CVMA NEWS LETTER 13

British Technical Committee, Corpus Vitrearum Medii Aevi

Physics, University of York 21 February 1975 Ref. TC/75/2

CONTENTS

1 GENERAL

1.1 ORGANIZATION OF CVMA DURING 1975

A meeting of the Bureau of Union Académique Internationale, at which Comité International d'Histoire de l'Art representatives were present, was held in Paris on 22nd January and it was agreed that, for the present, Professor Louis Grodecki should take care of the general organization of CVMA and of the art-historical aspects, and I should co-ordinate those international aspects which are of a technical nature.

The 9th Colloquium of the CVMA, due to be held in September 1975, is still plagued by financial difficulties but it is hoped that a small specialist colloquium can be held in Paris to which a limited number of contributors may be invited. The meeting would be devoted solely to the mechanism of the weathering of glass and the appropriateness of various conservation procedures. It is hoped that, at the same time, a meeting of the Chairmen of the National Committees can be held to recommend a successor to Professor Hahnloser.

1.2 REPORT OF M. BETTEMBOURG'S VISIT TO BRITAIN

Ing. J.M. Bettembourg came to Britain between 23rd September and 6th October 1974 on a grant from the British Council, and he visited Cambridge, Canterbury, London (Victoria and Albert Museum), Norwich, Sheffield, Wells and York. He has prepared an interesting five-page report, the highlights of which are summarised here.

He particularly comments that the divergencies in methods of conservation, which he noticed two years ago when he attended the 1972 Symposium in York and Canterbury, have tended to disappear as conservation techniques become based more and more on a scientific understanding of the basic problems. (No doubt these News Letters have assisted this process!) Thus, although the doctrines and philosophies regarding restoration differ from country to country, such differences in techniques as remain arise largely from the differences in the states of deterioration of the windows, for example the corrosion is more serious at Canterbury than at York. Other differences concern questions of replacing badly-corroded medieval glass by modern glass or by other ancient glass of the same colour, and whether the replacement glass should be left plain, be painted, or be given a patinated appearance.

Epoxy resins for edge-joining broken glass are being replaced by silicone adhesives, following the French work on accelerated ageing of adhesives (Ref.8 of British Academy Bibliography). He remarks that, in Canterbury Cathedral, one window contains 120 pieces of glass which have been "doubled" with clear glass thus adding to the weight of the window whereas, in France, the tendency is now to protect cleaned glass with a resin layer in preference to "doubling".

He remarks that he had profitable discussions with everyone he met in Britain and that such exchanges, especially as between craftsmen, should continue because they can but improve the general life of medieval windows everywhere.

1.3 LASERS FOR CLEANING GLASS?

Item 1.6 of N.L. No.11 (p.3) carried a note by Professor O.S. Heavens about the possibility of cleaning crusted medieval glass with laser beams. Dr John F. Asmus of the University of California, San Diego has now sent a comment, given at (i) below and Professor Heavens' reply is at (ii). Dr Asmus has also sent me a preprint of his paper, on the use of lasers in the conservation of stained glass, to be given at the Stockholm IIC-NKF Joint International Congress (see Abstract No.179 on page 7).

(i) Comment by Dr John F. Asmus

With the exception of his closing paragraph, Prof. O.S. Heavens' conclusions in "Lasers for Cleaning of Glass?" (N.L. No 11) are entirely consistent with our analyses and experimental observations. Unfortunately, in his final paragraph concerning costs he seems to have confused the distinction between the peak pulse power and the continuous power of a laser. In fact "a 10-joule per pulse normal mode laser" at "60 pulses per minute" represents a peak (not "average") power of 10 kilowatts. Its average power is a much more modest 10 watts. This is 100 times smaller than the "1 kilowatt CW Nd-YAG laser system" for which he quotes a price of £42,000. In our work on stone and other materials we achieve coverages of some tens of square centimeters per minute as Prof. Heavens speculates. However, the average powers employed range from 5 to 25 watts and the laser systems cost £5,000 - 8,000. There are numerous concepts for reducing the costs of these lasers quite substantially including direct power line excitation of flash lamps, plastic pump cavities, and flowing dye active media. When the market for such products grows a bit more we may anticipate their commercial availability.

(ii) Reply by Professor O.S. Heavens

Professor Asmus is perfectly right in calling attention to the absurd error in my reference to the costs likely to be involved in laser cleaning of glass. The average power required for a reasonable rate of cleaning is indeed in the tens of watts, rather than in the kilowatts region. Unfortunately, this unforgivable error of a factor of about a thousand in power is not reflected in the price factor which, as Professor Asmus points out, is in the region of only 5 to 8. I was certainly pessimistic, but when labour costs and overheads are taken into account, it still seems as though one is talking in terms of $\sim$ £1-2 per dm^2 (£100-£200 per m^2) for the cleaning process. When the cost of removing and replacing the windows is taken into account, I believe that, notwithstanding my embarrassing lapse, my final comment, that "it is likely that the operating costs at present would be prohibitively high", remains valid. The situation may change. As Professor Asmus indicates, there are possibilities for reducing the costs of lasers and a substantial reduction can be expected when the 10-watt laser becomes an essential in every kitchen or motor car. (The first, prototype, colour television sets surely cost more than the present 10-watt laser!). Laser cleaning offers an exciting prospect and it would be enormously satisfying if it could rapidly become a normal and easily accessible technique of restoration.

1.4 HEATING OF MEDIEVAL GLASS!

My provocative remarks in item 3 of N.L. No.12 have already brought a comment from a reader. Mr Frederick W. Cole RF FMGP, who is in charge of the glass restoration studio for Canterbury Cathedral, has written to point out that, when edge-bonded pieces of medieval glass are heated to accelerate the curing of the adhesive, it is important to heat the glass up slowly and cool it down again slowly. He says, "The glass should be put into a cold kiln and allowed to warm slowly up to the required temperature, and then to cool without opening the kiln; this can take 24 hours.". He goes on to say that this procedure was followed with the mid-15th c. head of Elizabeth Woodville, from Canterbury Cathedral, and the glass is in good condition.

1.5 A HISTORY OF GLASSMAKING

From time to time I am asked to recommend "a book on glass technology" which would be of use to art-historians, architects or craftsmen who wish to gain some understanding of glass technology without getting too involved with the complexities of chemistry. I know of only one such book and I have no hesitation in recommending "A History of Glassmaking" by Professor R.W. Douglas and Miss Susan Frank, published in 1972 by G.T. Foulis & Co. Ltd. of Henley-on-Thames, Oxfordshire, at a price of £4.50.

1.6 WAR-TIME STORAGE OF MEDIEVAL GLASS

In response to my appeal for information on this subject, Mr B.J. Ashwell, the Architect for Gloucester Cathedral, has kindly consulted two retired vergers, Mr Moody who retired in 1970 and Mr Fred Berry who retired in 1966 and is now aged 82.

Briefly, some of the glass from the Great East Window was removed in 1940 and part of it was stored in crates in the cellars of Miserden House, near Stroud. The remainder of the glass which was taken out (some of the upper lights were left in) was stored in the crypt where the coronation chair and the Effigy of Robert Duke of Normandy were sandbagged for protection. The crypt became damp and mould grew on the wooden objects. So some ventilation was provided between the sandbags.

Thus this seems to be a situation worthy of further study, some of the glass being left in place, some being stored in apparently dry cellars (probably wrapped in newspaper and straw), and some being stored in a damp crypt for 7 or 8 years. If we can discover which glass was given each "treatment" it will be of great interest to compare the present state of the panels.

2 DOES CLEANING AFFECT WEATHERING ?

2.1 MORE RESULTS FROM THE EXPERIMENTS

Item 2 of N.L. No.12 described the start of a series of experiments on a small piece of green 12th c. glass from York Minster. Stages (a) to (d) were listed in the table at the top of page 5 and it was concluded that the crust on the surface (b) did not confer protection against accelerated weathering because the loss of K_2O (in 50h at 85°C in water) was 0.022%, and that airbrasive treatment of the whole surface (c) did not increase the rate of weathering (compared with the crusted sample) because the loss of K_2O was then 0.021%. Mechanical polishing (d), however, improved the durability, the loss of K_2O then being reduced to 0.012%.

Subsequently (Stage e) the sample was heated in an oxy-gas flame to give a fire-finished surface. During this strong heating it cracked into three pieces and the smallest was lost. The remaining two pieces measured about 14 x 14 x 2 mm and 16 x 7 x 2 mm, having a volume of about 0.65 ml and a surface area of about 900 mm^2; together they weighed 1615 mg.

After Soxhlet extraction for 50 hours a total of 0.36 mg of K_2O had been extracted, equivalent to a loss of 0.022% by weight. This is about the same as was found at stages (b) and (c) and might at first suggest that the flame-polishing had not been properly effective. It does, however, seem that Soxhlet extraction of these two very small pieces gives anomalously high results and therefore both pieces were airbraded on both surfaces (stage f). The new total weight was 1585 mg and 50 hours in the Soxhlet gave an extraction of 0.60 mg of K_2O. This corresponds to 0.038% and is nearly twice the figure previously recorded for the effect of airbrasion (stage c).

We thus seem to have confirmation that airbrasion reduces the durability of a polished surface, the loss of K_2O increasing by about 70% in both cases [(f)/(e) = 0.038/0.022 = 1.7 and (d)/(c) = 0.021 / 0.012 = 1.7] but it is not clear why the extraction rates on these two rather small pieces is about 80% higher [(f)/(d) = 0.038/0.021 = 1.8 and (e)/(c) = 0.022/0.012 = 1.8] than it was on the original large piece.

Finally, the two small airbraded pieces of glass were sent to Mr Frederick Cole to be acid-polished by the procedure which he uses at the Canterbury Cathedral Glass Restoration Studio, i.e. ten minutes in 40% HF. The acid attacked this poorly-durable glass rather vigorously; the two pieces lost about half their weight and one of them broke into two! At this stage (g) the combined weight of the three small pieces was only 784 mg and Soxhlet-extraction gave a loss of 0.275 mg. This is not a lower value and thus it seems that of all three kinds of polishing of the glass (mechanical, flame and acid) the first two improve the durability of the surface, but acid polishing seems not, on the basis of this single experiment, to give an improvement in durability, but it certainly does not make it worse!

To summarise the new data in the same form as the table at the top of page 5 of N.L. No.12 we get:

Procedure	Weight of samples (mg)	Percentage loss of K_2O	Comments
(e) Extraction after heating in a flame	1615	0.022	(These extraction rates are about (80% higher than those obtained (on the original large sample, (but the extraction from the air- (braded samples is about 70% (higher than from the polished (samples, as before.
(f) Extraction after airbrasion	1585	0.038	
(g) Extraction after acid polishing	784*	0.035	Acid polishing gives no improvement

* The acid has attacked this poorly durable glass rather strongly and it is evident that one must "know one's glass" before using this useful aid to restoration. Fortunately the Canterbury glass is generally much more durable than this sample, which was chosen for its lack of durability.

2.2 COMMENTS FROM A READER

Following my provocative remarks in N.L. No.12, Frau Dr Eva Frodl-Kraft has kindly written to draw my attention to the article abstracted as item No.183 on page 9. In particular she points out that the loss of the red deposit from the first stripe (see Fig.2 of N.L. No.12) might represent only part of a crusting-decrusting process, as occurred at Judenburg, and not an improvement in durability. I agree that this is a possibility and that the sample should be airbraded a third time and re-submitted to accelerated weathering; an experiment on these lines will be carried out.

3 PROTECTIVE GLAZINGS

3.1 THE ISOTHERMAL GLAZING EXPERIMENT AT SHEFFIELD

This experiment has now been completed ahead of schedule and a report is being prepared for the Building Research Establishment (BRE) which gave the contract to BGIRA on behalf of the Department of the Environment. One of the many conclusions is that isothermal glazing is much more "efficient" than had been thought because air velocities in the interspace have sometimes exceeded 1 metre per second, corresponding to 600 changes of air per hour in the cavity.

The BRE has now agreed that the unspent money from the contract can be used for a similar experiment at York Minster, using a window (No.s VIII) on the south choir aisle which already has external protective glazing in position. Some adjustable external ventilation of the interspace will be introduced so that the thermal, air-flow, and humidity conditions can be studied in this much cheaper alternative system of protecting ancient windows.

Figs. 1 and 2 show, by permission of the BRE, the arrangement which has been in use at Sheffield, in the "BGIRA cathedral", the letters indicating the positions of the various sensors.

Five kinds of sensor were used: (i) 14 chromel-alumel thermocouples all connected to one ice/water cold junction, indicated in Figs. 1 and 2 (and in the list below) by the letters A to P; (ii) 3 chromel-alumel "thermopiles" for measuring temperature differences between adjacent points, i.e. V measured the difference in temperature between the outside air and Face 2, W measured the difference between Face 2 and Face 3, and X measured the difference between Face 3 and the air inside the "cathedral"; (iii) 4 Plaster of Paris gauges were used to record when incipient condensation was occurring (or when actual condensation had occurred) and these are shown by the letters Q to T; (iv) a lithium chloride humidity sensor at U; and 30 anemometer sampling points (five are shown at Y in Fig.1) where a DISA hot-wire vibrating low-velocity anemometer could be inserted.

The key to the letters is:

A = outside air
B = Face 2, top
C = Face 2, bottom
D = interspace, top
E = interspace, middle
F = interspace, bottom
G = Face 3, top
H = Face 3, middle
J = Face 3, bottom
K = Face 4, top
L = Face 4, middle
M = Face 4, bottom
N = "cathedral air", top
P = "cathedral air", bottom
Q = Face 2, top
R = Face 2, bottom
S = Face 3, top
T = Face 3, bottom

It will be seen from the diagrams that the inner glazing, when first set up, consisted of three panels of float glass with two panels of 19th c. stained glass below them. The stained glass was replaced by float glass when it had been established that the stained glass became warmer than the float glass if it was irradiated from a clear sky (the window faces north west).

All the sensors will be taken to York Minster and installed on one of the three lancets of window sVIII, in almost exactly the same dispositions as in Figs. 1 and 2 (the window is about 5.6m tall) except that one of the incipient condensation gauges (R) will now be placed on Face 4 instead of Face 2 and there will probably be only one hole for the anemometer instead of 30!

Both of these experiments will be of the utmost value to architects and stained glass conservationists everywhere. All CVMA workers will owe a debt of gratitude to BRE, and to the Department of the Environment, for their foresightedness in financing the experiments; also to the Dean and Chapter of York Minster for so generously making window sVIII available for this important experiment.

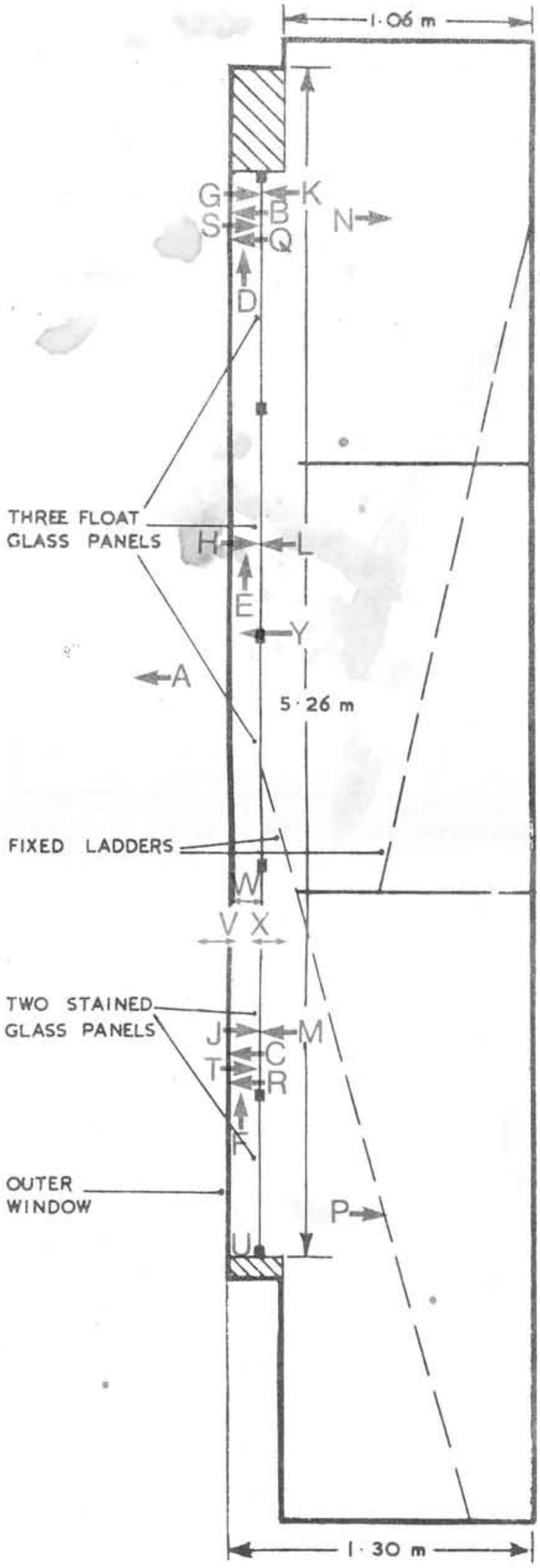


FIG. 2 "CATHEDRAL" SIDE ELEVATION

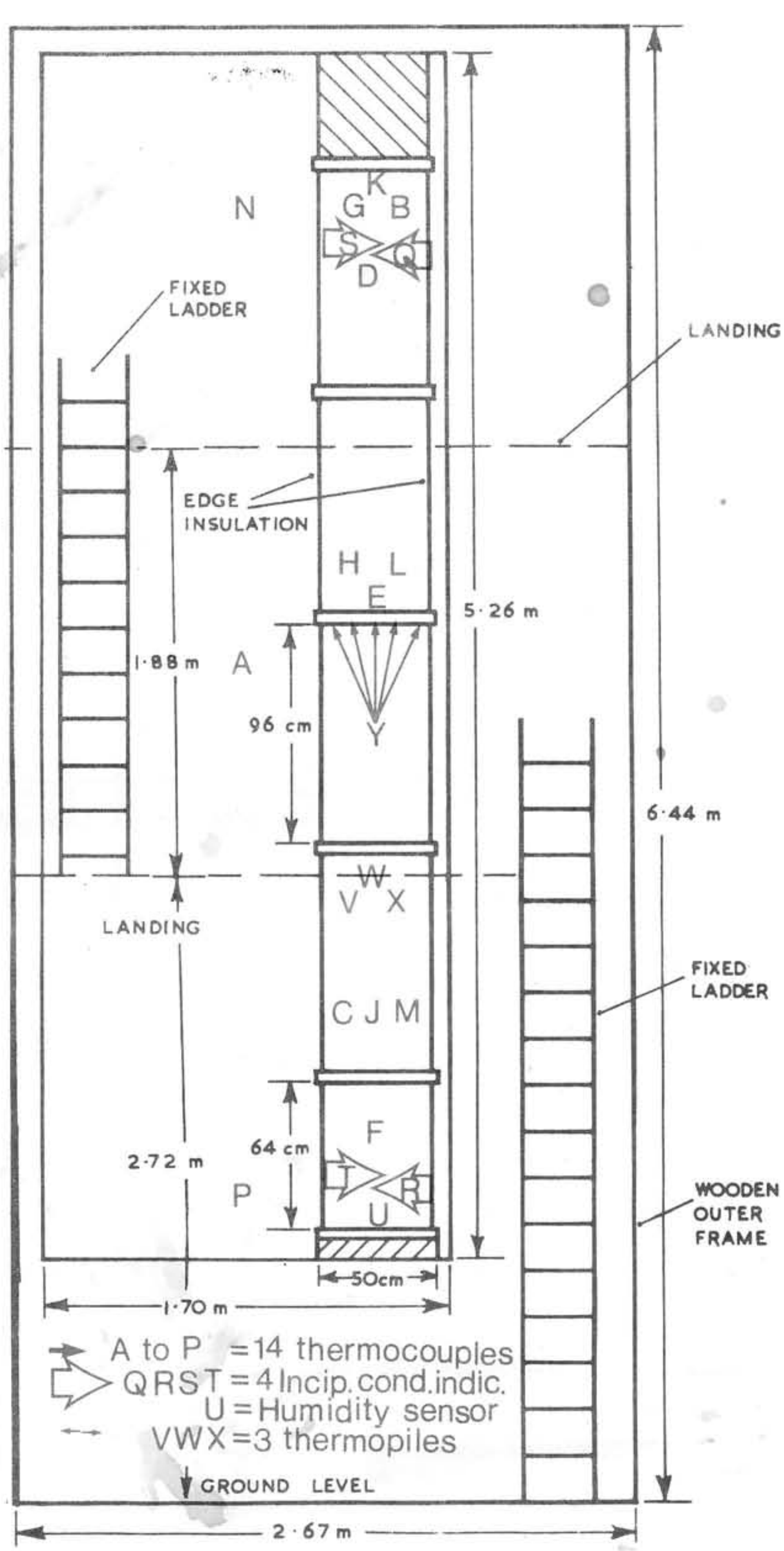


FIG. I "CATHEDRAL"— FRONT ELEVATION

Figs. 1 and 2 A diagrammatic representation of the positions of the 23 sensors used on the BGIRA simulated 'Cathedral' to study the mechanics of an isothermal glazing system. Only five of the 30 anemometer sampling points have been shown in the front elevation (Fig. 1) and only one of the 30 in the side elevation (Fig. 2). In Fig. 2 the four incipient condensation indicators have been shown by simple arrows.

3.2 EXTERNAL PROTECTIVE GLAZINGS

We need to know which medieval windows have been protected for several decades against rain, stones etc. and I have therefore asked readers to send me any information they have.

I am indebted to Mr Peter Gibson of York for the following information about the first external protective glazing to be used at York Minster.

(a) Yorkshire Gazette 29 June 1861, p.10.

The article discusses the heating to be installed in York Minster; 12 stoves at a total cost of £645 were expected to guarantee a temperature of 10°C. The temperature at St Paul's Cathedral in London was stated to be 15°C but the greater expanse of glass at York Minster makes this difficult to achieve. However the "Dean and Chapter have determined to glaze the outside of 'the five sisters' window, in the North Transept, with plate glass, to obviate the great draught of cold air through (sic) that expanse of glass; this work will also have the additional advantage that it will protect the beautiful stained glass which in heavy gales from the north is in danger of sustaining considerable damage". The article goes on to state that the scaffolding is in place for doing this work and hence the "Five Sisters" window seems to have been given external protective glazing in the middle of 1861 and it may well have been the first large window ever to be protected in this way.

(b) York Herald, a letter to the Editor dated 17 July 1862 complains about the "Dean's so-called improvements ... particularly covering the Five Sisters and the great West window with plate glass which takes away the depth of slay of the mullions and richness of effect, ... besides forming a space for dust to lodge in .....". Thus both the Five Sisters and the West window of the Nave already had external glazing by the middle of 1862.

(c) The Ninth Occasional Paper on the Restoration of York Minster, dated June 1906 comments (p.6), "As regards the West window, large plates of 'Hartley's rough patent glass' had been inserted in order to protect the medieval painted glass, but these plates had been fastened into their position with iron bars, which had contracted and expanded according to the varying temperature to which they were exposed, breaking the rough plates of glass and splitting the stone mullions .... the rough glass (is) replaced by a complete skin of clear 'crown glass' in diamond quarries, similar to the work done at the Chapter House". A letter to the Dean from the Clerk of Works, dated 22nd May 1906 (on p.31) commented that the old plate glass was in a very bad state and only one panel remained whole. The new glazing was 89 sq.m (958 sq.ft).

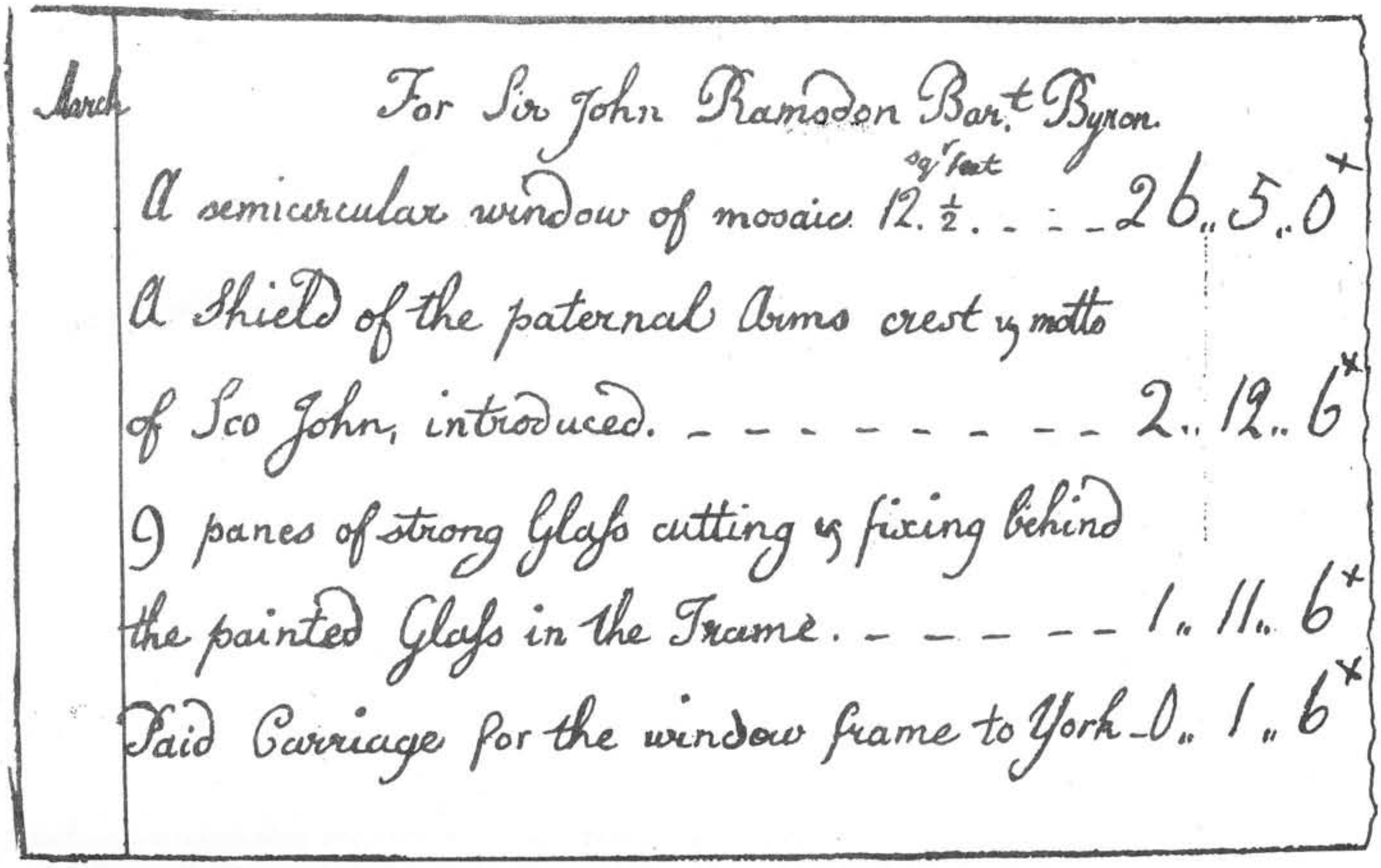
(d) The Tenth Occasional Paper on the Restoration of York Minster, dated July 1907, comments (on p.21) that the iron stanchions "have broken the thick plates of glass put up years ago .... an outer covering of plain white glass in quarries with lead glazing (will be) substituted for the present thick green plates ....". As regards the Great East Window .... "the substitution of white quarried glass for the green plates should not be delayed longer than we can help".

(e) The Eleventh Occasional Paper (dated August 1907) states "The rough green glass has now been removed from the 'Five Sisters' window. It is almost impossible to exaggerate the effect already produced upon the old glass, which now glistens with a lustre, and exhibits a delicacy and beauty which were dimmed and almost effaced by the late external covering .... The old glass has become so very thin and delicate that it requires the most constant care and attention, but as many of the thick green plates had split and were insecure ...., irreparable injury might have ensued at any time ....".

Thus the three major windows at York Minster have had some external protection for about 113 years and it seems that the glass of the "Five Sisters" was "very thin" in 1906. Large plates of glass (size unknown) are clearly a danger, as are iron stanchions, but the illustration in N.L. No.11 shows that the build-up of dust, feared by the writer of the letter in 1862, did not materialise.

Mr Dennis King, of Norwich, has kindly pointed out that William Peckitt had used outer protective glazing on his window at Audley End in Essex, and Mr Gibson therefore most helpfully carried out an examination of William Peckitt's Commission Book, now held by the York City Art Gallery. He did not in fact find any reference to external protection at Audley End, but he did find the entry reproduced here in Fig.3. This is a facsimile of part of p.31 (March 1782) of the book, reproduced here by courtesy of Mr J. Ingamells of York City Art Gallery. It records the purchase of nine panes of strong glass for fixing behind the painted glass in the frame for the panel made for Sir John Ramsden, High Sheriff at Byram Hall, near Ferrybridge, Yorkshire. The building has, however, been demolished so that we cannot study the results!

Mr Dennis King has also drawn my attention to the situation at Cothele, Cornwall, where external protective quarry glazing was removed in 1880. It is not known when the external glazing was installed (the 1480 window is known to have been altered in 1540) but the lead cames of the outer diamond quarries have produced a diamond-shaped corrosion pattern on the outside of the medieval window. It is hoped to give more information, and a photograph, in a subsequent News Letter. He also points out that the Collins-Martin window at Redbourne, Lincs. had outer glazing in iron frames, set up before 1845 (J.Brit.Soc.Master Glass Painters 8, 408).



March For Sir John Ramsdon Bar.t Byron.

A semicircular window of mosaic 12.½ sq.r feet . . . . 26..5..0 +

A Shield of the paternal Arms crest & motto

of Sir John, introduced. . . . . 2..12..6 +

9 panes of strong Glass cutting & fixing behind

the painted Glass in the Frame. . . . . . . 1..11..6 +

Paid Carriage for the window frame to York 0..1..6 +

Fig. 3 A facsimile of part of page 31 of William Peckitts Commission Book, for March 1782, reproduced by kind permission of Mr J. Ingamells of York City Art Gallery.

3.3 USE OF A DIFFUSING SCREEN

Dr G. Frenzel tells me that he first used a diffusing screen, between the protective glazing and the isothermally glazed medieval glass, at Henfenfeld, near Nuremberg, in 1967. The system was again used at Ingolstadt in 1972. It successfully reduces the effect of shadows, on the medieval glass, from the leading of the external glazing.

3.4 ENVIRONMENT OF THE GREAT EAST WINDOW AT YORK MINSTER

I am happy to report that the cost of the experimental work, reported in item 4.2 of N.L. No.12, (which suggested that the inter-space was "leaky" to the outside air in a desirable manner) has been met from the Pilgrim Trust Special Grant for the study of glass or windows having special scientific or conservational interest.

4 NEW ABSTRACTS

179. ASMUS, John F. (1975) "Use of lasers in the conservation of stained glass". Preprint of his paper for the IIC-NKF Joint International Congress, Stockholm, 1-7 June 1975, 6 pages of typescript and 4 illustrations.

The introduction to this paper mentions the many applications of lasers to modern technological problems and discusses the control of the size of the laser beam (and hence the area cleaned), the wavelength of the radiation (hence the depth of penetration into the material) and the pulse length (hence the localisation of the effects of the heating). As regards medieval glass he suggests that laser beams may be used (i) to remove opaque surface crusts by volatilisation or (ii) to "polish" the surface by localised melting.

Theoretical considerations are used to indicate that surface melting to a depth of 0.1 mm needs a pulse length of 2.5×10^{-3} seconds whereas 1/4s would be needed for 1 mm. The vapourization of a surface crust would need shorter times than these. He carried out some trials on badly-crusted medieval glass (probably 14th c.) using a single 10^{-3}s pulse from a ruby laser and his photographs show that the crust was vapourized, or melted, to give a dark spot where the beam had impinged.

Further tests are planned to identify the energy thresholds which might damage medieval glass. The present ruby laser, however, has too short a pulse length and a neodymium YAG rod will be used to increase the pulse length.

180. BACHER, E.(1974) "Ein mittelalterlicher Glasmalerei-fund in der Wiener Michaelerkirche" (A medieval painted glass find in St Michael's Church in Vienna). OZKD, 1974 28 210-212.

During the 1973-74 restoration work inside this church it was realised that a medieval east window had been bricked up during the Baroque period. The authorities thereupon decided to move the great late-Baroque altar which filled the whole apse, and three windows were then exposed, one of which contained late 13th c. glass. The paper gives details of the complicated technique which had to be adopted to move the glass safely (two lancets 0.38 m high and 0.52 m wide, and a quatrefoil 0.83 m diameter) but the present abstract is devoted to the state of corrosion of the glass which has not so far been found in Austria.

Starting from the outside, which is completely smooth and shows no corrosion damage, the process of decomposition is recognisable as a milky-opaque layer which extends more than half the thickness into the glass. An investigation of the phenomenon is in progress and it is possible that it has been caused by the special environment due to the walling-up, with wide differences in temperature between the cold wall on one side and the roof space on the other, with its extremes of temperature variation. The transparency of the glass is also impaired by residues of whitewash and plaster on the inside which could not be completely removed without endangering the paintwork.

181. BETTEMBOURG, J.M. and BURCK, J.J. (1974) "Restauration des vitraux anciens. Methodes, testées par le Laboratoire de Recherche des Monuments Historiques" (The restoration of ancient windows; methods tested by the LRMH). 10 pages of typescript.

The document points out that the present state of medieval windows demands urgent measures to save them. The researches undertaken by LRMH are part of an international programme devised by the CVMA. Cleaning is the basic problem because jointing, surface protection and re-attachment of paint can be carried out only on cleaned glass. The results described in the report are based on researches carried out in the fields of A, cleaning; B, adhesion of broken glass; C, protection by doubling; D, protection against attack by atmospheric agents; E, re-fixing of paint; F, cementing of the panels with a polymeric material. The state of the ancient glass should be considered very carefully before embarking on any treatment and the LRMH will gladly give technical assistance to any workshop which requires it.

A. Cleaning

(a) Mechanical cleaning is generally taboo, except for the careful use of small glass-fibre brushes, obtainable from suppliers to painters and restorers, eg. Soc. Adam, Bld. Edgar Quinet, Paris. (b) Ultrasonic cleaning is particularly useful for much-pitted glass but it should be used only with care. Paint should be perfectly adherent or it may become detached. The use of liquids other than water can endanger the glass, and the liquids (generally based on ammonia) offered by the suppliers of ultrasonic equipment are taboo. Suppliers are Soc. Ultra-sons Annemasse S.A., 76 ter, rue Etienne Dolet, 94-Cachan, France; Soc. Dentalex, 24 rue Godot de Mauroy, Paris 9e. (c) Chemical cleaning. The use of any acid, or strong base such as ammonia, is taboo but two chemical agents are advocated which have a rather slow action; this enables the cleaning to be observed and to be stopped whenever it is desired. (i) a mixture of 10% sodium thiosulphate and 5% sodium pyrophosphate (see also N.L. No.7, item 2.4(a) where fuller details are given; there is an error in that item and the second formula should, of course, be $Na_4P_2O_7.10\ H_2O$) permits the slow progressive removal of the crust without undue scraping, but it is not so useful on highly pitted glass because the time required is then very long. (ii) a mixture of 30 g/l of EDTA and 30 g/l of ammonium bicarbonate (see N.L. No.7, item 2.4(b) for extra detail). This has a faster action than (i) and it can therefore be useful for pitted glass. The cleaning can be done either with soaked pads of cotton wool, renewed from time to time, or entire panels can be immersed in a bath, providing the paint is properly adherent. One disadvantage of complete immersion is that the various pieces of glass might need different periods of treatment. Care should be taken to examine the outside surface of the glass because it was often painted (contrary to previous belief) and hasty cleaning could damage the modelling applied to the outside.

B. Adhesion of broken glass

The authors recommend replacing jointing-leads by edge-glueing with silicone adhesives (epoxy resins do not resist accelerated ageing). Suitable materials are CAF.3 (transparent, grey or white) from Rhone Poulenc, Ave. Montaigne, Paris 8e (British agents are R.W. Greeff, Acorn House, Victoria Road, London, W.3); Beriglace (transparent) from Soc. Bericol, 34 rue Clement, Marot, Lyon; Workey M.S.W. (transparent) from Soc. Vetter et fils, 6 rue C. de Wett, Villeurbanne.

The broken edges should be cleaned with acetone, and a thin layer of adhesive spread with a spatula. The bare edges should remain in humid air for about 15 minutes before joining under slight pressure. Keep the joint in place with adhesive paper and avoid handling for about 2 hours. Excess dry adhesive can be removed with a sharp knife or (before hardening) by wiping with alcohol.

C. Doubling

The use of a thin (1.5 mm) sheet of modern glass has two advantages. (a) If there are many very small fragments, their edge-jointing may not always be feasible but they can be stuck, piece-by-piece, on the backing sheet using a polyurethane resin (acrylic, vinyl and epoxy resins did not withstand the accelerated ageing test). The process is not easily reversible because much time is required for a solvent to penetrate, but this may be the only practicable way of saving the fragments. The polyurethane material tested was 80% Viacryl VC363 and 20% Desmodur 75. The former is obtainable from Vianova Kunstharz, 14 Johannesgasse, 1010 Wien, Austria (the British agents are Berger Chemicals, Resinous Chemicals Division, Wellington Mills, Dunston-on-Tyne, Gateshead, Co. Durham) and the latter from Soc. Bayer, 92 Neuilly, France (or Bayer UK Ltd., Bayer House, 18/24 Paradise Road, Richmond, Surrey, TW9 1SJ). 01 940 6077 ~ 8157

(b) Any important glass which has been much weakened by weathering (due to loss of thickness or risk of breakage) or one which has been "starred" by vandalism, can be plated, using a border of silicone to ensure a water-tight seal, e.g. Seelastrip from Expandite Ltd. or Arboseal from Adshead Ratcliffe, Belper. If the medieval glass is not flat, the plating glass should be shaped to fit it, using a mould of 1 part plaster and 1.2 parts grog and heating to 650-700°C.

D. Protection against attack by atmospheric agents

The background to their recommendations is given in item 170 on p.8 of N.L. No.11. Only Viacryl VC363 mixed with Desmodur was found satisfactory (see C above). The cleaned glass should be rinsed with acetone to remove traces of humidity and preferably removed from the leads so that the edges can be properly covered. Any tools can be cleaned, before the resin hardens, by using ethyl acetate. After hardening the film can be dissolved in Cital 12-12, liquid or paste, obtainable from Sodiema 397 ter, rue de Vaugirard, Paris 15e.

E. Re-fixing of paint

This can be done with the Viacryl Desmodur mixture quoted in C(a) above after diluting with ethyl acetate (1:1) to allow easier infiltration under the loose or porous paint. Apply with a capillary tube while the paint is being cleaned so that cleaning and fixing can be carried out simultaneously. Before complete drying, any excess resin can be wiped off with ethyl acetate. The process should be repeated 3 or 4 times until the paint is firmly fixed.

F. Cementing medieval panels

The background to their recommendations is given in item 169 on p.7 of N.L. No.11. Silicone mastics give better resistance to accelerated ageing than does the traditional cement or putty but their application is not quite so easy. Further experiments are in hand on improved mastics.

182. COLLONQUES, Professor, and Mme PEREZ Y JORBA (1973) "Sur le phénomène de corrosion des vitraux (Part I). ENCSP Paris, March 1973. (This is Part I of the paper abstracted as item 171 in N.L. No.11).

This earlier paper gives full details of the study of the weathering products on nearly 50 medieval glasses from Amiens (12 samples, 13th century); Aube (8 samples, 15th to 16th century); Beauvais (2 samples, 15th century); Brennelis (4 samples, 15th century); Evreux (5 samples, 13th century); Le Mans (3 samples, 13th to 15th century); Quimper (1 sample); Rouen (9 samples, 15th century) and St Denis (2 samples, 12th century).

No less than 13 separate crystalline materials were identified in the weathering crusts:- gypsum ($CaSO_4.2H_2O$); syngenite ($K_2SO_4.CaSO_4.H_2O$); silica (as α quartz and as β cristobalite); calcite ($CaCO_3$); five unidentified materials (which may be gorgéyite, $K_2Ca_5(SO_4)_6.H_2O$; schoenite, $K_2Mg(SO_4)_2.6H_2O$; leonite, $K_2Mg(SO_4)_2.4H_2O$; polyhalite, $K_2MgCa_2(SO_4)_4 2H_2O$; and six kieserites, $MgSO_4$ with 1,2,2½,4,6 or 7 molecules of H_2O); there were also another three unidentified materials which were found only on the grisaille windows at Evreux.

Gypsum occurs most frequently. Syngenite does not occur in the absence of gypsum and then only on glasses which are rich in K_2O and highly corroded. Calcite occurs about a dozen times and on glasses which have a high CaO content (12% to 20% by weight), except two windows at Aube but these are low in alkali.

Some of the corrosion products adhere well and are difficult to remove, whereas others are easily detached. Cleaning procedures could be related to the analytical results (RGN - but it would probably be too difficult for the conservators to obtain the necessary analytical results).

The paper ends with some speculations about the effects of atmospheric agents and some experiments were done in an environment rich in SO_2. The glasses were readily attacked but the corrosion products observed have not yet been identified and in no case do they correspond with those found on ancient glasses. (RGN - this experience emphasises the problem of devising suitable accelerated tests of corrosion to simulate the long-term corrosion; probably the SO_2 was too strong.)

183. FRODL-KRAFT, Eva (1974) "Mittelalterliche glasmalerei - erforschung, restaurierung" (Medieval painted glass - research and restoration). OZKD 1974 28 200-209.

The author starts by pointing out the very real difficulties of knowing what has happened to any glass, even during the present century. She then discusses four extremely interesting case histories.

(i) The Angel panel at Kremsmünster, (Figs. 162-164). After removal during the war it was re-installed the wrong way around, so that the painted side was exposed to the weather. In 30 years the painted linework has suffered no further damage (the author suggests that badly-fired linework had previously been lost and that the remaining well-fired linework did not deteriorate in the 30 years) but the half-tones have weathered away almost completely and the highlights (unpainted glass) have formed an opaque crust. Thus there is now nearly a "negative image". Thus 30 years' exposure to the weather was enough to form a crust on this glass. (RGN - but we must take care not to accept the corollary, that the first 30 years of life in the 15th century would have produced less weathering because the air was cleaner! There are the possibilities that (a) 500 years of exposure to the interior of the church had predisposed the inner surface to become prematurely crusted when it was reversed or (b) the war-time storage conditions had influenced both surfaces of the glass in such a way that severe deterioration and crusting could then occur in 30 years.)

(ii) The Presentation, Magdalen Church, Judenburg (Figs. 165-170). Thanks to the ready cooperation of the parish priest, and of the curator, it was possible to remove this 14th c. window in 1973 to compare its condition with that in 1963 (see p.360 of the Liège Congrès of the AIHV). Briefly, the six photographs show that some parts had become more opaque in the 10 years and some parts less so, and the key to this was the behaviour of an abnormally (?) flaky crust. Thus some parts of the crust had disappeared in the 10-year period whereas other parts of the glass showed renewed crusting. Thus, for this glass at least, the outside shows a cyclical crusting and "de-crusting" process which can be observed during these 10 years. The well-fired black paint has, however, been particularly resistant to weathering and the author herself points out (p.204 col.2) that the polluted air of Judenburg can have affected the outside surface only although the internal atmosphere of the church must also have been polluted. ("Selbst wenn die allgemeine Luftqualität sehr schlecht ist (dies trifft für Judenburg zu) und die Luft im Kircheninneren dieselbe Zussamensetzung hat wie die Aussenluft (Keine Filterung)." RGN - perhaps there would not be so much sulphur dioxide inside the church because it would react with the furnishings!)

(iii) The Founders Window from the chancel of St Walpurgis (Figs. 171-185). This window was re-inserted in 1950, after war-time storage, but in recent years the darkening of the panels had become increasingly noticeable and the outer face is regarded as an example of particularly advanced weathering. It has been cleaned and external protective glazing has now been installed, use being made of the new system of hexagonal leading to give a better appearance to the outside of the window than would have been provided by flat sheets.

During the cleaning the restorer remarked that the crust consisted of uniform layers which could be removed only by repeating the operation several times. After each cleaning a new white film was present within a few days. The window had been photographed in 1950 (Figs. 180-182) but no-one had thought of also recording the extent of weathering on the outside and hence there must be some speculation about the course of events, especially as there are unusually large variations in the state of weathering, from almost intact glass to heavily cratered surfaces (Fig. 179), even on the same piece of glass (Fig. 177); here there is much discussion of the possible effects of glass composition, extent of exposure to the weather, effects of the presence of paint or not, but without any firm conclusions about the relationship with weathering behaviour. Nevertheless the discussions about the presence of painting, and of its type, have a profound bearing on any possible technique of restoration. The Austrian Ministry concerned with historical monuments has, in fact, ruled against restoration techniques which are dependent upon subjective judgments, even though they might be justified on conservational grounds. Prolonged contact with water, in the corners of the leads, seems to encourage weathering.

In 1950 some of the cracked or splintered pieces of glass were plated with an interlayer and the condition was quite unchanged in 1974, even though the cover glasses had been flat and not moulded to fit the medieval glass as would be done now. The effectiveness of this system has also been confirmed from the panels at Waidhofen on the Ybbs which were plated in 1947, no dust or moisture having penetrated. The work by Taralon and Bettembourg in Paris has demonstrated that silicone adhesives are likely to give even better results.

(iv) The protective glazing at Burg Kreuzenstein, on the Danube. As part of the discussion on the effects which heating by sunshine may have on the air in the interspace, the case of Burg Kreuzenstein is quoted. Standard window panes were installed not later than 1914 and the medieval glass was moved inwards to form sliding windows which meet in the middle and would have been unlikely ever to have formed a seal. Nevertheless these 13th c. panels are at risk because the leads have distorted (? expanded under the influence of the heat "- infolge der wärmebedingten Ausdehrung des Bleis ..." ?) and have become so bent that they have come out of the frames and no longer adhere to the individual pieces of glass.

If the frames had not been sunk into the wall grooves we should now be left with nothing but a pile of fragments, and adequate ventilation of the interspace between the two glazings is necessary for external protective glazing to function properly. The efficacy of this external glazing can be seen by comparing the medieval glass here with other unprotected windows at Kreuzenstein, where wind erosion is important.

Finally, the author reminds us that almost every conservation technique used in the distant past, or even quite recently, has had some disadvantage which its initiators or advocates did not (or even could not) know about; therefore it is particularly important to share experiences which have been backed up by systematic experiments.

184. NEWTON, R.G. (1974e) "Recent impetus in the study of the conservation of medieval stained glass windows". Glass, 1974 51 405-409.

This article, timed to co-incide with the appeal for funds for the restoration of Canterbury Cathedral, describes the reasons for the upsurge in technical activities since September 1971 and outlines the stages in the history of the Technical Sub-Committee of the British Committee of the CVMA. Brief reference is made to the various scientific advances made in the last three years.

185. NEWTON, R.G. (1975) "Conservation of medieval windows (isothermal glazing)". Preprint of his paper for the IIC-NKF Joint International Congress, Stockholm, 1-7 June 1975, 13 pages of typescript.

This account of the advantages and disadvantages of isothermal glazing is essentially an expanded version of that given in N.L. No.7, pages 4-11.

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NOTE: Will readers of these News Letters please draw my attention to any papers which should be abstracted here. It would be particularly helpful if photocopies of the papers could be supplied. My address is 5, Hardwick Crescent, Sheffield, S11 8WB, England.

Roy Newton

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