Why Research and Development Work for Retrofitting of Commercial and Administrative Buildings?

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1. More Co-operation between Building Physics and Building Services!

Why research and development for retrofitting? Why do we retrofit our buildings? Why do we retrofit commercial buildings? One answer is: We are not content with our commercial buildings. The energy consumption is too big, the indoor conditions are not satisfying. One of the main reasons for our dissatisfaction is the relatively bad co-operation between building physics and building services. Commercial buildings and structures of good quality can only be achieved in co-operation between building physics and building services, because the impact of both disciplines is interconnected and cannot be considered separately. You will not be able to keep to a reasonable cost budget without co-operation. The investment cost will climb and the running costs too, for many decades. The co-operation must include the following phenomena:

Heat

Energy saving is increasingly necessary and constitutes a problem which will in future have a profound influence on the technical design of buildings and structures. Control, calculation, design and execution of necessary energy saving measures within the building is indispensable for architect and civil engineer. The German regulations on thermal insulation require detailed knowledge of this. Heat in connection with protection against moisture creates comfortable and domestically hygienic conditions. The future belongs to the low-energy house or even the zero heating-energy house.

Moisture
Only few external forces are so intensive and at the same time so perilous for the building, its function and its durability as moisture. Questions of joints and problems of moisture protection, all kinds of moisture penetrating from outside, inside, below and in cross section have to be controlled by architects and engineers in every detail.

Sound
In our highly technical society noise is increasingly becoming a scourge of mankind. The discussion about the sound insulation regulations has illustrated this drastically. A "quiet" dwelling is the desire of millions of people. Urban sound insulation between buildings and traffic areas is becoming more and more one of the most important measures in environmental protection. Bridges are provided with sound insulation walls. Architects and engineers must be capable of taking into consideration sound insulation measures in design and construction.

Fire
Every year thousands of millions of damage is done by fire. Protection of life and health, protection of property and protection of material assets require knowledge of the laws and regulations and their application to structural design and construction.

Daylight
When planning buildings, the design of windows, natural lighting and insolation is of great importance as regards interior work because of energy economy and noise transmission from outside. Daylight and insolation are also indispensable for the psychological and physical well-being of the building users.

Urban Planning Physics
In view of the ever increasing urbanization, the events "ante portas" are of ever increasing importance. We are no longer happy with the changes caused by our building-infested environment. The deterioration of our climate and the noise propagation in the close surroundings of our buildings is an increasing cause of concern.

A lot of research work must be done in these fields. When you analyze different trends in constructional activities for commercial buildings at present, you will find three basic tendencies full of problems, i.e.:

- The building design is not adjusted to the local climatic conditions. One does not distinguish whether the building is a so-called summer or a winter problem.
- The energy consumption is too high.
- The indoor climate is not convenient. The user complains of SBS (Sick Building Syndrome).

In the following these three negative trends are to be described in greater detail and their effects on necessary research work presented.

2. Summer or Winter Problem?

Many commercial buildings are not adapted to their local climatic conditions as regards their building concept. A classic example of with what irresponsible disregard climate-oriented design was neglected is provided by the various international hotel chains, which always build their hotels in accordance with the same principle, e.g. glass-and-steel construction, irrespective of whether they are intended for damp and sultry, for dry and hot or for temperate climatic regions. The design deficite is then compensated for by air-conditioning installations which consume a lot of energy. In reality a clear a priori decision ought to be made as to whether the building presents a so-called summer or winter problem (Figs. 1 and 2).

As a rule, an administrative building (Fig. 1) possesses far higher internal heat loads than a residential building (Fig. 2). The higher heat loads result (compare Fig. 3) from:

- the physiological heat diffusion from the people inside, as the occupation density is much higher.
- the higher illumination requirements
- the large number of pieces of equipment needed for the calculating and communications systems.

Summer problem

Example: future administration building

Internal heat load:	<< 100 W/m²
Total energy demand:	< 100 kWh/m²a
Heating energy demand:	10 kWh/m²a

Structural measures:

- solar protection
- avoidance of condensate

Technical measures:

- ventilating
- cooling
- moisturizing
- lighting
- (heating)

Figure 1: Description of a summer problem building, e.g. administration building, indicating the energy engineering data of the structural and technical measures.

The dominant feature in residential buildings is the heating energy requirement in winter. By contrast, the energy conception of administration buildings is determined by the cooling, dehumidification and lighting energy requirements in summer. This calls for different structural and technical measures. In residential buildings the primary requirements are insulation and heating. In administrative buildings, by contrast, solar protection and cooling measures are in the foreground; heating and insulation are less important, while the latter may even exercise a negative influence by impeding, under certain circumstances, the heat flow from inside the building. In the case of administration buildings with high heat loads, only the minimum heat protection required to prevent surface condensate formation should be undertaken. A lot of development work still has to be done in this sector as far as commercial buildings are concerned.

Winter problem

Example: future residential building

Internal heat load:	10 W/m²
Total energy demand:	< 60 kWh/m²a
Heating energy demand:	< 40 kWh/m²a

Structural measures:

Insulation
Ventilation

Technical measures:

Heating

Figure 2: Description of a winter problem building, e.g.: residential building, indicating the energy engineering data of structural and technical measures.

Internal heat loads

1. Physiological heat release (100 W per person)	2 to 200 W/m²
2. Lighting	5 to 50 W/m²
3. Equipment (EDP, text processing, printers, communications and information systems):	2 to 100 W/m²
Total:	10 to 350 W/m²
Average:	20 to 60 W/m²

Figure 3: Survey of internal heat loads in commercial buildings.

3. Too Much Energy Consumption!

The information contained in Fig. 1 shows that the total energy demand of commercial buildings in our local climate amounts to more than 100 kWh/m²a, in many modern administration buildings it is even 200 to 300 kWh/m²a. Administration buildings are in fact "real energy guzzlers".

Figure 4 shows the final energy consumption in percentages and the CO_2 emission of commercial buildings. One can realize that a relatively high percentage of energy is spent for ventilating and for moistening or dehumidifying. Lighting also contributes a significant share (especially in CO_2 emission!), because lighting principly needs electric energy. Figure 4 clearly shows in which fields saving energy is worth the effort in commercial buildings.

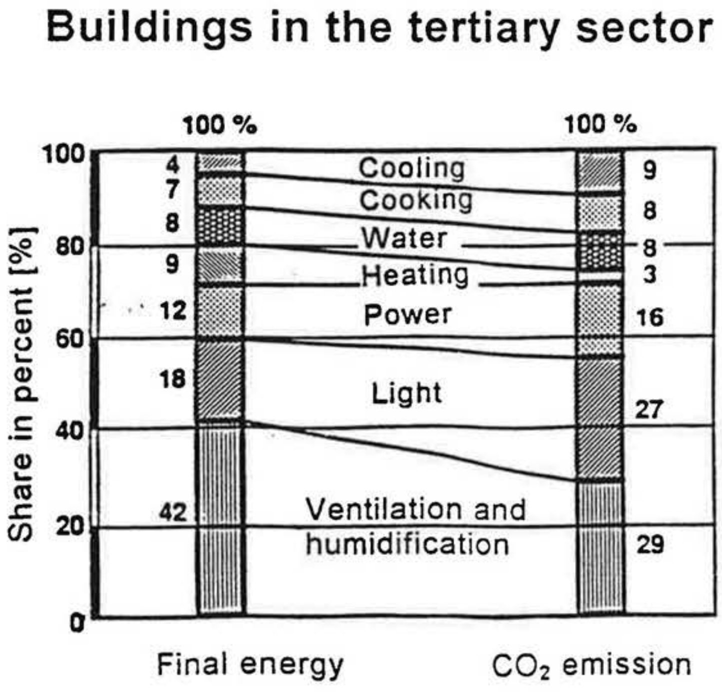

Figure 4: Percentage share of energy consumption and CO_2 emissions for various utilizations in commercial buildings.

4. Indoor Air Quality Must Be Improved!

SBS complaints about the so-called "Sick-Building Syndrom" have increased alarmingly recently in commercial buildings. Here a considerable research requirement exists. Figure 5 shows first results of initial investigations into the influence of moisture emissions as representative of many gaseous and dusty emissions inside rooms. One can realize from Figure 5 that complaints about too humid or too dry indoor air are increasing. It seems, however, remarkable, that too dry air is not complained about in clean-rooms. Complaints about too dry air appear only if the air is not clean, i.e. in the case of dusty or aerosol-loaded air. Dryness alone thus is not interferent to health. It leads to an irritation of the outer and middle respiratory tracts only, if the air is dirty. Complaints about dry air indicate therefore always a lack of indoor cleaning.

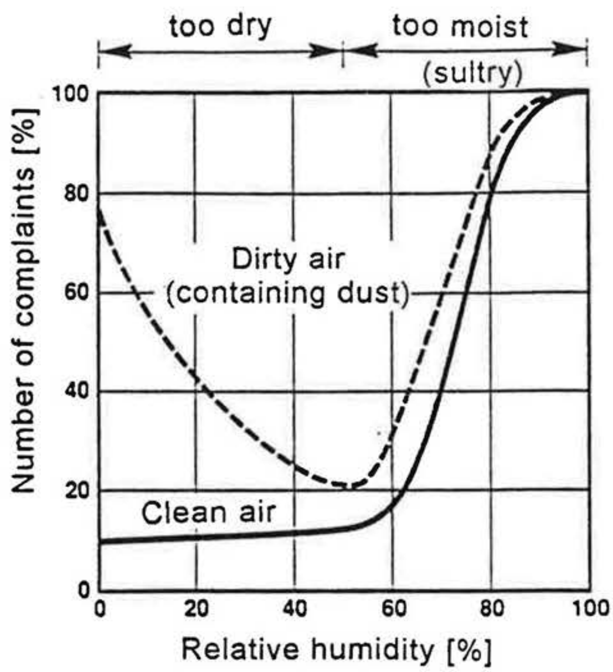

Figure 5: Relationship between frequency of complaints and relative humidity of air inside buildings (based on first preliminary investigations at the Fraunhofer Institute for Building Physics).

5. Better Education

On these fields I touched very briefly the main topics for research and development work, which must be considered. Nevertheless the education of our architects, civil engineers and building services engineers must also be "retrofitted", must be improved.

The aim of the education of architects and engineers in building physics and building services should be, to enable them to use the laws of building physics in planning and design in general and recognize those special problems which are difficult or important. The question whether a teacher of building physics or building services is included within the department of architecture or mechanical engineering or of civil engineering (or even of physics) either separately or to serve the different disciplines is of minor importance and can only be solved in relation to the existing university structure, which varies from country to country and from university to university. It is however, important that the different problems of building physics and building services are taught by one lecturer in one discipline, otherwise the students may not recognize the interaction between the various fields (e.g. if thermal insulation and water vapour transmission are dealt with in one lecture and sound insulation in another, the student may not hear both lectures or may fail to recognize that water vapour problems exist in sound insulation layers).

Due to the rapid development in building physics, its growing importance and higher demands, many architects, engineers and specialists are often overtaxed. Experts (e.g. building physicists) are then consulted. The goal is certainly to enable the architects and engineers to solve the building physics and building services problems within their team whenever possible and to appreciate when to seek expert advice.

Each country's different traditions and building laws will have an influence. It is therefore not very useful here to classify problems and responsibilities in building physics and building services together with the corresponding professions. But the motive is given here for the various countries not only to establish educational concepts for building physics but also to implement it into a performance concept, which is quite important in practice. This would also help in many controversies between architects and engineers concerning the climate-adjusted design of commercial buildings and the right way to retrofit them.