

Dipl.-Ing. (FH) Ulrich Sieberath  
Director of ift Rosenheim

## The ideal window from the technical point of view

### Solution methods for durable window and facade constructions and their evaluation

#### 1 Introduction

Desires are dreams that need to be realised. But have prospective homeowners ever "dreamed" of windows? Dreams are usually about new cars, a new bathroom or perhaps a prestigious photovoltaic system, to represent an innovative, environmental outlook. But this is not due to lack of available solutions. Already, we are able to produce windows that make use of the technology of tomorrow. The wide variety of innovations exhibited at BAU 2005, held in the spring of this year, showed that manufacturers are indeed responding to the demands of the market. These innovative projects need to be developed further in technical and scientific terms and, at the same time, have to cater for market needs, in other words making sure that the windows of tomorrow make our lives more comfortable, easier and safer.

When asked about their needs, the following criteria were on the wish lists of occupants: increased burglar protection, integration of solar and daylight protection, improved sound insulation and long service life with minimum maintenance and care. Criteria such as efficient thermal insulation and tightness go without saying.

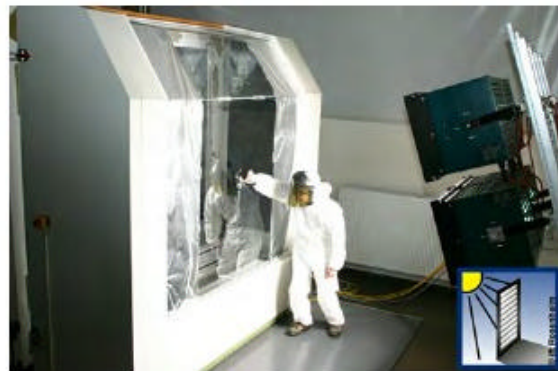


Figure 1 Testing complex innovative construction elements using calorimetric measurement methods

#### 2 Innovations and technical market trends

The building envelope of tomorrow will be modelled on the human skin – breathing, cleansing and renewing itself, and responding to heat, cold and moisture. Put simply: our skin makes us feel good. Thus the trend is moving towards "intelligent" and "smart" construction elements. Central functions such as ventilation, air conditioning, heating, safety and security are integrated into windows and facades to achieve a higher degree of comfort.

The general public has been more or less unaware of progress made in the fields of window, facade and glazing construction, although these developments represent a gripping high-tech story. The combined functions of thermal and solar protection, light guiding, energy generation, ventilation and safety can be achieved in extremely small spaces. The "intelligence" of innovative windows and facades lies in their adaptability – either automatic or via controls – to envi-



ronmental influences, which allows them to increase user comfort. Innovative glazing systems with controlled glass prisms or glass louvers provide solar protection and ensure glare-free lighting of indoor spaces. Electrochromic, gasochromic and thermotropic "colour layers" within the glass react to external influences and automatically change the degree of transparency of the glass pane. The use of electroconductive layers or vapour-deposited "electronic circuits" on the glass turn the glass into a multi-media surface.

recorded. Large building complexes can be centrally monitored and controlled at reasonable cost, independent of location. Possible innovations are use of biometric data, video scanning, single entry access control systems, security systems and video surveillance. As a result, ift Rosenheim initiated a research project "Integration of electronic systems into window, facade and door units". General specifications for tenders, recommendations for use, guidelines, test schemes as well as interfaces and demonstration projects are under development to heighten public awareness and promote practical application.



Figure 2 Innovative solar screens exhibited at the special "Light & Shadows" show at the fensterbau 2004 exhibition

### 2.1 Electronics make windows "smart"

The integration of electronic and electromechanical systems into the façade, and the increasing intelligence of products increases safety and user comfort. Intra-communication between different components is under development, and has been tested in pilot projects. Transfer of environmental data, e.g. local wind speeds or solar incidence facilitates efficient control of solar screens and opening units. The presence of occupants in the building or the locking status of windows can be

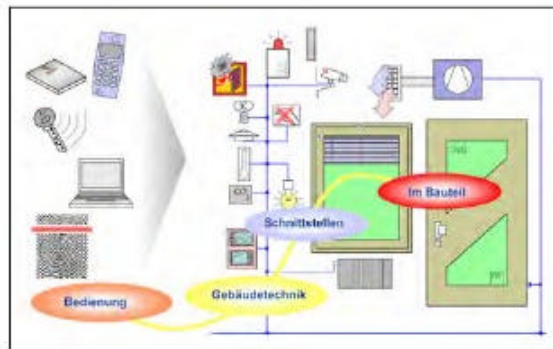


Figure 3 Electronic systems in window construction

### 2.2 Opportunities for nanotechnology

The objective of nanotechnology is to design "custom-tailored surfaces". Nanotechnology is able to meet almost any requirement. It is often based on examples from nature, with scientists attempting to reproduce these using a nanometric approach. Surface properties are the most crucial parameters for the window and façade industry. Apart from the well-known lotus effect, the following nanotechnological surfaces will allow completely new product characteristics:

- anti-graffiti coatings,
- scratch-resistant surfaces,
- anticorrosive, hydrophobic, hydrophilic and oleophobic finishes,
- antibacterial surfaces based on photocatalytic effects.

Nanotechnology is expected to become a key market player, because most of the functions and useful properties of technical products are dependent on the product's surface.

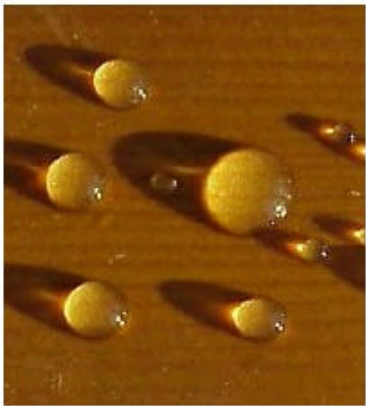


Figure 4 Surface properties improved by nanocoatings (lotus effect)

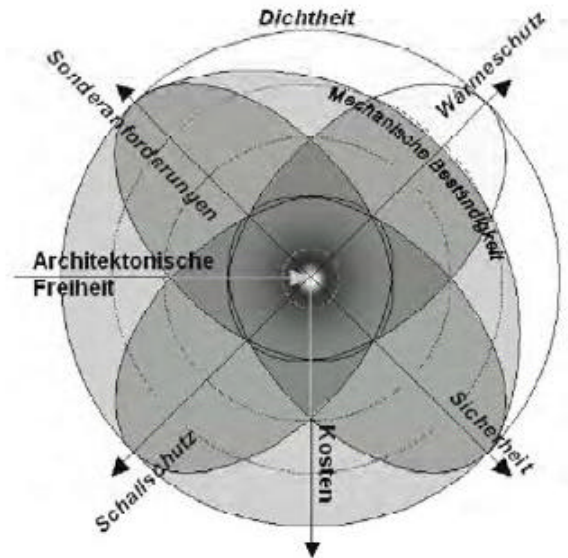


Figure 5 Overlapping of the key characteristics and functions of windows

### 2.3 Practicability must not be ignored

Due to the growing complexity of construction elements and specialisation within the various disciplines, an integrated approach is essential. This is illustrated by the following example. Triple insulating glass units are used to optimize the energetic performance of windows. Such units are heavier and are likely to reduce the service life of the window unit. Hence all major functions must be evaluated and checked to ensure practicability and fitness for use. This task is one of the key competencies of ift Rosenheim, i.e. using an integrated approach to make sure that practical aspects are not ignored.

### 3 Market needs and opportunities

Surveys held among housebuilders showed in an impressive way that building renovation is an efficient means for decreasing the number of vacant buildings in the property market. Official statistics published by the Federal Statistics Office suggest a growing renovation market, but this is not re-

flected in a growth in the window market. In real terms, the German window market is on the decline. When trying to find out the reasons for this disproportionate situation, we must face the question of whether perhaps the windows we produce do not meet the needs of the replacement market. As a result, windows are disregarded in a great number of building renovation measures. The main challenges can be summarized as follows:

- Despite continuous improvement of installation techniques, clients continue to request fast, cost-efficient and non-destructive window replacement.
- Not all of the specific technical requirements of building renovation are taken into account in an adequate manner. Overall planning is often neglected by designers, clients and window manufacturers. The issue of ventilation is not satisfactorily solved.
- A high level of user comfort, greater safety and reduced energy costs have not yet become commonplace.



The trends listed below have an additional significant impact on demand:

- Buyer behaviour, based on "greed is good" mentality,
- Demographic population growth,
- The issue of security in a globalised world,
- Climate change,
- Legislation, standardization, rules and regulations,
- Innovations in fenestration, architecture, art and design.

"barrier-free building" standard. Motorized drives are specified in many cases, but the conventional forces used to operate window or door handles have also been discussed. Older people can often not apply the forces formerly specified for the manual opening or closing devices. Thus these operating forces are considered too high (window handle 10 Nm, entrance door handle 5 Nm, locking/closing action 2.5 Nm). Our conventional mechanically-operated devices quickly reach the limits of their usefulness; while motorized products continue to have a number of weak spots. In addition to the issues of functional reliability and noise generation, they must be compatible with other systems such as building services and electrical systems, all of which have so far represented impediments to the greater acceptance of this technology. The ift research project "Elektronik im Fensterbau" (electronics in window construction) is aimed at creating a basis for the broader application of these products.

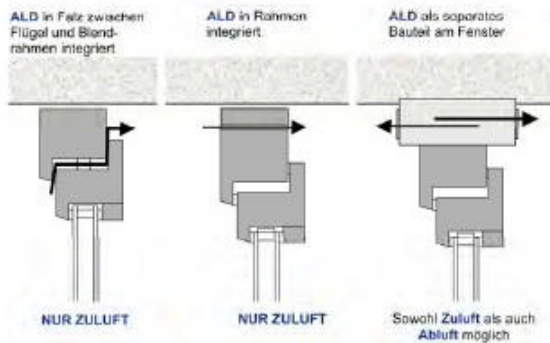


Figure 6 Positions of ventilation devices in the window

#### 4 Technical status quo and possible solutions

Current studies have shown that those "aged 60 and more" possess substantial financial means, and that they are willing to spend these funds on themselves. This leads of course to specific requirements and creates new opportunities in terms of the windows and facades produced by us. This target group places greater emphasis on user comfort and user safety. But also larger window areas and a higher degree of thermal insulation, sound insulation and burglar protection are requested.

##### 4.1 User comfort

The role played by user friendliness is underlined by the discussion and revision of the DIN 18030

##### 4.2 Windows and ventilation

Particularly when old buildings are refurbished without professional planning and design, insufficient attention is paid to the problem of ventilating the renovated facilities. This leads to the well-known issue of fungal growth. User-independent ventilation would rule out the possibility of insufficient and improper ventilation as the most frequent cause of fungal growth, thus preventing most damage claims. Therefore, simple and easy-to-use concepts should be developed when it comes to the design and dimensioning of ventilation units.

Installation of a central ventilation system in the context of building refurbishment is often impossible or uneconomical. For old buildings, decentralized ventilation devices, integrated into windows, are the systems of choice. Historically, the role of windows in buildings has been that of an element for the exchange of air, and this has also been the common understanding of the majority of occupants. Therefore, it can be expected that the installation of decentralized ventilation devices in or around the window will be accepted by

most users. It is also advantageous to position ventilators within or around the window, since no additional costs are incurred, because refurbishment will in any case involve the windows being replaced.

A classification table allowing uniformity in rating the performance characteristics of products would ensure the comparability of products and characteristics. Assistance in specifying the necessary requirements would be provided in the form of additional recommendations for use, based on the above-mentioned classification table. This makes it possible to select suitable products without the need for complex, cost-intensive planning, and facilitates comparison on an integrated basis.

#### 4.3 Protection against the effects of climate change – a task for the window construction industry?

The effects of global climate change become more and more apparent in the form of storms, heavy rains and floods. Insurance companies have already reacted to this in many fields by not covering specific insurance risks. People respond to this development, which is threatening the existence of each and every person, by looking for constructional solutions to protect their property. It is now up to the window construction industry to develop solutions to minimize damage and create windows that resist floods, hurricanes and high winds. **ift** has reacted by developing special test methods. Initial experiences show that advanced products are able to meet these requirements.

There is no German (DIN) or European (EN) standard to describe and test flood-resistant construction elements. Therefore, **ift** Rosenheim has prepared the **ift** guideline FE-07/1 "Hochwasserbeständige Fenster und Türen – Anforderungen, Prüfung, Klassifizierung" (Flood-resistant windows and doors – requirements, testing, classification). This guideline provides a procedure for the testing and classification of watertight and flood-resistant structures, and includes guidance on the installation and operation of these elements.

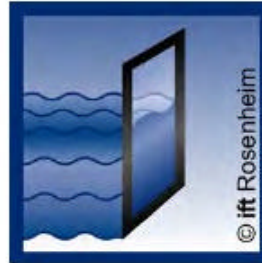


Figure 7 Pictograph representing flood-resistant windows

Changes in wind velocities, in conjunction with a greater frequency of high wind speeds at a regional level, have made it necessary to revise DIN 1055-4. With recent experiences of e.g. tornadoes in the Ruhr area, it is no wonder that debate has commenced on the subject of more stringent design principles and new assessment criteria. In the Southern United States, the "hurricane test" has become common practice for windows and facades. In addition to the application of static pressure loads and exposure to pressure changes, simulation of the impact of debris on the window is also required ("impact test"). A similar test method seems likely to be introduced for European windows in the European risk zones.



Figure 8 Impact test with wooden plank as missile



#### 4.4 Construction elements with security features

Insurance companies and the crime prevention commission have been addressing the problems of open borders and different social structures in the population for a long time. Discussions relating to personal safety are often overly heated and lacking in factual detail, with the result that older people in particular have reacted by raising their security requirements. The window industry has developed efficient and economical products with burglar and intrusion resistant characteristics to meet this need in the most effective way possible. In partnership with the industry, **ift** has prepared rules for defining comparable guidelines for all concerned. These initiatives need to be developed further with the objective of integrating burglar resistance into construction law, as is already the case in the Netherlands and Belgium.



Figure 9 Tests and certificates as a basis for CE marking

#### 5 Technical implementation of quality as a marketing tool

Studies have shown that it is not only the price that determines the purchase decision of many consumers, but also quality and safety features, and this trend is more pronounced the longer the service life of the products. The premium segment is profitable as a result of selling high-grade construction elements. However, customers do not want just to be satisfied; they want to be enthused. This is only possible by being consistently and fully committed to efficient quality strategies and quality assurance systems.

The new CE mark is mistaken by many for a quality mark. The CE mark obliges the manufacturer only to declare specific characteristics – it is not a quality mark. Only RAL quality assurance and certification by an independent third party confirms that the manufacturer has actually fulfilled the requirements. This and other quality-related characteristics that have a major impact on the quality of the product enable “Made in Germany” quality to be reached, which has been the distin-

guishing mark of the German window industry for many years. This makes it all the more important to strengthen successful concepts such as the RAL quality mark, and not always to challenge it. Our quality assurance approach has been the envy of many other countries, and they have tried to imitate our systems, e.g. with the “Acouterm” quality mark of our French colleagues, or similar approaches from our Belgian and Danish colleagues.

#### 6 The impact of standardization, legislation and technical rules

Next year we will be confronted with major changes, among others, those resulting from the implementation of the “Energie-Effizienz-Richtlinie” (energy efficiency guideline). The extended debate about the energy label will substantially stimulate demand for energy-saving



measures in the medium term. Additional business is likely to result from the preparation of energy labels and the projected demand for renovation. From a technical point of view, the new energy efficiency guideline will not give rise to many new developments in window technology, because the guideline is mainly based on the "Energieeinsparverordnung" (energy efficiency regulation).

In addition to the product standards for curtain walling, industrial doors, smoke and heat exhaust ventilators, the Formal Vote will start at last for the product standard "Windows and Doors" on 29 September 2005. Implementation could then start with the first CE marking for windows in June 2006.

CE marking in Germany will relate only to air permeability, and thermal and sound insulation. Further issues such as burglar resistance and mechanical durability are additional characteristics which have been discarded by building legislation and are thus not required for CE marking. The system of necessary certificates and testing is easy to understand and, as is the case with sound insulation, is based on tables – as is already the case with DIN 4109. In the case of thermal insulation also, evidence can be achieved by means of either simple calculations or tabulated values as per EN 10077-1. What remains is the air permeability test. Here, a representative window from the respective manufacturer is taken for testing. If the sealing planes and seals are of the same design, and the necessary pressure level is assured, the results can be extrapolated to different types of window.

Detailed practical solutions have already been developed in cooperation with system suppliers of windows. As regards implementation by medium and small sized wooden window manufacturers, much remains to be done in order to find solutions that are practical and which at the same time meet legal requirements for quality assurance. The practical orientation of the product standard is reflected by its reduced emphasis on standard solutions, and its greater focus on developing customized high performance designs.

The common objective of the German window and curtain walling manufacturers' association and the crafts associations should not be to return to standardized profiles, but should instead allow window manufacturers to offer custom-tailored products and gain access to the European market.

A negative example of a lack of cooperation is the revision of VOB DIN 18355 "General technical specifications for building works - joinery". The revised version links weatherproofing requirements with material recommendations and rules out the possibility of using economical and well-proven designs. As with product standards, it is important here that the requirements are material-neutral and performance-driven. In partnership with the manufacturers' associations concerned, ift has drawn up an expert opinion to speed up revision of the VOB.

## 7 Summary

There is no "ideal window". Windows need to be continuously tailored to user needs and requirements. They require a long-term and highly diversified approach by the window industry. Many technical necessities could have been successfully launched already if the advantages and possibilities offered had been efficiently promoted. When it comes to implementation, however, necessary and well-proven tests must be performed and taken into account to ensure fitness for intended use as a crucial quality feature in the long term. Defects, structural damage and recalls will immediately have a negative impact on the market for innovative products.

The image of windows and facades in Germany can be improved if the window industry gives higher priority to prevention of damage, throughout the entire production process and including installation and maintenance. This applies in particular to the premium segment. From practical experience gained at ift Rosenheim, damage prevention requires the following:



- Yet greater adherence to established design rules and regulations.
- Adequate testing and trials of new products.
- The performance of the product should not be overestimated, and the product should be used as instructed by the manufacturer.
- Evaluation must be based on technical, standard and legal requirements, so that clients and manufacturers are able to correctly assess the services to be rendered.
- The new RAL quality assurance system will be a sign of a high-grade product, to allow the manufacturers concerned to be recommended to clients and designers.

### Trends and Information in a nutshell

#### Technology

- Energy optimization will continue
- Availability and diversity of motorized and electronic systems will increase
- The share of ventilation systems will increase
- Windows will be integrated into building services and ventilation systems
- New modes of operation and hardware technology
- The importance of solar protection and light guiding will increase
- Smart glass with shading, light guiding, self-cleaning and energy generating characteristics
- Continuing large number of damage claims caused by unprofessional design and installation
- Increasing demand for burglar protection and security

#### Market

- Increasing share of refurbishment work
- Increasing cost pressure

- Market division into simple and premium windows
- European standardization and CE marking will change technical requirements
- Export orientation of competitively strong manufacturers
- Increasing importance of designs that meet the needs of older and disabled people

#### New ift guidelines and recommendations for use

- Zusätzliche technische Vertragsbedingungen (ZTV) für Fenster, Türen und Tore (Additional technical contractual terms (ZTV) for windows, and pedestrian and industrial doors)
- Dezentrale Lüftungseinrichtungen am Fenster (Decentralized ventilation systems for windows)
- Baukörperanschluss von Fenstern: Teil 1: Verfahren zur Ermittlung der Gebrauchstauglichkeit von Abdichtungssystemen, Teil 2: Verfahren zur Ermittlung der Gebrauchstauglichkeit von Befestigungssystemen (Wall connection of windows. Part 1: Method to determine the fitness for use of weatherproofing systems, Part 2: Method to determine the fitness for use of fixing systems)
- Produktspezifische Leitfäden zur CE-Kennzeichnung von Fenstern und Außentüren ohne Rauch- und Feuerschutzigenschaften, Vorhangfassaden, Türen, Innentüren und Glas (Product-specific guidance sheets on CE marking of windows and external pedestrian doorsets without resistance to fire and smoke leakage characteristics, curtain walling, industrial doors, flush doors and glass)
- Einsatzempfehlungen für Fenster und Außentüren; Richtlinie zur Ermittlung der Mindestklassifizierung in Abhängigkeit der Beanspruchung; Teil 1: Windwiderstandsfähigkeit, Schlagregendichtheit und Luftdurchlässigkeit (Application Guideline for Windows and Doors; Directive for the Evaluation of the Minimum Classification dependent on the Load; Part 1: Resis-





**Dipl.-Ing. (FH)  
Ulrich Sieberath**

Born on August 27, 1957

Studied Wood Technology at Rosenheim Polytechnic University

since 1982 Staff member at ift Rosenheim, Head of the Door Technology and Burglar Resistance Department

since 1995 Head of the Certification Centre for Quality Management Systems and Products

since 2000 Coordination of business units at ift Rosenheim

since 2002 Deputy Director of the Institute

since 02/2004 Director

Additional functions and activities:

- Lecturer at Rosenheim Polytechnic University
- Member of numerous standardization committees:  
German delegate to the Advisory Group of Notified Bodies, TC33/WG1+2/TG6+5 (Product Standard – Windows), convener of TG6, member of TC33AHF (Fire Resistance), NABau 09.01.02 Doors/Steel Frames DIN 18111, Fox Club, SVA Fire Resistance (Fire Resisting Doors and Shutters), member of working group “Sharing of experience between testing bodies”.
- Convener of NABau 09.01.00 (Mirror Committee to TC33) “Doors, windows, shutters, building hardware and curtain walling”, of NABau 09.01.00 Burglar resistance, of CEN TC33 /WG1+2 Windows and Doors, of TC 33 ad hoc Burglar Resistance and of the German Sector Group SG 06/09D Windows, Doors and Glass.
- Contributor, DIBt “SVA Fire-Resistant Doors and Shutters”
- Specialist assessor for:  
Federal Office of Measurement (Swiss accreditation body), principally for the fields of:  
Components testing for windows/doors/façades, materials testing – wood/timber-based materials /glass, burglar resistance testing – windows/shutters/doors/façades/glass/metal fittings.