Windowcraft – Part One

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Abstract

The first part of this two-part paper is about work undertaken with my husband, Hans Allbäck, to create conditions in which we could continue to use historic windows and doors. During the 1980s and 1990s the Swedish authorities, in association with window and glass manufacturers, wanted people to change to modern triple-glazed windows to save energy and achieve improved noise reduction. In order to to sell our services for renovating and protecting old houses, we therefore required scientific evidence of the performance of original doors and windows in use. In collaboration with Professor Bertil Fredlund of Lund Institute of Technology we have been able to provide a number of answers.

Background – the vision of life economy

Back in the 1970s, Hans [Allbäck] and I ran a small building company geared to the maintenance and reconstruction of older properties. We trusted the contemporary expertise of paint suppliers, building material traders, and researchers. Knowledge of the use of historic methods to restore and maintain older properties was very poor. We replaced old materials with new, and Hans worked frequently with alkyd-based paints that contained large amounts of solvents. At that time there was little mention of the problems of working in such an environment. After many years as a painter, Hans became ill as a result of exposure to the solvents. His symptoms, such as nausea, headaches, and apathy, became an accepted part of his daily life. He even put his beloved accordion aside, since he could no longer play it.

After a period of six months working at the Technical Museum in Malmö however, and in the absence of solvents, Hans could clearly feel his zest for life returning. Out came the accordion again. In 1982 we formulated the dream of 'good work' – to be able to work in a meaningful, creative, and agreeable manner that did not adversely affect our health. In order to be able to solve environmental problems with paint, putty, wood, and metal, we were forced to find unconventional solutions. These also needed to be simple because of our financial limitations. Through our work at a local museum and close contacts with old artisans in the district, we were inspired to search for our future in the past. Ethnology studies at the University of Lund provided a solid theoretical background. We found that methods of production for paint, putty, wood-filling compounds, adhesives, and cleaning agents from the 1700s, 1800s, and early 1900s fulfilled all our wishes when it came to function, quality, environment, durability, and last but not least, economy. We soon specialized in the restoration, renovation, and maintenance of historic windows and doors.

Windowcraft – combining traditional and modern techniques

Our specialization – in combination with the development of tools, materials, and methods – came to fruition in 1982–83 with the development of a new profession, 'Windowcraft'.[1] In this, traditional craftsmanship and materials are combined with modern machines and methods, the goal being to re-use original building materials, taking into account their durability and function as well as cultural, environmental, and financial issues. Every window is regarded as an individual unit, to be treated by a specially trained artisan who has access to an appropriately equipped workshop, regardless of whether the restoration process calls for carpentry, glazing, painting, metalworking, or bricklaying. The new profession, Windowcraft, is characterized by its holistic approach.

We started our training school in Sweden in 1985. Since the Windowcraft artisan is a carpenter, glazier, painter, blacksmith, and bricklayer, all rolled into one, he or she will thus be an expert on the interactions between the various materials of a window – wood, glass, paint, putty, fittings, and plaster – and will assume responsibility for the end result. This new organizational form removes earlier technical and financial limitations on the renovation and maintenance of windows. The individual parts create the whole (Figure 1).

Inventions and re-discoveries

As already mentioned, we had to solve problems relating to the environment, economy, and health.

Figure 1 *Windows from 1880, showing small-scale repairs.*

Economics forced us to invent the simple weatherproof temporary window that made it possible to work all year around. We also made a small adjustable platform to reach windows at any height.

The health challenges related to our need to remove all layers of paint (alkyd as well as acrylic) to reach the original material of frames and sashes. This work could be done by using a heat gun, gas, or linseed-oil dipping bath. The great problem with stripping paint is that potentially dangerous fumes are given off when using a heat gun. We therefore provided a special paint stripping area in the workshop with fans and good ventilation. But we no longer need to worry about paint fumes since the development of solvent-free, linseed-oil paint, and when it comes to improving working conditions in the paint shop, we hang the window casements from the ceiling to make it more comfortable to paint them. Read more about this in the next issue.

Another difficult problem that we encountered was how to soften hard linseed-oil putty in order to remove glass. The putty needs to be heated to more than 100ºC to soften (depending on the quality of the putty), but glass will crack long before that temperature. As we wanted to save the old blown glass in order to recycle all parts of the window, we carried out many trials before realizing that infrared radiation with a wavelength below 2.6 μm passed through the glass. At a wavelength of 2.0 μm, only 10–15 per cent of the energy is absorbed by the glass, depending on its thickness and iron oxide content. We knew that if we could regulate power to the lamp at a level where the infrared radiation was very high ($\sim 2.0\ \mu$m) and focus this energy, we might heat the surface without affecting the glass. This was the basis for the development of a new tool to soften hard putty without cracking the glass – the 'putty lamp' was born (Figure 2).[2] Infrared radiation passes through the glass, and softens the putty over and under it. Once the putty and pins are removed, the valuable, original glass can be lifted from the casement and recycled.

We also developed a system for cleaning ironmongery in a safe and quick manner, and re-discovered old-fashioned ways of protecting cleaned metal against further corrosion. In Norway, we learnt how to heat the metalwork and dip it into linseed oil. We also learnt from eighteenth-century sources how to provide protection using tin.

We also found many useful hand tools and quality materials, including a hand-driven profile planer from the early eighteenth century. Even today we use this 'machine' to complement the work of modern machinery in renewing windows from that period (Figure 3).

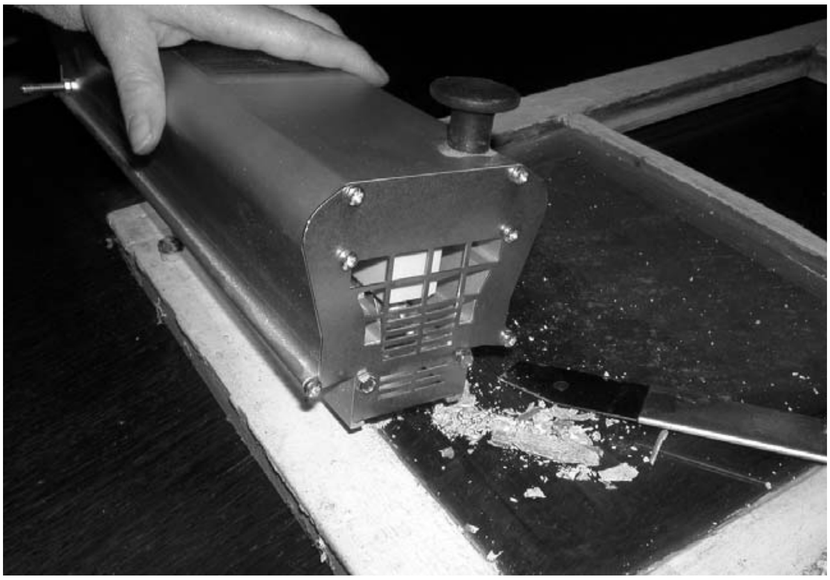

Figure 2 *The putty lamp – an innovation by Sonja and Hans Allbäck.*

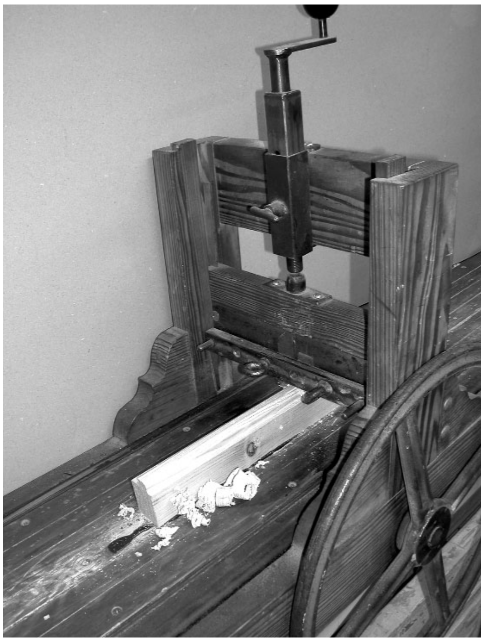

Figure 3 *Modified copy of a planer from the early eighteenth century.*

Old windows from 1880 fulfil all modern demands

Having noticed the very high quality of both materials and construction of windows up to *c*.1950, many people told us that they changed to modern plastic and aluminium windows because the old ones could not fulfil the requirements for heat loss and noise reduction. We did not agree.

Noise reduction of window from 1880

As part of research conducted with Borås, Sweden's testing and research institute, we tested a window produced in 1880 (an unhinged window with removable inner casement) in comparison with three modern glazed windows.[3] The historic window performed better than its modern counterparts. Why? The key issues were considered to be:

- asymmetrical glazing – different thicknesses of glass in the outer and inner casements (at least 30 per cent difference)
- large air gap between the glass panes
- two panes of glass only
- division with glazing bars and transoms

- mounting 'in line with the façade'
- new linseed-oil putty
- caulking between the frame and wall using flax caulking
- glued silicon-tube sealing strips (Sipla)
- solid wood construction

Wood quality

Through our work with thousands of old windows from three centuries, we have noticed great differences in wood quality (mostly pine) and construction. Before 1950, people were aware that you had to fell trees in wintertime when they were dormant and their metabolic rate was very low. They also knew about drying the timber slowly.[4] The threat of fungal decay is increased depending upon the factors of time, temperature, food, and water. These conditions influence the level of risk of decay affecting timber joinery units. If you choose timber with a high resin content, there will be less water in the wood. If the resin is absent, you can introduce linseed oil. Pinosylvin is a natural fungicide in the wood. In areas with long, hot and wet summers, conditions easily lead to decay and the tree will respond by producing it as natural protection.[5]

After the Second Word War, people disregarded quality and ignored the lessons of the past. Today we have many problems with windows and doors that are no more than 10 or 15 years old (Figure 4). In order to save as much of the older, good-quality material as possible, we have rediscovered simple techniques for repairing sashes and frames. We use

Figure 4 *Window sections 15 years old (left) and 150 years old (right).*

simple hand tools and old-fashioned casein glue. After impregnation with hot linseed oil, we apply linseed-oil paint produced from local flax. People often ask why good-quality windows are not produced today. The answer is that water-resistant, resin-bearing wood does not suit modern machinery. Modern paint systems are also inappropriate, as the resin will destroy alkyd paints. You can still buy good Baltic pine, but the timber industry chooses not to use it.

Pilot project in Leipzig

In 1997 we were invited by the community of Leipzig in Germany to undertake a pilot project by restoring one window from 1880. Here, the local authorities wanted to use local craftsman to restore traditional windows in order to stop the change to modern plastic units. The main aims of the project were therefore to show the possibilities for restoration and encourage local craftsmen to seek training in Windowcraft. In addition, the specific objectives were:

- to restore the window to an 'as-new' condition and prolong its life
- to fulfil modern requirements for thermal resistance and noise reduction
- to achieve good function so that the window could be opened and closed without friction
- to ensure simple and cost-effective future maintenance

'Kastenfenster', August-Bebel Strasse 80, Leipzig

The window from August Bebel-Strasse consisted of an inner and outer frame with three inward-opening inner casements and three-inward opening outer casements (Figure 5). The casements did not have cross bars, nor were there any fittings on the outside.

Quality and condition

All the frames and casements were of very good quality and well worth preserving. The timber was healthy and there was no fungal damage. In spite of neglected maintenance, the windows were in good condition.

Action

The casements and frames were dismantled and transported to our workshop in Ystad, Sweden. First, all the glass was removed with a putty lamp. Rusty fittings were removed for cleaning and all paint was

Figure 5 *Window from 'Kastenfenster' in Leipzig dating from 1880.*

completely removed. The outer and inner frames were fitted together and minor damage caused during transportation was repaired. After impregnation with raw linseed oil, the windows were re-glazed using linseed-oil putty of our own manufacture. Our goal was to keep the milled glass in the outer casements. As an experiment, we used 3 mm Pilkington Kappa Energy glass (K-Glass) in one of three inner casements, in order to show the differences in colour and light. Nobody noticed the difference.

Surface treatment

After impregnation with hot raw linseed oil, the frames were painted three times with solvent-free linseed-oil paint of our own manufacture. All the cleaned external fittings were treated for rust protection. The existing catches, hooks, and stays were repaired and polished before being re-mounted.

Improving thermal performance: a case study by Bertil Fredlund

Background

The point of departure for this project was the 'Allbäck' method, established 22 years ago by Allbäck Windowcraft (Allbäck Fönsterhantverk) for the renovation, restoration, and maintenance of windows from different periods. So far the method has been limited to restoring windows to their original state, with the limitations of thermal properties that this entails. In this project, a method has been developed to improve the thermal properties of the windows whilst retaining their aesthetic value. The project has been commissioned by Allbäck Windowcraft (Allbäck Fönsterhantverk) at Bjäresjö, Ystad, with finance provided by Teknopol in Lund.

The problem

Traditionally, improving the U-value (thermal transmittance coefficient) of windows has entailed replacing the units or fitting additional glazing. Both these approaches are expensive and detract from the aesthetic qualities of the original windows. A very sympathetic alternative is to improve the U-value in conjunction with renovation by replacing the inner pane with glass having a low emission coating. The problem with this however, is that the coated panes are usually at least 4 mm thick.

This gives rise to two complications: firstly, there is normally no space for a 4 mm pane in the existing glazing rebate intended for a 2–3 mm pane; secondly the 4 mm pane is likely to be too heavy for the existing frame.

In discussion with Pilkington, it was found that coated glass of only 3 mm thickness could be supplied at no extra cost and in the same delivery period.[6] This made it possible for a simple and aesthetically attractive solution to be applied, while upgrading the thermal performance of traditional of windows.

The aim of the project was thus to investigate and document improvements in the U-value of renovated windows where the inner pane is replaced with a pane having a low-emission coating. The test method and evaluation of measured values were compatible with Swedish standards applicable to the production of new windows, so that the results could be used in comparison with the installation or upgrading of new and existing windows.

Method

In order to achieve the stated aim of the study, tests were carried out on unrenovated, renovated, and upgraded windows in which the inner pane had been replaced by one with a low-emission coating. Tests were done using the hot-box method in accordance with Swedish Standard SS 02 42 12,[7] with evaluation conforming to the guidelines set out in Swedish Standard SS 02 42 13.[8]

Three windows, typical of their respective periods, were selected for the tests in consultation with Allbäck Windowcraft (Allbäck Fönsterhantverk). The outside frame dimensions of the windows in the test series were 1.2 × 1.2 m. The properties of other window sizes were obtained by calculation using FramePlus modelling software.[9] The windows selected for testing were carefully documented with regard to their condition prior to renovation. All action taken during renovation was also documented in detail. This work was performed by Allbäck Windowcraft (Allbäck Fönsterhantverk). The test windows may be described as follows:

- *Window No. 1*: Initially a four-light window from *c*.1880, which was too large for our test equipment. A suitable specimen size was obtained after the two smaller upper lights had been cut away. This is thus a 'two-light window' for test purposes, with two single panes, one in the outer casement and one in the removable inner casement. The glass thickness is 2 mm and the distance between the panes is 90 mm.
- *Window No. 2*: A two-pane window from *c*.1930. This has coupled casements in which the distance between the panes is 31 mm. Glass thickness is 3 mm.
- *Window No. 3*: A product from SP Windows, made in 1982. The window is fitted with a sealed unit consisting of three 4 mm panes, with 12 mm air gaps between the panes.

The frames and casements of all test windows were of pine. Measurements of the two older windows, No. 1 and No. 2, were taken in both their original states and after renovation (i.e. removal of paint, adjustment of fit between casement and frame, fitting of new sealing strips). The windows were upgraded, with the inner pane being replaced with one having a low-emission coating (Pilkington Kappa Energi Float). In the case of Window No. 1, the influence of two horizontal glazing bars per light was also tested. Measurements of the most recent window were made only with the window in its original state, since it was fitted with a sealed unit that could not be taken apart.

Evaluation

In order that a direct comparison of these three windows may be possible, the test results were corrected with respect to differences in window size. This correction was effected using FramePlus software. Calculations may be divided into three types:

1 Calculations performed on the windows in order to gain an idea of the accuracy of the program.
2 The effect of reducing or increasing the window size was studied by varying height and width by 10 per cent.
3 The U-value was calculated for Windows No. 2 and No. 3 when their height and width were standardized to those of Window No. 1 (i.e. 1.2×1.2 m).

The theoretical relative difference between the actual window size and this basic case was then used as the correction factor for the measured U-values.

The maximum difference between the calculated and measured U-values was 10 per cent. This was the degree of accuracy expected, and implied that FramePlus had adequate calculation accuracy for it to be used in correcting the measured U-values with respect to variations in window size.

Results

The U-values of the three tested windows are given in Table 1.

Condition	**Window (year of manufacture)**		
	No. 1 (1880)	**No. 2 (1930)**	**No. 3 (1982)**
Existing	2.44	2.56	1.83
Renovated	2.07	2.26	–
One new pane	1.60	1.77	–

Table 1 *U-values (W/m^2K) for tested windows.*

As may be seen from Table 1, the U-value or thermal transmittance of the older windows is in fact lower after upgrading than that for the three-pane window of 1982. The oldest window, from 1880, has the lowest transmittance value.

It may also be seen from this study that the effect of the glazing bar is relatively marginal. It makes no difference whether the glazing bar is fitted in only the outer casement or in both the outer and inner casements. For the 1880 window, the U-value deteriorated by 3–5 per cent when the window was fitted with a glazing bar.

Conclusion and recommendations

The study shows that heat losses through older windows can be reduced by *c.*35 per cent without any negative effects on the original aesthetic qualities.[10]

The method of upgrading is based upon replacing the window pane, preferably in the inner casement, with a new type of glass with a low-emission coating, available on the market today (Pilkington K-Glass). Pilkington manufactures this type of glass in 3 mm thickness that both suits existing glazing rebates and does not place excess load on the existing casement. A thicker glass may be too heavy. The emission coating on the glass is in the form of a very thin metallic deposit. This deposit is of a neutral colour and daylight is reduced by only a few per cent. Because of this, it is very difficult to distinguish these panes of glass from ordinary clear glass.

The result of renovating and replacing the glass in the window from 1880 shows it to be more effective than replacing it with a new unit. Heat losses are of the same order as in modern windows from the 1980s and 1990s. Since the low-emission glass is not appreciably more expensive than ordinary window glass, there is great potential for improving existing windows at a relatively modest cost.

The vision has become true

We often read and talk about the principles of restoration and authenticity, but not about authenticity in use. If the windows do not work, it is of little use to talk about such principles. It is, in our opinion, better to do nothing if you do not have the appropriate knowledge and skills.

Gaining experience as craftsmen is a pleasure. The hard work comes in finding ways of talking and collaborating with scientists and authorities. We were lucky to meet Bertil Fredlund in 1997 and Michael Knights, Principal Conservation Officer of Norfolk County Council, in 2000. Thanks to Michael Knights, we were introduced to Tom Coke at the Holkham Estate. They understood our way of thinking – that you have to look back in history if you want to see the future. Our vision has started to become true: to create a society in which craftsmen, academics, and officials collaborate in mutual respect, with the common goal of creating a sustainable, humane, and ecologically-sound society, thereby supporting the creativity and skills of the individual.

The second part of this paper will describe our work in rediscovering the qualities of linseed-oil paint, putty, and soap, and our experience of using these products.

Biography

Sonja Allbäck

Sonja Allbäck has a background as an economist and started her first company in 1969. She studied ethnology at Lund University in 1977–78 and worked for four years at a local museum. Together with her husband, Hans Allbäck – who trained as a bank clerk, decorator/painter, and carpenter – she developed the new Windowcraft profession. Since 1982, via documentation, product development, marketing, education and administration, she has been working to commercialize their innovations. Since 1985 she has run a private school for building care and focuses on windows and doors, and from 1998 she has also run Allbäck Linseed Oil Products Limited.

Bertil Fredlund MSc, LicEng, PhD

Professor Bertil Fredlund is head of the Department of Building Science at Lund Institute of Technology in Sweden. He has almost 25 years of experience in studying and analysing the energy performance of new and existing buildings. His department focuses on the energy performance of buildings and indoor thermal comfort. He has research interests in the design principles of low-energy buildings, climatic control, and utilization and protection against solar heat. He has also worked as development manager for Saint-Gobain Isover AB and chairman of a technical committee for the Swedish Standards Institute.

Notes

1 For further information on Windowcraft, see: www.windowcraft.se.
2 The putty lamp uses a tungsten filament, which operates at a temperature of 700–1,700°C to produce infrared radiation of wavelength $\sim 2.0\ \mu m$.
3 Simmons, C., *Fönster med hög ljudisolering mot trafikbuller* (*Windows with Good Noise Reduction against the Traffic Sound*), Rapport 1998–26, Sveriges Provnings-och Forskningsinstitut (The Swedish National Testing and Research Institute) (1998).
4 Nordiska Museet, *Var virket bättre förr* (*Was Timber Better in the Old Days?*), The Nordic Museum (1985).
5 Sjömar, P., *Byggnadsteknik och Timmermanskonst* (*Building Techniques and the Art of the Carpenter*), Chalmers Tekniska Högskola (Chalmers Institute of Technology) (1988), pp. 208–11.
6 Rolandsson, A., Market Communication Manager, Pilkington Sweden (personal communication).

7 Swedish Standards Institute, *Thermal Insulation – Determination of Thermal Resistance by Means of a Hot Box*, Swedish Standard SS 02 42 12, Stockholm (1981).

8 Swedish Standards Institute, *Thermal Insulation: Doors and Windows – Determination of Thermal Resistance by Means of a Hot Box*, Swedish Standard SS 02 42 13, Stockholm (1987).

9 FramePlus Toolkit, *User's Manual for DOS and MS Windows: Version 4.0*, Enermodal Engineering Ltd, Waterloo, Canada and Denver, USA (1995). A comprehensive tool for modelling heat transfer in windows, doors, walls, and other building components.

10 Fredlund, B., Lågemissionsglas och renovering förbättrar äldre fönsters värmeisolering (Low Emission Glass and Renovation Improve the Thermal Insulation of Older Windows), Report No. TABK–99/3055, Lund Institute of Technology, Department of Building Science, Lund, Sweden (1999).