Historical recipes for preparatory layers for oil paintings in manuals, manuscripts and handbooks in North West Europe, 1550-1900: analysis and reconstructions

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Citation for published version (APA):

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Figure 15.1 P.P. Rubens, The triumph of Rome: the youthful emperor Constantine honouring Rome, (c. 1622-23) panel, 54 x 69 cm, Inv. 837, Royal Picture Gallery Mauritshuis, The Hague

Photograph courtesy of the Royal Picture Gallery Mauritshuis, The Hague
Chapter 15 Reconstructing seventeenth-century streaky imprimatura layers used on panel paintings

15.1 Introduction

The visibility of the preparatory layer in a final painting can vary significantly. Differences can be related to the period when a painting was executed or to local customs, to the status of the work as a sketch, design (modello) or as a highly finished work. Visibility is obviously also influenced by ageing of the materials utilized in the paint layers, and by the quality of these materials.

An example of preparatory layers which play an important role in the aesthetic quality of the final painting are the streaky imprimatura layers which were used during the sixteenth and seventeenth century by Flemish artists such as Jan Brueghel the Elder (1568-1625) and Peter Paul Rubens (1577-1640). Although not always left visible in their more finished paintings, this layer was often left in sight in more sketchy works and modelli. Translucent, pigmented streaky imprimaturas were usually applied over a white chalk ground on panel and occasionally on canvas, their deliberate streakiness the result of the application tool and paint characteristics. Through its colour and textural effects, streaky imprimaturas bring a unified harmony and liveliness to painted sketches and to more finished paintings.

In modern literature, many suggestions have been made on the subject of the binding media utilized in imprimaturas. However clarity has not been reached. The present chapter investigates imprimatura binding media through a comparison of historical recipes, modern literature and painting analyses. The feasibility of different materials as a binding medium for imprimaturas is investigated in reconstructions. The question whether Rubens employed aqueous binding media, emulsions or thinned oil paint for his imprimaturas is relevant for conservation decisions. If, for instance, a fast-drying aqueous binder was employed for the imprimatura, a higher water-sensitivity may be expected.

15.2 Terminology

The Italian term ‘imprimatura’ is described by Giorgio Vasari in the introduction to his 1550 Vite:

When the artist wishes to begin, that is, after he has laid the gesso on the panels or framed canvases and smoothed it, he spreads over this with a sponge four or five coats of the smoothest size, and proceeds to grind the colours with walnut or linseed oil

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1 This chapter is an updated version of Stols-Witlox, Doherty and Schoonhoven 2008.
But first there must be made a composition of pigments which possess siccative qualities as white lead, dryers, and earth such as is used for bells [terra da campane], all thoroughly well mixed together and of one tint, and when the size is dry this must be plastered over the panel and then beaten with the palm of the hand, so that it becomes evenly united and spread all over, and this many call the *imprimatura*.

Here the term *imprimatura* describes an oil-based layer applied on the panel or canvas before painting. The application method suggests a thin, even layer. In other languages, similar terms have appeared, for instance the French *imprimeure* and the Dutch *primuersel*. Although these words often refer to thin, *translucent* final preparation layers that may play an aesthetic role, they are also used in a wider sense that included opaquely pigmented preparation layers (see Paragraph 2.1.5 for a more detailed discussion of the term *imprimatura*).

Van Mander (1604) explains the reasons to use a transparent *primuersel* (often translated with *imprimatura*) in his *Schilder-boeck* in his discussion of the methods of his predecessors:

> Some took some charcoal black finely ground with water [then] drew and shaded together their subjects very skillfully, as was fitting: they then applied artfully a fine, thin ‘primuersel’ on top through which one could [still] see everything and behold: the ‘primuersel’ was flesh coloured.

> When this had dried, they saw their subjects as if half finished, before their eyes, whereupon they set up everything and finished in one layer.

The use of a visible, streaky *imprimatura* is often associated with Peter Paul Rubens although he was not the first to use such layers. Van Mander mentions its use by Jan de Hollander (active 1528-1542) and Brueghel the Elder. Streaky *imprimaturas* play a prominent role in the mid-tones and shadows not only in nearly all Rubens's sketches and modelli, which number about 450, but also in several of his more finished paintings, especially those on panel (Fig. 15.1).

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3 De Mayerne 1620-44:98v.
4 van Mander 1604:47v,48r.
5 van Hout 1998:198-199. See also Part II, Chapter 4.
6 Translation by the author, compared to and modified according to partial translations by 1991: 62 and by Filedt Kok 1972. Van Mander 1604: 47v, 48r: ‘… dat sommighe namen/ eenich sine-kool swart, al fijntgens ghewreven/ met water, jae trocken en diepten t’samen/ hun dinghen seer vlytich naer het betamen: dan hebbensers aerdich over ghegheven Een dunne primuersel / alwaer men e…
7 Van Mander 1604: 215.
Visual examination of several of Rubens’s sketches shows streaky imprimaturas that appear almost careless in their application. The rather fluid, long strokes of paint, applied with wide brushes, form continuous layers. Areas where the brush has halted or skipped are hardly ever observed. Strokes may be applied in different directions, apparently unrelated to the overlying composition. In some paintings a single imprimatura layer is visible, within which brush strokes are cut off by strokes coming from different angles while they were still wet (Fig. 15.2). In other paintings overlapping strokes are present, of similar colour, brushed out in different directions (Figs. 15.3, 15.4). Pigment densities vary, resulting in imprimaturas of different transparency.

Although different binding media have been suggested, no definite answer has been given to the question of which binder Rubens used for his streaky imprimaturas. Reconstructions might shed light on this question by testing the usability of the different binders and investigating the visual characteristics and the working properties of binders mentioned in the literature. A similar approach has been used before, for example by Doerner. Since then, scientific research has presented us with new instrumental analyses (see below), but still has not been able to draw comprehensive conclusions on the question of streaky imprimatura binding media. The present reconstructions attempt to evaluate the proposed binding media in a systematic way. Research into historical paint materials has also progressed since Doerner’s time. For the present reconstructions materials are used that are as close as possible to what is nowadays known about historical paint materials.

15.3 Imprimaturas in recipes and previous analysis

Whether chalk-glue grounds on panel were prepared in artist’s workshops is uncertain, as professional primers are active in Antwerp since the fifteenth century. However, since a

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9 Recent investigations have found brush hairs in Rubens’ streaky imprimatura layers. Information kindly provided by Hélène Dubois, paintings conservator, Musée des Beaux Arts, Brussels
10 Doerner (English translation by Eugen Neuhaus) 1949. Doerner’s Malmaterial und seine Verwendung im Bilde was first published in 1921 in München, Berlin and Leipzig by the Verlag für Praktische Kunstwissenschaft.
11 See for instance Carlyle 2006 on historically appropriate materials. See also the introduction to the present research.
12 Van Hout 1998: 204
streaky imprimatura has a significant impact on the overall aesthetic of the painting, one presumes that it was applied according to the artist’s wishes, perhaps inside the studio. Most attempts to identify the composition of imprimaturas from seventeenth-century paintings have focused on Rubens. The overview of published pigment compositions of imprimaturas in his paintings (Appendix 22, Table 15.1) shows a preference for either grey imprimaturas, made up of lead white and charcoal black pigments, or for more warmly coloured imprimaturas containing umber and/or red or orange earth pigments together with lead white and charcoal black. Imprimaturas without distinct lead white particles and with chalk additions have also been found.

![Figure 15.3](image1.png)  
**Figure 15.3** P.P. Rubens, The ascent to calvary. The bearing of the cross (c. 1634)  
oil on panel, 104 x 78 cm (h x w)

*Inv. KMS 1856. National Gallery of Denmark, Copenhagen, Photographs: © SMK Photo*

There is evidence that some of Rubens’ more warmly coloured imprimaturas may originally have been intended to have a cooler tone. The imprimatura of Rubens’ *Modello for the assumption of the Virgin* (c.1622-1625)\(^{13}\) contains minium, besides lead white, chalk and charcoal black. The morphology of the minium (fibrous, crust-like particles), analysed by SEM-EDX as a red lead compound, and its appearance in combination with basic lead carbonate, suggest that it is a lead remineralisation product, formed due to a saponification reaction between lead white and the oil binder.\(^{14}\)

Unfortunately, extensive research has been unable to identify recipes for *streaky* imprimaturas. However, a number of ground recipes from the sixteenth and seventeenth centuries\(^{15}\) do describe a second ground layer of a pigment composition very similar to

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\(^{13}\) Panel 88 x 59.1 cm, Mauritshuis, The Hague, inv. 926.  
\(^{15}\) Recipes collected by Witlox for the HART project, see Witlox 2008.
that of the streaky imprimaturas used by Rubens, applied on top of a chalk/glue ground or chalk/gypsum ground (Appendix 2, Table 15.2). While no mention of translucency is present, in some cases the application information suggests thin, imprimatura-like layers.

Art historians and painting conservators have long speculated about the binding medium used for streaky imprimaturas. Scientific analysis of this layer is very difficult. Since imprimatura layers are extremely thin, scrapings taken for analysis are often suspected to be contaminated with binding media from other paint layers, either included accidentally in the sample or soaked in from the layer above. Therefore imprimatura binding medium analyses are often published with reservations. Analysis is further complicated by the mobility of components of binding media and varnish layers, even after they have dried. Recent reconstructions have shown that an oil binder may move to other paint layers even when the layers are separated by varnish isolation layers. From the 1920s on, research has suggested that aqueous media such as egg tempera or glue were used for streaky imprimaturas. This was based on the reasoning that such media dry quickly and retain the streaky texture imparted from a brush. Van Hout (1998) challenged this opinion. Approaching the subject from a historical perspective, he suggested an oil binder since ‘it is likely that the streaky imprimatura originated from the oil isolation layer, to which Early Netherlandish painters sometimes added pigments’.

Binders identified in seventeenth-century imprimaturas include: drying oil alone, linseed oil with an addition of pine resin and aqueous media. Recent analyses identified egg with possibly an addition of oil in Rubens’s Achilles series, and a drying oil in the Mauritshuis Modello for the assumption of the Virgin (Appendix 2, Table 15.1).

The notion that painters adapted their binding media to the requirements of certain layers or introduced aqueous layers into their oil paintings does not seem to be implausible, as binder analyses from paintings from pre-Eyckian times to the seventeenth century suggest. Analyses by Kockaert led to the conclusion that Rubens himself used emulsions of oil and protein in impasto-rich areas of the Elevation of the Cross in Antwerp Cathedral. However, as recent investigations by the National Gallery London demonstrate that the presence of saponified oil paint components have in the past lead to false positives for emulsion binders, some of these earlier analyses might need to be reconsidered.

Ground recipes mentioned in Appendix 2, Table 15.2 all have an oil binder (linseed or walnut). Other binders for grounds are mentioned less frequently. An addition of ‘common varnish’ [probably a colophony-containing varnish, although sandarac is also possible] to an oil ground is mentioned in 1587 by Armenini. An emulsion of oil and

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16 Boersma et al. 2007.
17 Keune 2005: 74.
18 Von Sonnenburg 1979c:24, note 28.
22 Kockaert 1992a:76-77.
23 Spring and Higgit 2006.
24 Armenini 1587: 124-5. The hypothesis that a ‘common varnish’ is likely to contain colophony, possibly sandarac is based on prior recipe research by Keller (1973) and by Stols-Witlox (Stols-Witlox 2001).
aqueous binder is described by Lebrun (1635) who explains how to ‘grind together some parchment glue and oil priming, and immediately prime the canvas with this; it will harden directly, but this priming is very apt to scale off when the canvas is rolled up’.

Recipe books from the late sixteenth and seventeenth centuries mention a number of oil paint modifications, showing that at this time artists were very aware of methods to modify the binder. It seems possible that similar techniques were employed for imprimaturas, to adapt the binder to the specific requirements of this thin, translucent layer.

Additions of volatile solvents to oil paint were regularly mentioned in seventeenth century sources. Turpentine was added as thinner to make the colours flow more easily. Rubens’s extensive use of diluents is apparent both from drips of very liquid paint in his paintings, and from the De Mayerne manuscript (1620-44 in a quotation marked ‘M. Rubens’ in the margin: ‘to make your colours spread easily, and as a consequence mix well, and also do not change, as for blues: but generally for all colours, while painting, from time to time dip your brush lightly in white oil of Venice turpentine, extracted in a bain-marie. Then with this brush mix your colours on the palette’.

Spike oil was mentioned amongst others in the De Mayerne manuscript, as an addition to blue and white oil paint and by Dupuy du Grez (1699) as a paint diluent. William Gandy (1673-99) provides a recipe for a gel-like medium made from mastic/turpentine varnish and siccative-treated oil, supposedly one of the binding media used by van Dyck.

Because of their presence in recipes contemporary to Rubens’s and Brueghel’s paintings, the above mentioned materials were all selected for reconstructions that investigated the properties of these materials in streaky imprimatura layers.

### 15.4 Reconstructions: protocol and execution

Where possible, historically appropriate materials have been used. Two separate sets of reconstructions were made by individual conservators. This allowed for an evaluation of the influence of the artist’s hand on the characteristic appearance of the imprimatura. The amount of pressure exerted on the brush and extent of brushing out of the layer have a strong impact on the final appearance of the imprimatura.

Because the present reconstructions are well documented and have compositions and layer build-up that closely resemble seventeenth-century painting practice, they are very useful for testing and evaluating analytical techniques. The reconstructions will be used to investigate the suitability of immunodetection and immuno-fluorescent staining.

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26 Examples are the Venus frigida, Royal Museum of Fine Arts, Antwerp, inv. 709, and The arch of the mint (front), inv. 317, Royal Museum of Fine Arts, Antwerp.
27 De Mayerne 1620-44:9v.
28 De Mayerne 1620-44: 7.
29 Dupuy du Grez 1699: 245.
30 The exact nature of spike oil is not certain, since historically, the essential oil of different plants was identified by this name. (Brachert 2001: 236).
32 Stols-Witlox and Doherty.
techniques for the analyses of proteinaceous binding media in imprimaturas. Both sets of reconstructions will be available for future research.\textsuperscript{33}

\textbf{15.4.1 The support and build-up of sizing and ground layers}

The present set of reconstructions has been executed on panels of quarter-sawn oak (24 x 29 cm). The ground materials and layer build-up are based on seventeenth-century recipes. First, two size layers of warm goatskin glue are applied with a brush, followed by a total of five coats of ground, prepared from unprocessed chalk and pigs skin glue.\textsuperscript{34} On half of each board, the dry ground is scraped with an iron furniture scraper, a method similar to scraping with steel spatulas or knives mentioned in contemporary historical recipes.\textsuperscript{35}

\textbf{15.4.2 Unpigmented isolation layers}

Cross-sections from paintings sometimes appear to have a medium-rich ‘band’ or layer over the ground. Whether this is a separate isolation layer of unpigmented medium (drying oil or glue have both been suggested in the literature), a separation of medium from the chalk/glue ground, or whether this layer consists of oil that has been absorbed from subsequent layers is subject to interpretation.\textsuperscript{36} The thinness of this layer, combined with its close connection to the ground, makes analysis extremely difficult. This is why reconstructed imprimaturas have been applied both directly on top of the ground, over an unpigmented isolation layer of litharge-treated oil and over an isolation layer of goatskin glue or sheep parchment glue.

\textbf{15.4.3 Underdrawing}

In several of his sketches and paintings Rubens employed dry underdrawing. His underdrawings were applied on top of the imprimatura, in accordance with current Italian

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\textsuperscript{33} Samples will be used to test the application of immuno-fluorescent staining techniques to cross-sections. With these analytical techniques, a distinction can be made between different protein types (Heginbotham et al. 2006), and these techniques may be able to determine the animal source for aqueous binding media Rubens could have employed in his streaky imprimature. Therefore four different animal glues were included in the reconstructions. In historical sources, generally the same type of glue is mentioned for both the sizing and ground layers within one painting. However this diversion from historical practice is suspected not to have any effect on imprimatura characteristics, since compositional variations between different mammal animal glues are relatively small (Eustoe and Leach 1977: 77). Apart from one factory-produced pighide glue, all other glues were prepared from scraps of leather or parchment following historical recipes. These –calf parchment glue, sheep parchment glue and glue made from alum tawed goats hide— are all mentioned in historical recipes. Witlox 2008. Since the reconstructions were executed, samples have been taken by different researchers, amongst which Esther Ferreira, Swiss Institute for Art Research in Zürich, Switzerland, and Katrien Keune, Dutch Agency for Cultural Heritage. Both researchers took samples in order to use them in tests to determine the sensitivity of different analytical instruments employed for the analysis of art materials.

\textsuperscript{34} ‘Take glew and seeth it very long in fayer water until the glew be dissolvèd, and the work is done. ... Take size made as above: mix it with whyting ground, heat it, and soe whyte your boards being made smooth. After you have whytened, then lett them dry after every whyting: then scrape them gently untill they be smooth; then draw over it whyte lead tempered with oyle‘. Norgate 1640 (transcription Hardie 1919: 91).

\textsuperscript{35} ‘Prime first with the aforesaid glue and chalk, when dry, scrape and flatten with a knife‘. De Mayerne 1620-44: 11

\textsuperscript{36} Witlox and Carlyle 2005.
\end{flushright}
and Northern European practice. This is in contrast to early Flemish painting technique where the imprimatura was applied on top of the underdrawing in order to seal the drawing from disruption by paint brushes. Black chalk is identified as having been used by Rubens for his underdrawing. Modern artificial black chalk is entirely different from the natural, carbonaceous clay used by Rubens. Since natural black chalk was not available, underdrawings have been executed with another material used during this period: charcoal stick. Underdrawing lines have been applied both below and above the imprimatura to investigate the consequences of the layer’s position in the layer build-up.

15.4.4 Imprimatura composition

Three groups of binders have been selected: aqueous binders, oil binders and emulsions. The full list of reconstructed binders includes: whole egg, egg white and egg yolk; goat’s skin glue, calf parchment glue and sheep parchment glue; gum Arabic and gum tragacanth; water-washed raw linseed oil and linseed oil heated with siccatives; fat and lean emulsions of oil and glue and of oil and egg; mastic varnish, colophony varnish and copal varnish; linseed oil with additions of either spike oil or turpentine oil (Appendix 22, Table 15.3). Plant gums are included because of their availability as an aqueous binder at the time, and their mention as addition to egg-white varnishes in contemporary recipes. All binders are mentioned in historical recipes, have been presented as possible imprimatura binders in modern conservation literature or their presence was confirmed by instrumental analysis (Appendix 22, Table 15.1).

Where possible, materials were prepared by the authors to ensure the highest level of historical accuracy. As mentioned above, this includes nearly all animal glues, prepared according to historical recipes, and the use of unprocessed chalk. However, ‘historical accuracy’ is not possible in all cases. A compromise had to be made in the case of turpentine and spike oil, since no distillation facilities could be created within the context of the project. This means that conclusions based on the set of reconstructions involving those oils can only describe the general effects of the addition of volatile oils, not relate them directly to historical practice.

Imprimaturas are pigmented with stack-process lead white, raw umber and charcoal black. The charcoal sticks that are also used for the underdrawing, are ground into a powder to obtain a coarse black, as seen in Rubens’s streaky imprimaturas. In some reconstructions, unprocessed chalk is added. Imprimaturas are applied with 4 cm wide and 3.5 cm long hogshair brushes. The brush-size in the original Rubens imprimaturas has been measured and it falls within a range of 4-5.7 cm. Brushes are pre-wetted with the imprimatura’s binder and/or a diluent in order to enable spreading. Once the imprimaturas has dried, a paint layer of vermilion, bound in litharge-treated linseed oil, is applied locally in order to emulate the layering found in ‘real’ paintings. Vermilion is

38 Boersma et al. 2007.
39 See Siejek 2004 for a discussion of underdrawing materials. Charcoal was prepared by Astrid Smeets, Limburg Conservation Institute, Maastricht, for project P9 (Infrared reflectography: evaluative studies), De Mayerne research programme.
40 Recent master thesis research by Nienke Woltman shows a slight compositional difference between ‘modern’ turpentine oil and turpentine oil created in reconstructions that employed historical distillation methods (Woltman used both sandbath and steam distillation). Woltman employed the ‘historically appropriate’ turpentine oils she distilled for reconstructions investigating the effect of additions of volatile components to oil paint. Working properties of historically appropriate turpentine oils do not seem to differ significantly from modern turpentine oil in the applications that Woltman tested. (Woltman, unpublished 2010).
41 Witlox and Carlyle 2005: 54-55.
chosen because it was commonly used during the seventeenth century, creates a relatively opaque paint layer and can be easily distinguished in cross-section from the preparation layers. In some reconstructions, turpentine thinned oil paint, pigmented with madder lake and raw umber, is applied as a monochrome underpainting similar in colour to what was used by Rubens for this purpose.

15.5 Observations and evaluation

The evaluation of a binder’s suitability for streaky imprimaturas is based on several parameters. Firstly, preparation and handling properties are taken into account. Secondly the reconstructions are compared visually to detailed photographs of paintings by Rubens. Thirdly, a comparison is made between cross-sections from original paintings and from reconstructions.

15.5.1 Observations on the different imprimatura binders

One of the most obvious conclusions is that with an undiluted and unmodified hand ground oil paint, prepared with raw oil or siccative-treated oil, it is practically impossible to create a streaky imprimatura. The paint is simply too stiff and cannot be spread over the surface of the ground, no matter whether it has been pre-treated with an unpigmented isolation layer or not. Repeated brushing will eventually cover the whole surface but this evens out all streaks. When the layer is thinned with more oil to enable spreading, pigmentation becomes so dilute that streaks are no longer visible. The high amount of oil also results in the formation of a greasy layer on the surface, which is likely to hinder the application of subsequent paint layers. An addition of a volatile oil such as turpentine oil or spike oil, thins this imprimatura binder into a fluid paint that spreads well, and it provides a convincing streaky layer (Fig. 15.5).

Animal glue imprimaturas are straightforward to prepare, although care must be taken that the paint does not dry out while mixing the pigment with glue on a grinding slab. When diluted sufficiently, streaks are easily made. Glues are easy to apply and dry quickly, which means that the painter can proceed quickly to the next stage of painting. The streaks appear more crisp than streaks made with solvent-diluted oil paint. A cross-section from a goatskin glue imprimatura applied straight onto the chalk/glue ground shows a transparent band with increased UV fluorescence at the top of the chalk/glue ground. This may indicate that some of the binding medium of the imprimatura has been absorbed into the ground (Figs. 15.6a, 15.6b). While such transparent bands appear in other cross-sections, thus far no clear pattern can be established between binder, unpigmented isolation layer and the presence or absence of transparent bands.
On a larger surface, the fast drying rate of animal glues may actually be a negative quality. When the paint dries in the jar or on the dish it is kept in during application, more water is needed. Repeated thinning results in a layer of uneven thickness and opacity. Secondly, in our approach the brush fills up with dried paint. This hinders application.

**Layer 1:** ground of unprocessed chalk and pigs skin glue, 5 applications of which three are visible  
**Layer 2:** streaky imprimatura of goat’s skin glue, lead white, charcoal black and raw umber  
**Layer 3:** vermilion in litharge treated linseed oil

Both the monochrome underpainting and the vermilion oil paint applied to some of the glue imprimaturas show some bleeding out of the binding medium into the imprimatura. This suggests that the presence of oil in an imprimatura during analysis may in fact be related to such an infusion from an oil layer applied on top.

Imprimaturas prepared from different egg-components (yolk, white or whole egg) have a somewhat ‘slimy’ texture and require repeated brushing for even spreading.

A problem of the egg binders is the appearance of disturbing air bubbles.

*Figure 15.6a*  Sample from reconstruction of imprimatura with goat’s skin glue.  
*Fig. 15.6b*  The same sample, UV image  
(Sample location: panel 4, section C)

*Figure 15.7*  Air-bubbles in reconstruction of egg white imprimatura
during application (Fig. 15.7). Of the egg binders tested, egg-white contains the most air bubbles, whole egg the least.\textsuperscript{42} Egg imprimaturas form pleasant underlayers for the turpentine-thinned oil paint used to sketch a composition. Fluid lines are easily created and no bleeding out or pulling-together of the paint is noted.

Plant gum imprimaturas (gum Arabic and gum tragacanth) are difficult to prepare due to the stickiness of the binder. They require repeated additions of water in order for the pigment to be mixed properly with the binder, and too much water leads to the formation of air bubbles during application. They present a somewhat soapy character. Of all the imprimatura binders tested, the plant gum imprimaturas have the most matte and grainy surface, probably partially due to difficulties in grinding the pigments. The grains on the surface hinder the application of monochrome underpainting in oil paint. They interrupt the strokes, resulting in discontinuous lines that do not resemble Rubens’s fluid underpainting.

Different emulsions of linseed oil with whole egg and linseed oil with glue have been tested. Fat emulsions (with a high oil ratio) of oil and egg and of oil and glue spread well, however the paints behave like opaque, bulky paint layers. In cross-section, these imprimaturas appear as thick as the vermilion paint layer applied on top. Thinning with turpentine results in fluid media that spread easily and create semi-transparent streaky layers. Monochrome oil-bound underpaint applied over fat oil-and-glue emulsions does not adhere to the imprimatura surface and pulls together. This is an important drawback. The same phenomenon is not observed in fat oil-and-egg emulsions. Furthermore, oil-and-glue emulsions are not stable. This leads to binder component separation within the applied layer and to oil floating to the surface. Oil-and-egg emulsions form more stable emulsions and no greasy oil layer forms on the surface. Lean emulsions of egg-and-oil and glue-and-oil do not require thinning. Increasing the ratio of egg or glue to oil in the emulsion provides enough fluidity for easy spreading, and the resulting imprimaturas have beautiful, sharp and well-defined streaks. They visually resemble streaks made with animal glue, and show less leveling out than streaks created with diluted oil paint (Fig. 15.8). Both lean emulsions tested form very workable underlayers for subsequent monochrome oil underpainting. In layers

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image.png}
\caption{Reconstruction of imprimatura bound with lean emulsion of egg and oil}
\end{figure}

\textsuperscript{42} Future research into the use of egg for imprimatura layers should include investigations of the effect of the age of the egg binder. For the present set of reconstructions, only relatively fresh eggs were employed. Degradation of the proteins may result in lowered surface tension and could influence the formation of air bubbles. For the creation of streaky layers with egg binding media, very vigorous and fast brushing is required in comparison to that employed in medieval tempera painting. This may explain the fact that in those paintings, air bubble formation does not seem to present a problem.
applied on top, no pulling together or bleeding out of the binder is observed. An important difference between fat and lean emulsions is drying time. Whereas fat emulsions have drying characteristics close to those of pure linseed oil, lean emulsions are fast driers.

The resin media tested included mastic and colophony, both dissolved in turpentine oil, and a varnish of copal in oil.\textsuperscript{43} Grinding pigments into these media is difficult due to solvent evaporation. The paints are somewhat gritty, which is noticeable in the resulting imprimaturas. Media with a large proportion of resin are difficult to spread, although diluting with turpentine oil remedies this somewhat. Upon repeated brushing, crumbles of drying paint are pulled out of the layer by the brush. Both vermilion and monochrome underpaint applied onto one of the resin-containing media show severe bleeding out of the paint.

15.5.2 The effect of isolation layers

Only in the case of glue imprimaturas can an influence of isolation layers on their handling properties be noted. Glue imprimaturas tend to swell the glue isolation layers slightly. Oil isolation layers seem to make the application of the glue imprimaturas a little easier, although this effect is only very minimal. In other cases, no differences are noted. The isolation layers do have a noticeable effect on the visual characteristics of some of the resulting imprimaturas. Imprimaturas applied on top of an unpigmented isolation layers have a higher colour saturation. Cross-sections with and without isolation layers both show transparent bands in the upper regions of the chalk/glue ground. The presence of such transparent regions therefore does not seem to be dependent on the presence of a glue isolation layer. The width of the transparent bands seems to relate to the thickness of the imprimatura, thicker imprimaturas resulting in a wider band. This suggests that they are caused by imprimatur binder absorbance. Isolation layers affect bleeding out of the oil binder of the vermilion which appears over some of the glue imprimaturas and results in the creation of a halo of oil around the red paint. In areas without isolation layers no halo is created. The extent of bleeding out can be interpreted as a measure for the effectiveness of an isolation layer. In areas without haloes of binding media, all oil appears to be absorbed into the ground. In areas with haloes around the paint, the isolation layer appears to have prevented the oil from being absorbed into the ground and it was absorbed into the imprimatura instead.

\textsuperscript{43} Copal varnish made by Leslie Carlyle in 1993, prepared from Kauri copal, linseed oil and turpentine oil. Mastic varnish prepared from 1 pt. mastic resin and 2 pts. turpentine oil. (Carlyle 2000: 8-9).
15.6 Conclusions

Despite efforts to work with materials and techniques similar to the ones available to painters in the seventeenth century, these reconstructions are only an approximation of historical practice. The difference between a seventeenth-century painting studio with skilled artist and assistants and conservators working from a twenty-first century viewpoint should never be under-estimated.

In executing these reconstructions, the choice was made to limit experiments to mixtures of no more than two binding media. Although one may argue that mixtures of more than two materials seem unnecessarily complicated, we cannot rule out that the practice inside an artist’s studio allowed for their use. However, even with these limitations, the conclusion may be drawn that reconstructions remain an extremely useful tool in establishing general differences between groups of materials and that they help to eliminate certain materials from the list of possibilities; in this case these materials are plant gums and varnishes.

Although animal glue and egg are successful in creating a streaky surface on a small scale, these purely aqueous binding media are not able to reproduce the smooth, fluid character of Rubens’s streaky imprimaturas on a larger scale. The imprimaturas prepared with only aqueous binders often halt or skip over the surface, both on the chalk-glue ground and on top of unpigmented isolation layers. Imprimaturas prepared with egg binders form air bubbles. Diluted linseed oil and oil-containing emulsions, both fat and lean, are easy to brush out and cover well. They therefore seem more likely to have been used as imprimatura binders than glue or egg alone.

Of the more successful media, emulsions are the most pleasing to work with, due to their silky feel and beautiful, even streaks. This might motivate an artist to use them, despite their relatively laborious preparation methods. Thin paint applied on top of lean emulsions create a smooth, homogenous paint layer as opposed to that applied over a fat emulsion, where binder is observed to bleed out from the paint film.

Reconstructions cannot tell us what choice Rubens actually made. They do show that streaky imprimaturas can be created with a range of materials, both aqueous and oil-containing. Earlier in this chapter, two types of imprimaturas were described as having been seen in Rubens’s sketches. In the first type, streaks were cut off by following brush strokes coming from a different angle, suggesting a medium that does not dry immediately (Figs 15.1, 15.2). Reconstructions show that this effect can be created with both (diluted) drying oil and with emulsions. Imprimaturas with overlapping strokes, the second type of imprimatura (Figs. 15.3, 15.4) however, are difficult to create using drying oil or fat emulsions, on account of their long drying time. Lean emulsions lend themselves better to this purpose and are therefore more likely to have been used in these particular cases.

It is conceivable that various binding media have been found in earlier instrumental analysis because Rubens at different times used different binding media for his imprimaturas. The variety in stroke characteristics in his sketches and paintings supports this assumption. Increased transparency as a result of ageing of oil imprimatura binders may even have emphasized these visual differences. However we may wonder at the
importance of the visual differences noted in the characteristics of imprimaturas in different paintings. Would the fact that in some cases strokes overlap while in other cases they cut through each other have motivated Rubens’s choice for particular binding media? This does not seem to be at all certain, because the overall effect of both types of imprimatura is very similar. It seems more likely that Rubens could have been interested in the influence of each of these media on the painting process. As noted in these reconstructions, imprimatura binders influence the gloss of subsequent paint layers, the effect of the spreading of the paint and the appearance of oil haloes. Rubens’s oeuvre gives evidence of his thorough knowledge of painting materials and his virtuosity in their application. There can be no doubt that an artist like Rubens understood the different advantages and drawbacks of paint binders, adjusting his materials to artistic demands while taking into account their practical implications.