basic concept, individual concepts were developed for the various usage profiles in the building for bistro, atrium, offices, meeting rooms, laboratories, training rooms, sanitary facilities and corridors, which each fit harmoniously into the overall concept. The additional costs associated with this rather complex lighting concept were consciously accepted in favour of the well-being of employees and guests.

User perspective

Right from the start, the focus was on people, their needs and their comfort in the building in accordance with the philosophy: The user doesn't have to operate anything, the intelligent building serves the user. This contains:

- No paternalism for employees
- The ventilation and lighting can be customized
- Brightness that can be freely set in wide areas

The integral design of architecture and technology followed a holistic concept. Even the building's reduced colour concept continues through to the digital user interfaces.

The building is operated mainly via PC apps on the smart phone, with which the employees can influence the air, temperature and light quality and adapt their workplace to their needs with just a few clicks.

Lessons learned

The decisive factor for the successful implementation of intelligent systems in this project turned out to be an integral design process. On the basis of a detailed project analysis, all essential features of the building's operational and operating philosophy were designed at the early stage of the architectural design.

On the installation side, the current solution combines ventilation and heat. Practice shows that this is not an ideal solution. However, the double floor offers the opportunity to remedy this shortcoming in the future.

"The additional costs associated with this rather complex lighting concept were consciously accepted in favour of the well-being"

Programming in *Codesys* also turned out to be difficult to maintain in retrospect. A modular and parameterizable software solution would be the method of choice for a future project.

Further information

M. Bali, D. Half, D. Polle and J. Spitz (2018). D*IAL GmbH case study: Licht und Mensch* in *Smart Building Design - Conception, Planning, Realization, and Operation*. De Gruyter. ISBN 978-3-0356-1629-3

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