"As much as necessary, as little as possible" Notes on the Protection and Restoration of Medieval and Renaissance Stained Glass*

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France is, by rights the traditional land of medieval glass paintings. The Cathedral of Chartres and the glass shrine of the Sainte Chapelle in Paris, with their virtually inexhaustible abundance of rows of almost completely preserved coloured windows, have for many years been no less than places of pilgrimage for devotees and friends of this art form. What wealth of medieval and Renaissance glass pictures still remains hidden in the cathedrals, churches and chapels of the French provinces is largely unknown in Germany, and is only being revealed gradually, even in France, through the records in the "Recensement" volumes of the Corpus Vitrearum France[1].

Germany, by comparison, has few glass paintings, with large areas in which not one single glass panel from the Middle Ages had been preserved. We know from various documents, reports and notices that the churches and chapels in these areas had coloured glass windows and virtually every archaeological exploration on church sites produces coloured glass fragments. We may assume from this that almost every medieval church had coloured panels, at least in the chancel windows. What has been preserved, more or less by chance, would amount, at most, to five percent of the original numbers, possibly even much less[2]. The greater part of this still remarkable and abundant stock of glass paintings was removed and hidden away during the war. Some, which was not protected, was preserved by good fortune; some, including works of extremely high quality, was lost, except for some meagre remains[3]. After the war, during the years of reconstruction, the panels were repaired, badly more often than properly, and replaced. Since then, about 30 years have passed, in which most of the stained glass windows have been exposed, without sufficient protection. to wind and weather. Natural ageing insufficient care, the installation of heating systems in churches and the related increase in the build-up of condensation, and no less important, the constant pollution of the air with noxious substances (sulphur- and carbon-dioxide, hydrochloric and hydro-fluoric acid, from factory and domestic chimneys, and from vehicles) have caused such serious damage, by an insidious process of deterioration, to large numbers of glass paintings, that they are close to final destruction. Their protection and restoration is an urgent task; this is the only way of ensuring the survival of this part of our historical and artistic heritage and of passing it on to future generations.

Since the full extent of this multiple problem has only been realised relatively recently-glass paintings, unlike wall pictures and sculptures, cannot usually be subjected to continual close observation- and since the research and practical application of stained-glass restoration has only been intensified, on a more widespread basis, within the last two decades, there is a lack of that tradition and tested experience which other branches of restoration technology have enjoyed for decades[4]. It has been possible to remove a considerable proportion of medieval glass paintings from immediate danger, in recent years. The following pages give an account of experience gained from this. Some simplifications were inevitable and no claims are made regarding completeness.

Preventive Measures

The most dangerous enemy of stained glass is water. Rain, dew and condensation combine with the noxious substances in the polluted atmosphere to form dilute acids, which - barely perceptibly at first - leach and corrode glass and black enamel and finally destroy them.

In theory, the simplest and reliable method of preserving threatened glass paintings would be to keep them in museums , replacing them with copies. However, this is impratical; no one could build museums on the scale of Cologne or Regensburg cathedral or the minster churches of Freiburg and Ulm. Besides which, stained glass windows are an essential part of the church building, even more than

altars and sculptures, and should not on principle be removed from the place for which they were made, centuries before. Replacing them by copies can only be considered in cases where the original has been destroyed to such an extent that, even after restoration, it is still in danger so that installation in the original position cannot be justified on conservation grounds. This solution must be reserved for exceptional cases.

It is therefore worthwhile to take measures which provide the conditions for an on-site "museum - like" preservation. The type of stained glass protection which to date, is the best-tried, simplest and offers fewest risks is the installation of an isothermal, i. e. internally ventilated, outer protective glazing. The endangered panels are removed, fitted with a strong metal frame (usually brass U-sections) and re-inserted, a few centimeters inside their original position, before a protective window which has been installed in the window rabbet. This prevents external weathering. Ventilation slits in the sill and above the top panels of the lancets or lights ensure that the original panels are circled by the internal atmosphere, thus providing a roughly constant climate both in front and behind the stained glass windows. This means that condensation will only form on the protective glazing; the stained glass windows are removed wholesale from the corrosive effect of noxious atmospheric substances, because they remain dry[5]. Additional heating filaments can be installed on the window sills in order to reduce the relative humidity in the area of the window. At a relative humidity of approx. 45% the noxious substances which are present even in the inside atmosphere of churches can have no corrosive effect.

A major disadvantage of the internally ventilated outer protective glazing is the aesthetic disturbance of the external architecture, if over-large full glass panes are used. This can be remedied by dividing the panes protecting the stained glass into smaller sizes, by using rectangular panes, diamond quarries or bull's eye panes (Figs. 1,3). These however are only recommended if the medieval stained glass is of very low transparency, due either to relatively thick layers of black enamel or glass corrosion. The line pattern of the protective glazing is then scarcely noticeable from within the church (Fig. 2), It is outlined on the original panes only in direct sunlight, but this minor nuisance can be tolerated since the protection of the valuable stained glass is more important.

On churches with an extremely delicate external architecture and with very light, transparent windows. the stark line pattern of a square or diamond pane division would have a disruptive effect. In such cases the lead design can be repeated, in simplified form, on the protective glazing (Figs 4, 5). The installation of panes of obscured glass between the protective glass and the original, in order to avoid the "copying" of the line pattern, noticeably reduces light, adds weight to the window and is also expensive.

The glass material chosen for the protective glazing depends on the financial resources of the church authorities and on aesthetic demands and requirements. Laminated safety glass need only be used where the protective windows themselves are in danger of being damaged frequently by ball or stone-throwing (Fig. 3). The problems of cutting this glass permit only simple, straightline division in this case[6].

There is another disadvantage of isothermal protective glazing which must not be concealed: the inward displacement , by some centimeters, of the original panels necessarily reduces the impression of the mullions and of the wall depth. Normally, in the dim light inside churches, the mullion and tracery-work appears dark beside the much brighter glass paintings, if not actually black (Figs 2, 4). So this is a minor nuisance which can be tolerated.

In addition, experience has shown that when inspecting the windows church visitors do not even notice the reduction of the mullion and wall depth, any more than they notice the fine slits of light which are often visible between brass frames and posts, caused by unevenness of the stone-work. Lead strips can be soldered on to conceal wider slits, in order to avoid cross-glare. The cover bars must also be large enough to extend over the whole width of the panels, including the frame, with no light penetration at the ends.

While it is true that externally ventilated protective glazing, whereby the original stained glass windows remain in the old rabbet, does protect the glass paintings from the direct action of driving rain, hail, dew and wind, this has considerable and serious disadvantages. The air cushion between the protective glass and the original does in fact moderate the difference in temperature between the inside and outside air, but cannot prevent formation of condensation on the stained glass. There are also the aesthetic problems of a fixture on the outside of the window. The breaking or cutting of new rabbets in the intrados and walls for a solid fixture is extremely risky, as this always means interfering with the architecture and thus, with the

monumental substance of the building.

Internally ventilated protective glazing currently offers the best protection against weathering of the stained glass windows from the outside and the harmful deposition of condensation on the inside. Since the glass paintings are not cemented in, but are only held in position by means of cover bars and splints or screws, they can be removed and placed in a safe location quickly, and at any time-eg. for construction or decorating work, or in case of emergency.

Screen-wire lattices, the use of which was recorded even in the Middle Ages and which are still common in many places, are always ugly. They are not normally necessary where protective glazing is installed, but there are some circumstances in which the extra protection is essential. In order to cause as little aesthetic disruption as possible to the outer appearance of a church or chapel,these lattices should not extend across the whole width of the window, but should only be inserted into the separate lancets, so that the mullion and tracery work between them remains visible. Plastic nets are thinner and lighter than screen-wire and they are barely visible. On the other hand, they age more rapidly and tear more easily: more importantly , they tend to stretch and sag.

Conservation Measures

Hardly any stained-glass window, removed after a long period of time for intallation of protective glazing, can be replaced without further treatment, with only a stabilizing brass frame. Even when removed with great care, edge panes are often broken, particuarly when the panels have been held in position by concrete mortar. Often, the saddle-bars are completely rusted through, the clamps are broken, the leading is sagging, buckled and damaged, and the dried-out, brittle cement has fallen out. Then, there are weathering encrustations on the outside, corrosion products on the inside, countless cracks caused by damage to the leading, and holes and blemishes by the throwing of balls and stones, as well as from air-guns and small-calibre firearms. Many windows have lost a lot of their black enamel and virtually all panels are incredibly dirty (Fig 6): coated with chalk and plaster splashes, cement remainders, soot from fuel oil and candle sticks and grease, and flying dust from heating systems; in addition, the accumulation of thick layers of algae can mean that the glass and the painting are almost indistinguishable, and can even render a stained glass window completely opaque, In this condition, it is virtually impossible to determine whether the black enamel, under the dirt, is still intact or whether and to what extent it has been corroded and weathered away or attacked by deposits formed on the inside. Deposits of soot and dust can make even a relatively clean stained-glass window look as though it is covered with gypsum effloresence, as flakes of dust and soot settle in even the smallest irregularities in the glass and paint.

Preliminary cleaning at different spots, using fine brushes or - for thick layers of dirt-water and a soft sponge, will reveal the condition of the glass and the paint (Fig. 7). It often happens that the layer of dirt can be removed relatively easily and that there is sound and undamaged black enamel underneath. Occasionally, old records will show that the same extent of damaged black enamel was present centuries ago. However, the inside of the window should always be cleaned with the greatest care and caution.

Protection of loosened paint requires special care and finger-tip sensitivity, as the weathered stained glass must be impregnated with well-diluted synthetic resin. Sometimes surface dirt must also be fixed together with the paint. There can be no such thing as an "emergency protection" as for the present no materials other than synthetic resin are available and because impregnation with these materials cannot be reversed. The removal of weathering crusts from the outside is both a conservation and restoration measure. It requires the same care as cleaning of the inside, particularly when examination shows that the there are the remains of the outside paint underneath the layers. These should also be preserved as part of the work of art and should be protected in the same way as the damaged black enamel on the inside. Fibreglass grinders and scalpels have proved the most practical tools for the removal of crusts as they can be precisely controlled. Careful moistening and softening with water can aid removal of the window which have not been painted. Ultrasonic cleaning, whereby it is essential to immerse the whole panel in a water bath, is extremely risky, as there is no means of preventing damaged paint from being loosened or shaken off with the corrosion products.

Damage to the leading can generally be removed without difficulty: this is usually a matter of ordinary repair work, such as the soldering of broken joints and partial re-leading. Buckled and sagging panels can be corrected using sand bags. Since the fitting of protective glazing protects the stained glass windows from the mechanical stress of wind and storm, there is usually no need for the costly re-leading of whole panels and windows especially as the saddle-bars and frames provide the necessary rigidity. Medieval lead-

ing is extremely rare in this country. For this reason they have to be preserved, even in small sections, in addition to which they are mostly intact and in a sound condition. Obviously, holes and defects in the glass must be closed. Because of a certain reluctance to imitate the original, there is a school of thought which favours filling in holes with "neutral" types of glass, Apart from the fact that there are no neutral tones in glass painting, since every piece of glass, even the less striking greys and greens, has its own specific shade of colour. additions of this kind very often appear out of place in the design of a coloured window. It depends largely on the colour sense of the cutter and the skill and care of the glass-painter whether the additions look out of place or blend harmoniously into the old panel. Added pieces should always be marked, inconspicuously, preferably with an engraving of the year. The more successful the addition, the more important to identify it. Unfortunately this is often omitted, because it is simply forgotton amongst all the other processes, or because of shortage of time. However. pressure of time can never be conducive to careful conservation or restoration.

Occasionally, if a church has very large windows the structural engineer rejects the installation of protective glazing on the grounds that doubling the weight would overload the mullions. However, since a cleaned and repaired or restored window cannot be exposed without weather protection-as this would give rise to further corrosion and decay-other methods of conservation must be applied. A method which has proved successful is the application of a thin coating of bees wax on the warmed panels; this covers and seals evenly all the crevices, corrosion cracks and fissures in the dilapidated glass. Wax remains unchanged for centuries, and also remains soluble. Endangered black enamel on these windows must, however. also be protected. nevertheless, the conserving wax coating will be used only in special cirumstances and can only be considered for windows which are not exposed to bright sunlight. Tests on the use of water-repellent silicon coatings are still being carried out. At present, they still have the disadvantage that they must be renewed every few years.

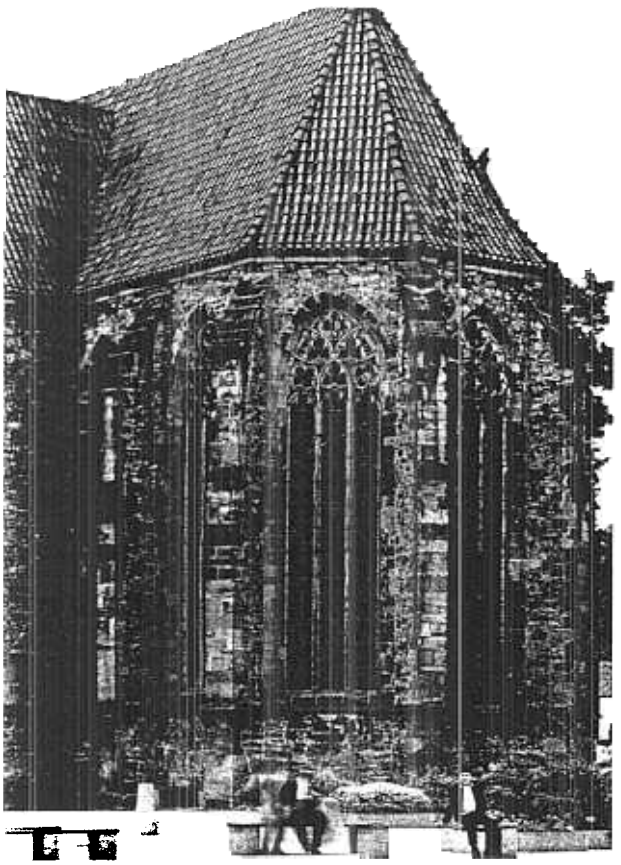
Restoration Measures

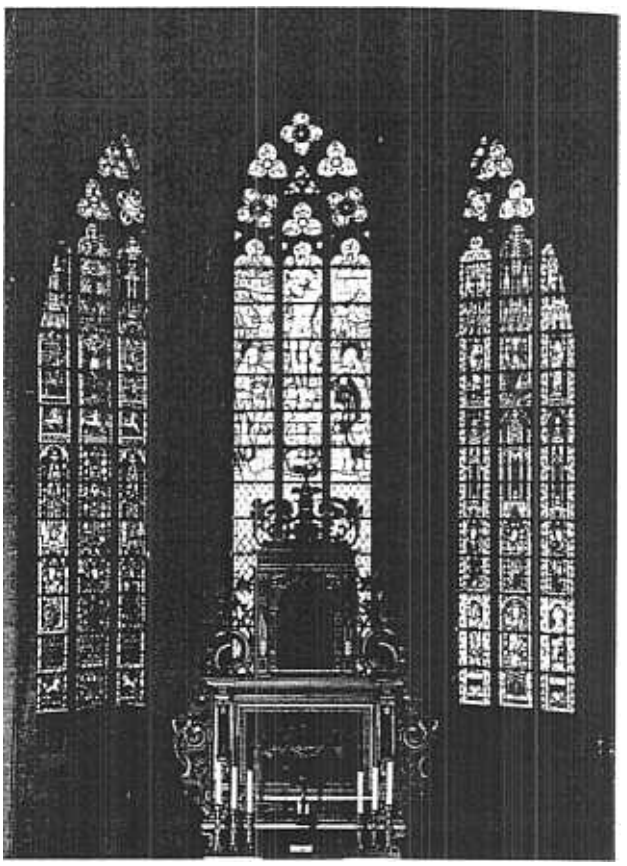
In principle, after cleaning, repair and conservation work has been carried out, a window can be reinstalled without further treatment. Most stained-glass windows have not only suffered corrosion and decay of the glass and paint in the course of the centuries, but have also been distorted in other ways. The panels are interlaced with mending leads which render the composition and picture content difficult to discern. More or less rough, usually makeshift patches spoil the coherence, and clumsy additions from earlier restorations introduce inappropriate colours into the picture (Figs. 8-10, 15-18). A stained-glass window can literally be spoiled to the point that it becomes unrecognizable.

It is not surprising that the wish is often expressed to restore or to reconstruct the original state. The improvement of the "show value" is the main consideration in this case, particuarly with windows which can be observed at close range by church visitors and tourists. This is a legitimate wish and often the efforts of church authorities, monument trustees and workshops have a common direction, However, restitution of the original medieval state is a deceptive illusion; this is because it is at best possible to create a ficititious original condition-which cannot and should not be the task or aim of restoration work. A stained glass window which looks "like new" after restoration is either a fake or has been falsified to such an extent that it hardly can be considered an original. Every window bears the marks of its age and its history and no one is entitled to erase or reverse them so easily, Planning of a restoration requires a high degree of responsibility, care and constant critical examination of the processes, by all those involved, while the first principle should be the complete respect for the original and its history.

"As much as necessary and as little as possible" is a proven and still valuable maxim for restoration of painted glass. There are no patent recipes which can be applied to all types of glass paintings. Another principle for all restoration work must be that all processes and measures are reversible,i.e. that they can be undone at any time without damage to the original.

One of the most serious defects in glass paintings is the large number of mending and temporary leads (Figs. 11-13). The lead work is part of the graphic composition so any lead strips added later will disrupt the pattern. On many old repairs, the edges of cracked panes have been grozed or have been roughly broken off; mending leads can often be remedied only with a great deal of sticking and "plating". Cutting of the flanges, which are unnecessarily wide in any case, helps to reduce the problem to manageable proportions without reducing the solidity. In the case of part





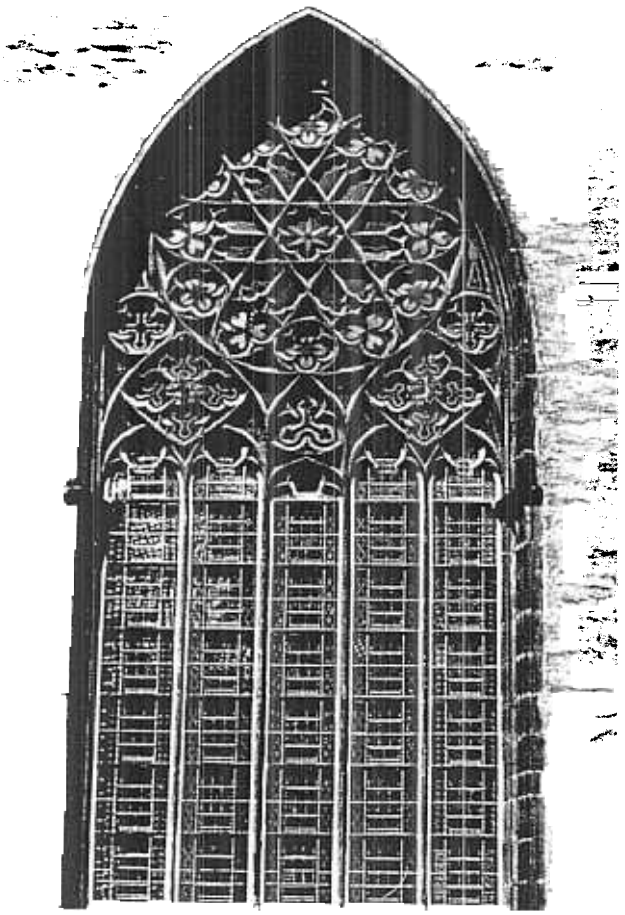


Fig. 1

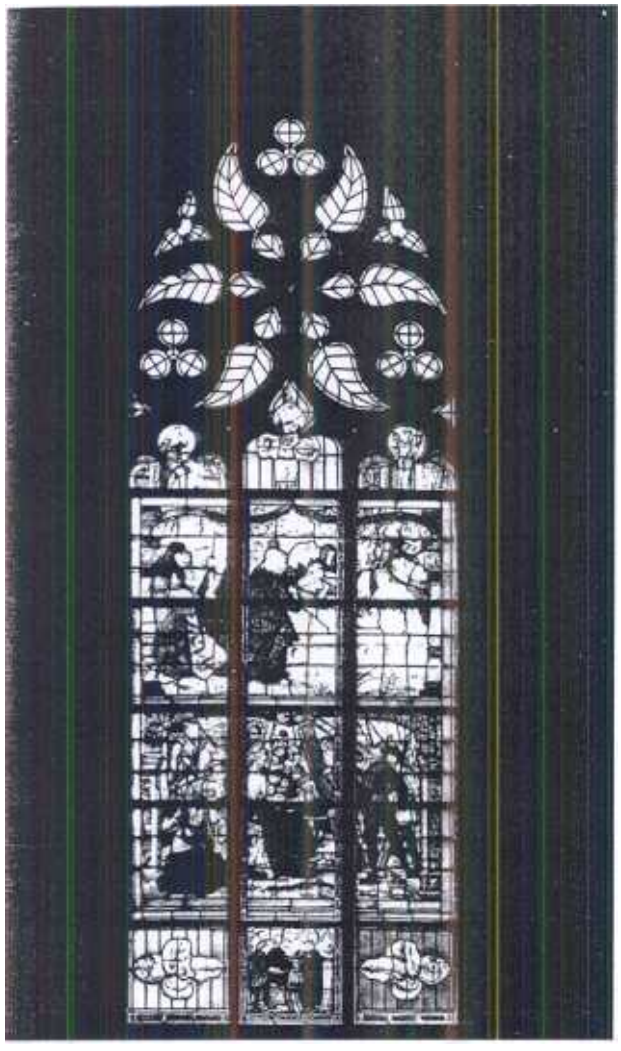
Herford, Neustadter Johanniskirche. Chhancel window with isothermal protective glazing, 1969. The diamond pattern takes into account the delicate exterior of the chancel but covers the splendid external line-effect of the leading in the medieval panels.

Fig. 2

Herford Neustader Johanniskirche. The side windows of the chancel, from the 3rd quarter of the 14th century, conceal the totally varied distribution of protective glazing. The diamonds can hardly be seen even in the early 16th century bright middle window.

Fig. 3

Lemogo, St. Nikolai. Heraldic window of 1670, in south-chancel. The danger of ball-throwing necessitated the use of laminated safety glass. The large-mush rectangular pattern repeats the main of the heraldic panels and does not disrupt the delicate tracery of this magnigicent window.



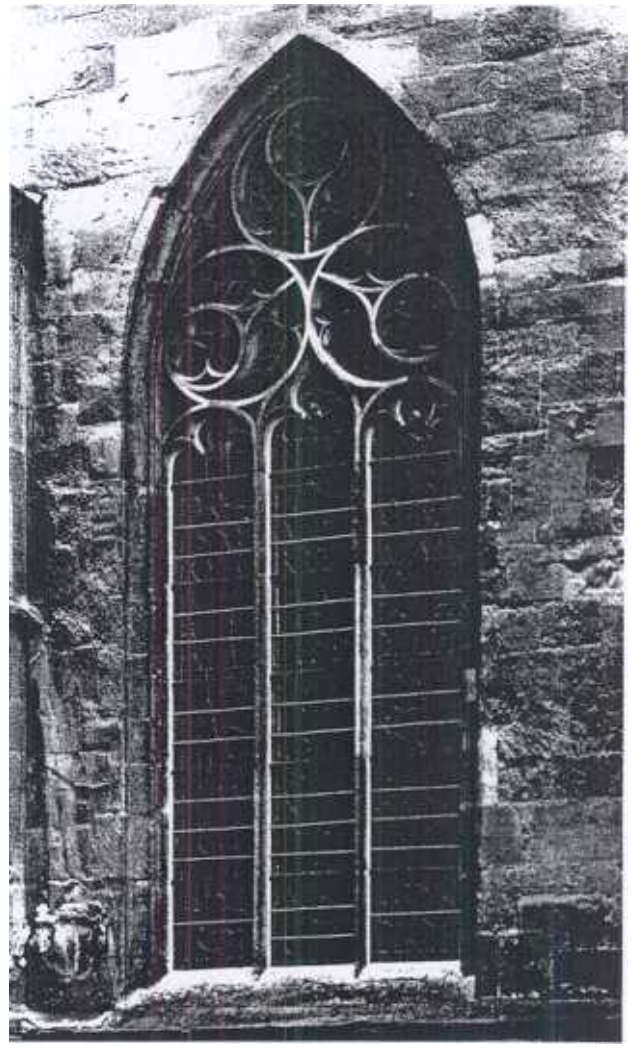


Fig. 4 - 5

Muster, Cathedral, north window XV, The Marienfeld window of about 1550, after protective work and restoration, ready installed with isothermal protective glazing. The outside shows the simplified leading outline. The lead webs of the original and the protective glazing can only be seen separately from a side view.

important or particularly striking parts of a glass painting synthetic resin adhesive material can be used to fill the crack between grozed edges. Straight cracks can be re-closed easily by glueing edge to edge, using synthetic resin adhesives. V-shaped or jagged cracks can be protected, without plating, by the use of additonal strips fixed to the edge of the lead; small rivets, the heads of which are not bigger than the head of a pin, have proved very useful and very effective. Even at a short distance they are not noticeable.

Glueing also includes the insertion of precise-fitting and painted additional pieces, which often have to be used to close gaps in fragmented pieces to avoid using new, extra leading (Figs. 19-22), Panes which are fragmented, or covered with large numbers of cracks or mending lead "spiders" often have to be plated in order to bind all the splinters and fragment together sufficiently.

There are a number of methods of plating, the use of which must be considered and examined carefully. The fragmented or stuck original piece can either be placed on a new glass support or embedded between two thin pieces of clear glass, which have been previously heated and shaped in a chamotte plaster mould to correspond to the irregularities of the original glass. In the past, whole windows were sandwiched with interlayers of plastic adhesive film on both sides. This process has a number of serious disadvatages which really preclude its use: the existing leading cannot be retained because of the considerably increased thickness of the sandwiched panes and must be replaced completely; the glass must be cleaned

radically to remove every trace of corrosion products, which necessarily involves a loss of substance and a considerable brightening of the colours; overlaying of the trasparency of the glass and the optical disappearance of half-tone painting (grease-spot effect); the plastics used tend to turn yellow. In addition, the restoration work is not sufficiently reversible, as when the covering and the original are separated, parts of the painting stick to the adhesive layer and are thus lost. This process has fortunately been abandoned, but what happens if some day the windows have to be "de-restored" because of unforeseen damage?

The example demonstrates the problems which can arise from the use of plastic adhesives in the restoration of glass paintings. At present, we do not know enough about the behaviour of plastics after periods of 50 or 100 years, whether they become brittle and crumbly or rock-hard, possibly combining indissolubly with the panes, or whether and to what extent they yellow after a number of years, thus altering the whole colour scale of the window or a plated section. There are a number of examples which show that epoxy resins change colour after a short period of time; whether acrylic resins will prove satisfactory, remains to be seen . For this reason, plating with an adhesive interlayer should only be used when there is no other way of stabilizing fragmented panes. One solution is to apply adhesive to the edge, to provide a seal against possible moisture penetration. The least risky method, as before, is "dry" plating, where bonded fragments are bound together and protected on one or both sides using thin glass, lead and cement only .This of course requires great care in the leading and cementing, although craftsmen-like care and solidness should be the principle in every case and for all processes.

There is hardly one glass painting which has not already been restored and completed in previous centuries, mostly in the 19th century. The quality of these restorations varies widely and depends both on the artistic skill of the glass painter who carried out the restoration work and on the materials which were available at the time. There were indeed glass painters in the mid-19th century who strove, with a great deal of sensitivity, to fit the necessary additions into the original as inconspicuously as possible, with the result that it is now difficult to distinguish the old from the new panes.

More frequently, however, parts restored in previous centuries appear disagreeable or even obtrusive, either because of the tasteless drawing, which does not capture the style of the original, or because of colours which do not match the tones of the medieval picture. Normally, these badly restored sections are retained, for the very fact that they also form part of the historical substance of the painting, and because it is extremely difficult to replace them with quasi-medieval inventions. As it was also common in the 19th century to replace even slightly damaged or only craked panes on a large scale these more or less carefully worked copies take on a record value, because they quite often reflect lost originals. False colour tones can often be corrected, or at least improved,by placing tinted panes behind them[7]. In addition to coloured glass and leading, the painted design, with outline strokes and shading washes is part of the composition of a glass painting and enables the subject-matter to be identified. Loss of paint always reduces the legibility and hence the show value of the glass painting. The scale of black enamel damage ranges from small losses of contours and half-tones, through every degree, up to the total obliteration of the paint, where only pieces of coloured glass remain in the leading. Sections of black enamel which are only affected should be protected-where necessary- but otherwise left as they are, More serious defects can be retouched carefully by "cold" painting, always bearing in mind that this must be reversible. Under no circumstances should damaged or obliterated parts of the drawing be re-outlined and fired with black enamel. This process cannot be reversed and there is a high risk of damaging the old glass.

Provided that the glass itself is not corroded, half-tones which have been weathered away can be rendered visible again by coating the formerly painted parts with a thin shading wash of black enamel. but which is not then fired (Figs. 23, 24). This can be wiped off again without difficulty, but is sufficently fast to allow panels treated in this way to be handled.

A practical method which does not interfere with or damage the original, but which is reversible at any time, is that of dry overlaying with clear, thin covering glass, on which the painting is completed and fired to the required depth (Figs. 25. 26), In this way a panel which has been completely effaced or corroded can be made legible, so that the picture content is revealed to the observer. It is true that the shape of the worn-off outlines can often be distinguished only by faint marks and scarcely perceivable variations in the glass surface. The extent to which the painting is restored in these cases depends not least on the degree

to which the shape and run of the outlines can be distinguished. No additions should be made which are not supported by evidence as they might falsify the whole.

Documentary Records

A documentary record of the various states of deterioration should of course be part and parcel of all restoration work. This has long since been customary practice in studios and workshops engaged in the restoration of paintings and sculptures. Written reports describing states of damage and the materials and techniques used in repairing same are indeed very useful but at the same time extremely laborious and time-consuming; moreover,it is in the majority of cases very difficult to find adequate words to describe with any exactitude the extent and phenomena of damage or deterioration. In such cases it is far more expedient to use a camera for the purpose of recording the actual condition of the part to be restored. In this way it is possible to achieve the desired degree of exactitude without having to resort to long-winded descriptions. It is at least necessary that photographs be taken of each individual panel, both immediately after its removal and after the completed preservation or restoration work, prior to its replacement. Such photographic records can, and should, be complemented by detailed photographs which clearly show not only the nature and extent of the damage on both sides of the panel and the methods used in its repair but also the artistic, stylistic or technical peculiarities of the glass painting itself (Figs. 11-14).

The best method of recording restoration measures has in practice proved to be a photo index containing all necessary full-view and detailed-view photographs. An additional card for each panel, showing the outline of the leading, can be used as a means of indicating, by the use of hatches and other markings and symbols, the state of preservation and the measures taken in restoring the panel (Fig.18). A coding system comprising letters and figures serves to render this already simple, graphical form of documentation even easier to use and comprehend. With this concise yet comprehensive recording system it is possible to store all necessary information concerning the nature and condition of the glass, the leading, the black enamel, and the frame and to keep a record of all the restoration work which has been carried out.

Such detailed photographic records are a welcome aid not only to the art historian or research student-especially as stained-glass windows, once repaired, are returned to their original locations which are not always readily accessible-but also to the restorer himself who may at some time in the future be required to do further restoration work on a stained-glass panel.

Concluding Remarks

It goes without saying that all measures for the prophylactic protection, the conservation and restoration of glass paintings should be planned and prepared carefully. Conservation measures carried out using modern practicable and advocated methods and restoration which is accomplished with the required care, attention and skill, accompanied and controlled by scientific experts and specialists from the field of glass painting, can restore to a large extent the original effect of a mis-handled and badly damaged medieval glass painting and can protect the artwork from further damage.

Research will continue, new methods and better materials for conservation will be developed. Many methods are also refined or modified in practical application. First and foremost, however, every effort must be directed towords the aim of protecting the valuable glass treasures from further damage and of removing the threat of their complete destruction.

Notes

1) In addition to the first two volumes of the French Corpus Vitrearum Medii Aevi (Vol.I: M. Aubert, L. Grodecki, J. Lafond, J. Verrier, Les vitraux de Notre-Dame et dela SainteChapelle de Paris 1959: Vol. IV.2/1: J.Lafond. F.Perrot P.Popesco, Les vitrauxdu choeur de l' église Saint Ouen de Rouen, Paris 1970) and the first volume of the "Etudes" (L.Grodecki, Les vitraux de Saint-Denis, Étude sur le vitrail au XII siécle. Paris 1976), of the six planned volumes of the short-catalogue type "Recensement des vitraux anciens de la France", two have appeared: i. vitraux de Paris, de la Région parisienne et du Nord-pas-de Calais, paris 1978, and II Les vitraux du Centre et des Pays de la Loire, Paris 1981.

2) Of the 21 planned volumes of the German Corpus Vitrearum Medii Aevi the following have appeared in West Germany: 1,1: H.Wentzel, Die Glasmalereien in Schwaben von 1200-1350, Berlin 1958; II,I: R.Becksmann,Die mittelalterlichen Glasmalereien in Baden und der Pfalz (ohne Feriburgi. Br.) Berlin 1979, IV,I:H.Rode, Die mittelalter- lichen Glasmalereien des Kölner Domes, Berlin 197- Five further volumes are in the process of preparation.-in the German Democratic Republic there are: I.1: E.Drachenberg. K.J.Maercker, C.Schmidt, Die mittelalterlicne Glasmalereien in den Ordenskirchen und im Angermuseum zu Erfurt. Berlin 1976.and 1,2: E. Drachenberg.Diemittelalterliche Glasmalerei in Erfurter Dom, Text, Berlin 1979. Three further volumes are being prepared.

3) In Lubeck, in 1942, the whole of the coloured glazing of the Marienkirche, which had been removed and stored in boxes in the South Tower, melted under the red-hot bells, which had fallen. The 14th century east window of the Amelungs: in monastery church was destroyed by bombs in the last days of the war. A bridge demolition in April 1945 caused the loss of the late-Gothic refectory windows from the Lüne monastery; the cloister windows were also badly damaged. Only 24 panels from one window had been removed from the late-Gothic chancel glazing in the Dortmund Reinoldikirche; the rest was destroyed in what followed bombing raids.

4) From the mass of literature on this problem, only a few contributions can be given here: G.Frenzel/E.Frodl-Kraft, Referat auf der Tagung "Corpus Vitrearum Medii Aevi", Erfurt 1962, in Osterreichische Zeitschrift für Kunst und Denkmalpflege, 17,1963,p.93-114; U.D.Korn, Ursachen und Symptome des Zerfalls mittelalterlicher Glasgemälde, in: Deutsche Kunst und Denkmalpflege, 29.1971, p 58-73; R.G.Newton, Bibliography of Studies on the Deterioration and Conservation of Stained Glass, in : IIC-Art and Archaeology Technical Abstracts, Vol. 1973, No. 2; U.D. Korn, Glasmalerei, in Konservieren-Restaurieren, Westfalen, 20. Sonderheft, Measer 1975, p. 91-107, on p.93 further lirerature references; Verresa et Refractaires, Vol.30, No.1, Jan./Febe. 1796: Actes du IX Collpque International du Corpus Vitrtearum Medii Aevi; CV (Corpus Vitrearum) News Letters, publ. by ICCROM, No1-33/34, 1972-1982. An excellent critical summary is given by H.Kuhn, Glasmalerei in Erhaltung und pflege von Kunstwerken und Antiquitaten. Vol.2. Munch 1981,p.230-265.

5) For double glazing see E.Bacher, Außenschutzverglasung, in: Österreichische Zeitschrift ful Kunst und Denkmalpflege 27, 1973,p.66 ff.: for numerous details of the construction of external proective glazings see G.Frenzel, Probleme der Konserveruing und prophylaktischen Sicherung mittelalterlicher Glasmalereiem, in:Knustspiegel, 1981,p, 173-209-The Oidtmann studio at Linnich prouced one of the first double glazings for development of praxticable construction in numerous places during the last two decades.

6) The use of glass-type transparent plastic sheets for protective glazing appears at least problematical. These materials are impact-resistant but they attract dust and dirt, so that they require cleaning; this can easily be the cause of scratches, which can in turn give rise to an increased accumulation of dirt. I have no information available on ageing properties, but the majority are not fire-proof. In addition, since they are supplied as large sheets the same applies to these as to whole glass panes, regarding aesthetic disturbance of the external appearance. through the use of sheets which are too lage.

7) On the question of the restoration, completion and reconstruction of glass paintings in larger sections, see the article by R.Becksmann in this volume.

Fig. 6

Arnsberg, propsteikirche Wedinghausen, window, I,9b (about 1250). The late Romanesque window was so dirty and corroded on the inside 47 years after the last cleaning (1935) that the run and shape of the fine ornamental painting could be distinguished only roughly, even when illuminated.

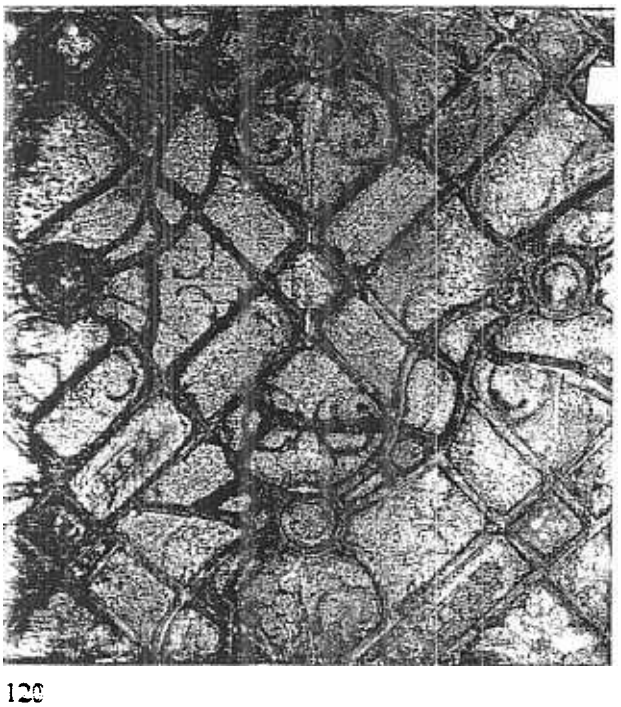
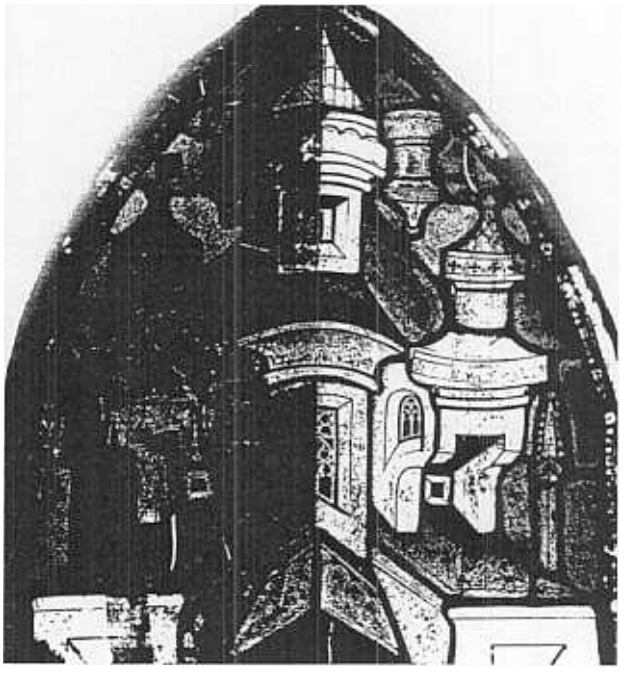


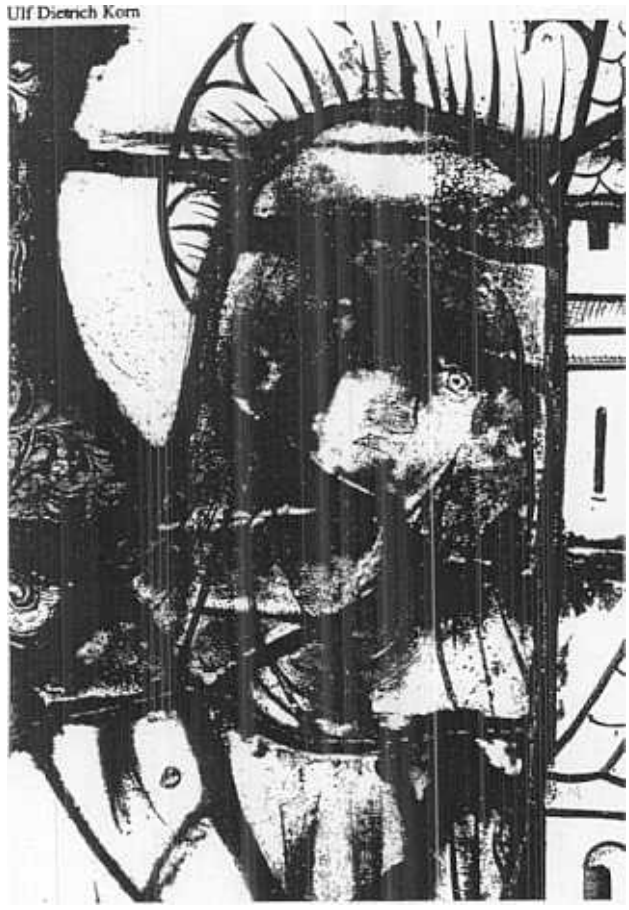
Fig. 7

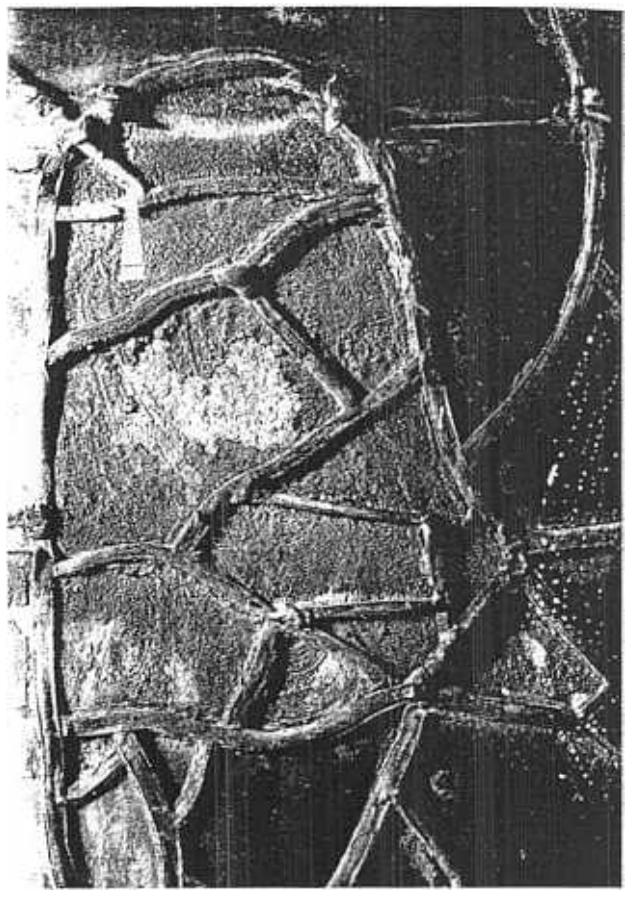
Ebstorf, nunnery chancel window N II, 9c (about 1930). The window was last cleaned and repaired in 1852. In 130 years, It has become obscured, to the point of opaqueness, by the deposits of dirt, algae and outside corrosion. The removal of the weathering crusts considerable brightening; cleaning of the inside exposes the almose intact painting.



Figs. 8-10

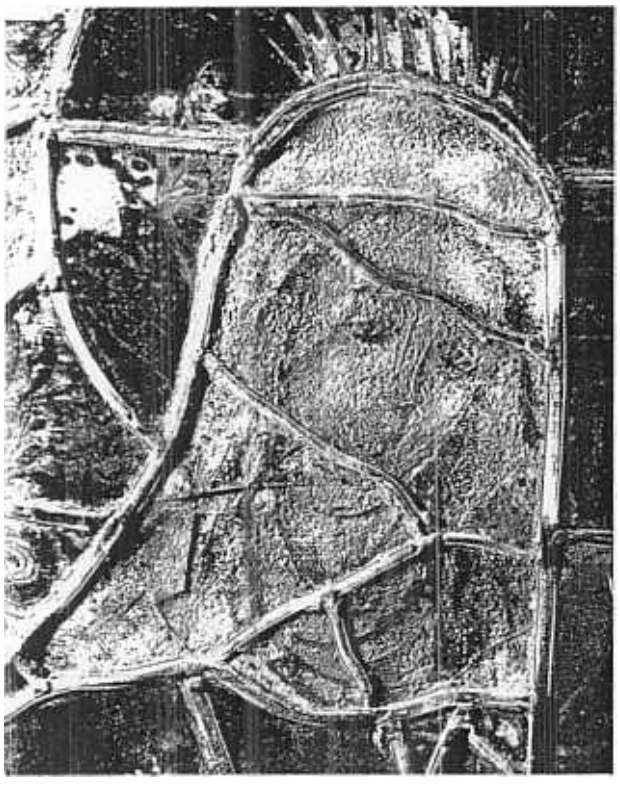
Hannover, Marktkiche, window I,5c (about 1400). The condition before restoration appears almost hopeless: rough patching and thick mending leads have created a ruin out of a work of art. The same panel after dismantling of the leading: innumerable fragments and bits of glass which can hardly be recognized as parts of a coherent picture,-The restored panel does reveal the marks of its in the eroded surfaces and fading outlines, but nevertheless, the picture is still clear; St George is to be tortured on the wheel, but tje judgement wheel, which is stuck with swords, is destroyed by stones which fall from the clouds.

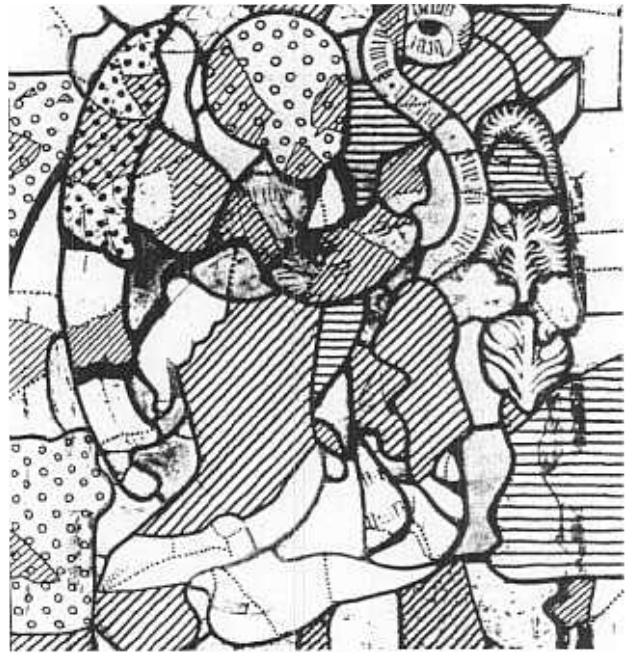




Figs. 11- 14

Hannover, Marktkirche, south window II, 4a, section (about 1420). The view and illuminated picture of the front and rear, in the un-restored state, reveal the darkening caused by weathering encrustations and the scarred as well as the numerous leading repairs and cracks. All the temporary leadings were removed, the brittle fragments were glued edge to edge and overlaid on the reverse side with a thin clear glass pane. The affected paint is protected, but not restored.





Figs. 15-18

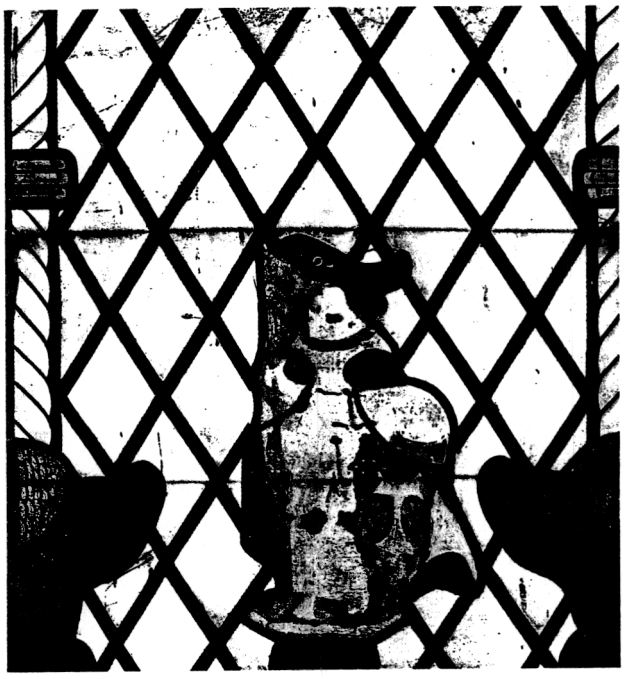
Uelzen, Chapel of the Holy Ghost, north window III, 2a (about 1412). In the salvage operation in 1942, the panel with the Angel of the Annunciation was in reasonably good condition. It was badly damaged in 1946 by stone-throwing, after which it had to be patched. With the aid of a good photograph of its 1942 condition, the panel was restored and reconstructed in 1980/81. The hatched drawing shows which pieces were restored and from which period they come

(horizontal: 19th century,

diagonal: 1980/81; dots and rings represent platings).

Figs.19-22

Uelzen. Chapel of the Holy Ghost, north window III, 2a. The head of the Angel of the Annunciation was alredy cracked in 1942, while almost half of the original was lost in 1946 because of stone-throwing. After careful bonding of the fragments and the grinding of the new panes with the subtly restored fine painting, the fact that a large part of the head dates, not from 1412, but from 1980/81, is scarcely noticeable.



Figs. 23 - 24

Ebstor, nunnery chancel, north window IV,7b, section. The 1523 window has almost completely lost the insufficiently fired black enamel. part of the painting was revealed during restoration using a thin, non-fired, shading wash; a covering pane carries the completed main outlines.

Figs. 25 - 26

Luneburg, town, law court's hall, window II, 2a. The inscription on this early 15th century panel, "optimum est maiorum vestigia sequi, hirecte praecedant Seneca." which was completely erased, was reconstructed from faint marks, on to a covering pane. Thus the small figure is identified as the Roman philosopher.

Figs. 27
Munster, Westfalisches Landesmuseum. Reconstructive replica of the Tree of Jesse Window (1230/40) from Legden, St. Brigida, 1969, Detail.

* Licht, Glas, Farbe. Arbeiten in glas und Stein Aus den Werkstatten