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ADAPTING AND EVOLVING THE TRADITIONAL TECHNIQUE OF EGG TEMPERA RETOUCHING AT THE HAMILTON KERR INSTITUTE

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ABSTRACT

This paper discusses the traditional retouching method of egg tempera, which, amongst other retouching techniques, remains a practised and taught method at the Hamilton Kerr Institute (HKI), University of Cambridge, UK. Since its introduction to Britain, the method has evolved and adapted, most recently owing to the absence of MS2A resin. Laropal A81 has been used as the replacement isolating varnish. However, the physical properties and handling differ from MS2A.
The typical diluent used at the HKI for Laropal A81 varnish is a 50:50 mixture of Shellsol A100 and Shellsol D40, however, when used as the isolating resin over an area of retouching this mixture could disrupt lower tempera layers. To remedy this, the diluent was changed to cyclococtane, an aliphatic hydrocarbon. Cyclooctane benefits from being less toxic compared to the aromatic hydrocarbon Shellsol A100 and can be manipulated more on the surface before the activation of lower Laropal A81 layers becomes problematic.
Laropal A81 solubilized in cyclooctane was successfully used as the isolating resin for egg tempera retouching and offers promise for a variety of varnishing scenarios and retouching. This paper demonstrates this adapted method of egg tempera retouching through a case study of a 16th-century panel painting with large losses perfectly suited to this method.

Keywords
Egg tempera retouching; Laropal A81; Cyclooctane; mimetic retouching

1. INTRODUCTION

The traditional retouching method of egg tempera remains a practised and taught retouching technique at the Hamilton Kerr Institute (HKI), University of Cambridge, UK. This paper will discuss the developments of egg tempera retouching from its origins in 19th-century Germany, through to the present day. While the method is largely unchanged, the materials used have evolved and have adapted through the generations of conservators using this method. One recent adaption of the materials for egg tempera retouching at the HKI involves substituting the diluent used for the isolating resin layer of Laropal A81, from a mixture of Shellsol A100 and Shellsol D40 to cyclooctane. To elaborate further on this adaption and to offer the reasoning behind it, a case study of a British 16th century panel painting is presented. This painting displayed large lacunae after cleaning and was perfectly suited to the egg tempera retouching system. A review of cyclooctane and its potential advantageous use within conservation is also considered. The aim of this study is to disseminate the recent adaptions into the wider conservation community.

1.1 The development of egg tempera retouching from Germany to the UK

Egg Tempera as a retouching medium originated in 19th-century Germany, where a number of painting restorers were known to work with the method. These include landscape painter and painting restorer Christian Philipp Köster (1784-1851) who worked at the Boisserée Collection, Heidelberg, the Solly Collection, Berlin, and later at the Königliches

Museum, Berlin; Köster's student and brother-in-law, Jacob Schlesinger (1792-1855), studied in Heidelberg, then later worked alongside Köster at the Boisserée Collection. Johann Christian Xeller (1784-1872) trained in Dusseldorf followed by an excursion to Italy, and from 1825 worked at the Gemäldegalerie, Berlin and the Boisserée Collection with Köster and Schlesinger [1]. Köster's 1827 volume *Ueber Restauration alter Oelgemälde* on the restoration of oil paintings [2], included a 30-page treatise written by Schlesinger on early Italian egg tempera paintings and their restoration. From 1929, Helmet Ruhemann (1891-1973) worked at the Kaiser Friedrich Museum, Berlin, where he was advised by the restorer and artist William Suhr (1896-1984), who is said to have taught Ruhemann the use of tempera. In 1933, during Hitler's rule over Germany, Ruhemann fled to England, and by the following year was working at the National Gallery, London. Ruhemann, whose preferred retouching method was tempera, trained numerous students and assistants. Herbert Lank (1925-2020) first worked privately with Ruhemann at his home before they worked together at the National Gallery. As skillful as Ruhemann was as a retoucher, his trolley was apparently somewhat chaotic and messy, initiating Lank to make some refinements to Ruhemann's tempera method with a more methodical approach [3]. Lank became the HKI's inaugural Director in 1976 and in 1980 initiated a sister-studio located at Ebury Street, London.

1.2 Egg tempera retouching methodology and the evolution of materials

Since its 19th-century origins, the materials used for tempera retouching have evolved. Schlesinger wrote in his 1827 treatise of retouching on white putty with egg tempera underlayers followed by lean oil colours. His egg tempera mix was composed of egg yolk mixed with a little vinegar as a preservative. He favoured egg tempera as it was fast drying and enabled the retouching to be done in thin layers, thereby achieving the appearance of an aged oil paint. Ruhemann modified Schlesinger's egg tempera method by using the whole of the egg (albumen and yolk) with a drop of wax-paste (beeswax and white spirit, 1:3), shaken together in a bottle of water (equal to the egg's volume), with a drop of acetic acid as a preservative. The egg tempera could then be ground on the palette with the desired dry pigments. Both Schlesinger and Ruhemann aimed to complete the majority, if not all, of a retouching using tempera, with a minimal mixture of pigments, burnishing each application with silk. If required, Ruhemann completed final glazing using oil or watercolour, and he then applied a brush varnish of mastic. Lank further refined Ruhemann's egg tempera approach; the number of pigments used was reduced to 23 (using only stable pigments). Like Ruhemann, Lank used the whole of the egg, but diluted it only with water (removing the wax paste Ruhemann had added for adhesion). Lank then used MS2A for isolating resin layers (aiding reversibility) and glazed with the same medium, instead of oil, or watercolour. With the development of spray guns, the final varnish application could now be sprayed enabling the same resin (MS2A) to be used without disrupting the glazing (also in MS2A). Ruhemann and Lank both advocated using a hair dryer to speed up the drying of the egg tempera application. This also has the added benefit of cross-linking the emulsion, ensuring stability [4]. Lank continued to teach egg tempera retouching to the students of the HKI, a practice which still occurs today, now alongside a variety of retouching systems, such as Paraloid B72 and Gamblin Conservation Colours.

1.3 Egg tempera as a retouching medium today

Today, one of the main draws of egg tempera retouching remains its versatility; it has the optical ability to achieve both opaqueness and transparency, but is especially suited to achieving large swatches of opaque colour. It is therefore well suited to paintings with large lacunae because when applied in multiple lean layers (and colour-matched accordingly), the optical interaction between the pigment and medium has the ability to flawlessly match aged oil paint. It is suitable for use on filled losses only, but when used in conjunction with a resin retouching medium (as is used for glazing the egg tempera), this is not problematic as retouching out paint abrasion is better achieved through resin retouching. As dried egg can become embrittled with age, there have been concerns over its reversibility, especially if painted directly onto areas of original paint [5]. However, used correctly, there should be no risk of irreversibility; first, the whole painting receives a full isolating varnish (using a reversible resin), in addition, the tempera mixture uses the whole of the egg combined with water (not just the yolk which can become insoluble) and is then, ground with pigment and further diluted on the palette with water, and applied in thin, lean, layers to the painting's filled loss. An isolating reversible resin varnish is applied locally between the tempera layers (offering saturation and aiding reversibility). Reversibility concerns are based on egg tempera retouching in its 19th-century incarnation where the yolk only was used and where it was combined with glazing in oils. Lank's adaptations have now mitigated these concerns.

The technique of egg tempera retouching takes time to master. The layering system can limit efficiency to some degree, however, the optical appearance of a near-perfect retouching makes up for this [6]. Once familiar and experienced with the method it soon becomes second nature and is a very effective method for retouching large losses which require large swatches of body colour, before refining the upper layers to mimetically match the surrounding paint. Another draw of egg tempera is it requires only water as a diluent, and therefore limits solvent exposure for the conservator. That said, the isolating resin layers and glazing do require a solvent and historically MS2A was used, which requires an aliphatic hydrocarbon, such as Shellsol D40.

1.4 Demise of MS2A

Since production of MS2A stopped in around 2014 conservators have looked elsewhere for suitable reversible resin varnishes[i]. Like many institutions and private practices, the HKI turned to conservation-grade synthetics such as Laropal A81, Paraloid B72 and Regalrez 1094. For this process, Laropal A81, being a low molecular weight resin, is the best substitute for MS2A given its capacity to saturate well[ii].

Laropal A81 is an urea aldehyde resin, manufactured by BASF. It is resistant to yellowing and remains soluble in artificial aging tests [7]. Owing to its refractive index (RI) of 1.503 [8] the resin has excellent wetting properties and is soluble in a range of widely available solvents, making it a suitable candidate for varnishing and retouching [9]. In practice, it requires a solvent with high aromatic content for solubility (a 50:50 mixture of Shellsol A100 and Shellsol D40 is used at the HKI), making Laropal A81 less favourable for the health of the conservator[iii].

The inherent leanness of the egg tempera can result in a porous layer (even after burnishing), which then requires saturation. To remedy this, an isolating varnish layer is sandwiched between tempera layers which enables the conservator to 'fix' lower layers with sufficient saturation (and in turn aiding a correct colour match) prior to working on the subsequent layer[iv]. This resin layer also acts to ensure reversibility as the lean tempera layer is easily undercut with the resin's active solvent.

The scope of this paper is not to explore the practical methods of egg tempera retouching. Ample literature is available on the subject.

2. CASE STUDY

A complication was recently encountered when using Laropal A81 as an isolating varnish for the egg tempera retouching of a British Tudor portrait, which, after cleaning, displayed significant paint loss in large lacunae, and therefore was an ideal candidate for egg tempera retouching (Figures 1 and 2).

2.1 The problems encountered with Laropal A81

After cleaning *Unidentified Lady*, tests found the best varnishing result to be a composite layer structure composed of an initial application of Paraloid B72 (15% in Shellsol A100), followed by a further varnish application of Laropal A81 (17% in Shellsol A100 and Shellsol D40, 50:50). The painting received an initial brush varnish of Paraloid B72. For this varnish layering method, the Paraloid B72 layer needs to dry over a period of approximately one week prior to a further varnish application. To economize time, filling of the large lacunae was completed during this interval[v]. The fills were locally isolated using a weak solution of shellac (in Industrial Denatured Alcohol) and the first egg tempera application, pigmented to match the painting's ground colour, was applied (Figure 3). This egg tempera layer was burnished and the final brush varnish (covering the entirety of the painting) was applied using Laropal A81. This has the benefit of achieving good saturation whilst simultaneously isolating the initial lay-in of egg tempera. Application of subsequent egg tempera layers were when difficulties were encountered: These included a lack of achievable saturation to the egg

Figure 1 – Unidentified lady; 16th century, British; oil on oak panel; 65 cm ×58 cm; Emmanuel College, University of Cambridge, UK. Before treatment. Photograph © Chris Titmus Hamilton Kerr Institute, University of Cambridge. By courtesy of The Master and Fellows of Emmanuel College, Cambridge

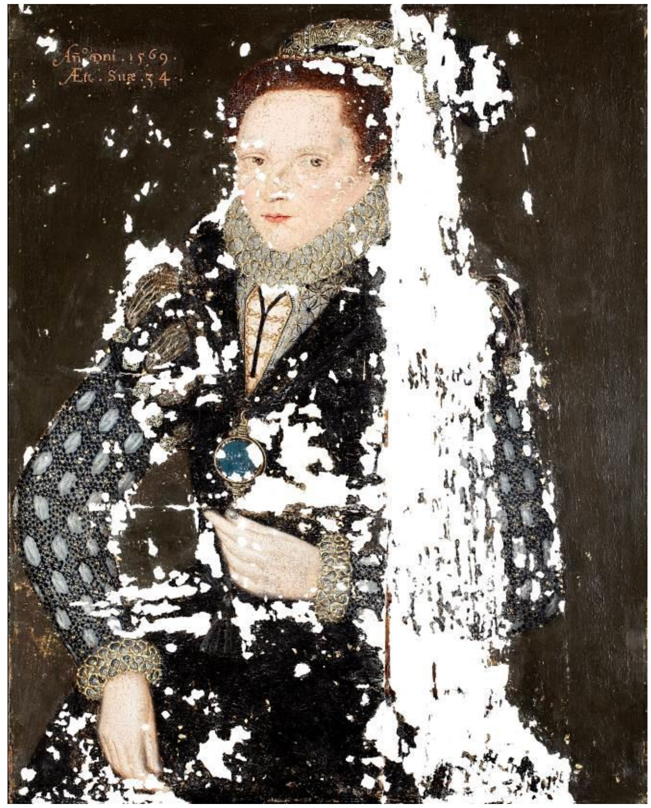

Figure 2 – Unidentified lady; after cleaning, filling and first full isolating varnish (Paraloid B72). Photograph © Christine Braybrook, Hamilton Kerr Institute, University of Cambridge. By courtesy of The Master and Fellows of Emmanuel College, Cambridge

tempera and disruption of the retouching (redistribution and pick-up of pigment) because of re-activation/re-solubilization of the lower Laropal A81 layer.

Laropal A81 is easily reversible using a wide range of high and medium polar solvents. The porosity and lack of saturation of the egg tempera - especially some pigment mixes containing earths – necessitates the need for saturation from the localized isolating resin, however, to achieve a suitable level of saturation several passes with the brush were required. Frustratingly, this resulted in re-activating the lower Laropal A81 layer and therefore disruption of the egg tempera layers.

2.2 Testing

To remedy the problem encountered with the re-solubilisation of the Laropal A81, a reduction of the amount of brushing required to achieve saturation was the initial aim. Reducing the aromatic content of the solvent diluent mixture from 50:50 to a 60:40 mixture of Shellsol D40 and Shellsol A100 (which in practice is the lowest concentration to achieve solubility of the resin) and increasing the percentage of the resin up to 25%. This offered a limited improvement, but still resulted in disruption to the egg tempera.

Substituting the diluent to one with a lower aromatic content yet still with the ability to solubilise the resin was then investigated. A literature review of Laropal A81 located an article on the subject, written in 2015 by Alan Phenix and Agata Graczyk, discussing the use of aromatic-free hydrocarbons as a diluent for Laropal A81[10].

In the article, the authors discuss the RI of a hydrocarbon as a strong indicator of solvent power and connected with the polarizability of an organic substance; described by Phenix and Graczyk as, “the

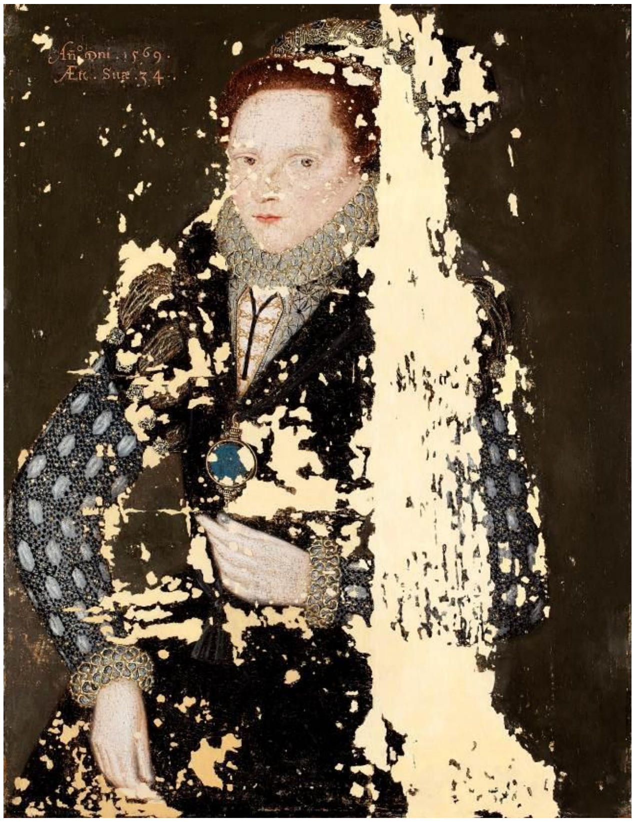

Figure 3 – Unidentified lady; During retouching, egg tempera applied to the filled losses to mimic the painting's ground colour. Photograph © Christine Braybrook, Hamilton Kerr Institute, University of Cambridge. By courtesy of The Master and Fellows of Emmanuel College, Cambridge

disposition for the electron cloud of the molecules to be distorted from normal shape by an external electric field" [11]. This could also be described as temporary dispersion forces. An aromatic hydrocarbon has a high RI and high polarizability, making them capable of strong dispersion force interactions [12]. Practically, this indicates that an aromatic hydrocarbon is capable of dissolving Laropal A81.

Phenix and Graczyk state cyclooctane's RI of 1.4557 is a higher value compared to a 70:30 mixture of Shellsol D38 and xylene which has a RI of 1.4380, suggesting its ability to solubilize Laropal A81 (requiring an RI of 1.430) [13].

3. CYCLOOCTANE

Cyclooctane is a monocyclic saturated hydrocarbon (Figure 4). A benefit to the use of cycloocane over Shellsol A100 is it poses no serious health risk to the user. Currently, it carries two Hazard Statements on its Safety Data Sheet: H226: Flammable liquids and vapour; and H304: Aspiration hazard, may be fatal if swallowed and enters airways. While perhaps far from ideal, this is significantly better than the current seven Hazard Statements for Xylene and five for Shellsol A100[vi]. Therefore, cyclooctane, when used appropriately, and in low quantities, is potentially suitable for use in the open studio (with adequate ventilation, local extraction, and PPE where required)[vii].

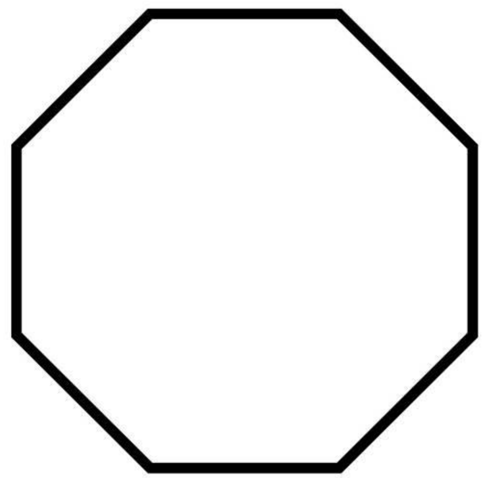

Figure 4 – Chemical structure of cyclooctane, C_8H_{16}

In practice, empirical testing found evaporation rates and drying time to be comparable between a 25% solution of Laropal A81 made with cyclooctane and the same concentration made with a 50:50 mixture of Shellsol A100 and Shellsol D40. The main disadvantage of cyclooctane is its cost. At the time of writing, it costs £45 for 100ml, or £450 for 2.5 litres. Whereas 1 litre of Xylene costs £27, and one litre of Shellsol D40 is £6.50. However, this compares favourably with the price of green solvents, which offer similar benefits[viii]. There is real potential for some solvents to be phased out of use and therefore a gradual switch to these solvents now may prove advantageous for the future.

For increased economy, Phenix and Graczyk discuss options for dilution, stating leeway in the non-polar solubility limitation of Laropal A81 [14]. A suggestion is given to a 50:50 mixture of cyclooctane and petroleum benzene, resulting in a RI of 1.4322, marginally higher than 1.430 (which is the required RI

Figures 5 and 6 – *Unidentified lady*; During the egg tempera retouching. The retouching's layer structure is built up to match that of the original painting. To enable accuracy, reference material was referred to throughout the memetic reconstruction process. Photograph © Christine Braybrook, Hamilton Kerr Institute, University of Cambridge. By courtesy of The Master and Fellows of Emmanuel College-

to dissolve Laropal A81). In studio conditions, the author was unable to solubilise Laropal A81 with mixtures using cyclooctane and petroleum spirit[xix].

Cyclooctane was successfully employed as the diluent carrier for Laropal A81 for the isolating resin layers for the egg tempera retouching of *Unidentified Lady (Figures 5-10).* This enabled the isolating resin to be brushed on without reactivating previous resin layers or disrupting the egg tempera retouching. Glazing of the egg tempera and retouching of abraded paint were completed using Gamblin Conservation Colours (using propan-2-ol as the diluent), where necessary for additional gloss, Laropal A81 in cyclooctane was added to the paint mix.

4. CONCLUSION

Cyclooctane worked well as the diluent for Laropal A81 when used as a localised isolating varnish layer for egg tempera retouching. It achieved an acceptable saturation whilst enabling more brushing without reactivating lower Laropal A81 resin layers. This was a far better result than the use of the conventional solvent mixture of Shellsol D40 and Shellsol A100 (50:50) which had resulted in the redistribution of the egg tempera layer. Significant health benefits are also an advantage to the use of cyclooctane, which may outweigh any cost disadvantage.

Cyclooctane is now the preferred diluent at the HKI for localised isolating varnish layers with Laropal A81 when retouching with egg tempera. It has also been successfully employed as the diluent for Laropal A81 when ground with dry pigments for retouching, and tests suggest it could be a feasible option if a secondary brush varnish application is required over an initial Laropal A81 varnish layer. Tests are also promising for the application of a brush varnish in Laropal A81 (in cyclooctane) upon a varnish or retouching completed using Paraloid B72, without disruption to the Paraloid B72. It will also prove useful for activities away from the studio environment, such as varnishing *in situ*, where access to an extraction unit may be limited.

Figure 7 – Unidentified lady; after egg tempera retouching, before glazing with Gamblin Conservation Colours. Photograph © Christine Braybrook, Hamilton Kerr Institute, University of Cambridge. By courtesy of The Master and Fellows of Emmanuel College, Cambridge

Figure 8 – Undentified lady; After treatment. Photograph © Christine Braybrook, Hamilton Kerr Institute, University of Cambridge. By courtesy of The Master and Fellows of Emmanuel College, Cambridge

Figures 9 and 10 – Unidentified lady; details of completed egg tempera retouching. Photograph © Christine Braybrook, Hamilton Kerr Institute, University of Cambridge. By courtesy of The Master and Fellows of Emmanuel College, Cambridge

Figure 11– Unidentified lady; detail of completed egg tempera retouching. Photograph © Christine Braybrook, Hamilton Kerr Institute, University of Cambridge. By courtesy of The Master and Fellows of Emmanuel College, Cambridge

Figure 12– Unidentified lady; detail of completed egg tempera retouching. Photograph © Christine Braybrook, Hamilton Kerr Institute, University of Cambridge. By courtesy of The Master and Fellows of Emmanuel College, Cambridge

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REFERENCES

[1] MASSING, A. (2020). The history of egg tempera as a retouching medium. In ELLISON, R., SMITHEN, P. & TURNBULL, R., (Eds.), (2010). *Mixing and Matching. Approaches to Retouching Paintings*. London: Archetype: 5-17 (p. 5-6).

[2] KÖSTER, C. P. (2001) Ueber Restauration alter Oelgemälde. Nachdruck der Originalausgabe von 1827 bis 1830, Herausgegeben und mit ener Einleitung sowie einem Anhang versehen von Thomas Rudi, Bücherei des Restaurators Band 5, Herausgegeben von Ulrich Schiessl. Leipzig: E.A. Seemann Verlag. See MASSING, A. (2020). The history of egg tempera as a retouching medium. In ELLISON, R., SMITHEN, P. & TURNBULL, R., (Eds.), (2010). *Mixing and Matching. Approaches to Retouching Paintings*. London: Archetype: 5-17 (p. 6).

[3] See [1] (p. 7-8).

[4] *Ibid.* (p. 7-8).

[5] DIGNEY-PEER, S., THOMAS, K., PERRY, R., TOWNSEND, J., GRITT, S., (2012) The imitative retouching of easel paintings, In STONER, J, H., RUSHFIELD, R. (Eds), The Conservation of Easel Paintings. London and New York: Routledge: 607-634 (p. 627).

[6] KEMPSKI, M., (2010) The art of tempera retouching. In ELLISON, R., SMITHEN, P. & TURNBULL, R., (Eds.) (2010). *Mixing and Matching. Approaches to Retouching Paintings*. London: Archetype: 36-46 (p. 37).

[7] DE LA RIE, R., QUILLEN LOMAX, S., PALMER, M. AND MAINES, C. (2002) An investigation of the photo-chemical stability of films of the urea-aldehyde resins

Laropal® A81 and Laropal® A101, In VONTOBEL, R (ED), *Preprints of the ICOM-CC 13th Triennial Meeting*, Vol II. London: James & James: 881-7.
[8] ARSLANOGLU, J., & LEARNER, T. (2001) The evaluation of Laropal A81: Paraloid B-72 polymer blend varnishes for painted and decorative surfaces – appearance and practical considerations, *The Conservator*, 25:1, 62-72 (p.66)

[9] REDDINGTON, S., (2015) Laropal A81 as an alternative to MS2A and other resins, In BARROS, D., BONE, L., CLARRICOATES, R., DOWDING, H (Eds), *Current technical challenges in the conservation of paintings*: 54-68 (p. 58).

[10] PHENIX, A., GRACZYK, A., (2015) An aromatic-free hydrocarbon solvent/diluent for Laropal® A81 and Gamblin Conservation Colors. WAAC Newsletter 37 (3), 17- 20.

[11] *Ibid.* (p. 17).

[12] *Ibid.* (p. 18).

[13] *Ibid.* (p. 18).

[14] *Ibid.* (p. 19).

[i] MS3, a substitute for MS2A is now in production, although the author has not had experience of this product it may offer promise for isolating varnish layers for egg tempera. https://www.boronmolecular.com/case-study/resin-for-old-masters/

[ii] Regalrez 1094, although a low molecular weight resin was not considered suitable for this application owing to its solubility parameters and inability to saturate the egg tempera application.
[iii] The author recommends referring to an up to date Safety Data Sheet provided by the supplier.

[iv] The frequency of the isolating resin layer is dependent on the preference of the individual conservator. The author suggests a resin layer is applied after every 2-3 tempera layers. In reality, this is commonly at the point of a colour change, as dictated by the artist's original technique.

[v] The filler was composed of calcium carbonate, gelatin (10% in deionized water), with a small addition of poly vinyl alcohol adhesive (Resin W) for flexibility.

[vi] Xylene: H226, flammable liquid and vapor; H304, may be fatal if swallowed and enters airways; H312 & H332, harmful in contact with skin or if inhaled; H315, causes skin irritation; H319, causes serious eye irritation; H335, may cause respiratory irritation; H373, may cause damage to organs through prolonged or repeated exposure; H412, harmful to aquatic life with long lasting effects
Shellsol A100: H226, flammable liquid and vapour; H304, may be fatal if swallowed and enters airways; H335, may cause respiratory irritation; H336, may cause drowsiness or dizziness; H411, toxic to aquatic life with long lasting effects.

[vii] Engagement in a substance's Safety Data Sheet and reading (or composing) the risk assessment prior to working with a new substance is essential to eliminate and reduce risks relating to exposure and working practices.

[viii] Two green solvents were looked at for their potential use to dissolve Laropal A81; Limonene and Ethyl lactate. Green solvents benefit from being less harmful to both the health of the conservator and for the environment. Although not tested practically for suitability as a varnish diluent, they have the ability to dissolve the resin. They offer a similar price comparison to cyclooctane, both are currently available from Sigma Aldrich.

[xix] The UK equivalent to petroleum benzene. It is thought the mixture was not able to solubilize the Laropal A81 resin due to disparities in the commercial hydrocarbon mix of petroleum spirit compared to the US petroleum benzene, resulting in a lower RI then what is stated. Tests were completed using a 30:70 mixture (petroleum spirit 100-120 and cyclooctane) which was also found to be unable to dissolve the resin.