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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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General introduction

Unless otherwise stated, translations of historical recipe texts have been made by the author

General introduction

There is nothing, perhaps, on which the durability of a picture so much depends as on the goodness of the ground

Merrifield 1849⁵

The influence of preparatory layers on the stability of oil paintings is a subject that has occupied the minds of many authors of artist's manuals, recipe books and related historical sources. 'Goodness of the ground', however, comes in many guises. Depending on their location in time and space, artists have had different views on the subject and have selected different materials and techniques to prepare their support for painting.

In their position between the support and the paint layers, preparatory layers influence the texture of a painting. Their colour has an impact on the tonality of the finished picture and their absorbency influences both painting technique and paint chemistry. The materials employed in preparatory layers co-determine the ageing and degradation of the painting.

Because of these facts, the technique and materials of preparatory layers are of interest both to paintings conservators, conservation scientists and (technical) art historians. For painting conservators and conservation scientists, information on the layer structure of preparatory layers, on their composition and on the degradation of their materials are particularly important. However, a good understanding of the intention of the artist and the original appearance of the painting is also necessary, since these influence conservation decisions.

In the past, preparatory layers have been investigated by a number of methods. Both scientific examination of paintings and paint samples as well as research of written documents have been carried out. Previous recipe-based studies have investigated smaller areas. The present research for the first time investigates a large group of recipes for preparatory layers, dating over a long period. Investigating a longer period allows for the identification of trends and provides a context for individual recipes. This results in a more profound insight into the meaning of these texts and raises their potential to inform conservators, scientists and art historians.⁶ By including reconstructions as a research tool, a link can be made between written texts and the materials and condition of actual paintings.

The following paragraphs take a look at the approach taken by earlier researchers who investigated preparatory layers and give a short description of the results of those studies

⁵ Merrifield 1849 (reprint 1999): cclxxxi.

⁶ The importance of investigating a large collection of recipes and long period was discussed in Witlox and Carlyle 2005

that are most relevant to this thesis, before the focus is directed to the present research, its goals and methodology.

1.1 Earlier research on preparatory layers for oil painting

Initially, research into preparatory layers was executed from two distinct angles. Either written texts on the subject were studied, in very few cases combined with reconstructions, or the materials of historical paintings were examined by taking samples. Publications tended to relate the results of either type of research. A more integrated approach that combined both types of research became more common from the middle of the twentieth century onwards.

1.1.1 Research into historic documents

Publications in the field of documentary research, dating from the second half of the eighteenth century or from the early nineteenth century, are relatively unknown and not widely available, unlike results of the research of Eastlake (1847) and Merrifield (1849), whose transcriptions with translation of historical recipe sources are easily accessed through a number of reprints and are still consulted.⁷ Eastlake and Merrifield focused mainly on Medieval and Renaissance recipes, with some reference to more recent sources. They were motivated by a wish to understand developments in Italian and early Flemish painting methods that led to the 'invention' of oil painting, which Vasari (1550) had placed with the Van Eyck brothers.⁸ The treatises they transcribed and translated, contained recipes for preparatory layers and they discussed the materials and function of these layers in their introductions.

The efforts of Eastlake and Merrifield were followed by other publications of historical sources. The *Quellenschrifte für Kunstgeschichte und Kunsttechnik des Mittelalters und der Neuzeit*, a series published in Vienna within the last decades of the nineteenth century and during the early twentieth century, was intended to make available historic sources to art historians. The published transcripts included a number of historical treatises on painting technique, amongst which was Filarete (Antonio Averlino), who describes preparatory layers.⁹ Simultaneously, German painter and art academy professor Berger (1857-1919) was examining historical manuscripts and was making reconstructions. Between 1893 and 1912 he published an impressive number of excerpts from historical manuscripts in his books on historical painting methods, which were of great importance for the dissemination of historical texts, in particular to German speaking countries. The manuscripts he studied included important Baroque sources like the 'De Mayerne

⁷ Merrifield 1849, 2 vols., was reprinted at least twice: New York: Dover 1967 in two volumes; Mineola, New York: Dover publications 1999 in a single volume. Eastlake 1847 was reprinted as: New York: Dover 1960, in two volumes. See for a discussion on earlier documentary research Nadolny et al. 2012

⁸ Although Merrifield in her introduction refers to many more recent publications and includes interviews with contemporary artists, with whom she had conversations about the painting technique of sixteenth and seventeenth painting. Merrifield 1849 (reprint 1999). Eastlake after describing Flemish painting techniques devotes a detailed section to preparatory layers, discussing their alleged absorbency. Eastlake 1847 (reprint 1960), vol. 1: 369, etc. The fascination of Merrifield and Eastlake with the 'discovery' of oil paint is described by Nadolny 2005: 1028-1030.

⁹ Founded in 1871 by Rudolf Eitelberger von Edelberg.

(<http://www.dictionarofarthistorians.org/eitelbergerr.htm>, accessed 26-4-2012). 18 volumes were published between 1871 and 1908. Oettingen 1890, Neue Folge, vol III is the volume that contains Filarete's treatise.

manuscript¹⁰ and expanded into the eighteenth century with sources such as Pernety, Watin, Buonanni, Dossie and Cröker,¹¹ all sources that include recipes for preparatory layers. Between 1915 and 1922, Bredius published partial transcripts of artists' inventories.¹² In the 1930s, British chemist A.P. Laurie, specialized in the analysis of paintings, published a number of books on historical painting techniques. He based his ideas regarding the methods of earlier painters on several historical sources and included partial transcriptions. However, the transcriptions he provided were all based on earlier work carried out by Merrifield and others.¹³

Since then, many historical treatises or recipe books have become available in facsimile editions and annotated (partial) transcriptions and/or translations.¹⁴ Several extremely useful bibliographies with titles and short descriptions of manuscripts and published manuals on artists' techniques, represent an important step towards developing more broad-based research of historical recipes on painting technique.¹⁵ The most recent development in the availability of historical recipes is the establishment of online resources that offer access to scanned documents as well as print-on-demand facsimile copies of historical sources.¹⁶

¹⁰ The 'De Mayerne manuscript' was discussed earlier by Eastlake, but without many of the details and with fewer transcriptions than Berger published.

¹¹ Important in the context of this dissertation are: Berger 1901 (facsimile 1986), Berger 1904, Berger 1909, Berger 1912 (reprint 2000). Kinseher (2012) provides background information on Berger.

¹² Bredius 1915-22.

¹³ A.P. Laurie, published *Materials of the painter's craft in Europe and Egypt, from the earliest times to the end of the XVIIIth century* (1910), *Pigments and mediums of the old masters* (1914), *Painter's methods and materials* (1926).

¹⁴ See for instance the transcripts of historical sources by: Van de Graaf 1958; Maclehoose 1960; Hawthorne and Smith 1963; Borradaile 1966; Olszewski 1977; Miedema and Meijer 1979; Beal 1984; Veliz 1986; Lehmann 2002 (Müller); Bartl, Krekel, Oltrogge 2005, Frezzato and Seccaroni 2010 and the English translation of De Lairese 1707 (De Vries 2011). Also partial transcripts or transcripts of single recipes should be mentioned, for instance those by Thompson 1956, Van Schendel 1958; Thomson 1960, Rajnai 1993, Hermens/Wallert 1998. Examples of reprints that have found practical use in the present research are: Boltz von Ruffach 1549 (reprints München 1913, Vaduz 1988); Stalker and Parker 1688 (reprint London: 1960); Dupuy du Grez 1699, (reprint Genève: Minkoff 1973), Watin 1774, reproduced by Kremer in Eichstetten, no date [1987?], Le Pileur d'apligny: 1779 (reprint Genève Minkoff: 1973), Watin 1788 (reprint Paris: Laget: 1977), Dutens 1812 (reprint Genève: Minkoff 1972), Jay 1817 (reprint Genève: Minkoff 1973).

¹⁵ Ogden 1947; Bordini 1991; Schießl 1999; Clarke 2001; Bentchev 2004; Zindel 2010. More restricted in scope but worth mentioning is Harley's bibliography of manuscripts on painting technique in the British Museum, which was published in 1969. Although much more than a bibliography of historical sources, Harley's *Artists' Pigments 1600-1835* provides in her first chapters a detailed overview of manuscripts that fall within the period under study, with an emphasis on manuscripts and published books in the English language. She provides interesting background details on most of the sources mentioned (Harley 1970). Bregnhøi 2003 provided a list of instruction books for house painters presently available in Denmark. She suggests that these same manuals were available in nineteenth century and early twentieth century Denmark; Nadolny et al. 2012 provides appendices which contain an annotated overview of historical treatises dating from the Middle Ages until the end of the nineteenth century as well as where background information and examples of guild regulations and artists contracts can be located.

¹⁶ For instance: <http://www.books.google.com>; <http://www.retrobibliothek.de>; <http://www.archive.org>; <http://www.gallica.bnf.fr>; <http://www.zvdd.de>; <http://www.vd18-proto.bibliothek.uni-halle.de>.

At the Fachhochschule in Cologne, Germany, Doris Oltrogge has established a database that contains a large number of transcriptions of medieval and early modern art technological recipes from manuscripts produced in the German speaking domain. Oltrogge, Doris, 'Datenbank mittelaltlicher und frühneuzeitlicher kunsttechnologischer Rezepte in handschriftlicher Überlieferung, (<http://db.re.fh-koeln.de/ICSFH/forschung/rezepte.aspx>, accessed 29-6-2012. No other similar efforts are known to the author.

While historical sources, in particular recipe books, have become more available, only few publications have focused on recipes for preparatory layers. A general overview of materials and techniques employed in Western painting from the Middle Ages until the end of the nineteenth century, compiled by Rousseau and Van Sonnenburg (1963), made reference to historical recipes for preparatory layers assembled from previously published manuscripts and books (those published by Merrifield, Laurie, etc.). The 1968 paper 'The ground in pictures' by Hendy and Lucas, incorporated large sections of the 1963 paper of Rousseau and Von Sonnenburg, but was accompanied by an extensive overview of photomicrographs of paint cross sections, prepared by conservation scientist Joyce Plesters. Although not referred to directly in the text, the addition of analytical data to accompany the overview could be taken as a desire to establish a link between historical documents and actual paintings.¹⁷

The last thirty years witnessed only few publications dedicated to recipes for preparatory layers. Talley's (1981) publication on portrait painting in England between the end of the sixteenth century and 1700, investigated the techniques and materials described in historical recipes from the period, including recipes for preparatory layers. Talley discussed 22 historical sources from within this period and provided a description of each source in which he included information on its author, intended audience and scope, thus showing an awareness of the importance of context.¹⁸

Bosshard's (1989) paper on nineteenth century recipes for binding media in grounds and paint layers used tables to organize the historical information in chronological order and included a large number of sources.¹⁹ Massing (1998) gave a detailed description of recipes for preparatory layers in seventeenth and early eighteenth century French recipe books, summarizing the information and analyzing and comparing recipes from different sources to form an overview of the techniques mentioned. Massing spoke about the relation between recipes and actual paintings.²⁰

Carlyle's dissertation (1991) and book (2001) on nineteenth century British artists' handbooks, manuals and treatises provided a detailed overview and analysis of the information contained in these sources and includes a comprehensive annotated bibliography of the sources consulted.

In Callen's (2000) publication on Impressionist painting technique, information from French contemporary sources (and selected earlier sources or foreign sources) went hand in hand with research into supplier's archives. On a small number of occasions, reference was made to the actual use of certain materials and techniques in paintings. Callen discussed the concepts of ground absorbency and ground colour and placed these in a

¹⁷ Hendy and Lucas (and Plesters) 1968.

¹⁸ Talley 1981 included results of analysis.

¹⁹ Bosshard, Mühlethaler 1989. The sources discussed date from the second half of the eighteenth century until the early years of the twentieth century and include the *Technische Mitteilungen für Malerei*, an influential Munich periodical on painting technique, both historical and contemporary. See Kinseher 2012 for background information on this periodical.

²⁰ Massing 1998. It is unfortunate that for some general descriptions of contemporary practice only very few recipes were cited. The application of a cold, gelled glue size layer to canvas was presented as the standard method, while this was backed up by little documentary evidence. Chapter 11 of this thesis discusses glue size layer options in more detail, and draws the conclusion that they were more diverse than suggested by Massing. (Massing 1998: 349-50). Massing also contributed to Nadolny et al. 2012.

historical perspective.²¹ Raft (2006) presented an overview of seventeenth and eighteenth century recipes for multilayered primings.²²

Mayer and Myers (2011) wrote an overview of the techniques employed by American painters from the colonial period up to 1860 that is based on recipe books, journals, manuals and artists' letters. Their book includes valuable information on the preparatory layers employed by these artists.²³ In addition, research into the materials and techniques of Vincent Van Gogh made use of the artist's correspondence. Results include everything the artist said about his use of supports.²⁴

Information from written sources is also found in archives or historical collections of paint materials. Both are potentially interesting sources of information on materials employed in preparatory layers. The archives that have been investigated to extract information relating to painting materials vary from historical collections of paint materials,²⁵ historical account books²⁶ to apothecary taxes.²⁷ Nineteenth century collections and archives have received much attention recently, for instance in Haaf's (1987) study on nineteenth century pre-primed canvas, in the investigation on the archive of the nineteenth century colourman Roberson (Woodcock 1995, 1997), in Clarke and Carlyle's publications on the Winsor & Newton archive (2005a, 2005b) and in Barrett's (2009) publication on the Belgian paint manufacturer Blockx's archive.²⁸

Not exactly written sources, but related to this type of source, are depictions of artists' studios that include unfinished paintings with the ground visible (*see cover image*)²⁹, and

²¹ Callen 2000. Although Callen discusses some results of scientific analysis, her publication is not described in the paragraph that discussed studies with an integrated approach, since the emphasis lies much more on documentary research.

²² Raft 2006. Raft concludes that although emulsions of flour and oil were mentioned in some recipes, they were only used from the end of the nineteenth century on. He does not provide proof for this statement.

²³ Mayer and Myers 2011.

²⁴ A discussion on Van Gogh's letters has been included in some of the publications on his painting technique that were described earlier in this chapter. In the Netherlands, some artists' archives are kept by the RKD (Netherlands Institute for Art History, <http://www.rkd.nl>, accessed 21-2-'12). Recently, the correspondence by Vincent van Gogh has been published online in an annotated version by the Van Gogh Museum Amsterdam (<http://www.vangoghletters.org/vg/>, accessed 21-2-'12).

²⁵ In this respect the research of Ineke Pey (1987) on the Hafkenscheid collection of paint materials (c. 1800-1830s) and by Lisa Wagner (2007) on the collection of apothecary materials owned by Dr. Vigani in Cambridge (c. 1805) are of particular interest.

²⁶ Studies of historical accountbooks have also proven to be an interesting source on painting materials. Haack Christensen (2011) published on the seventeenth century accountbooks of the Royal Danish court in the early seventeenth century and is currently working on a PhD dissertation on that subject, Haller 2005 has published on the sixteenth century accountbook of Wolfgang Pronner.

²⁷ A currently running project at the Doerner Institute in Munich is studying German apothecary taxes (<http://www.doernerinstitut.de/en/projekte/taxenprojekt/index.html>, accessed on 6-2-12), *see* also Krekel and Burmester 2003

²⁸ Naturally in this context one should not fail to mention Rosamund Harley's earlier work on Winsor and Newton preprimed canvases made in the early twentieth century and on her handbook on historical pigments. Harley 1987, Harley 1970. Callen 2000 includes a number of illustrations of primed supports dating c. 1906, Bourgeois factory.

²⁹ Kleinert's (2006) publication on seventeenth century genre paintings depicting artists' studios investigated whether studios depicted in paintings can be considered truthful depictions of artists' practice. She concluded that although such images show elements of actual practice, we have to consider the tendency to simplify and only show what are generally considered archetypal images of painter practice. Kleinert 2006. Jonkman and Geudeker's (2010) book on nineteenth century depictions (photographs and paintings) of artists' studios includes photographs of unfinished paintings. The authors discuss the fact that especially later in the century

Van Hout's study on unfinished paintings.³⁰ Depictions of unfinished paintings can be helpful in investigations into ground colour.

1.1.2 *The evolution of source research: developments in source research methodology*

The above cited publications appeared during a period that witnessed a growing interest in research based on historical sources, in particular written documents. This growing interest went along with the establishment of research groups and the development of a more conscious approach to written documents containing information on painting technique.

A decade ago, this growing interest in investigations of historical sources on art technique led to the establishment of the Art Technological Source Research (ATSR) working group, whose goals are: 'to establish a forum for research on historical sources for artists' materials and techniques; to systematize appropriate methodologies for this type of research; and to provide an international platform for the dissemination of information and research data'.³¹ Under the umbrella of the ATSR working group, now operating as an ICOM-CC³² working group, a number of symposia and workshops about historical source research were organized. The electronic newsletter of this group circulates information about the availability of information on historical sources.

The field of historical source research has evolved in the last decades, which is evident from the number of papers that examine research methodologies. Some researchers have raised the issue of the relevance of written recipes for actual painting practice or discussed the possibilities and limitations in the interpretation of written sources.³³ Van de Graaf's publication in 1963 was a forerunner in this respect. In this publication, Van de Graaf demonstrated awareness of the importance of the context in which recipes were written. He furthermore argued that it was important not to place too much emphasis on single recipes but to study them in relation to earlier, contemporary and later sources and to always attempt to relate recipes to actual painting practice.³⁴ Carlyle published in the late 1980s and 1990s on the subject of nineteenth century British artists' handbooks and manuals, and demonstrated how through careful analysis of the books, the context of the source, the ideological basis on which authors wrote about painting practice and their intended purpose could be incorporated in the interpretation of the texts they

more successful artists used two studios: a more formal studio or reception room in which they received visitors and posed for photographs, and a second studio in which they executed their actual work. Jonkman, Geudeker (eds.) 2010.

³⁰ Van Hout and Huvenne 2012

³¹ The ATSR group was conceived by Ad Stijnman, then working at the ICN, Amsterdam (Netherlands Institute for Cultural Heritage, now part of the RCE, Rijksdienst Cultureel Erfgoed), where it was founded in 2002. ATSR is now a working group under ICOM-CC. <http://www.clericus.org>, accessed 4-2-12. Quote from: <http://www.icom-cc.org/workinggroups/art-technological-source-research>, accessed 4-2-12. Postprints of the ATSR symposia were all published in London by Archetype.

³² ICOM-CC stands for International Council of Museums, Committee of Conservation.

³³ Apart from difficulties with the interpretation of recipes, also the reason for transcribing and/or publishing certain collections of historical recipes must be taken into account. Nadolny 2005 argues how both Eastlake and Merrifield had a particular motive in publishing the recipes they transcribed: they wanted to find support for their theory that during the Middle ages oil painting had been employed only for decorative painting and outdoor painting, not as a standard binder for artistic paintings.

³⁴ Van de Graaf 1962.

produced.³⁵ Awareness of the importance of the social context within which sources were written was also evident in publications by Massing (1994-2012).³⁶

The role and meaning of alchemical recipes, whose context necessitates a special approach towards their interpretation, was the topic of Eamon's (1994) publication on 'books of secrets'.³⁷ Bucklow (1999-2011) published on the context and meaning of recipes in alchemical treatises, focusing in particular on 'impossible recipes' that do not lead to practical results but that make sense according to alchemic theory.³⁸

Discussions about the question of the practical value of written texts on painting technique appeared in a number of publications, many of which focused on Medieval treatises. Owen-Crocker (2009) wrote about issues encountered in the interpretation of Anglo-Saxon manuscripts³⁹ and Clarke (2001-2011) published on the practical value of Medieval manuscripts for contemporary artists' practice. He argued that the practical value can only be established by investigating authorship, intended audience, physical appearance of the book/manuscript and by comparing the information contained in different editions.⁴⁰ In addition, a number of contemporary researchers included discussions on their methods to establish the practical value of different editions and copies of the same manuscript, again focusing on Medieval treatises.⁴¹ Van Eikema Hommes (2004) introduced a classification system in order to be able to group and process historical information.⁴² Most recently, the overview of the state-of-the-art in documentary source research, written by Nadolny et al. (2012), forms a very useful text for those interested in research into documentary sources and provides some rules for *best practice*.⁴³

Nowadays, specialized researchers generally consider the context of a single textual source, context meaning its author, the intended audience and the society that produced the source. Researchers also recognize the problem of using historical texts in transcription or translation and try to work with facsimiles, scans or originals.⁴⁴ These factors will provide more depth to the interpretation of information contained in the source itself. However, although specialized researchers employ this approach, it cannot yet be considered standard practice. Two recent publications still mention 'oversimplifications', which are made because authors content themselves with a relatively small number of easily accessible historical sources, as Nadolny et al. (2012)

³⁵ See for example: Carlyle 1988, Carlyle 1990a, Carlyle 1990b, Carlyle 1991, Carlyle and Southall 1993, Carlyle 1995, Carlyle 2001. In the introduction to her PhD thesis, Carlyle discusses the purpose and types of sources published within this period. Carlyle 1991.

³⁶ Massing 1995, 1998 Massing's contribution to Nadolny et al. 2012.

³⁷ Eamon 1994.

³⁸ Amongst others in: Bucklow 1999, Bucklow 2000, Bucklow 2001, Bucklow 2009, Bucklow 2011.

³⁹ Owen-Crocker 2009.

⁴⁰ Clarke 2008; Clarke 2009; Clarke 2011a; Clarke 2011b: 19-24.

⁴¹ Villela-Petit 2006 ; Neven 2009; Neven 2011.

⁴² Van Eikema Hommes argued that classification of recipes according to their function can significantly increase chances of their correct interpretation. In particular fragmentary information can thus be complemented and compared with other recipes with a similar purpose. In this approach, also recipes from different time periods and geographical areas may be included for comparison. Van Eikema Hommes 2004.

⁴³ Nadolny et al. 2012.

⁴⁴ Nadolny 2008: 7 provided the example of Thompson's edition of Cennini. Thompson apparently was not very consistent in his use of technical terms.

write.⁴⁵ According to Clarke (2008): ‘The same few sources are found to be used over and over to answer all kinds of questions, even with reference to artefacts and practices far distant in place and time from where and when those sources were compiled ... If only a few sources are known, no others will be cited, so no other will *become* well known. ... Researchers urgently need to make themselves aware of this range of material and to stop using the same few sources, however good these sources may be’.⁴⁶

1.1.3 Reconstructions for the investigation of preparatory layers

Historical recipes invite to be executed, and indeed a number of recipe-based studies have extended their methodology to include reconstructions. The use of reconstructions to understand the properties of paint materials and to understand the purpose of a layer build-up is no recent development. Already Merrifield (1849) recorded her experiments or reconstructions, carried out to help with the interpretation of recipes.⁴⁷

Notwithstanding their potential, only few modern publications have employed reconstructions to investigate the properties of preparatory layers. Brinkman (1993) made reconstructions in an effort to shed light on the possible composition and function of the isolation layer in Van Eyck’s paintings.⁴⁸ He examined the working properties of a number of binding media thought to have been employed, and based a hypothesis about the type of oil that Van Eyck used to isolate his grounds on these reconstructions. Brinkman made direct comparisons between his reconstructions and Van Eyck’s technique. His report on the reconstructions does not mention awareness of possible differences between modern and historic materials. Gypsum chemistry was investigated with practical experiments by Federspiel (1995), Zillich (1998), Santos Gómez (2005) and Pombo Cardoso (2010).⁴⁹ These authors all focused on the chemical reactions that take place when gypsum is burnt and/or rehydrated for use in preparatory layers. They investigated burning temperatures and the working properties of gypsum in different hydration states.

Van Laar (Keune 2011) based experiments with quartz grounds on Groen’s investigations of the grounds employed by Rembrandt van Rijn.⁵⁰ Artist Van Laar actually employs similar grounds for his own paintings; and also made a pictorial reconstruction of a Rembrandt painting. Unfortunately, comparisons between his conclusions and historical practice are difficult due to differences between the characteristics of the materials that he selected and the materials available historically to Rembrandt.⁵¹

Around 1992-1993, Carlyle introduced the concept of ‘historical accuracy’ in reconstructions, drawing attention to the importance of selecting historically appropriate materials for reconstructions that are used to understand the properties and ageing characteristics of historical materials.⁵² By investigating the historical production methods

⁴⁵ Nadolny et al. 2012: 10

⁴⁶ Clarke 2008: 20

⁴⁷ Merrifield 1849 (1999): liv-lv described reconstructions of enamel colours; Ibid.: ccxxxv reconstructions of recipes to purify and prepare oil for painting;

⁴⁸ Brinkman 1993.

⁴⁹ Federspiel 1995, Zillich 1998, Santos Gómez 2005; Pombo Cardoso 2010.

⁵⁰ Keune 2011; Groen 2011b.

⁵¹ The paper describes the use of white and yellow pottery clay, river clay, fine sand, silversand or aquarium sand. Keune 2011: 25.

⁵² This concept was introduced while executing varnish reconstructions at the Canadian Conservation Institute during 1992-3, and developed further in subsequent reconstruction projects. The term ‘historically accurate

and material properties of materials employed for reconstructions, and subsequently choosing materials that resemble such materials as closely as possible, Carlyle seeks to produce reconstructions which are more comparable to the original paintings. She recognizes that it is impossible to exactly recreate the circumstances in which paintings were created in former centuries, compromises are unavoidable. However, attempts to work with 'historically accurate' materials instead of the highly refined and purified materials produced today will, according to Carlyle, result in reconstructions that may be considered more similar to historical objects.

Carlyle herself executed 'historically accurate' reconstructions in a number of projects with materials that were selected after a careful analysis of historical preparation methods, amongst which were studies of nineteenth century flour paste grounds and the grounds used by Van Gogh.⁵³ The reconstructions of Van Gogh's grounds resulted in practical observations about the handling and application properties of the materials and about the colour and absorbency of ground types similar to those employed by Van Gogh. Carlyle furthermore demonstrated how well-documented reconstructions may serve a purpose as reference sets for instrumental analysis.⁵⁴

The influence of Carlyle's approach is felt in reconstruction-based studies executed by Vandivere (2011, 2013). Vandivere published on the influence of *imprimatura* isolation layers on the visibility of underdrawings⁵⁵ and worked as much as possible with materials prepared according to historical methods, such as stack-process lead white. Although she had to compromise in a number of instances, an awareness of the effect of these compromises has been included in her conclusions.

Recently, Bucklow (2012) suggested replacing the term 'historically accurate' with 'historically informed' as, he rightly states, historical accuracy is impossible to achieve.⁵⁶ The term 'historically informed' is nowadays recommended for the performance of period music with contemporary instruments and following our present-day knowledge of historic aesthetic tastes.⁵⁷ Carlyle suggests the term 'historically appropriate'. This is the term adopted in this thesis.⁵⁸

Reconstructions for didactic purposes, to inform the general public of painting methods or to replace missing elements or decorations, were an important topic in the *Studies in honour of Renate Woudhuysen-Keller* (2012).⁵⁹ For such reconstructions, attention to historical accuracy is not as important as it is for those that are compared directly with the results of scientific investigation into historical materials.

reconstruction' was first used by Carlyle in a publication in 2001. Email from Carlyle dated 21-2-'12. Carlyle explains and applies the principle in a number of publications: Carlyle 2006; Carlyle et al. 2008; Carlyle 2012a, Carlyle 2012b.

⁵³ Carlyle 2006; Carlyle et al. 2008a; Carlyle et al. 2008b

⁵⁴ Carlyle, Boon, Haswell and Stols-Witlox 2008.

⁵⁵ Vandivere 2011; Vandivere 2013.

⁵⁶ Bucklow in Wrapson et al. (eds.) 2012: 26

⁵⁷ See Butt 2002.

⁵⁸ Carlyle, oral communication, June 2013.

⁵⁹ Wrapson et al. (eds.) 2012

The use of reconstructions and reconstruction methodology is still in development. The requirements that should be placed on reconstructions, reconstruction documentation and reconstruction storage are also being explored. Carlyle (2012a, 2012b) describes current views on the use of ‘historically accurate’ reconstructions.

1.1.4 *The start of scientific investigations of preparatory layers*

Nadolny (2003) places the beginning of the scientific examination of paintings in the late eighteenth century. During the nineteenth century, a number of leading chemists of the day, like Faraday and Chaptal, investigated paintings and analyzed their composition. The question when oil was introduced as a binder for artistic painting, one of the main issues that occupied the minds of nineteenth century art historians and chemists, was investigated by swiping tests on paintings,⁶⁰ but also by analysis of paint samples. Scientists examined properties such as solubility, melting point, smell, taste and reaction to heat.⁶¹ Nadolny’s 2003 publication suggests that the first analyses focused more on paint layers than on preparatory layers, however her study shows that some scientific analysis of the composition of preparatory layers was indeed published during the nineteenth century.⁶² Merrifield (1849) mentioned ‘experiments on the grounds of the old Venetian pictures’ executed by ‘a Venetian professor’ who as a result of his experiments considered himself able to conclude that these grounds were all made of gesso, sometimes with a little black added, and covered with a glue isolation layer.⁶³ In Nadolny (2005) we find how Eastlake had a paint sample analyzed by a chemist because he wanted to know if pumice powder was present in the preparatory layers.⁶⁴

Wülfert (1999) dates the introduction of microscopy and microchemical testing to analyze works of art in Germany in the second half of the nineteenth century.⁶⁵ Certainly, by 1929 when Dutch paintings conservator and chemist A.M. de Wild published his PhD research on pigment microscopy and micro-chemical analysis of pigments in works of art, methods were considered to have reached an academic standard.⁶⁶

Although some of the conclusions of nineteenth century investigations may still be valid,⁶⁷ early studies are, today, not usually referenced as scientific evidence. The earliest publications on the analysis of preparatory layers for oil paintings that are still quoted as scientific support in more recent publications date from the 1950s. That was the time when Gettens and Mrose as well as Bones devoted papers to the analysis of calcium sulphate grounds in Italian pictures and when Coremans, Gettens and Thissen published their investigations of the painting techniques of early Flemish painting.⁶⁸

⁶⁰ Swiping tests involve testing the solubility of the layer with different solvents. As solubility depends on the nature of the material, such tests can result in a rough determination of the binder of the layer.

⁶¹ Nadolny 2003: 42.

⁶² Nadolny 2003: 44-47.

⁶³ Merrifield 1849 (1999): cclxxxviii.

⁶⁴ Nadolny 2005: 1031.

⁶⁵ Wülfert 1999: 3-4.

⁶⁶ De Wild 1928.

⁶⁷ For instance some of the pigment identifications of Humphry and Haslam (Rees-Jones 1990).

⁶⁸ Gettens and Mrose 1954. Gettens published results of chemical analysis of ground layers earlier, in a 1935 paper on an Italian painting, but this publication was not solely focused on grounds (Gettens 1935: 165-73); Bones 1954; Coremans, Gettens and Thissen 1952.

The 1950s and 1960s saw a number of publications discussing the scientific analysis of high-profile paintings.⁶⁹ These publications were followed by several papers that communicated the results of scientific analysis of paintings that fell within specific periods or that covered certain geographical areas, like Rioux's (1973) publication on French seventeenth and eighteenth century red grounds.⁷⁰

In contrast to the more limited scope of these publications, Plesters (1968) published an overview consisting of photomicrographs of paintings dating from the Middle Ages until the nineteenth century. Her synopsis, mentioned earlier in relation to the paper by Hendy and Lucas on 'grounds in paintings', was the first scientific publication on the subject of preparatory layers with such a wide scope.⁷¹

Methods for instrumental analysis of pictures were evolving quickly and 'new' methods were applied for instance to the study of lead white and calcium carbonate, important materials in preparatory layers.⁷² In 1976 the field was ready for a survey of methods employed between 1961 and 1972 for the scientific investigation of painting materials. This overview was written by Plesters, who included developments in documentary source research and focused on an integrated approach that above all should not 'lose sight, behind the serried ranks of grey boxes of electronics, of the work of art'.⁷³

1.1.5 From the 1970s onwards: more combinations of recipe research and instrumental analysis

Plesters was not alone in feeling the need for an integrated approach. A desire to combine scientific analyses with the study of historical documents in order to answer questions relating to painting technique, was evident in Kühn's 1967 publications on lead white⁷⁴ and in Von Sonnenburg's writings on Rubens's painting technique (1979).⁷⁵ An interesting study that compared information from a written source, Thomas Bardwell's treatise *The practice of painting (1756)*, with the painting techniques used by this artist, was published

⁶⁹ Coremans and Thissen's publications on Van Eyck's *Ghent altarpiece* included the results of the scientific examination on the preparatory layers Coremans 1953, Coremans and Thissen 1962. See also Rees-Jones, S.G. 1990. Also their 1962/63 investigation on Rubens's *Descent from the cross* discussed preparatory layers. Coremans and Thissen 1962, See also Phillipot and Phillipot 1963. In 1965 Kühn presented the results of scientific analysis of ground materials used by Rembrandt. Kühn 1965. His investigation of Rembrandt grounds was initiated to provide context for the quartz containing ground found in the Stuttgart *self-portrait*, which authenticity was contested at the time. Paint samples were not usually mounted as cross sections during this investigation, which limited the conclusions possible. Van de Wetering 1986: 18. In 1967 Kühn wrote about Vermeer's pigments and grounds. Kühn 1967. Kühn simultaneously continued publishing on Rembrandt's grounds (Kühn 1976, 1977). In these later investigations paint samples mounted as cross sections allowed for a more precise determination of ground materials and layer build-up. Groen 2005b: 319.

⁷⁰ Rioux 1973.

⁷¹ Hendy, Lucas (and Plesters) 1968.

⁷² See for instance Houtman and Turkstra 1964; Kühn 1966 and Kühn 1967; Coremans and Thissen 1959; Keisch 1970; Keisch and Callahan 1973; Johnson and Packard 1971; Winter 1975. In 1986, Mairinger and Schreiner described investigation methods for the investigation of preparatory layers (Mairinger and Schreiner 1986: chapter IX). The development of methods for paint investigation and the evolution of the profession of conservation scientist in the Netherlands was described in Groen 2011a.

⁷³ Plesters 1976: 5.

⁷⁴ Kühn 1967.

⁷⁵ Von Sonnenburg 1979 referred to the De Mayerne manuscript, De Piles and the manuscripts published by Berger as historical sources on preparatory layers.

by Talley and Groen in 1975. The paper investigated the link between one artist's writings and his actual practice. The authors were able to conclude that although Bardwell did follow the methods he described, his actual paintings tended to be less complicated than the advice issued in his book.⁷⁶

In 1979, Miedema and Meijer published a study that incorporated visual observation, documentary evidence from historical sources and previously published results of scientific analyses, to investigate the transition from whitish to coloured grounds in sixteenth century Netherlandish art. The authors counted instances of white versus coloured grounds on panel and on canvas in a number of exhibition catalogues. By complementing these results with the outcomes of earlier investigations on ground colour, they were able to draw tentative conclusions about the transition from panel to canvas in the Netherlands and to relate this transition to the introduction of coloured grounds in the sixteenth century Netherlands.⁷⁷ Notwithstanding the limited data they had available, many of their conclusions still stand.

The above and other publications were quoted by Straub and Koller in their thorough and well-referenced reviews of the state-of-the-art of research on historical painting techniques from the Middle Ages until the twentieth century, that were published in the three volume *Reclam's Handbuch* (1984). In their essays, both authors presented chronological outlines of painting techniques, consistently combining the findings of earlier scientific research with historical documentary evidence.⁷⁸ The authors listed and in some cases briefly summarized individual historical sources. There was no room for complete content of the recipe sources nor for the context in which they appeared.

Between 1984 and the present, more information has been published about the preparatory layers of single artists and smaller groups of artists.⁷⁹ Some of these studies are of particular importance to our topic. Papers on respectively Italian painting techniques and artists' materials between 1400 and 1550 and on seventeenth century painter's practices by Billinge (1997) and Kirby (1999), helped to build a context for the

⁷⁶ Talley and Groen 1975.

⁷⁷ Miedema and Meijer 1979.

⁷⁸ *Reclam's Handbuch*, 3 volumes, 1984, written by different authors amongst which Manfred Koller and Rolf E. Straub. Volume 1 deals with historical painting techniques.

⁷⁹ The following publications are used elsewhere in this thesis and not described in the main text of this paragraph: Goldberg et al (1998) on Dürer's techniques and materials; Pérez (1992) published on Velázquez; Martin et al. (2003) described the grounds of a number of painting produced in Rome and Bologna in the 1620s. Many publications exist on Rubens's painting technique. The overview by Sonnenburg 1979 gives a detailed description of Rubens's procedures and includes descriptions of preparatory layers on both panel and canvas; the techniques of Rubens's paintings, including preparatory layers, are also described in Van Hout 1998; Van Hout (unpublished) 2005, Van Hout 2007, Van Hout 2008, Martin et al. 2005, Martin 2008. A number of publications describe Van Dyck's use of preparatory layers, amongst others: Christensen et al 1991; Roy 1999a and White 1999. Van Eikema Hommes (2012) describes the preparatory layers employed by Ferdinand Bol; Van Eikema Hommes and Speleers (2011) the materials employed by painters who decorated the *Oranjezaal* in Paleis Huis Ten Bosch; the grounds employed by Flinck, Jordaens, Lievens, De Groot, Bol and Ovens for the the Royal Palace Amsterdam are described in Van Eikema Hommes and Froment (2011); Costaras 1998, Levy-van Halm 1998 and Wadum (1998) discuss different aspects of Vermeer's technique; Duval (1992) wrote an overview of the preparatory layers employed by Poussin, Boucher, Coypel and French contemporaries; Duval (1994) also examined the grounds of 26 paintings by Poussin; Hackney, Jones and Townsend (eds.) 1999 share the results of the technical examination and instrumental analysis of a selection of British paintings dating from the end of the sixteenth to the twentieth century, Townsend 2004 describes the techniques of the Pre-Raphaelites.

recipes discussed in this thesis. Kirby's paper includes a wealth of information on documentary sources for this period. It discusses the different types of sources available (artists' handbooks, legal and commercial records, pharmacopoeias) and provides background information on a number of these sources. The section describing seventeenth century grounds, uses brief quotes from documentary sources (recipe books, inventories, painter's contracts) combined with the results of visual and scientific examination of paintings. Documentary evidence on the preparation of panels for painting focuses mainly on the practice in Antwerp, but Kirby's description of the preparation of canvases also discusses English and Italian methods.

Also Dunkerton and co-authors' two volumes on Italian painting technique (1991, 1999) are very relevant to this thesis. They share the results of the analysis of a number of the preparatory layers of paintings from the collection of the National Gallery London and place them in the context of historical and technical developments.⁸⁰ Historical recipes play a smaller role in these overviews than the results of scientific investigations.

Besides publications that focus on a larger area and longer period, this PhD research also benefits from prior research into the techniques and materials of single artists or within smaller geographical areas. Preparatory layers employed by French seventeenth and eighteenth century painters have been the subject of studies by Duval, Bergeon and Martin. Their publications present a mixture of scientific data and historical recipes, with an overall emphasis on the analysis.⁸¹ A comparable study of ca. 100 Italian baroque paintings has been carried out by Hamsík (1993), although the resulting paper unfortunately is very brief.⁸² Noble's (2004) overview of the materials used in the grounds of portrait paintings in the Mauritshuis provides an interesting review of the materials and colours employed by a number of seventeenth and eighteenth century artists.⁸³

An important contribution to the field has been made by the Rembrandt Research Project.⁸⁴ A concise overview of Groen's research on preparatory layers employed by Rembrandt and contemporary Amsterdam and Haarlem painters was published in the fourth volume of the *Corpus of Rembrandt paintings* (2005).⁸⁵ Publications by Hendriks on the painting technique of Frans Hals and on grounds used by Vincent van Gogh in his Antwerp and Paris periods are valuable sources of information within the context of the present research.⁸⁶ Hendriks (2005) also wrote about the results of the scientific examination of preparatory layers used by Haarlem painters active between c. 1550 and

⁸⁰ Dunkerton et al. 1991; Dunkerton et al. 1999.

⁸¹ Bergeon and Martin 1994 provide an overview of French recipe books from the seventeenth and eighteenth century and attempt to link these to results of scientific investigation of paintings; Martin 2008 builds on the extensive analysis executed by Duval on coloured preparatory layers in French paintings and attempts to group preparatory layers used on canvas between 1600 and 1640 based on the material composition of the lowest layer only.

⁸² Hamsík 1993.

⁸³ Noble 2004.

⁸⁴ Van de Wetering 1997 describes preparatory layers on panel and canvas as used by Rembrandt.

⁸⁵ Groen 2005. The investigations focused on the elemental composition of the preparatory layers, binding medium analysis was not included as a standard method and was referred to once in the text. Groen 2005: 325.

⁸⁶ Hendriks 1990, Hendriks and Geldof 2005; Hendriks 2006a and 2006b. Also the recent monograph on Van Gogh's studio practice (2013) contains information on the preparatory layers employed by this artist, in particular on the preprimed canvas that he ordered from the Paris colourmerchant Tasset et l'Hôte and on the quantitative analysis by SEM-EDX of lead white and extenders in his ground layers. Vellekoop et al. 2013.

1700 in an essay on Haarlem paint materials.⁸⁷ The nineteenth century use of India rubber or caoutchouc in preparatory layers has been discussed by Carlyle⁸⁸ amongst others, and was the subject of a detailed study by Labreuche (2011).⁸⁹

Similar studies into South European ground materials seem less frequent. The monograph by Bruquetas-Galán (2002) about painting materials and techniques in Golden Age Spain is an interesting and valuable exception. It is based on a wide variety of documentary sources and links these to the results of paint analyses.⁹⁰

Interest in the analysis of preparatory layers of eighteenth century paintings has been limited. The few publications that include information on eighteenth century ground materials tend to focus on the first half of the century, in examinations that have an interest in their relation to seventeenth century painting techniques.⁹¹

The preparation of less frequently employed supports has been discussed in a number of publications. First Van de Graaf (1976) and later Horovitz (1986, 2012) wrote on preparatory layers for copper supports, based on painting investigations and documentary evidence,⁹² Reifsnnyder (1999, 2012) published on painting on lapidary surfaces in fifteenth and sixteenth century Italy.⁹³ Föttsch (2008) wrote about the use of laminated sheets of paper, cardboard, fibre boards in late nineteenth century studies by a German painter,⁹⁴ a support that was also discussed by Cove (2004) in relation to Constable's oil sketches.⁹⁵ A number of studies have focused in particular on the materials and techniques used for preparatory layers in North America.⁹⁶

For investigations of preparatory layers also publications that investigate individual materials used in these layers are important. Studies in this area that are interesting in the context of this thesis include both general overviews such as the *Pigment Compendium* or

⁸⁷ Hendriks and Geldof 2005.

⁸⁸ Carlyle 1991, Carlyle 2001.

⁸⁹ Labreuche 2011 discussed the materials and condition of paintings on India rubber ground, patents and other documentary evidence.

⁹⁰ Bruquetas-Galán 2002. Veliz 1998 also provides important documentary evidence and discussed results from the investigation of Spanish panel paintings in an article that describes their material properties from the Middle Ages until the seventeenth century.

⁹¹ One of the few publications with a specific focus on eighteenth century painting technique is Groen and De Keijzer's paper on the materials used in nine Dutch paintings dating from the first half of the eighteenth century (Groen and De Keijser, 1996). Wallert 1999 discusses some eighteenth century flower paintings. Reports on Eighteenth century Italian paintings have on occasion been published and usually contain a description of their preparatory layers. (For instance: Bomford and Roy 1993 on paintings by Canaletto; Keith 1994 on a painting by Tiepolo). Duval and colleagues included French eighteenth century paintings in some of their investigations (e.g. Duval 1992).

⁹² Van de Graaf 1976; Horovitz 1986; Horovitz 2012.

⁹³ Reifsnnyder 1999; Horovitz and Reifsnnyder 2012.

⁹⁴ Föttsch 2008.

⁹⁵ Cove 2004.

⁹⁶ Although outside of the scope of the present study, they are mentioned briefly here: Fulton et al. 2005 published on the materials of Meade, Quimby 1974 provides an overview of techniques employed in American paintings before 1776; Quandt 1971 and Quandt 1972 discusses grounds in 18th century American pictures, Zucker 1999 in 19th century American paintings, Goldberg 1993 and Currie 1995 describe the use of scored wooden panels and grounds in 19th century American paintings; Muller 1992 describes an early plywood panel (1880) used by an American painter; Katlan 1992: 41-3 discusses the introduction of ready-made plywood panel supports for paintings; Katlan 1999 provides an overview of 19th century technical innovations for painters in America.

the *Glossaire des Matériaux* and investigations focusing on particular pigments, such as the *Artists' pigments* series.⁹⁷ Red and yellow earth pigments were singled out for investigation in Grygar et al.'s study on the use of such earth pigments in the grounds of Baroque paintings.⁹⁸

Recently, a number of new online resources has become available that share results of the technical analyses of paintings, including information on preparatory layers:⁹⁹ the *Cranach digital archive*,¹⁰⁰ the website established by the KIK/IRPA in Brussels with the reports of technical investigations of the Ghent altarpiece,¹⁰¹ the *Rembrandt Database*¹⁰² and the online publication of the research project 'Painting techniques of Impressionism and Post-impressionism'.¹⁰³

1.1.6 The achievements and limitations of previous research

The above synopsis of previous research demonstrates that preparatory layers received interest from the nineteenth century onward. Their importance was recognized by many authors, who investigated their composition and function both through documentary research and through the scientific examination of paintings and paint samples. It is these investigations that have built our present state of knowledge on the materials and techniques employed for preparatory layers.

Previous researchers had different motives to investigate preparatory layers. Throughout the approximate 150 years of research on preparatory layers, the desire to understand paint technological developments was an important motivation. It is evident in many publications, all the way from Eastlake (1847) to the present day, and it seems to have been the driving force behind the overviews of Plesters (1968) and Koller & Straub (1984), and of monographs that deal with smaller geographical areas and shorter periods. Reasons for wishing to understand technological developments vary, but in general we can say that with knowledge of painting technique, a more multifaceted understanding of the history of paintings was developed, and a context was created for the history and material identity of specific objects.

The materiality of preparatory layers has also been studied in order to inform questions of authenticity and chronology. This was one of the motives of, for instance, the Rembrandt Research Project for analyzing Rembrandt's preparatory layers and the grounds of his contemporaries (see Groen 2005).

Has previous research provided enough information about preparatory layers to support conservators, conservation scientists and (technical) art historians in their work? And also,

⁹⁷ *Artists' Pigments*, four volumes: Feller (ed.), 1986, Roy (ed.) 1993, West Fitzhugh (ed.) 1997, Berrie (ed.) 2007; Eastaugh et al. 2004; Guineau 2005.

⁹⁸ Grygar et al. 2003.

⁹⁹ In addition to these project, a research project at CITAR in Portugal, on painters from the North of Portugal, will also result in an online resource for information on this topic . Calvo and Matos Lopes Pinto Leão Aguiar 2011.

¹⁰⁰ http://www.lucascranach.org/relatedprojects_en.html, accessed 22-3-2013.

¹⁰¹ <http://www.closetovaneyck.kikirpa.be/#home>, accessed 5-6-2013.

¹⁰² <http://www.rembrandtdatabase.org/Rembrandt>, accessed 22-3-2013.

¹⁰³ http://www.museenkoeln.de/ausstellungen/wrm_0802_impressionismus/info_e.asp?lang=en, accessed 22-3-2013.

have the data that have become available through previous research been interpreted in accordance with present-day research standards?

It is evident that our current view of preparatory layers for oil paintings depends more on instrumental analysis than on the investigation of recipe books and other written documents or on reconstructions. Some of the analytical results are of a relatively early date and in particular information on binders and media may need to be re-evaluated.¹⁰⁴

Only a relatively small group of recipes for preparatory layers has received general attention, and their interpretation is not always abreast with current standards for recipe study. In few cases, reconstructions have been applied to understand the practicalities of preparatory layers, and only a small number of researchers have done so. Most publications involving reconstructions of preparatory layers are of a relatively recent date. While early reconstruction based studies do not discuss the material properties of historical materials, more recent investigations, in particular those by Carlyle, make an effort to employ materials that bear as close a resemblance to historical materials as possible. The potential of such reconstructions to both enrich investigations into painting technique, and as a means to study degradation mechanisms, has been demonstrated in these studies.

Since Straub and Koller's essays in *Reclam's Handbuch*, some 23 years ago, no comprehensive overviews of developments in the use of ground materials over longer periods and larger geographical areas have been published. Straub and Koller's overviews are supported mainly by the results of scientific analysis, to which some information from a small number of historical sources has been added. Although the reviews of these authors are excellent, they are not up to date with current knowledge.

Studies from the past twenty years have tended to focus on local developments in artistic centers or on the techniques of individual artists, sometimes revisiting, refining or complimenting earlier research. As a result, small 'islands' exist of up to date and in-depth knowledge on the preparatory layers employed in particular artistic centers or artists, while limited attention has been paid to other areas. This is unfortunate, since often the connection between these islands can only be made at a superficial level, which results in a fragmented image.

The overview of current knowledge about the materials of preparatory layers that was published as Stols-Witlox (2012), can be considered a recent effort in the spirit of Straub and Koller. This publication is based on investigations of preparatory layers by previous authors, with reference to a selection of the more easily available historical recipe sources.¹⁰⁵ It demonstrates that sufficient information is available from previous technical investigations for a more updated general overview of developments of the materials and techniques employed in preparatory layers for oil painting in post-Medieval Europe¹⁰⁶. However, while such a synopsis may provide valuable information to support research and

¹⁰⁴ See Spring and Higgitt 2006, Higgitt and White 2005.

¹⁰⁵ The chapter on preparatory layers appeared in a book for painting conservation students and professionals that is presented as a '... comprehensive text on the history, philosophy, and methods of treatment of easel painting that combines theory with practice'. Hill Stoner and Rushfield (eds.) 2012: back flap. The aim of the chapter was to provide a general overview of what the field at present believes to be the main developments in the materials and layering of preparatory layers in European oil painting, and to guide the readers towards more focused publications for more detailed information on certain aspects. Stols-Witlox 2012

¹⁰⁶ Although not too much emphasis must be placed on earlier binding medium analyses, as recent research has demonstrated its limitations. See for instance Spring and Higgitt 2006, Higgitt and White 2005.

conservation, it does not tell the whole story: Why did artists choose certain binders, pigmentations and layer build-up? How were the ingredients that they used prepared? Were minor additions included? And finally, are the materials we now detect in preparatory layers the result of the artist's intent or of earlier conservation inventions? All these questions are highly relevant to the work of conservation scientists, practicing conservators or (technical) art historians and can not be answered by instrumental analysis.

The role of preparatory layers in determining the state of conservation of paintings has rarely been the focus of earlier publications. If addressed at all, this topic was usually mentioned only in passing.¹⁰⁷ Exceptions are found in a very small number of investigations, like Labreuche's study (2011) about paintings executed on India Rubber grounds or Carlyle, Young and Alpine's study (2008b) on the mechanical responses of different types of grounds. Carlyle's (1991, 2001) study of British painting handbooks includes a section about artists' views on the degradation of materials, with comments about the role of preparatory layers.¹⁰⁸

Outside of the period and area investigated by Carlyle, we do not know if artists were aware of the long-term consequences of their use of materials in preparatory layers and if they took these into account when choosing or preparing their preparatory system.

1.2 The central aims of this thesis

The development of conservation science has now reached a point where investigation methods are sensitive enough to often detect trace components. Thus, the influence of paint additives and minor components on paint chemistry, in this particular case on the chemistry of preparatory layers, can be more effectively studied.¹⁰⁹ As preparatory layers influence the visual characteristics of a painting as well as its ageing behaviour, their degradation and their influence on other layers in the painting are an important topic for investigation.

Without knowledge of the original composition of the paint, the internal conditions of degraded paint layers are difficult to understand. Detailed information about materials that we know to have been used historically, helps with the interpretation of data obtained from instrumental analysis.¹¹⁰ Study of historical documents provides such

¹⁰⁷ For instance in Vandivere (2011), the increased translucency of oil and lead white based imprimatura layers only plays a small role in her chapter on the use of translucent flesh-coloured imprimatura layers. In her section on the visibility of the underdrawing through the primuersel, Vandivere mentions the increase in refractive index of an aged linseed oil but fails to mention the increased transparency of lead white containing layers through saponification. Vandivere 2011: 83.

¹⁰⁸ Carlyle 1991, vol. 1: 347-370; Carlyle 2001: 257-268.

¹⁰⁹ The chemistry of aged oil paintings has recently been studied in research projects focusing on reaction mechanisms that take place during drying and degrading oil paints. Inside the Netherlands, I am referring to research executed under the umbrella of the the MOLArt Project (1995-2002) and the De Mayerne Programme (2002-2006). This work is continued in the PAInT project, part of the Science4Arts programme (2012-2016), all multi-disciplinary programs sponsored by NWO. See <http://www.nwo.nl> for more information on these programmes.

¹¹⁰ A further complicating factor regarding the interpretation of scientific data, is identified by Keune and Carlyle (2005): paint components within the layer structure of a painting can move through the layer system.

information. It tells us which materials we should consider because of their availability and/or the fact that they were advised for use in similar layers.

If scientific investigations are preceded or accompanied by in-depth research into historical written sources, more accurate interpretations of the results of instrumental analysis are within reach. Instrumental analysis needs to be complemented with research that explores the origin of ground materials, that investigates preparation and application methods and that focuses on the role of possible additives. This will lead to a more full and multi-faceted understanding of these layers, which is vital for the conservation field. For only if we know more about the starting point of the ageing process of paintings, can we come closer to a full understanding of the paths of degradation.

Documentary research clearly has its limitations too, in particular regarding the availability of sources and their interpretation, which is not always straightforward. Research based on documentary sources does not lead to absolute certainties. But if both instrumental analysis and documentary source research are carried out, the results can complement each other. This relation between documentary and scientific research is of a symbiotic nature.

Paragrah 1.1 has indicated that information on painting materials and preparation methods has previously been sought and found in several types of historical documents, such as bills for materials or lists of materials purchased, artists' correspondence, historical collections of (paint) materials, paint manufacturers catalogues, guild regulations, historical recipes and artists' inventories.

Of all these categories of historical documents, recipes are the *only* type of document that not only lists materials, but provides systematical instructions on how to use these materials in the creation of preparatory layers. Recipes form a separate category of written records, and they are the category that this thesis will focus on, because recipes provide the most complete answer to the question: which materials can be expected in preparatory layers, how were such materials employed and why were they selected for use?

The potential value of research of historical recipes as a means to create clarity about the intended purpose of materials and as a means to inform the interpretation of analytical results, has been proven in earlier studies. In particular in combination with reconstructions, recipe-based research can significantly increase our understanding of the use and degradation of painting materials.

Reconstructions play an important role in establishing a link between recipes and actual painting technique. They lead to insight into the actual effects of materials and procedures, and can be used to study the causes of degradation phenomena observed in paintings. In some cases, chemical characterization by Instrumental analysis is executed to support these investigations.

In this thesis, for the first time historical recipes for preparatory layers from a long time period and large geographical area will be thoroughly and systematically investigated.

Keune analyzed the location of paint binder components in reconstructions executed by Carlyle. Binder components were proven to move to other layers in the build-up, even in the presence of intermediary isolation layers. Keune 2005: 74.

This investigation focuses both on the material characteristics, chronology of use and on the reasons why they were advised for use in the preparatory system. The recipes are investigated by textual analysis and by reconstruction.

The wide-angle approach taken, allows the researcher to take a step back from individual recipes in order to identify trends. A second result of this approach is the fact that the sometimes limited, unclear or incomplete information given in one recipe can be clarified through this context. By combining information from different recipes, missing details can be filled in and a more sound basis for conclusions is possible.

For this dissertation, the choice was initially made to gather recipes from a long period, starting from around the time when the Van Eyck brothers were active (early fifteenth century) to the late nineteenth century, and from a large geographical area, North West Europe. However, as will be discussed in Chapter 2, which describes the size and scope of the recipe collection, insufficient recipes were available from before 1550 to allow for a recipe-based approach to the subject of preparatory layers. Therefore the decision was made to take 1550 as a start date.

The value of recipe-based research into preparatory layers for conservation-related research has been outlined above. But the outcomes of this investigation are also relevant for practicing conservators. As knowledge about the composition and function of preparatory layers increases our understanding of the chemical and physical state of a painting, it influences and co-determines decisions for both active and passive conservation.

Art technological investigations will benefit from information in the recipes about the motives of artists to include certain materials in their preparatory layers. Recipe texts tell us why artists chose particular ground colours or how they dealt with the working properties of the different supports and grounds. Discussions on the advantages and disadvantages of certain types of preparation shed an interesting light on what drove artists, and how they reflected on their own practice.

1.3 Research methodology

As introduced above, this PhD dissertation reports on research that integrates the results of three different approaches or research methods: the textual analysis of a large collection of recipes, reconstructions of historical recipes and instrumental analysis. Recipes form the backbone of the research and are the starting point of all investigations.

As a first step, a recipe collection is established that includes European recipes for preparatory layers from c. 1400 to 1900. Simultaneously, research into secondary literature on the topic of preparatory layer materials and on methodologies for recipe study is executed.¹¹¹ As stated above, the boundaries of the period and area investigated are determined by the scope of the recipe collection. Paragraph 2.1 describes the size and scope of the recipe collection and explains why the decision was made to focus on North West European recipes dated between c. 1550-1900.

¹¹¹ The search strategy employed is explained in Paragraph 2.1.

As a second step, the contents of recipes are described in detail. Chronology and the use of materials are investigated. Recipe texts are analyzed by a 'thick description method',¹¹² which investigates the recipe texts in detail while taking into account the context of the recipe (source, author, location, period, relation to contemporary, earlier and later recipes). Information about the professions of the authors of recipe books and the audience they wished to address are included in cases where they provide important information about the role of particular recipes.

These descriptions act as a reference guide for future investigations into preparatory layers and form the basis of later chapters. From the recipe descriptions, a number of themes that attract attention throughout the time period are selected for further study. Topics are chosen for focused attention when the sources provide information that is vital for our level of knowledge about workshop practice or when their investigation leads to more insight into the degradation of preparatory layers. Some themes or questions that are selected, focus on the characteristics of fresh grounds, while other questions concern the aging of preparatory layers. Questions that fall within the first category are: the working properties and the aesthetic effects of grounds, both in colour, texture and saturation and the role of commercial ground preparation. Questions that focus on the aged grounds, deal with the influence of specific pigments on the degradation of a painting, the role of the ground binder or binding medium and the influence of ground layering and thickness on the degradation of paintings.

Further study of these themes leads to more knowledge about the motivation of artists, explains certain characteristics observed in preparatory layers and results in a more thorough understanding of the material aspects of ground preparation, application and degradation in general.

Throughout the thesis, bar graphs are employed to represent chronology in recipe content. These bar graphs, such as for instance Figure 5.1, are a tool to analyze the recipe groups, and clarify general developments regarding materials and layer build-up. In order to produce recipe groups that are large enough to be meaningful, some generalization is unavoidable. For instance slight ground colour variations cannot be accounted for, and the exact nature of an earth pigment is not visible in the bar graphs. While this is unfortunate, grouping cannot be avoided, as without it, the meaning of the graphs is lost in the multitude of variables. However, when reading these graphs, readers have to be aware of this fact and are advised to refer to the transcripts of individual recipes which are provided on CD for more detail.

¹¹² 'Thick description' was introduced as a qualitative research tool in anthropological research by Gilbert Ryle in 1971. Ponterotto 2006 discusses the meaning of the term and provides a working definition, focused on anthropological research but applicable to recipe research if instead of 'social actions' we think about recipes (writing and/or publishing a recipe can be interpreted as a social action). Ponterotto's definition is: 'Thick description refers to the researcher's task of both describing and interpreting observed social action (or behavior) within its particular context.'... 'Thick description accurately describes observed social actions and assigns purpose and intentionality to these actions, by way of the researcher's understanding and clear description of the context under which the social actions took place. Thick description captures the thoughts and feelings of participants as well as the often complex web of relationships among them'. Ponterotto 2006: 543.

Through reconstruction-based studies, links are established with actual paintings. Reconstructions are executed in order to investigate the properties of different groups of materials that are mentioned in the recipes. Reconstruction-based chapters investigate the handling properties of the materials, their effect on the painting process and their long-term effect on the ageing of the paintings. Such issues cannot be investigated solely through instrumental analysis of aged and/or restored paintings or through the textual analysis of the recipes only.

As in these cases a direct comparison between original objects and reconstructions is intended, historical accuracy is of crucial importance and is pursued at the highest possible level. Much emphasis is therefore placed on sourcing suitable materials.

If the highest level of historical accuracy cannot be achieved without personal danger to the practitioner, or within a feasible time frame, or if insufficient data are available about the original materials, compromises are unavoidable. An example of such a compromise is the decision to use distilled or demineralized water. This decision has been made because, even though water with this degree purity was not available in former centuries, it ensures that the water used does not contain salts or acids that would not have been present historically.¹¹³ The choice for demineralized or distilled water furthermore raises the level of reproducibility of the reconstructions, because it does not introduce materials of unknown and varying composition. The pH of the water and the amount of dissolved salts will however influence the chemical reactions that take place and possibly also the characteristics of the final product, for instance during glue preparation¹¹⁴ and during washing of lead white pigment.¹¹⁵

It is important to realise and acknowledge that even if materials are located that can be directly compared to the materials available in former centuries, we are operating in a field with a large number of variables and unknowns. Therefore a reconstruction will at its best *approach* the process of a particular artist in a particular situation, it can never claim to be a perfect replica. In addition, as Carlyle writes, direct comparisons must always be made with care because of another important difference: the difference between a practiced workman in the setting of a studio or factory and the modern paint researcher preparing small samples inside his chemical lab.¹¹⁶

Instrumental analysis is employed to link the results of reconstructions to data from actual paintings which has been obtained from the literature. Analytical methods employed are: light microscopy, polarised light microscopy, Scanning Electron Microscopy (SEM-EDX) and

¹¹³ For instance in the Netherlands, rain water nowadays may contain ammonia (from fertilizers), NO₃, SO₄ (emission of SO₂ from the industry), heavy metals (Fluor, Nickel, Zinc, Cadmium, Lead). *See*: Swaluw et al. 2010. Tapwater in Amsterdam, according to the report on water quality in the first three months of 2012, contains trace amounts of aluminium, arsenic, fluoride, ammonia, nitrate, and larger amounts of chlorine, magnesium, sodium, sulphates.

<http://www.waternet.nl/media/407425/waterkwaliteit%20kwartaal%201%202012.pdf>

, accessed 14-5-2012. Naturally water in former centuries would also have contained ionized salts, etc. However the exact amount and composition would have depended on the period (think of the influence of industrial pollution, etc.) and on the geographical area. By choosing demineralised or distilled water, a more constant water quality is available, which raises the possibility of reproducible reconstructions.

¹¹⁴ For which a low salt content is advised, *see* Chapter 11

¹¹⁵ *See* Chapters 13 and 14

¹¹⁶ Carlyle discussed problems of downscaling briefly in Carlyle 2012b: 111.

X-ray diffraction (XRD). Microscopy has been performed by the author, SEM-EDX and XRD analysis have been performed by or in cooperation with conservation scientists.

1.4 Structure of the dissertation

This dissertation consists of two main parts, followed by general conclusions. Part I of this thesis concerns the textual analysis of the recipes for preparatory layers that have been gathered. Part II assembles studies that employ reconstructions in order to understand phenomena observed in actual paintings.

The first chapter of Part I, Chapter 2, describes the recipe collection, its size and scope. In this chapter, the choice to focus on the time period 1550-1900 is made and explained. This chapter furthermore contains an analysis of the character of the sources and their authors and it discusses the possible impact of historical recipe books. Chapter 3 describes the terminology employed for the description of the different preparatory layers in this thesis and places terminology in a historical context. Chapter 4 provides a synopsis of developments regarding ground layers during the time period preceding the main period under investigation. It acts as an introduction to the main period. Chapter 5 consists of a detailed description of the recipe content, ordered thematically and chronologically. Chapter 6 discusses the materials that are mentioned in the recipes. It provides information on the origin and preparation of these materials and describes their chronology. Chapter 7 focuses on the application methods and handling properties of preparatory layers. This chapter addresses the questions how preparatory layers were applied and smoothed, why certain application methods were advised and how application methods relate to texture of preparatory layers. Together, Chapters 5 to 7 function as a reference section on recipes for preparatory layers. Chapter 8, on the subject of ground colour, investigates the role of ground colour in painting. Was ground colour considered important, which ground colours were advised and for what reason? How did discussions on ground colour change throughout the period? Was ground colour subject-related? Did ground colours change with commercial manufacture? Chapter 9 focuses on the role of commercial ground preparation. It traces the role of commercial suppliers of prepared supports throughout the period, and investigates the relation between commercially primed and artist-primed supports. Chapter 10 investigates comments on the ageing and degradation of preparatory layers as they appear in the sources. It discusses the influence of individual pigments, the role of ground colour and ground absorbency, the influence of layer thickness on the degradation, and analyses advice in historical recipe books to prevent degradation phenomena.

The recipe-based reconstructions discussed in Part II examine preparatory layer characteristics and the influence of preparatory layers on the finished painting and on its degradation. The subjects that are investigated through reconstructions are: the effect of animal glue size layers on the properties of the preparatory system (Chapter 11), starch and flour paste as size and ground layers (Chapter 12), lead white quality and the effects of lead white washing on pigment composition (Chapters 13 and 14) and binders used for streaky imprimaturas (Chapter 15).

Part II is followed by general conclusions, which discuss the main findings and identify areas that require further study.