Complex Building Automation
Energy Efficient New Construction of Hagen Sparkasse by Klaus auf der Springe

Dipl.-Ing. Klaus auf der Springe (Author)

Project Manager Electrical Measuring, and Automatic Control Engineering
THS Consulting, Gelsenkirchen
Chairman of the VDI Guideline Committee 6105 "BUS Systems in Building Installation – Examples of Application" and involvement in other VDI guideline committees.

Corresponding email: klaus.aufderspringe@ths-consulting.de

THE PLANNING TEAM

In mid-2002 the Friedberg architects' bureau Bremmer, Lorenz, Frielinghaus, which had been successful in the architecture competition, was commissioned to plan the new construction of the main branch of the Hagen Sparkasse (savings bank). The Sparkasse had already decided to demolish the 22-storey 1970s office block known for miles around as "Langer Oskar". Redevelopment of the Hagen landmark was not economically viable and instead its spectacular blowing up was to open the door to technical progress. To complete the planning team Skiba Ingeniurgesellschaft für Gebäudetechnik from Herne, which in the meantime has merged with THS Consulting GmbH, Gelsenkirchen, was commissioned with the planning of all the internal technical facilities, including the extensive media installations and the preparation of an integrated facility management and operating plan. The planning team was rounded off with structural planners, sound insulation experts, a fire safety consultancy company and the EGS-plan engineering company for energy, structural and solar technology. The project management for the building was assumed by DBB, Deutsche Bautec Baumanagement GmbH based in Mainz, which originated out of DAL Bautec.
In collaboration with our engineering bureau, EGS-plan drew up the integrated energy plan for the new building, which in addition to the necessary requirements for the shell of the building also had a strong influence all the building's internal technical systems. As the Sparkasse was incurring high energy costs because of the ageing technical systems and façade of the existing building, the client had placed particular value on the economic operation of the new building, without impairing the convenience, amenities or the attractiveness of the building. The use of natural resources formed apart of further considerations, was discussed together with the clients and led to the overall design of the building approved for further planning.

THE STRUCTURE OF THE NEW BUILDING

A five-story building was erected on an area of around 125 m × 50 m. The basement acts as an underground garage with 145 parking spaces and is also used as a storage area, strong-room and for the archives. It also contains the heating and cooling control systems. On the ground floor, in addition to the elliptical entrance and the cash machine areas accessible

outside opening hours, is the expansive customer foyer over 20 m in height with consultation desks, privacy and waiting zones.
An events area, the conference and events room, a Mediterranean-style restaurant and integrated VIP area, a coffee bar, an atrium with a glass roof (22 m high) as well as five shop units make up the remaining space.

In addition to offices, the Sparkasse's conference rooms are located on the first floor. The conference room above the main entrance has been designed in a particularly exclusive manner, taking on the shape of the main entrance. The second to fourth floors are predominantly used as offices, with the Sparkasse's casino also being located on the 4th floor. The Sparkasse offers offices to rent on the floors 1 to 4 of the southwest wing of the building.

INTEGRATED ENERGY CONCEPT

In addition to the user requirements in terms of functionality and convenience, the integrated consideration and planning of a building also includes the subsequent operating costs of the building. In regard to the economic viability of the investment and the subsequent operating and maintenance costs, the drawing up of a sustainable energy concept plays a central role in planning.

In the discussions between all the parties involved in the planning the following objectives were defined:
– Window ventilation rather then mechanical ventilation,
– Air-conditioning or cooling as an exception,
– Reduction in heating and cooling costs,
– As much use of daylight as possible
– Individual room regulation,
– Use of natural resources,
– High level of sound-proofing from outside as the building is located directly adjacent to several bus stops.

The concept also included training of the building users in order to harmonise their expectations and behaviour with the new building.

BUILDING SHELL

In the initial phase of consideration decisions on the building shell were made.

First decision: the office will have box windows, which in the case of rooms facing the street will also have a "deflector pane" for sound-proofing reasons. This deflector pane effectively reduces the noise of arriving and departing buses but still allows the windows to open for natural ventilation as narrow gaps between the deflector pane glass and the facade allow air to be exchanged.

The glass-covered area of the customer foyer, the events area and the inner atrium as well as the entrance area designed as a glass facade are constructed with different qualities of glass in order to create optimum thermal insulation conditions and a feeling of comfort in the interior.

VENTILATION

The building was divided into zones with different ventilation concepts.

The principle of natural ventilation before mechanical ventilation was taken into account in the offices.

Offices adjoining the customer foyer area or the atrium are provided with displacement ventilation via air outlets integrated into the lower sections of cupboards. The air drifts through the room and is directed via sound-proofed facade ventilation elements into the customer foyer/atrium.

The total quantity of air in the offices in conjunction with the adjoining customer foyer and atrium take is balanced out via shutters for natural and/or mechanical ventilation and venting of these areas depending on the weather.

An extensive ventilation shutter control system in the façade and glass roof also ensure pleasant temperatures in the customer foyer and atrium.

A weather station records climatic data, wind strength and direction so that the necessary shutters can be opened for optimum ventilation of the foyer without draughts being felt or rain coming in. Depending on the assigned individual room settings of the offices and customer foyer, the optimum shutter opening is set. However, there are areas in the new Sparkasse building that require mechanical ventilation and venting in the interests of user comfort, in particular the conference rooms in which many people are frequently expected, but also in the gastronomic areas of the restaurant, coffee bar and casino. These areas are mechanically ventilated, whereby of course ventilation devices with heat recovery integrated as circulatory composite systems are used. The ventilation controls are located on the roof behind a technical membrane.

SMOKE EXTRACTION

As well as the ventilation plan, smoke extraction forms an integral part of the installation technology and the associated natural ventilation and venting, particularly in the customer foyer. As part of the integrated planning of the building a concept was developed in collaboration with the fire safety consultancy company Lorenz that makes use of the existing ventilation and venting technology as far as possible.

This means that the ventilation and venting shutters, as well their control systems, assume an important dual function in extracting smoke from the customer foyer. If the event of a (hopefully never to occur) incident the weather station data is also used, but this time for the purpose or extracting smoke from the foyer as quickly as possible. Here the key is not an absence of draughts, but opening the façade and roof shutter so allow the greatest possible movement of air. At the same time the opening of shutters that could cause banked-up pressure in the foyer must be avoided. In accordance with the fire safety plan, in addition to the corridor areas from which smoke must be extracted, there are three smoke extraction zones – the atrium, events area and inner courtyards. Smoke is extracted from the atrium via smoke-heat removal windows (SHR windows) in the roof, which are also used for natural ventilation and venting. Electric doors to the shop area which in the event of a fire alarm in the atrium can be opened by way of a fire alarm system (FAS) contact within 90 seconds serve to provide an additional air flow, and at the same time the FAS controls the closure of the roller grilles in front of the doors. The partition wall to the events area should be closed or remain closed, the ventilation and air-conditioning switch of and the natural ventilation and

venting shutter close. The SHR windows in the roof of the atrium are arranged in such a way that groups can be formed in various areas so that depending on the wind direction and strength at least two of the four areas can be opened. The specifications were determined for each flow situation. A similar smoke extraction plan applies in area 2, the events area. Here, the shading systems must be moved into the "open position" in the event of a fire.

Smoke is also extracted from the inner courtyard via SHR windows in the roof that are used for natural ventilation and venting. Here, electrically operated additional flow openings in the outer façade provide additional flow and these can also be opened within 90 s by way of an FAS contact. The partition wall between the atrium and events area as well as the smoke extraction openings in these areas must be closed in the event of a fire alarm in the inner courtyard, the ventilation and air-conditioning systems switch off and the natural ventilation and venting shutter close.

HEATING, COOLING, BUILDING ELEMENTS ACTIVATION SYSTEM

Via the comprehensive building elements activation system provided in the office floors a basic temperature equalisation of the building is achieved. As a three-pipe system the building elements activation system can be used for both heating and cooling. However, in order to keep to the principle of optimising energy use cooling has been largely dispensed with. Therefore it is permissible for office temperatures not to be kept constant throughout the day in the summer months as is the case with cooling ceilings, but to fluctuate in accordance with changes in the outside temperature. If this basic temperature equalisation is inadequate the building is heated by heaters. The offices have individual room regulators which in addition to radiator valve regulation provide important room data to the building process control systems. Evaluation of this data optimises the deployment of building element activation. In the entrance hall, customer foyer, consultation desk area, events area and conference area underfloor heating/cooling is built in in combination with a double floor as a three-pipe system. The consultation, training and board rooms are also supplied via a three-pipe system, though in connection with single room regulation, cooling ceilings and cooling sails. Depending on the recorded room and weather station data the building component activation system is charged during the night. The cooling machines are designed for acyclic use by the consumers, i.e. not all consumers can be cooled at the same time. The system was optimised to use the building element activation system at night, whereby a basic load through constant consumers of cold, e.g. the dataprocessing and server rooms was added.

The cooling system allows the following four operating modes:
1. Normal operation
2. Heat coupling to the three-pipe system
3. Free cooling operation 1,
4. Free cooling operation 2.

As the various operating modes can change smoothly from one to another, the operating management for automatically selecting the relevant operating mode has been optimised to this use.

Normal operation is activated at external temperatures of over 20 °C . It is defined in that free cooling operation is not possible due to too high external temperatures and no more heat is being requested by the building element activation three-pipe system.

At external temperatures below 20 °C heat energy is required for the three-pipe system (operating mode heat coupling). Free cooling operation 1 (external temperatures below 14°C) is a combination of free cooling operation with simultaneous operation of the cooling machines. It is primarily intended for concrete core cooling, but also for the “server room” cooling cycle. Due to the hydraulic design of the installation as a dual-circuit system and the by-pass regulation on the cooling machines, simultaneous operation of the cooling machines and free cooling can be achieved.

Free cooling operation 2 is classic free cooling operation, without simultaneous cooling machine operation. Free cooling is triggered at external temperatures of below 7°C or if the specified value of the flow temperature of the “server room“ cooling circuit exceeds the external temperature by more than 5 K.

ROOM AUTOMATION

For room temperature regulation and control of solar protection, daylight and artificial lighting use the building the building will have a bus-capable room automation system as a result of the system architecture based on the LON Mark standard.

The full functionality of the room automation stations is shown on the central building control system. The individual room management system allows individual necessity-related regulation of thermal by each room user with simultaneous minimum energy requirements. The integration of all room functions, in particular the combination of heating, ventilation, climate control with daylight utilisation, lighting, solar protection, access control and safety systems is also possible.

The solar protection system has variously shaped and coated panels which in the upper section direct light into the room. Depending on the position of the sun the panels are automatically moved into the optimum position so as to provide protection from the sun at the same time as continuing to guarantee optimum utilisation of daylight. By way of a daylight measuring sensor, which not only transmits the light intensity, but also the elevation and azimuth to the room automation devices, depending on room occupation the lighting, solar protection and, where available, also antiglare systems are moved into the optimum position. The solar protection system also minimises external heat gain or, in winter, serves to enable solar energy to be used for room heating.

The following take place via the bus interface
– individual, group and zone control of the individual rooms,
– energy requirement signalling to energy production and distribution systems,
– individual use with the start-up and service software,
– individual adaptation to changing room conditions and
– access to every information point of the connected regulation and control devices.

Local operation is via room controls. Programmable are functions such as, for example:
– remote control and display via LonMark on LON bus,
– manual recording of room use via room controls, or automatically via presence recorders
– recording of variables, e.g. by way of window contacts (energy block),
– regulation of the room temperature in heating and/or cooling operation and air exchange (comfort operation),
– reducing or increasing the room temperature when not in use (stand-by operation)

– individual allocation of timer programs,
– if necessary integration of all room functions including the combination of heating, ventilation, and climate control regulation with lighting and solar protection
– rapid warming or cooling,
– free night cooling,
– morning purging,
– summer/winter compensation.

RECORDING CONSUMPTION AND ENERGY MONITORING

In order to be able to monitor the ambitious targets of optimised building operation, the Sparkasse Hagen has decided to use remote-readable metering devices and to commission EGS-plan with monitoring the energy for two years.

In addition to the advantage of allowing easy-to-understand running cost accounting with the tenants through extensive measurements and meter data, the measurements recorded by the central building control system are to be evaluated in collaboration with all those involved and used for further optimisation of installation operation and energy use. In this way both the operator and user can see the sustainability of the planning and optimisations.

Of course, the optimisation phase assumes the collaboration of users and operators. But caution is required as measures not accepted by the users will rapidly lead to dissatisfaction with the building. Eagerly awaited therefore is the first building data which after the introductory phase of the extensive building control systems should provide information about the achieved level of economic viability and user comfort.

Facts and technical data

Heating:
2 gas condensing boilers each with approx. 790 kW modulating, distributed to 20 heating circuits

Cooling:
3 cooling machines as screw-type compressor each with 438 kW cooling output at 139 kW compressor output distributed to 26 cooling circuits including 3 pipe system

Sprinkler system:
CEA/VdS-tested sprinkler system with side wall sprinklers as wide-angle nozzles in the offices, umbrella sprinklers and mist sprinklers in the other areas, pump output 90 kW.

Argon gas extinguishing systems:
For the archives, server rooms, back-up rooms, central distribution rooms data-processing with automatic fire alarm system and a fire early detection system.

Sanitary installations:
Fountains for the customer foyer, greenery in the atrium and entrance, sanitary fittings in various qualities.
2 fat separators

Ventilation and air-conditioning:
12 ventilation control systems with fresh air supply and outgoing air of 6000 m³/h to 45,000 m³/h with heat recovery and smoke extraction function
2 fat separators for the gastronomy areas and canteen
Garage CO- and smoke extraction system
Jet ventilators for garage smoke extraction and CO control

High voltage electricity
2 transformers 10 kV/400V each with 1000 kVA for bank operation
1 transformer 10 kV/400V with 1000 kVA for tenants
1 mains back-up system 700 kVA
1 no-break power supply system 240 kVA
2 no-break power supply systems 11 kVA
2 no-break power supply systems 7 kVA
2 no-break power supply systems 5 kVA
4 low-voltage main distribution frames (2 secure supply, 1 normal mains supply, 1 tenants' supply)
Security lighting system 35 kVA wit 15 sub-stations in function preservation
50 differently equipped sub-distribution frames

Telecommunications and IT installations:
DP network FTTO with mini-switches in the offices, designed completely as an optical fibre network
ISDN telephone system with 400 users
Camera system in accordance with accident prevention guidelines
Break-in alarm system partly class "C" with certificate
Fire alarm system with push button alarms, optical smoke alarms, smoke extraction systems
Venting installation
Access monitoring system with time recording
Emergency exit controls
Security cell DP certified in accordance with ECBS (European Certification Board Security Systems), quality class R60D; type-tested in accordance with EN 1047-2

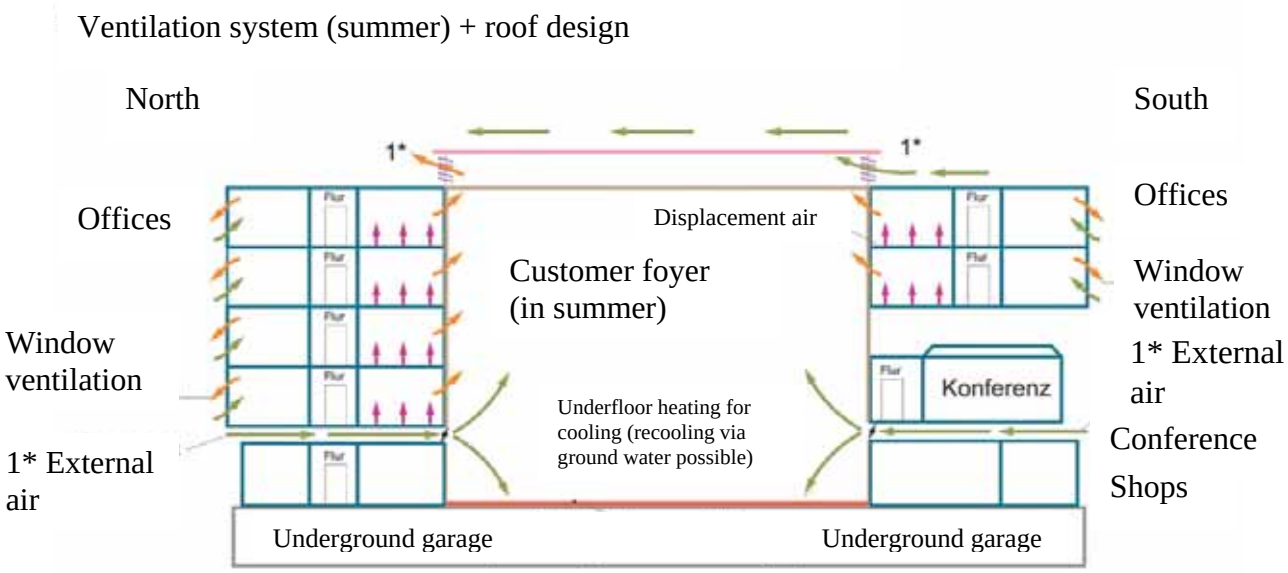
Media technology:
PA systems, including amplifiers, mixing panels, loudspeakers
Stage lighting systems
Plasma screens
Interactive information points (Infopoints)
Screens
Projection systems with uplighting and rear projection systems
Movable ceiling stands
Light rails
Light scanners
Control systems
AV cupboard
Transportable camera system
Training system
Conference system
Touch screen
Monitors

Software

Measuring, control and regulation systems, central building control:
Control system with 2 servers, ODBC interface to other systems
2 operating stations
1 touch screen at atrium reception
Individual room control systems LON
9 information centres
approx 12,000 data points hardware
Weather station
Consumption data recording via LON

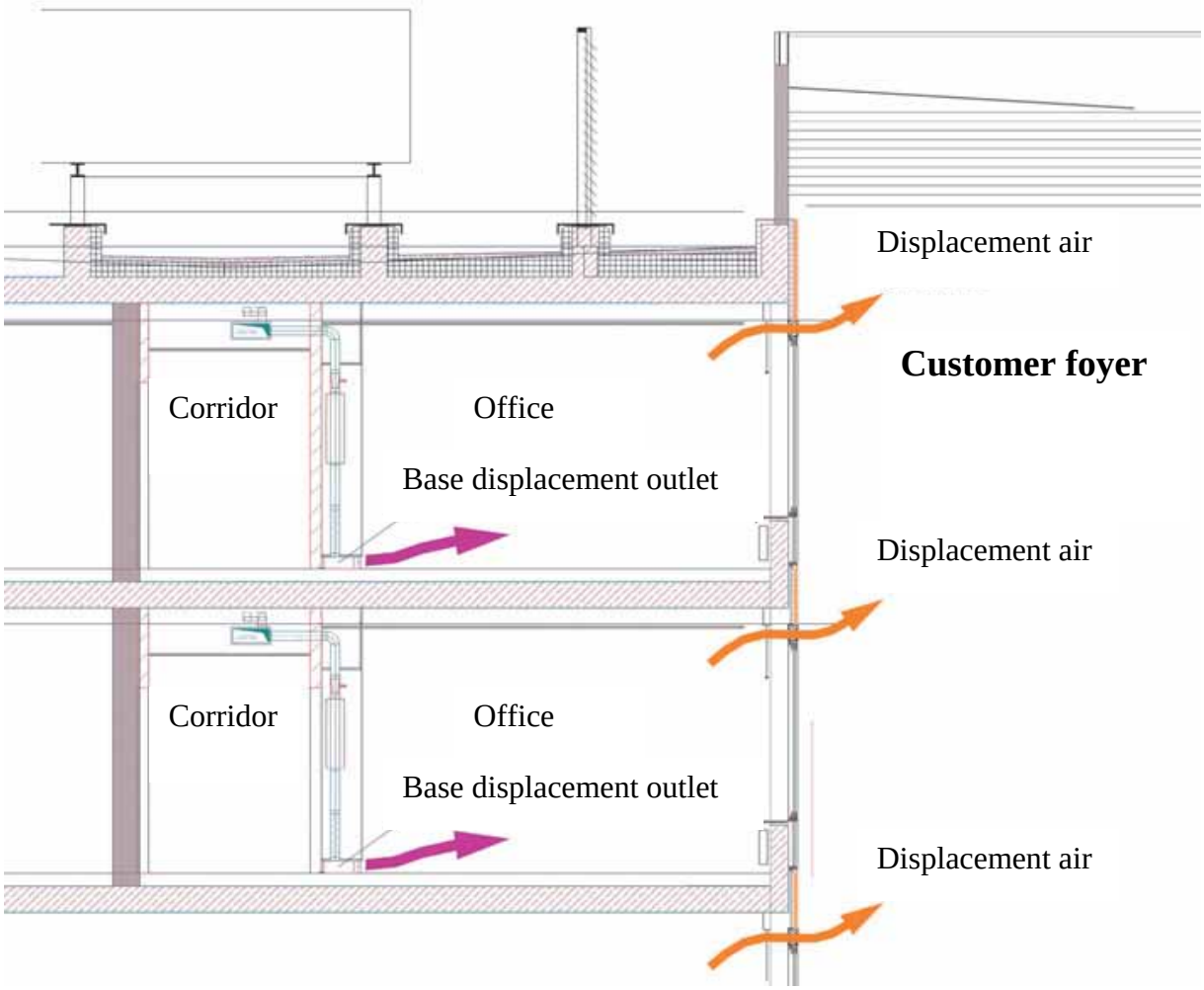
1 New building Sparkasse Hagen

2 Large customer foyer with “functional roof”



1* Shutter control of the external air and outgoing air via the roof façade depending on the temperature, CO2 volume in the customer foyer, wind speed and wind direction

3 Ventilation



4 Ventilation principle for the offices adjoining the foyer

5 Cooling centre

6 Events area with professional stage lighting and PA technology

7 View into the covered atrium to the restaurant “Hagen1“

8 Planted atrium with rest areas

9 Clever architecture creates consultation areas

10 Lift shaft as light source

11 Reception area

12 Roof structure with ventilation panels

13 Fassade of the customer foyer