SCIENTIA ARTIS 12

Between Carpentry and Joinery

Wood Finishing Work in European Medieval and Modern Architecture

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Royal Institute for Cultural Heritage

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Contents

Introduction: Wood finishing work, a promising area of research? 7
Paulo Charruadas, Pascale Fraiture, Patrice Gautier, Mathieu Piavaux, Philippe Sosnowska

Between carpentry and joinery: Constructing flooring, ceilings and roofing

1 **Constructing ceilings: The floors of the Rhone region in the south of France at the end of the Middle Ages** 24
Émilien Bouticourt

2 **Structural timber in 15th- and 16th-century town houses in 's-Hertogenbosch (The Netherlands): Recent research on supporting structures** 46
Maarten W. Enderman

3 **Ceilings and floorings in Austria: Types, dating and wood species** 66
Michael Grabner, Andrea Klein, Sebastian Nemestothy, Erwin Salzger

4 **Contribution to the history of Brussels floorings, Belgium (16th-19th centuries): Initial results of an archaeological and dendrochronological investigation** 78
Philippe Sosnowska, Pascale Fraiture, Sarah Crémer

5 **Panelled frames, modes of use: A technological and typological study of several roof frames in the Hainaut (Belgium)** 112
Jean-Louis Vanden Eynde

6 **Wood shingles of medieval roofs: A first approach in France** 128
Pierre Mille

Organising light and space: Doors, windows, stairs and panelling

7 **Wooden witnesses: Romanesque joinery and other wooden elements or their negatives divulging historical secrets of the St Martin's Church, Zaventem (Belgium)** 150
Karin Keutgens, Bernard Delmotte, Charles Indekeu

8 **Wooden nailed doors in western France: An Armorican model inherited from the Middle Ages?** 166
Vincent Bernard, Bruno Béthencourt, Yannick Le Digol, David Nicolas-Mery, Pierre Mille

9 **Analyses of wooden front doors in rural buildings from Austria** 182
Sebastian Nemestothy, Andrea Klein, Michael Grabner

10 **The watertight integrity of window sills in western France: A simple system with a complex development history** 198
Arnaud Tiercelin

11 **Window frame inventory number 3079 in the collections of the Royal Museums of Art and History, Brussels (Belgium): Results of archaeological, historical and dendrochronological studies** 222
Patrice Gautier, Pascale Fraiture, Valérie Montens

12 **Grand staircase and joinery work on the Lange Vijverberg, The Hague (The Netherlands) in light of documents** 240
Ada de Wit

13 **Indoor joinery and furniture made for 18th-century houses in Liège (Belgium)** 254
Isabelle Gilles

Introduction: Wood finishing work, a promising area of research?

Paulo Charruadas[1], Pascale Fraiture[2], Patrice Gautier[3], Mathieu Piavaux[4], Philippe Sosnowska[5]

Translation from French: Rebecca Miller

First and foremost, we would like to make it clear that this introduction is not intended to be an exhaustive portrait and a complete historiographic overview of the question. As will be shown, the very partial exploration of this area of research to date prevents such an endeavour. We have therefore deliberately chosen to focus on the regions that are less poorly known for us: the former Low Countries (the Netherlands and Belgium), France and Italy. The aim of this introduction is thus to prepare the ground for discussion of the question of wood finishing work, that future research will necessarily complement and improve.

From finishing work, early architectural treatises and joinery…

Finishing work using wood has a very minor place in architectural treatises of the 15th and 16th centuries. The well-known works of Alberti, Palladio and Delorme, who perpetuated the Vitruvian concept of architecture, thus focus in particular on the orders and ratios of proportions as well as on building functions. More technical considerations reserved for the different kinds of materials and their use are not uncommon, however, especially in the work of Alberti

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and Delorme, but are more concerned with construction work; for finishing work only Classical techniques are mentioned. When wood is addressed, it is to describe the material (quality and selection of different species) and to specify strategies of felling (identification of areas suitable for exploitation, period of felling and precautions to observe) and use (notably drying). Strongly inspired by Classical theories – considerations of wood material stemming most often from the Hippocratic theory of humours, the cardinal points conditioning the quality of the trees, and the seasons, like the moon, the period of felling –, such technical requirements generally deviate from recent observations by archaeologists and dendrochronologists (Touzé, 2011).

The drying time before wood could be used is one of the rare technical elements linked to finishing work. At least three years were needed before processing wood for 'planks, doors and windows',[1] according to Alberti, Palladio and Delorme. This period would often be extended by another two years in publications from the late 17th and 18th centuries (Bullet, 1691; Blondel, 1737-1738 Diderot and d'Alembert, vol. 10, 1765).

Delorme, whose theoretical work gives wood working in architecture an atypically important role for the period, focuses almost exclusively on carpentry, rarely discussing finishing work except to mention ornaments 'made of small pieces'[2] or, in the great tradition of Vitruvianism, the ratios of the proportions to respect for doors and windows based on their placement in a building (Delorme, 1561). In the early 17th century, the work of Jousse confirms the importance of carpentry in architectural theory in France (Jousse, 1627). Doors, frames, planks and panelling – as the work of joiners – are logically not discussed.

These considerations on Italian and French treatises can be extended with caution to those written during the same period in the Low Countries, for example *De Architectura* by Charles De Beste c. 1599 (van den Heuvel, 1993; van den Heuvel, 1995). In contrast, the unfinished (and unfortunately incomplete) work of Simon Stevin, *De Huysbou*, probably written between the late 16th and early 17th centuries, contains a few concrete descriptions related to elements of finishing work (shutters, staircases, ceilings), although these are still imbued with Vitruvian mathematical concepts and the aesthetic vocabulary of the Italian Renaissance (van den Heuvel, 2005). The idea is based on both a high degree of urbanity (relationship of a house to the city and to urbanism) and a strong practical sense (the most convenient means of implementation and the best markets for maintenance, the most resistant to weather, advice to prevent a given kind of wear, etc.). In the chapter discussing shutters, for example, Stevin takes care to describe the different closure systems with the advantages and disadvantages of each (van den Heuvel, 2005: 261-264).

In France, from all evidence the 17th century played a pivotal role in the study of the techniques of wood finishing work. Interest in 'joinery works' significantly increased in publications by the end of the century. While the question was not addressed in detail by Savot (1685)[3], it grew in importance in works of the next several decades, and in practice, with an increasing focus on finishing work techniques. Bullet (1691), for example, successively envisages doors, casements, panelling, partitions, parquets and chimney fireplaces, all elements composing the 'principal works of joinery'.[4] The metier of joinery, however, is not specifically addressed by this author,[5] who limits himself to recommendations on the preferred proportions, dimensions (units of measurement) and forms. Félibien (1690) approaches the question from a more technical viewpoint, considering woodworking in terms of metiers. The joiner thus collaborated on a work site with the wood sculptor and engraver, as well as with the painter, a metier that the author associates with marquetry work. It is d'Aviler (1691) who would synthesise the state of knowledge on the question of finishing work in his architectural course, via notices devoted as much to the different elements of wood finishing work in a building as to the associated metiers. The joinery of the assemblage is thus differentiated from that of veneering, while another notice discusses marquetry. Jacques-François Blondel next attempted a synthesis in *De l'assemblage & des différens Profils de Menuiserie à l'usage de la décoration des appartemens* (Blondel, 1737-1738). The technical tone demonstrates a good understanding of the contribution of joinery in architecture at the time and the different aspects of the profession: the quality of the wood, drying time, different kinds of assemblages, profiles of casements and panelling, etc., are all discussed, with plates.[6] Profiles of the professions were redefined in the *Encyclopédie* (Diderot and d'Alembert, 1765), and then in the famous treatise by Roubo (1769): cabinetmaking/marquetry, 'where one uses wood of different colours, cut into very thin sheets, applied by compartment on ordinary joinery',[7] is thus clearly differentiated from assemblage joinery 'which has the aim of decoration and covering the apartments, for which knowledge of the design is necessary'[8] (Diderot and d'Alembert, 1765). These two works would further give a mark of prestige to joiners, whose technical knowledge forms the main theme for the discussion, while earlier architectural works gave precedence to the logic of architecture. Much more synthetic than Roubo's work, the entry in the *Encyclopedia* connects the strategies of selections and conditions for the use of wood – as in earlier works, a drying time of five years minimum is recommended – by providing the reader with a long list of potential defects in the material; it continues with eight different types of assemblages and then addresses the 'art of profiling and joining them together'[9] in panelling, mouldings and doors. An exposé on joiners' tools accompanies the entry (Diderot and d'Alembert, 1765).

In a monumental work in four parts and six volumes, the third part being divided into three separately published 'sections', André-Jacob Roubo, companion joiner and student of Jacques-François Blondel, presents a detailed and knowledgeable discussion of all of the known aspects of his metier. '*Menuiserie de Bâtiment*' is addressed in the first two parts (Roubo, 1769). The author incorporates the information previously provided by Blondel, d'Aviler and in the *Encyclopedia*, enriching it with his own practical knowledge. The author also played the role of educator when, in the preface, he emphasises the differences between carpenters and joiners: the first 'use only large nearly green wood elements, cut and squared with a loggers' axe and a wood chisel'[10], while the second 'use only seasoned woods of a mediocre thickness, that are shaped with a jointer plane and a smoothing plane'.[11] He also focuses on the subtleties of the terminology for professional profiles involved in joinery, emphasising that the 'Assemblage Joiners'[12] (not to be confused with the 'Cabinetmakers')[13] are subdivided into two bodies, the 'Building Joiners' and the 'Coach Joiners'.[14] The craft of building joiner is discussed in 25 chapters, each addressing a specific aspect. In the first five chapters, the author successively discusses the geometric knowledge needed, the wood used for joinery, profiles, assemblages and tools. The eight subsequent chapters consider separately the different parts of the finishing work. Casements, 'shutters or pedestrian doors in gates',[15] doors – the theme covered in three successive chapters –,[16] 'parquet floors'[17] and panelling are all described in detail. The author then develops each theme according to the kind of architecture, including living areas, churches, 'sacristies or treasuries',[18] confessionals or organ cases. This is followed by several very technical chapters which address the '*Art du trait*' or stereotomy, how to glue wood in different compositions and ways to shape the wood. The work concludes with an exposé on staircases.

The work of Roubo, by both its quality and relative precision, would considerably influence the bibliography of the 19th century. In 1827, the *Manuel du menuisier en meubles et en bâtiments suivi de l'art de l'ébéniste* (Nosban, 1827 traces the path followed by the master joiner, contributing many nuances, particularly with respect to the use of different species.[19] The *Nouveau manuel du menuisier en bâtimens* by Teyssèdre is also based in majority on Roubo's writings (Teyssèdre, 1836). Even if the work of Oslet and Jeannin (1898) exposes the technical inventions and development of the kinds of living areas during the 19th century, among others by many examples of woodwork specific to different rooms in a house, it also appears to have been inspired in its structure by Roubo's fundamental technical information and skills.

… to modern scientific literature

While 18th- and 19th-century technical treatises address the architecture of their times, the first modern scientific research on wood finishing work, in the 19th century, focuses on the medieval period in a context of construction of broad national narratives and their heritage corollaries. In his famous explanatory dictionary, Viollet-le-Duc was a pioneer in the article 'Joinery'[20] (Viollet-le-Duc, 1854-1868, vol. 5: 345-386), by studying the technical design of 'Fences, skylights, shutters and panelling'[21] during the Middle Ages. He also presents examples of known medieval gates in the articles on 'Joinery' and 'Door wings'[22] (Viollet-le-Duc, vol. 9: 346). The wood frame, rare in medieval architecture, is discussed more briefly in the article 'Casement'[23] (Viollet-le-Duc, 1854-1868, vol. 5: 96). In his architectural treatise, the Belgian engineer and architect Louis Cloquet proposes 'archaeological' observations with technical recommendations based on joiners' treatises (Cloquet, 1898-1901).

Such interest is manifested at the same time in museum contexts. A number of institutions enriched their collections of decorative arts with pieces of finishing work. Doors, frames and shutters, medieval and post-medieval, were acquired, primarily for aesthetic reasons – they were considered here as part of the décor –, but also for preservation of an endangered cultural heritage faced with transformations of the landscapes and national territories.

The constructive approach preferred by 19th-century architects and joiners seems to have had little impact on the work of archaeologists and art historians. Manuals on medieval archaeology were not much interested in wood finishing work and discuss it principally in terms of typology and style. Canon Edmond Reusens, for example, devoted several commentaries to doors and hinges, but discusses in more detail wooden fences, inspired here by the data provided by Viollet-le-Duc (Reusens, 1875). Camille Enlart would also be as terse fifty years later, although commenting briefly on ceilings, especially those that were painted, illustrated with plates (Enlart, 1929: 146).

The typological and stylistic approach dominates the bibliography until the 1970s-1980s (e.g., Bruneel-Hye de Crom, 1965; Janse, 1971; Devliegher, 1980) with a few notable exceptions that illustrate the still used book by Robert Salzman. Salzman, an economic historian, published in 1952 a detailed synthesis of all the professions and types of construction materials used in English buildings during the Middle Ages.[24]

In the 1980s, other approaches gradually began to reopen the question. Like Salzman, historians first examined written archives for information on the commerce of construction materials, especially wood (Fanchamps, 1966; Sosson, 1966; Sosson, 1977; Sosson, 1986; Rackham, 1982) although it was less commonly used than stone and metal. Based on sometimes very explicit documentation, the history of the crafts and corporations would also contribute, in the 1980s, to a better determination of the role of joiners on construction sites and to better understand the relationships between this profession and that of carpenters during the entire *Ancien Régime*.[25]

Research on urban and rural homes also became fertile ground for studies of finishing work. Such studies proliferated during the last quarter of the 20th century, particularly benefiting of restoration projects and the development of building archaeology (Esquieu, 1995; Morris, 2000; Morriss, 2000). At the same time, interest in wood finishing work is illustrated by the increasing number of studies of frames, doors, floorings and panelling (Genicot, 1987; Arnold and Kleber, 1996; Lewis, 1995). Their study, however, remained unequal, the works cited benefiting from the attention of researchers while others, such as staircases, were more or less neglected apart from a few publications like the volume of *Demeures historiques et jardins* devoted to this question through examples in Benelux (*Maison d'hier et d'aujourd'hui*, 1988). We can only point out here the pioneering two-volume work on technical and aesthetic studies of windows and doors in Ghent houses (Baillieul *et al.*, 1993; Baillieul *et al.*, 1995). The chronological period is broad, covering seven centuries of history. The volume on windows is divided into two parts, the first discussing the materials used (wood, iron and glass) while the second presents historical development using an architectural, archaeological, technical and aesthetic approach to the study of building construction and finishing work. The volume on doors uses the same structure, with an introductory chapter on coaches. Another work of note is the collection *Architecture rurale de Wallonie*, edited by Luc-Francis Genicot (1983-1992), which synthesises the observations made during the inventory of building heritage in Wallonia. Each volume is dedicated to a region for which the typology of rural buildings is described, as well as particular attention paid to wooden finishing work, that is recorded and drawn such as structural elements of the buildings.

In Germany, the first summary of research focusing specifically on finishing work appeared in 2004 in volume 50 of the *Jahrbuch für Hausforschung* (*Historische Ausstattung*). Wood is well-represented with a section on doors and windows, and several contributions addressing, at least in part, ceilings and panelling. Observations are sometimes complemented by precise drawings and a material and technical analysis of the elements studied (Klos, 2004). In France, the thematic inventories of cultural heritage[26] have in the last several years concentrated on wooden finishing work, with volumes on frames (Bontemps, 2000; Bontemps, 2008), floorings and parquets (Togni, 2012), ceilings (Férault, 2014) and panelling (Roman *et al.*, 2015). In Belgium, research on timber-framed buildings in the Meuse Basin has offered substantial insights into finishing work in this kind of construction (Houbrechts, 2008). Several case studies have comprehensively analysed certain elements of finishing work, such as parquets (Buijs and Bergmans, 2010). Other more general publications propose an inventory of the different interior arrangements (panelling, doors, windows, parquets), but essentially from formal and aesthetic perspectives (de Harlez de Deulin, 2003; Carpeaux, 2004; Carpeaux, 2005). Some authors have also examined the spread of different kinds of works, including double-hung windows (Georges, 2002: 25-32). In the Netherlands, syntheses have been published on wood staircases throughout the territory (Janse, 1995), as well as several works on windows (Janse, 1978: 170-176; van Drunen, 1993: 123-136) and an essay on changes in windows from the Netherlands and in north-western Europe (Jehee, 2010). The symposium *Over de vloer*, organised in 2008 by the *Rijksdienst voor Archeologie, Cultuurlandschap en Monumenten*, propose a consideration of the role of floor coverings in building structures, a theme divided by material type and for which a contribution specifically presents a case study for wooden floor coverings (Viersen, 2008: 116-125). The numerous archaeological and heritage investigations of the Dutch urban house offer a considerable amount of information on finishing work (van Engelenhoven, 2005; Weve, 2013), although a synthesis of the data collected has not yet been presented. We note, also, the important volume devoted to interiors in Groningen during the 16th and 17th centuries, that gives a prominent place to staircases, floorings, doors, wooden chimney, panelling, etc., through examination of written sources and an architectural and art historical analysis (de Haan, 2005). Finally, we point out the study handbook of building heritage, *Inleiding in de Bouwhistorie*, that, via a pedagogical approach, proposes a synthetic view of some finishing work products, principally doors, windows and staircases (Stenvert and van Tussenbroek, 2007). In Great Britain, research on windows and staircases benefits from particular attention through two relatively recent publications (Tutton and Hirst, 2007; Campbell and Tutton, 2013) that include archaeologists, historians, architecture historians, architects, engineers and restorers. These publications thus apply a multidisciplinary approach to the study and include an historical synthesis as well. Windows, for example, are addressed in three chapters: the window and its evolution (Louw, 2007), window frames (Roseman, 2007) and glasswork (Martlew, 2007). Three chapters also discuss staircases: first their use in England (Campbell, 2013), then more specifically in London (Roseman, 2013) and finally changes in their implementation and decoration (Hall, 2013). We also note works on medieval doors (Yeomans and Harrison, 2014). In Italy, this interest in finishing work is shown, for example, in archaeological studies of buildings in urban contexts (Boato, 2005). In addition, a study was recently made on the spread of French-style windows in the Milan region during the 18th century (Landi, 2016).

Since the 1990s, dendrochronology has become a vital method of dating for the timbers used in carpentry. However, it took longer to be applied to the thin planks used in finishing work, as the present volume demonstrates. The obstacles encountered are both technical and methodological. A few pioneering studies proposed dendrochronological dates for a window frame, a ceiling and an alcove (Fletcher and Morgan, 1981; Hoffsummer, 1989; Houbrechts, 1999; Houbrechts, 2008; Tyers and Tyers, 2007; Crone and Sproat, 2011; Crone and Mills, 2012), while the dendrochronology of works of art, particularly panel paintings and sculptures, gradually allowed refinement of the method (Crone *et al.* 2000; Tyers 2001; Fraiture, 2002; Fraiture, 2007). In Belgium, the University of Liège conducted experimental research on finishing work (e.g., Fraiture and Houbrechts, 2004a; Fraiture and Houbrechts, 2004b). At present, the first baseline studies of the potential of this method for a better understanding of joinery elements in buildings are being conducted (Fraiture, 2015). Finally, most recently, research undertaken in France, Italy and Belgium have demonstrated the contribution of an interdisciplinary building archaeology for the study of ceilings (sometimes painted) and floorings (Bouticourt and Guibal, 2008; Guibal and Bouticourt, 2010; Boato and Decri, 2009; Bernardi and Mathon, 2011; Sosnowska, 2013). This research now allows better dating of these elements and better understanding of the wood species utilised and, through this, an in-depth consideration of supply networks. It also contributed to the refinement of the history of techniques by comparing archaeological observations with theoretical recommendations in 17th- and 18th-century treatises.

Contribution of this publication

From reading of this historiographic summary for a long time period, it is clear that wooden finishing work is the poor relation of research in the history and archaeology of construction, carpentry taking priority. The present publication is part of a desire to change this trend of research and work habits of historian and archaeologists specialised in buildings. It shows, on one hand, both a real interest in an approach to finishing work for dating and the study of ancient buildings, and for a better understanding of the material cultures and modes of living. It reminds, on the other hand, that the limit between carpentry and joinery, while not entirely denuded of meaning, appears porous, sometimes artificial. This point underlines most emphatically that a global approach to the wood used is a necessary condition to entirely understand the structure of a house, the logic of its construction and its 'use' and, more generally, the complex history of the building(s) studied. To go further, this suggests that the study of construction materials should be considered as a whole, beyond the wood addressed in this publication. Awaiting research programmes that go beyond 'material' specialities, we take the first step here toward a global approach to wood materials in architecture, from construction to finishing work, from carpentry to joinery.

The articles in this volume were first presented during an International Study Day held in Brussels on 29-30 November 2013 at the Royal Institute for Cultural Heritage, organised by this institute, the University of Namur, the Université libre de Bruxelles and the Royal Museums of Art and History.[27] After this meeting, several authors unable to attend were solicited to enrich this volume and contribute additional insights. This has resulted in a volume exploring the question of finishing work in medieval and modern European architecture in two separate, but complementary, parts.

The first section, entitled ***Between carpentry and joinery: Constructing flooring, ceiling and roofing***, addresses the gap, often difficult to classify, between construction and finishing work. Émilien Bouticourt opens the discussion by an in-depth study of floorings and ceilings in the Rhodanian Midi (France) at the end of the Middle Ages. Examining a rich and well-documented corpus, the author demonstrates the high level of knowledge and skills of the carpenters (the *fustiers*) as well as changes in the profession and the organisation of work sites with the appearance and surge in joiners. Maarten Enderman continues this theme by a thorough consideration of wooden structures separating the stories of buildings (beams, joists, floorings) in the houses of 's-Hertogenbosh (the Netherlands), mainly after the fire of 1463 that ravaged part of the Brabantine city. The study combines methods (typology and changes in construction patterns, dendrochronology and dendroprovenancing) and suggests new lines of research to understand certain changes in construction. The article by Michael Grabner, Andrea Klein, Sebastian Nemestothy and Erwin Salzger presents the results of a systematic study of ceilings in Austria, based on a dataset of 142 buildings of different types. The authors have established a chrono-typology for ceilings, development in the choice of wood species used, and show the path to follow for this type of cataloguing approach. The study of Philippe Sosnowska, Pascale Fraiture and Sarah Crémer proposes the first multidisciplinary synthesis of floorings and their use in Brussels (Belgium) between the late 16th and 19th centuries. The study is based on detailed archaeological examination conducted over the last ten years during preventive excavations in the Belgian capital, dendrochronological dating and identification of wood species, all of which enable establishment of a preliminary chrono-typology. Still in Belgium, the contribution of Jean-Louis Vanden Eynde addresses the question of pointed panelled barrel vault frames in the province of Hainaut that were studied during restoration projects. This method of covering is attested between the 13th and 17th centuries, in the Gothic style, and demonstrates a chronological progression towards increasing refinement and technical skill. The last article, by Pierre Mille, examines the largely understudied topic of wooden shingles. In addition to an extensive examination of the archaeological material yielded at three sites in France in recent decades, the author presents a salutary clarification of the question, exploiting a rich historical and archaeological bibliography that goes beyond the French borders.

The second part of this publication, entitled ***Organising light and space: Doors, windows, stairs and panelling***, resituates chronologically, typographically and architecturally several elements of finishing work in their formal aspects and points out their contribution to the organisation and ornamentation of buildings. The contribution of Karin Keutgens, Bernard Delmotte and Charles Indekeu is the result of an archaeological study of St Martin's Church in Zaventem (Belgium) conducted during its restoration. Among the rich harvest of architectural observations provided by the study, its interest resides in the demonstration of ancient primitive Romanesque bays and elements of the wooden frame found in the grooves within the Gothic masonry, not yet dated by dendrochronology or radiocarbon. Two contributions present an archaeological and technical study of doors. The article by Vincent Bernard, Bruno Béthencourt, Yannick Le Digol, David Nicolas-Mery and Pierre Mille focuses on examination of a very specific kind of door (and more rarely shutters) termed wooden-nailed doors observed in rural context in Brittany and Normandy (historical region of Armorica, France). Dated between the 14th and 18th centuries, behind an apparent simplicity of execution, the examples studied show a high level of mechanical knowledge in the utilisation of wooden material, here primarily oak. The second article, by Sebastian Nemestothy, Andrea Klein and Michael Grabner examines the main entrance doors of rural Austrian buildings. Using a corpus 'artificially' constituted of 51 doors from buildings reassembled in the Austrian Open Air Museum in Stübing, the authors propose a preliminary typology of these structures and clarification of the wood species used. The contribution of Arnaud Tiercelin is next, based on French material, and proposes a technical analysis of the development of processes to ensure the watertightness of windows. The author in particular illustrates how windows of today owe much to a technical mastery progressively elaborated between the 15th and 18th centuries. The contribution of Patrice Gautier, Pascale Fraiture and Valérie Montens proposes an in-depth monographic study of a window frame conserved at the Royal Museums of Art and History in Brussels. This element, of a high quality of manufacture, is meticulously described and dated by dendrochronology to the second third of the 16th century. The final two contributions lead us into the domain of monumental staircases and ornamental joinery at the end of the *Ancien Régime*. The article by Ada de Wit, using exceptional accounting documentation, sheds light on the realisation of a grand sculpted staircase today conserved in museum context. The work was ordered from a master carpenter and joiner by a rich officer in the entourage of the *stathouder* and the king of England William III of Orange, for his hotel in The Hague (the Netherlands) at the end of the 17th century. To conclude the volume, Isabelle Gilles introduces us to the heart of the furnishings and woodwork of 18th- century houses in Liège (Belgium), using archival records. This article shows with extreme justice the importance of such finishing work and decoration for the affirmation of social status. This contribution in particular reveals the necessity of taking these elements into account for full comprehension of the functional logistics and social and cultural meanings. The today imperfectly preserved buildings do not always allow reconstruction of these by their contemporary material state.

Perspectives for future research

The contributions included in the present volume altogether cover a relatively broad, but incomplete, chronological and thematic range. The question obviously merits expansion to new territories. Many investigations remain to be done for floorings and ceilings, shutters, doors and windows, domains that are beginning to attract the attention of researchers. In contrast, staircases and panelling, apart from aesthetic considerations, still belong to *terra incognita*. With respect to chronology, it can be asked whether the end of the 18th century is a pertinent *terminus*. The few works devoted to rural vernacular architecture suggest that the 19th century, and even part of the 20th century, could easily be included.

Both due to the novelty of the theme and the personal networks of the editors of this publication, it was not possible to include all countries and all of the broad historical regions. The former Low Countries are dominant in the geographic area covered with seven articles, five in Belgium (Brussels, Hainaut, Liège and Zaventem) and two in the modern Netherlands ('s-Hertogenbosch and The Hague). Four articles are dedicated to France, in a specific region (southern Rhone Valley, Brittany) or not. Finally, two contributions concern Austria and its Open Air Museum in Stübing. It appears, however, indispensable to expand the geographic coverage: Great Britain and Germany come immediately to mind, with a rich dendrochronological tradition and a powerful current for the study of buildings that appear entirely designed to produce the first overviews and attempts at synthesis. Others regions should follow: the Mediterranean, Central Europe and Scandinavia.

Also, in this perspective, the question of vocabulary is raised. Several contributions in this volume have shown the lexicographic complexity of finishing work, both in the original languages and in English. The edition of this work, with English proofreading or translation, was a difficult and meticulous exercise and it was a conscious decision to leave the different lists of technical terms associated with the article rather than combined in a general lexicon. However, an objective in the near future should focus on the harmonisation and formalisation of the technical vocabulary, such that the scientific community interested in the question of finishing work can advance on a common basis and communicate efficiently.

Notes

1 Authors' translation of: '*les planchers, portes et fenêtres*'.

2 Authors' translation in the text of: '*faits de petites pièces*' (Delorme, 1561).

3 Doors and windows are treated from the point of view of their masonry frame and the recommended ratios of proportions; continuing with vaults, the author is particularly interested in the flooring, detailing the dimensions of the joists, sleepers and other elements. The term 'joinery' appears at the end of the volume, when the 'ordinary price of joinery' (authors' translation of: '*le prix ordinaire de la menuiserie*') is presented. The author here discusses only doors and casements (Savot, 1685: 317-319).

4 Authors' translation in the text of: '*principaux ouvrages de menuiserie*' (Bullet, 1691).

5 Except when the author envisages the necessary qualities of the wood: 'The wood that we use for Joinery should ordinarily be of the highest quality oak, dried at least five years, with a straight grain, that is, without knots or sapwood, and no rotting' (authors' translation of: '*Le bois que l'on emploie pour la Menuiserie doit être ordinairement de chêne de la meilleure qualité, sec au moins de cinq ans, de droit fil, c'est-à-dire, sans nœuds ni aubier, ni aucune pourriture*'; Bullet, 1695: 340).

6 The author is also conscious of being a pioneer when he declares: 'Having found nothing on this material that was developed enough, I felt that I should apply myself and give examples of a sensible and distinct grandeur' (authors' translation of: '*N'ayant encore rien trouvé sur cette matière qui fût assez développé, j'ai cru devoir m'y attacher & en donner des exemples d'une grandeur sensible & distincte*'; Blondel, 1732: 152).

7 Authors' translation in the text of: '*où l'on emploie les bois de différentes couleurs, débités par feuilles très minces, qu'on applique par compartiment sur de la menuiserie ordinaire*'.

8 Authors' translation in the text of: '*qui a pour objet la décoration & les revêtisemens des appartemens, pour laquelle la connaissance du dessein est nécessaire*' (Diderot and d'Alembert, 1765).

9 Authors' translation in the text of: '*art de les profiler et de les joindre ensembles*' (Diderot and d'Alembert, 1765).

10 Authors' translation in the text of: '*n'emploient que des gros bois presque toujours verts, charpentés et équarris avec la coignée et reparés seulement avec la bisaigüe*'.

11 Authors' translation in the text of: '*n'emploient que des bois secs et d'une médiocre épaisseur, lesquels sont corroyés avec la varlope et le rabot*'.

12 Original text (translated by the authors): *Menuisiers d'Assemblage*.

13 Original text (translated by the authors): *Ébénistes*.

14 Original text (translated by the authors): *Menuisiers de Bâtiments* and the *Menuisiers en Carrosses*.

15 Original text (translated by the authors): *Volets ou guichets*.

16 Chapter IX presents 'Doors in general' (original text, translated by the authors: '*Des portes en général*'), chapter X 'Medium-sized doors in general' (original text, translated by the authors: '*Des moyennes portes en général*') and chapter XI 'Small doors' (original text, translated by the authors: '*Des petites portes*').

17 Original text (translated by the authors): *parquets en plancher*.

18 Original text (translated by the authors): *sacristies ou trésors*.

19 This work was republised by Nosban in 1843, appearing under the title *Nouveau manuel complet du menuisier en batiments et du layetier-emballeur*.

20 Original text (translated by the authors): *Menuiserie*.

21 Original text (translated by the authors): *Clôtures, claires-voies, volets et lambris*.

22 Original text (translated by the authors): *Vantail*.

23 Original text (translated by the authors): *Dormant*.

24 Note in particular a chapter specifically on finishing work, '*Doors, shutters, panelling, screens*' (Salzman, 1952: 253-261).

25 Among others, the well-studied example of wood profession in Brussels (Bonenfant-Feytmans, 1981; Janssens, 1988; Paquay, 1997) and Paris (Roux, 1991).

26 The work of the Centre de recherche sur les Monuments Historiques is the topic of a brief presentation in *Forêts alpines & charpentes* (Bernardi, 2007; Mayer, 2007: 165-170).

27 International Study Day *From Carpentry to Joinery. Floors and Ceilings, Shutters and Frames, Doors and Panelling in Medieval and Modern Architecture*, 29-30 November 2013.

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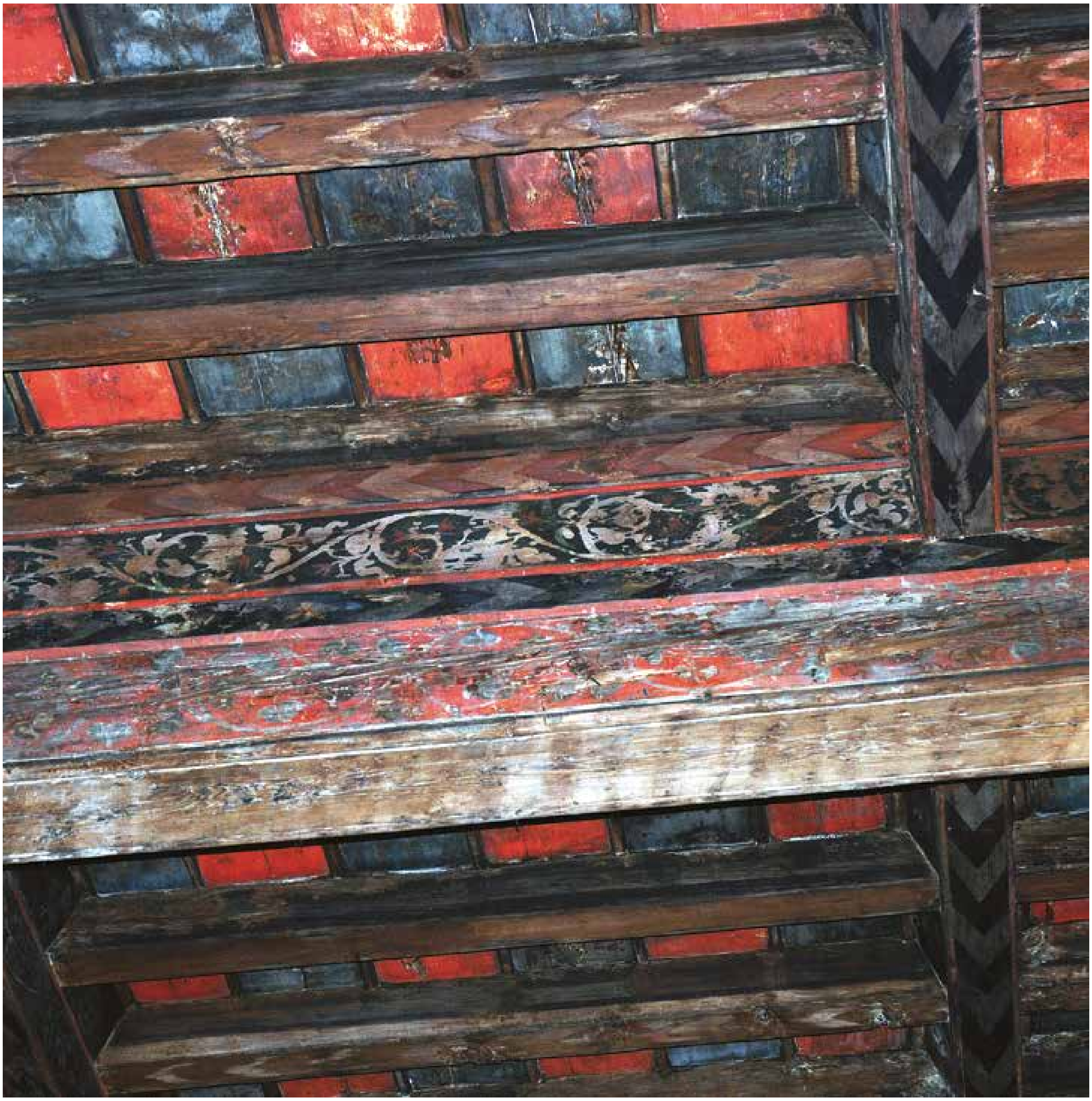

1.1

1

Constructing ceilings: The floors of the Rhone region in the south of France at the end of the Middle Ages

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Translation from French: Rebecca Miller

Key words
Middle Ages / South of France / Floorings / Ceilings / Structural construction / Finishing work / Building frames / Joinery

* An asterisk in the text refers to the glossary at the end of the article.

Introduction

Since the 19th century, dictionaries have defined wooden floors (*planchers**) as 'the structure separating the stories of a building' and ceilings (*plafonds**) as the upper limit of a covered space.[1] These conventions thus mean that when the floor is left visible above one's head, its beams (*poutres**) and joists (*solives**) are also called ceilings, equivalent to a lightweight framework installed beneath that would conceal them. One can marvel at, for example, the French-style ceiling in the guard room of the Château of Cheverny although it is only the reflection of the structure of the flooring (part of the structural construction) and find it ingenious to create ceilings attached with juxtaposed wooden cane and covered with plaster (finishing work) as well as those preserved in some Provençal houses.

The interpretation of these building elements was not always made with this distinction. The *Dictionnaire de Trévoux* explains that the term *plancher* was used in the 18th century to designate both the 'flooring on which one walks [...] and the flooring overhead'.[2] A century earlier, Pierre Le Muet had already indicated in his 1645 translation of Palladio that it was by carefully arranging the position of the joists that the 'floors are much stronger and pleasing to the

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Fig. 1.1. Livrée de Viviers, Avignon (department of the Bouches-du-Rhône). Triple-system floor.

eye' (not using the term for ceilings) (Le Muet, 1645: 129). Many other examples confirm that during the Modern Period the term *plancher* refers uniquely to supporting structures (floor *sensu stricto*, part of the structural construction) and ceilings to a lightweight framework beneath (finishing work).

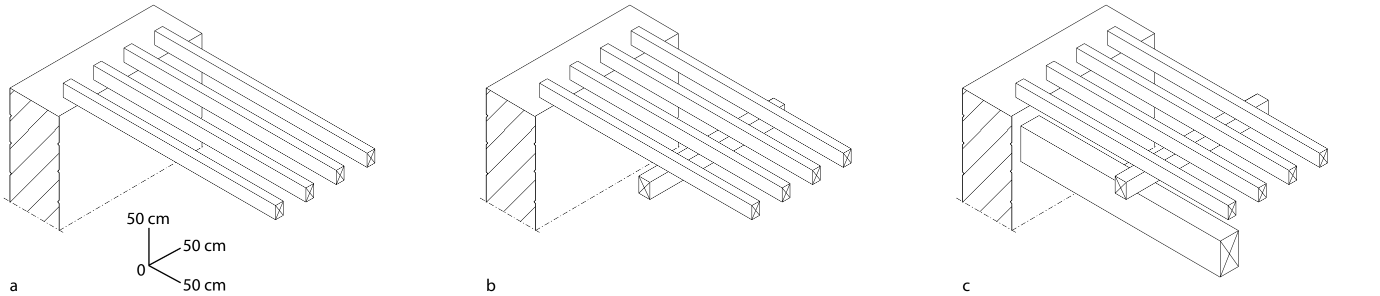
Rejecting the existence of such finishing work elements that hid the structure, Eugène Viollet-le-Duc confirmed that in the Middle Ages 'it was the construction of the floor that gave the form and appearance of the ceiling', meaning that by constructing the floors, the carpenters also created ceilings, both formed of a single structure. The architect thus explained to the reader in the *Dictionnaire* that these medieval structures should be considered both a structure (the floor) and an element for the residence (the ceiling) (Viollet-le-Duc, 1854-1868, vol. 7: 198). It is this view that we feel is of most utility to address a series of questions raised by the use of floors as ceilings.

The present paper thus examines which elements make the floors beautiful, pleasing and comfortable, when and how these structures were built, the skills needed to do so and whether this was carpentry or joinery work, i.e., part of the structural construction or finishing work. Contributing a response to these questions, this paper presents the results of a study of 30 floors[3] in the south of France located in the region between the cities of Arles and Avignon.[4] These are dated to the 14th and 15th centuries and separate the stories of palaces, castles and houses of varying importance in the cities of Avignon, Arles, Tarascon, Villeneuve-lès-Avignon, Le Thor, etc. (fig. 1.1). Some are in a state of ruin, others restored and still in use in private or public buildings. They are the product of *fustiers** (wood craftsmen), like Jean *Moleti* and Jean *Petri* who we see, for example, working in 1457 on the reconstruction of the floors of the ancient episcopal palace of Avignon (Pansier, 1931), today the Petit Palais Museum.

To explain the work of these *fustiers* in the building of floors, we first briefly discuss these structures and their installation, leaving to one side the technical changes in these floors to concentrate on the creation of ceilings. We examine the preparation of the wood surface and then the moulded ornamentation. We then demonstrate the function of the planks installed in the structures to perfect the creation of medieval ceilings, a procedure that would be abandoned in the 16th century.

The structures

The floors built in the 14th and 15th centuries in the study area generally reflect three kinds of structures, or three floor systems, which were built of conifer wood.[5] The simplest solution consisted in arranging the joists between two parallel walls and installing filler boards (*ais d'entrevous**) above them to form the flooring of the upper storey (fig. 1.2a). It goes without saying that the joists were systematically installed along the width of the covered space to reduce the weight of the structure as much as possible. In the second solution, the floor beams, separated by several meters, were transversally placed to support longitudinal joists (fig. 1.2b). The third solution employed included a row of supplementary beams placed between the principal beams and the joists (fig. 1.2c).



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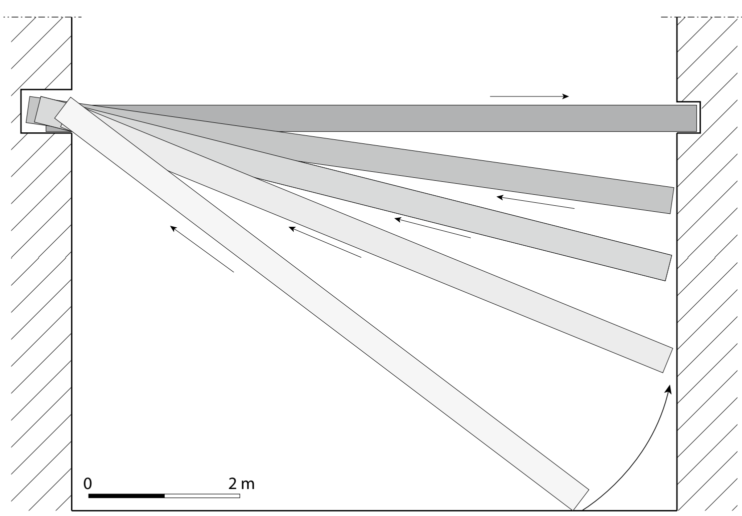


1.3

This intermediate row was installed along the length of the covered space while the first row of beams and joists were installed along its width.

The installation of these structures could occur at different times during the construction of a building. Laying the floor sometimes took place once the walls were built. Hoisting (*levage**) inside a completed building was naturally constrained by the beams, which were longer than the width available between the walls. It was therefore necessary to leave openings or cut beam pockets (*opes**) into the walls that were sufficiently deep to obliquely insert one end of the beam in one wall and bring it to horizontal by inserting the other end in the beam pocket on the opposing wall (fig. 1.3). So, to anchor a 30-cm wide beam into a wall, it was crucial to make a hole at least twice as deep and fairly open from above to allow the beam to be set straight. The partially demolished floor of the hexagonal room (no. 49) at the Château of Tarascon (1415-1435) is one of the rare examples showing this kind of installation (fig. 1.4). To seal the elements of the first or 'single' system, sufficiently large beam pockets were left in the walls by the masons so that the *fustiers* could manoeuvre and place the beams and joist supports (*linçoirs**) in their final positions. An installation of beams between two already built walls is found more frequently when the floors belonged to a reconstruction phase of a pre-existing building. This is the case for the floors of the Petit Palais in Avignon, ordered in 1457d[6] by Bishop Alain de Coëtivy for the renovation of the episcopal palace. Their installation

Fig. 1.2. Different systems of installing flooring (scale 1:100): a) Simple joist: single system; b) Superimposed rafters and joists: dual system; c) Two rows of superimposed rafters and joists: triple system.

Fig. 1.3. Principle of raising a rafter between two pre-existing walls (scale 1:100).

1.4

Fig. 1.4. Beam pockets in the walls built and largely open to allow later installation of the rafters. Hexagonal room (room no. 49), Château, Tarascon (department of the Vaucluse).

lower than they were originally led to the fastidious cutting of a multitude of deep beam pockets in order to properly raise and set the beams in the walls.

Apart from these restructuring phases, observation of the masonry around the beams suggests that the hoisting and installation of the floors most often occurred simultaneously with the building of the walls. This did not necessarily involve putting the entire structure in place, but raising and positioning the heaviest and most cumbersome elements. At the Palais Arnaud de Via in Villeneuve-lès-Avignon, for example, the continuity between the mortar for the stones and that used to seal the beams and their corbels shows that these flooring elements (1320-1330d)[7] were clearly installed at the same time as the walls. In the Papal Tower (1335-1337) in Avignon, the two rows of beams that were more than 10 m long were raised and installed at the same time as the walls. In this type of construction, the ends of the beams are generally deeply anchored into the masonry (30-40 cm) and their heights often coincide with the wall base of the upper storey.

Some artistic scenes of medieval construction sites illustrate the simultaneous installation of masonry and wood structures. The construction of the temple of Jerusalem, painted by Pesellino in the mid-15th century, for example, shows two workers in the process of building the walls while two others hoist and install the floor beams.[8] By following this procedure, it is undeniable that a beam, longer than the interior width of the buildings, could be manipulated above the walls and set in its final position much more easily. Written sources also evidence the co-activity of wood and stone crafts. Texts on the construction of the Pont in Avignon Tower clearly indicate that the floors were installed by the *fustiers*, storey by storey, with the walls built by the stonecutters/masons (*lapicides**) (Pansier, 1930: 5-29).

In sum, it can be seen that, regardless of when the beams were installed, the structure of the floors should be considered as a part of the structural construction work, requiring the intervention of many craftsmen, ropes, and perhaps hoisting engines to manipulate the heaviest elements. While this is part of the structural work, comparable to the building of the foundations, walls and roof, it remains true that the *fustiers* had to anticipate some final treatment before the raising and setting of the beams.

Preparation of surfaces

Thus, for all of the floors in which the structure played a role in the decoration of the covered space, the *fustiers* prepared elements prior to their installation in order to remove marks left by squaring (*équarrissage**) and sawing. Trace-wear analysis shows that to smooth (*blanchir**) the wood, they used a large smoothing plane (*rabot**). It also demonstrates that for the iron to bite more effectively, the blade on these large planes was quite often rounded. The specific use of the intermediate size of this tool, called a scrub plane (*riflard**), can be seen on the beams of the Livrée de Viviers in Avignon (1320-1330d)[9] for example (fig. 1.5). Here, as in most of the cases observed, the scrub plane left curved grooves overlapping in parallel along the grain of the wood. The curves are generally 50-60

1.5

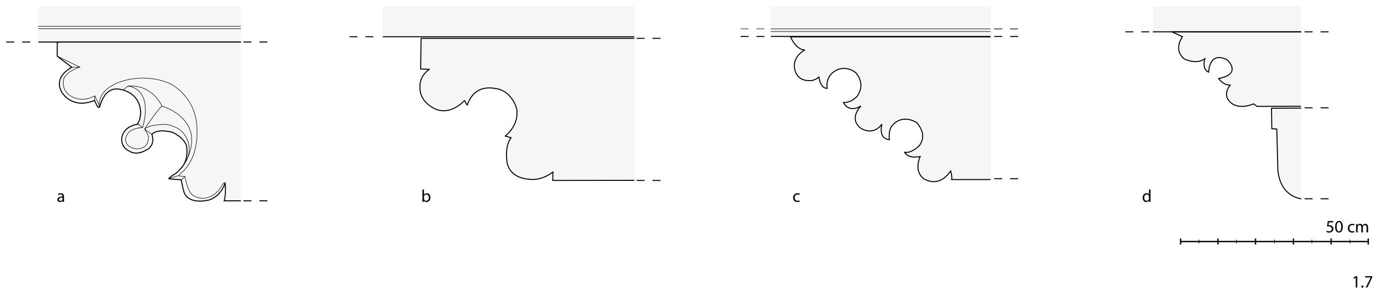
1.6

cm long depending on the reach of the *fustier*, or *fustiers* because these large planes could be used by two people at once. Finishing was obtained by the progressive removal of very fine wood shavings, sometime tearing the wood fibres, especially near knots. The craftsmen did not plane the sides of the pieces facing into the assembly. The filler boards, for example, were installed to hide their rough sawn side and to show the visibly smoothed side. This can also be seen on quadrangular elements with thick sections. If the carpenters privileged the finishing work of certain elements or ignored the sides of others, this was because they already knew, when the wood elements were being planed, where these elements would be placed when the structure was assembled. An exception, however: the bodies of mouldings were carefully planed on counterfaces so that they would fit perfectly with the flat surfaces of other pieces.

The final treatment of the surfaces did not remove, however, the wane (*flaches**) left by squaring or splitting the edges of the wood elements. These curved edges could negatively affect the aesthetics of some prestigious works. In a concern for detail, the *fustiers* had recourse to different solutions to correct or hide these defects. Such edges could simply be placed as the upper edges of the beams, keeping the squared parts most visible from the floor of the room covered. The wane could also be hidden behind mouldings or joint trimming (*closoirs**) attached to the upper edge of the beams. In some cases, the painters took advantage of it by outlining the wane in patterns as if they were bevels (*chanfreins**) where the colour would emphasise their presence. When these defects posed real problems for the finishing of the most delicate pieces, the *fustiers* added small pieces of wood to compensate for the curving due to the wane, creating perfectly sharp edges (fig. 1.6). These grafts were typically attached by one or two nails but, with time, could become separated from their support. Small repairs were also made where wood fibres had been torn due to the presence of a knot, probably during sawing. Instead of removing the detached wood piece, the craftsmen smoothed and nailed it again to hide the defect. The care given in the preparation of the surfaces of wood pieces is close to the work of joinery. Such attention to detail is even more marked in the construction of the moulded elements.

Fig. 1.5. Traces of planing visible on the lateral sides of a rafter. Livrée de Viviers, Avignon (department of the Bouches-du-Rhône).

Fig. 1.6. Repair of a waney ridge of a corbel. Livrée de Viviers, Avignon (department of the Bouches-du-Rhône).



Moulded decorations

In the early 15th century, wood corbels placed below the floor beams were the most finely crafted (fig. 1.1 and 1.7). Generally more developed than those of stone, they underline the beams for 30-50 cm in front of the perpendicular wall. They show quite elaborate moulding work, using a succession of tori and grooves (convex and concave mouldings). Trace-wear analysis indicates that making these shaped decorations at the ends of the corbels was done with two tools. The most common technique was to progressively hollow the wood with a chisel and gouge as seen, for example, in the concave striations left within the grooves of the corbels of the Livrée Ceccano in Avignon (1333-1335). More surprising are traces of sawing discovered inside overpassed grooves of the corbels of a beam (1360d)[10] at the Château of Le Thor (fig. 1.8). Here, the *fustiers* used a very narrow-bladed saw so that it could turn along the curve of the profile. These were probably striations left by a scroll saw with a handle equipped with a fine supple blade and held in a frame in the form of a U.

While 14th-century floors in the Rhodanian Midi were often supported on corbels with highly worked profiles, other elements were only slightly decorated. These understated mouldings appear in two forms: engraved directly onto the lower edge of beams and joists or added in the form of baguettes. For the first, the moulding work of large wood pieces took place before their installation; if not, the fact that the profile of the sealed beams in the walls extends into the masonry cannot be explained. Indeed, it is difficult to conceive of doing the moulding work after insertion, arms in the air, while it is much simpler to do it on the ground or on trestles. Work at heights would allow only minor changes to be made, such as adjusting or perfecting the alignment between the different moulded elements at the angles (fig. 1.9). For the second form, that of moulded baguettes inserted into the structures, examination of tool marks and systematic recording of their size show that they were cut in place during installation. This procedure allowed them to be adjusted according to the proportions of the beam and its irregularities. The baguettes were thus prepared in advance so the *fustiers* would have them available when needed at the construction site. The simplest have a bevelled profile. It is, for example, from two bevels that the trapezoidal section of the joint covers (*couvre-joints**), called *listel** or *listeaux** in 15th-century building contracts, was obtained (fig. 1.10). But based on the preserved remains, their use in this form is attested from the early 14th century. The *fustiers* made the joint covers with a drawknife (*plane**). This sharp cutting tool enabled removal of the two ridges of a baguette around 5 cm wide and 1.5 cm thick, previously cut with a saw. Once

Fig. 1.7. Sections of wood corbels. Flooring (scale 1:20). a) Livrée de Viviers, Avignon (department of the Bouches-du-Rhône); b) Palais Arnaud de Via, Villeneuve-lès-Avignon (department of the Gard); c) Palais de Boulogne, Villeneuve-lès-Avignon (department of the Gard); d) Château, Le Thor (department of the Vaucluse).

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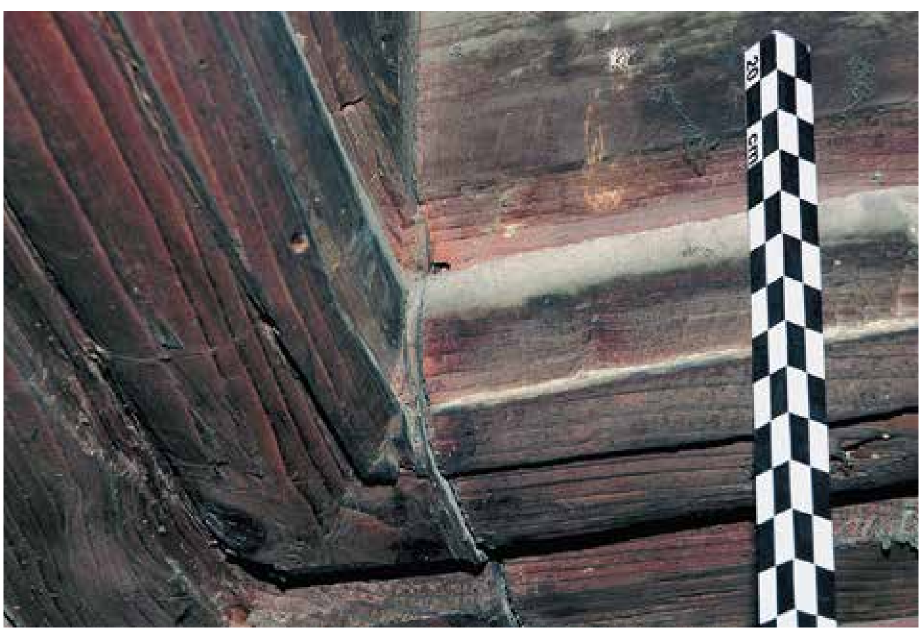

1.9

made, the joint cover was installed during assembly (*montage**) of the structure. These were positioned in notches chiselled into the upper angle of the joists to the junction with the filler boards, thus preventing dust and air currents from entering while ensuring a squared pattern between the joists.

From the second half of the 14th century, the joint cover system was elaborated by adding opposing joint covers (*contre couvre-joints**), also called false joint covers (fig. 1.11). These, placed at right angles to create a pattern of squares in the spaces between the joists, served only as decoration. They have a single bevelled edge. This profile allowed them to be set flat in the continuous

Fig. 1.8. Gouges made with a saw. Château, Le Thor (department of the Vaucluse).

Fig. 1.9. Small wooden wedge (slat) inserted at the junction of two moulded rafters. Hexagonal room (room no. 49), Château, Tarascon (department of the Vaucluse).

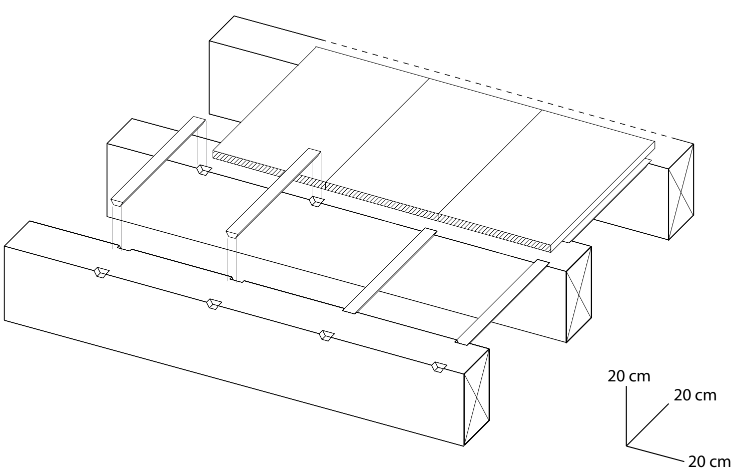

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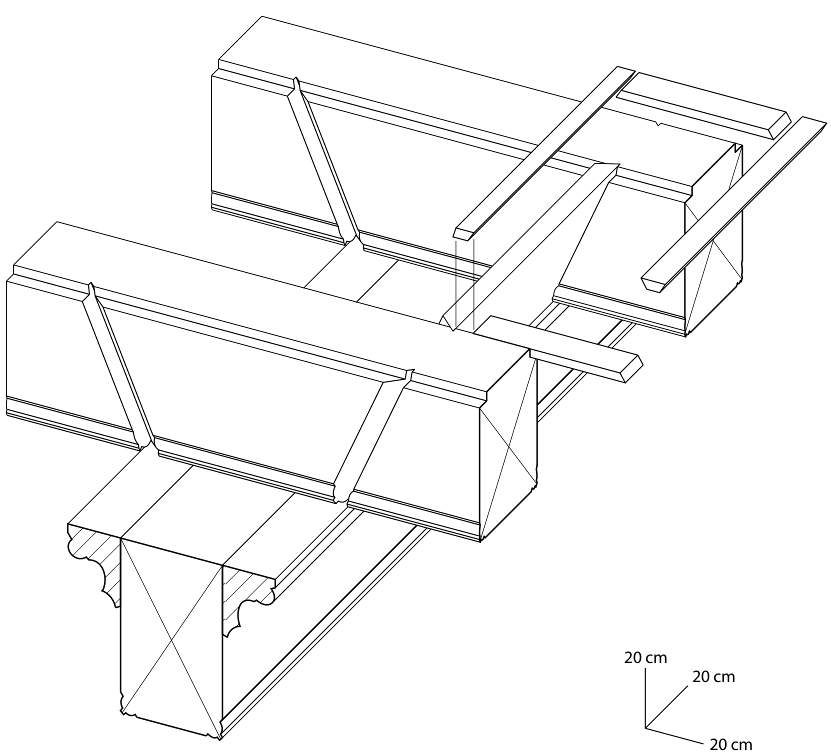
Fig. 1.10. Joint cover. Wardrobe, Palais des Papes, Avignon (department of the Bouches-du-Rhône) – Principle of assembly (scale 1:25).



1.11

Fig. 1.11. Joint cover and false joint cover. Room no. 16, Petit Palais, Avignon (department of the Bouches-du-Rhône) – Installation principle (scale 1:25).

grooves made in the upper angle of the joists and rafters. The *fustiers* made the grooves in the joists with a *guiomus* (Bernardi, 1995: 227). The shoulder plane (*guillaume**) has an iron blade the same width as the sole, allowing it to cut a groove at right angles. To our knowledge, the first structure with opposing joint covers is found under the roof frame of the Maison des Chevaliers in Pont-Saint-Esprit (1337-1342d).[11] Although common from the mid-14th century, this technique was not imposed; both solutions – simple joint cover or joint covers and false joint cover – were in use after 1350 and during the entire 15th century.

The bevelled section was also used for the first moulding elements nailed against the beams to retain the long joint trimming of triple-system floor. This assembly is observed, for example, at the Livrée de Viviers (1320-1325d) in Avignon (fig. 1.1 and 1.5) and the Palais de Boulogne (1334-1342) in Villeneuve-lès-Avignon on the opposite bank of the Rhône. At first, the inserted baguettes were not elaborate and were simple planks bevelled along their length. In the second half of the 14th century, the *fustiers* used these baguettes to move the joint trimming further from the beams by forming a sort of plank coffer. This system appears to have been applied for the first time for the floors at the Château of Le Thor (1360d) (fig. 1.12) and the cloister of the Cathédrale of Fréjus (1353-1368d).[12]

To decorate the beams and joists of the floors, the *fustiers* preferred the torus and bevel. This round moulding most commonly has an overpassed section, that is, greater than or equal to a half-circle. It first appears in the floor beams. The earliest example is observed at the Livrée de Viviers (1320-1325d). The proportions of the moulding were adapted to the size of the beams and the different levels of floor, with the section decreasing in size at each row. In the 14th century, the torus was not used to decorate all of the structures and remained of relatively discreet size (fig. 1.13a). It was particularly in the 15th century that it underwent development. Moreover, it is only after 1458 that the verb *bordonar*[13], meaning to make round mouldings, appears in written Provençal sources. This verb is the root of the term *bordonador*, used for a plane with a sole and a concave blade to make round profiles.

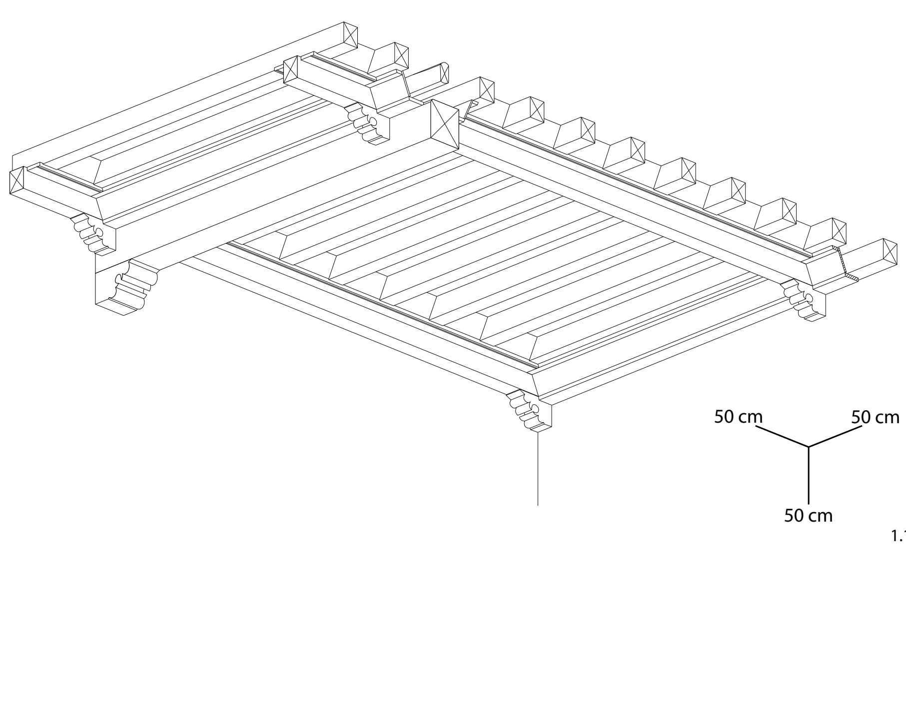
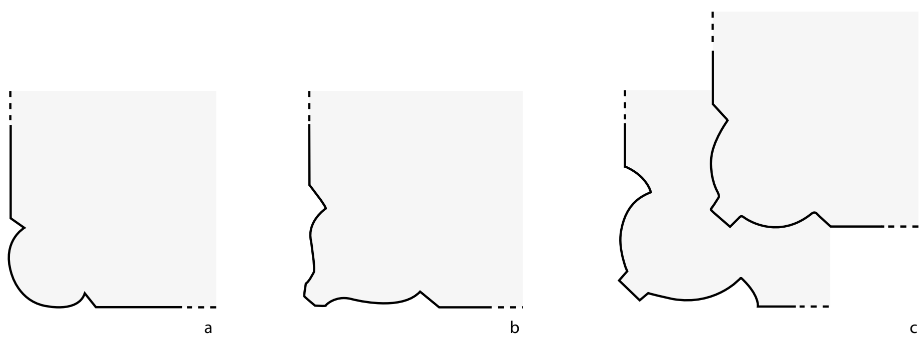


Fig. 1.12. Small bevelled plank allowing the joint trimming to be moved. Flooring (detail of a span), Château, Le Thor (department of the Vaucluse) (scale 1:75).



The *fustiers* rapidly refined the section of the torus by adding a joint cover. This new moulding is first seen in the roof frames, as shown by the lower edges of the tie-beams and rafters of the roof of the Collégiale of Roquemaure (1340-1350d)[14] (fig. 1.13b). Its contour, however, does not yet have the highly detailed section we later find on the beams of 15th century-ceilings, for example at the Château of Tarascon (1415-1435) and the Petit Palais (1447d) in Avignon (fig. 1.9 and 1.13c). To obtain this more precise outline, it appears that the craftsmen precisely engraved the section on the ends of the beams.

In the 15th century, the *fustiers* also developed the sections of the baguettes inserted in the flooring structure by combining a pattern of tori and grooves (fig. 1.11). It is moreover when such mouldings became more elaborate that we find them mentioned using the term *simas* in carpentry contracts for buildings; the earliest reference dates to 1398.[15] These panelling frames (*cimaises**) were also set and nailed against the beams. Sometimes, to emphasise the joists delimited by the beams or to border the entire ceiling, they formed a square against the walls. In this case, their junction was made by mitre joints (*en onglet**) or 'false' mitre joints (*faux onglet**). Small scratches were sometimes made on the beams to show where they were to be located. These frames were attached with nails or, more rarely, with pegs. The *fustiers* used them in particular as ornamental elements and to support the trimming that filled the space between the beams and the joists.

Partitioning the structures

To make the floor structures pleasing to look at and comfortable to live beneath, the *fustiers* partitioned the spaces formed by the organisation of different beam systems. Obviously, filler boards were installed on the joists to place the floor of the storey above, but planks were also laid on edge between the joists and beams to close the structure. Designated in the 14th century as *buget*[16] and today termed joint trimming (*closoir*)[17], this type of plank is typical of a certain number of southern roofs, known particularly for the painted motifs that very quickly attracted the attention of art historians.[18]

Fig. 1.13. Change in the torus section: a) simple: 1320d; b) at the inlay (1st stage): 1340-1350d; c) at the inlay (2nd stage): 1415-1450.

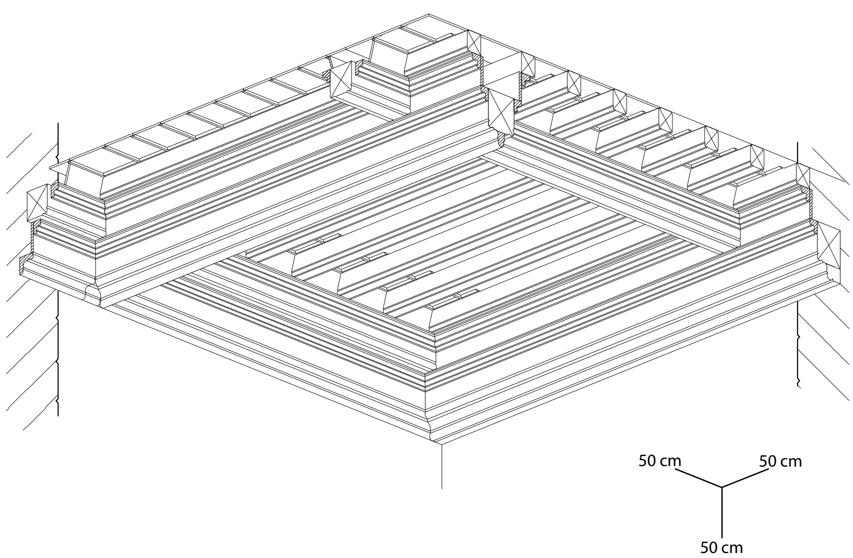
From 1.5 to 3 cm thick, these joint trimmings were short (c. 35 ± 5 cm) when found between joists and long (2.3-2.8 m) when placed between the secondary beams of triple-system floor (fig. 1.1 and 1.12). For both, the joint trimming installed on 14^{th}-century floors was always slightly inclined, between 65° and 70°. Based on the observed tool marks, they were cut from planks previously sawn either manually or mechanically. In anticipation of their installation, the *fustiers* sawed both ends in a bevel to slide them into triangular notches cut into their supports. Short joint trimmings were maintained by two notches cut in the lateral sides (*joues**) of the joists and posed on the secondary beams. Their upper edge is blocked against the first joint cover, installed in the space between the joists. They could also follow the length of the walls on panel frames nailed to the underside of the joists. Of course, long joint trimmings existed only in the triple-system floors since they filled the space between the secondary beams. Their lower edge is supported by the main beams and their upper edge against the sides of the joists.

Written sources remain uncommunicative regarding the function of the joint trimming, except that the medieval term *buget* is associated with partitioning (Bernardi, 2009: 61) and that it was a preferred support for painted decorations. It is probable that because *bugets* were very common in the elaboration of floorings, price quotes do not specify their usage. It is perhaps also because they filled several functions that building contracts did not mention one in particular. The first function is likely structural since they are part of the floor bracing. A second function is for comfort, since they prevented dust, noise and air currents to pass from the storey above. A final function is decorative since they concealed unsightly dark gaps caused by the overlapping or superimposition of the elements and were ideal supports for decoration, ingeniously multiplying the surfaces available to paint. It was additionally probably to increase their visibility that they were installed at angles between the joists and beams. Obviously, their number varied with the surface of the structure into which they were put; several hundred can be counted between the joists of the large rooms of 14^{th}-century palaces.

It would be incorrect to believe that the joint trimmings – pieces that were nearly accessories – could be installed in the floor structure at any point during its assembly. They had to be inserted into the notches prior to the installation of the filler boards, because this would then have definitively blocked access to the joists from the top of the structure. Their installation was also conditioned by the work of painters since they sometimes decorated the joint trimming before it was given to the *fustiers*. At the Petit Palais in Avignon, for example, Guillaume and Albéric Dombet, father and son, were required to complete in time the trimmings painted with the arms of Alain de Coëtivy so the craftsmen could include them in the ceilings.[19] This can also be seen from the archaeological evidence because when the trimmings were decorated in advance, thin painted surfaces are masked by their assembly at the junction with the joists.

The location of the joint trimming and their inclination were scratched onto the face of the joists with a point. Using these markers, the *fustiers* most often made the notches by obliquely sawing a few times to cut the wood fibres along the angle of the trimming. The excess wood material was removed with an axe struck parallel to the saw cuts. The notches were generally made in place, that is, directly on the already assembled structure. The placement of the trimming on their lower support sometimes necessitated adjustments with a chisel to set them perfectly in place without leaving gaps. Nails or reversed wooden wedges ensured their firm attachment.

Floors from the second half of the 14th century, and especially in the 15th century, show that *fustiers* combined joint trimming with panel frames to form a subtle pattern of partitioning on the structures. The combination of these two complementary elements without real structural function allowed the trimming from the face of the joists to be moved by 7 to 10 cm. The construction of these increasingly compartmentalised floors constitutes a stage in the development of coffered ceilings (*plafonds à caissons**). These were not yet true coffers, as the beams did not cross in a single plane but remained superimposed. However, that the coffer form was the intended goal is clear: the trimmings are no longer positioned at angles in the structure but vertically like the struts (*entretoises**). This stage can be seen in particular on the floors built for Pierre de Beauvau (1429-1435) at the Château of Tarascon (fig. 1.14). Here, the struts,



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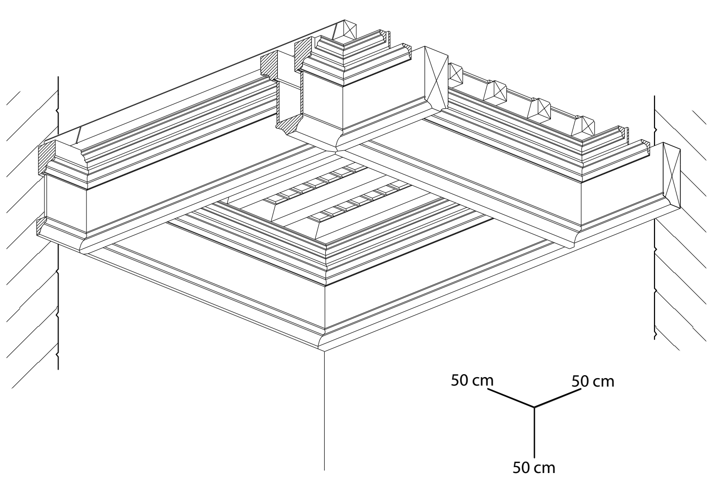

1.15

Fig. 1.14. Triple-system floor belonging to a coffered ceiling (detail). Chambre de Pierre de Beauvau (room no. 36), Château, Tarascon (department of the Vaucluse) (scale 1:75).

Fig. 1.15. Triple-system floor for which the first two rows are superimposed in plumb to form large coffers (detail). Maison, Rue du Bac, Arles (department of the Vaucluse) (scale 1:75).

installed along the length of the walls on the panel frames, aim to give the illusion that true beams abutting the walls bordered the ceiling on each side.

In the second half of the 15th century, these false beams (*fausses poutres* or *poutres menuisées**), visible along the walls, would be placed in the centre of the floor to orthogonally cross the support beams. The perfection of this system, imitating true beams, would ultimately enable the creation of coffered ceilings like those of the house on the Rue du Bac in Arles (fig. 1.15) and at the Palais du Roure in Avignon.

Conclusion

The investigation conducted of the medieval floors of the Rhodanian Midi demonstrates, with some exceptions, that the beams were installed at the same time as the walls and sealed with the same mortar. The construction of the floors was thus part of the structural work. In the 14th century, decoration of the ceilings – the undersurface of the floorings –, limited to the partitioning of the spaces between the joists by joint trimmings and the use of mouldings, can be considered part of the finishing work. However, these decorative elements (trimmings, joint covers, etc.) would have been installed before the filler boards for the floor of the upper storey and were also the responsibility of the *fustiers*. It was only in the second half of the 14th century, and especially the 15th century that it became possible for part of the ceiling to be installed after the structural work. This in particular involved the addition of elements such as moulded baguettes and false beams, placed first along the walls and then also in the centre of the floor, leading to coffered ceilings. The *fustiers* thus had a dual activity. They were responsible for installing the floor at the same time that the masons were building the walls. They also prepared the moulded baguettes in advance, perhaps in workshops, to be installed once the structure was assembled. Such finishing work became common in most constructions during the 15th century. It appears as the work of joiners rather than carpenters. It is, moreover, a few decades before the 16th century that apprenticeship contracts increasingly clearly differentiate carpentry (*fustaria*) from joinery (*minusaria*).[20]

Glossary of technical terms (*French* – English)

The definitions of technical terms proposed here are based on several publications: Baudry and Bozo, 1978; Bouticourt, 2014; Compagnons Passants Charpentiers du Devoir, 1980 (CPCD); d'Aviler, 1755; Jossier, 1881; Pérouse de Montclos, 1972. Some have been adapted to more exactly describe the wood elements specific to the floors in the south of France.

n. m. noun, masculine;
n. f. noun, feminine;
n. pl. noun, plural ;
v. verb.

Ais n. m. *Terme anciennement utilisé par les charpentiers pour désigner des planches* (CPCD).

Term formerly used by carpenters-joiners to designate planks (CPCD).

Ais d'entrevous n. m. *Planche destinée à clore l'espace entre les solives permettant de constituer l'aire qui supportera le sol des locaux. Les ais ou planches d'entrevous sont soit parallèles aux solives soit perpendiculaire*s (Bouticourt, 2014).

Filler boards. Planks to fill the space between joists in order to create the area that will support the floorings of the rooms. The filler boards are either parallel or perpendicular to the joists (Bouticourt, 2014).

Blanchir v. *Il s'agit d'enlever les traces de hache ou de scie de la surface des pièces de bois livrées brutes d'équarrissage pour leur donner un aspect plus net* (Bouticourt, 2014).

To smooth. To remove axe and saw marks from the surface of pieces of wood after squaring or rough trimming to give them a smoother finish (Bouticourt, 2014).

Caissons n. pl. *Compartiments creux d'un plafond formés par l'entrecroisement apparent des pièces de structure ou par une imitation de cet entrecroisement* (Pérouse de Montclos, 1972). ***Plafond à caissons.***

Caissons, coffers or **sunken panels**. Hollow compartments in a ceiling formed by the visible crossing of the structural elements or by an imitation of such crossing (Pérouse de Montclos, 1972). **Coffered ceiling**.

Chanfrein n. m. *Moulure plate, oblique par rapport aux pans voisins : c'est théoriquement le plat obtenu en abattant une arête* (Pérouse de Montclos, 1972).

Chamfer. Flat bevelled moulding, oblique to the adjacent planks: this is theoretically the flattened part obtained by removing a ridge (Pérouse de Montclos, 1972).

Cimaise n. f. *Pièce de bois moulurée qui, placée à environ 1 m de hauteur, forme le cadre d'un lambris* (CPCD). *Dans les charpentes méridionales, elle est clouée au sommet des poutres et sert d'appui aux closoirs placés dans l'entrevous des solives* (Bouticourt, 2014).

Panel frame. Piece of moulded wood that, placed about 1 m high, forms the frame of a wainscot (CPCD). In carpentry works from southern France, it is nailed at the top of the beams and serves as support for the joint trimming (*closoirs**) placed in the intervals between the joists (Bouticourt, 2014).

Closoir n. m. *(du latin* claudere *: fermer, clore) Type de cache moineaux que l'on place en contre-profil des matériaux de couverture, pour en clore les raccords avec le bardage* (CPCD). *Planchette placée de chant (légèrement inclinée) entre deux pièces contiguës de charpente (de toit ou de plancher). Il existe des closoirs courts et des closoirs longs. Les premiers sont les plus fréquents. On les observe entre les solives des planchers ou les chevrons des charpentes de toits. Ils s'observent aussi entre les pannes des charpentes à fermes et pannes. Les longs se rencontrent seulement dans les planchers à trois systèmes, c'est-à-dire à trois niveaux de poutres et de solives superposés orthogonalement. Ils se placent entre les poutres du deuxième système* (Bouticourt, 2014).

Joint trimming. A type of filler board that is placed in counter-profile to the roofing materials in order to conceal the joins of the cladding (CPCD: 36). Thin plank placed at a slight angle between two contiguous pieces of the carpentry work (roof frame or floor). Short and long trimming forms exist. The first are more common and are found between the floor joists or rafters of roof frames. They are also observed between the purlins of truss-and-purlin roof frames. The long form is found only in triple-system floors, that is, with three levels of beams and joists orthogonally superimposed. They are placed between the beams of the second system (Bouticourt, 2014).

Couvre-joint n. m. *Mince baguette de bois qui sert à couvrir l'interstice de deux planches juxtaposées comme les voliges, les ais d'entrevous, les lambris, etc.* ***Faux couvre-joint.*** *Mince baguette de même profil qu'un couvre joint mais ne couvrant aucun interstice. Sa fonction est seulement esthétique ; il peut être disposé en retour d'équerre d'un couvre-joint afin de compartimenter les entrevous des solives, des chevrons etc. On peut alors parler de* ***contre couvre-joint*** (Bouticourt, 2014).

Joint cover. Thin wood baguette that is used to cover the gap of two adjacent planks such as battens, filler boards, wainscot, etc. **False joint cover.** Thin baguette of the same profile as a joint cover but not covering an interstice. Its function is aesthetic only and can be placed opposite a joint cover to partition the intervals between joists, rafters, etc. These are also called **opposing cover joints** (Bouticourt, 2014).

Entretoise n. f. *Pièce de bois que l'on assemble ou que l'on cloue entre deux autres, pour maintenir leur écartement, les raidir et les empêcher de gauchir* (CPCD). *Les entretoises peuvent être utilisées pour réaliser de fausses poutres placées le long de murs ou au centre de la structure afin de réaliser des caissons avec les poutres massives* (Bouticourt, 2014).

Strut. Piece of wood that is assembled or nailed between two others to maintain their separation, strengthen them and prevent them from warping (CPCD). Struts can be used to create false beams placed along the walls or in the middle of the structure in order to create coffers with the massive rafters (Bouticourt, 2014).

Entrevous n. m. *Intervalle entre les solives d'un plancher ou les poteaux d'une cloison, qu'on remplit de maçonnerie ou qu'on couvre seulement d'un enduit sur lattes* (Jossier, 1881). *Espace compris entre deux pièces de bois consécutives* (CPCD).

Term referring to the interval between floor joists or wall posts that is filled with masonry or only by laths and plaster (Jossier, 1881). Space or gap between two consecutive pieces of wood (CPCD).

Équarrir v. *Donner une forme carrée ou rectangulaire à une grume en sciant les dosses ou en les autant progressivement à l'aide d'une hache* (Bouticourt, 2014). ***Équarrissement n. m.*** *C'est la réduction d'une pièce de bois en grume à la forme carrée, en ôtant les quatre dosses flaches ; ce qui peut faire un déchet à peu près de la moitié de la grosseur (*d'Aviler, 1755). ***Équarrissage n. m.*** *Grosseur du bois équarri. Pièce de faible ou de fort équarrissage* (Pérouse de Montclos, 1972). *Le terme équarrissage est aussi employé aujourd'hui pour désigner l'action de tailler une bille de bois, etc.* (Bouticourt, 2014).

To square. To give a squared or rectangular section to a timber by sawing it along its length on four sides or to do so progressively using an axe (Bouticourt, 2014). **Squaring.** Action of roughly cutting a timber to create a squared section by removing the four waney slabs; this can waste nearly half of its diameter (d'Aviler, 1755). Can also refer to the result, and the relative degree of squaring of a timber ('Element of rough or marked squaring', Pérouse de Montclos, 1972).

Feuillet, n. m. *Planche mince utilisée pour divers travaux […] les feuillets ont 8, 10, 12, 18, ou 22 mm d'épaisseur* (CPCD). *On emploie le terme feuillet pour designer les couvre-joints de quelques millimètres d'épaisseur (de 2 à 5 mm) posés à plat sur les solives pour obstruer le raccord entre les ais d'entrevous. On en trouve des exemples dans l'Aude à partir du XIII^e^ siècle* (Bouticourt, 2014).

Slat. Thin plank for various uses […] 'thin planks are 8, 10, 12, 18 or 22 mm thick' (CPCD). The term is used to designate the joint covers of a few mm thick (2-5 mm) laid flat on the joists to block the abutments between the filler boards. We find example in the Aude from the 13th century (Bouticourt, 2014).

Flache n. f. *Dépression à la surface d'un plateau, ou arrondi d'une arête, provenant d'un tronc d'arbre dont les déformations n'ont pas pu être enlevées totalement, lors du débit. Dans le Larousse, ce mot est du genre féminin, mais les professionnels l'emploient au masculin et disent, par exemple : 'le flache des arbalétriers s'oriente toujours en tête'* (CPCD).

Wane. Depression on the surface of a side, or curvature of an edge, from a tree trunk for which the deformations could not be entirely removed during sawing. In the Larousse dictionary, for example: 'the wane of the rafters is always oriented upwards' (CPCD).

Fustier n. m. *Charpentier, menuisier, artisan travaillant le bois* (Bouticourt, 2014).
This medieval French term designates different persons who worked wood (carpenters, joiners) (Bouticourt, 2014).

Guillaume n. m. *Outil à fût étroit, sans contre-fer et à lumière latérale, ayant environ 30 cm de longueur et 8 à 10 cm de hauteur, et dont l'épaisseur variable n'excède pas 3 cm : 'le guillaume sert à pousser des feuillures à angle droit'* (CPCD).

Shoulder plane. Tool with a narrow shaft without a counter-iron, with a lateral mouth, around 30 cm long and 8-10 cm high with a variable thickness not exceeding 3 cm: 'the shoulder plane serves to create rebates at a right angle' (CPCD). An iron blade set in a sole having the same width as the sole, allowing it to cut right angles.

Joue n. f. *Chacune des faces des solives qui délimitent leur entrevous (*CPCD). ***Joug de solive.*** *Nom qu'on donne aux côtés des solives, considérés par l'entrevous* (d'Aviler, 1755).

Joist side. Each of the sides of the joists that delimit the open interval between them (CPCD) (called *joue* in French, *joug* in old French after D'Aviler, 1755).

Lapicide n.m. *(du latin* lapicida*) Maçon, tailleur de pierre.*

Mason, stonecutter.

Levage n. m. *Terme de charpenterie. C'est l'élévation ou le transport du bois de l'atelier sur le tas* (d'Aviler, 1755). *Elévation et mise en place des gros ouvrages de charpenterie dans les constructions. Les ouvriers disent aller au levage* (Jossier, 1881).

Hoisting. Carpentry term. The raising or transport of wood from the workshop to the place it will be installed (d'Aviler, 1755). Lifting and installation of large carpentry structures in building sites. Workers say 'going to hoist' (Jossier, 1881).

Linçoir n. m. *Pièce de bois placée à 5 ou 10 cm d'un mur, parallèlement à celui-ci, en un endroit où les solives ne peuvent venir en scellement dans le mur, et destinée à les supporter* (CPCD).

Joist support. Piece of wood placed 5 or 10 cm from a wall, parallel to it, in a place where the joists could not be sealed in the wall, serving as supports (CPCD).

Listel n. m. *Petite moulure carrée et unie, qui couronne ou accompagne une autre moulure plus grande, ou qui sépare les cannelures d'une colonne, d'un pilastre, ou bien encore qui est rapportée sur un champ uni. Petits morceaux de bois employés en menuiserie pour former encadrement, moulure ou rebord. On dit au pluriel 'listeaux'* (Jossier, 1881).

Listel. Small squared joined moulding that crowns or accompanies another larger moulding, or that separates the grooves of a column or pilaster or also that which is attached onto a flat surface. Small pieces of wood used in joinery to form a frame, moulding or ledge (Jossier, 1881).

Monter v. act. *C'est en maçonnerie, élever avec des machines des matériaux préparés du chantier sur le tas. En charpenterie et en menuiserie, c'est assembler des ouvrages préparés, et les poser en place* (d'Aviler, 1755). ***Remonter****, c'est rassembler les pièces de quelque machine, ou de quelque vieux comble ou pan de bois, dont on fait resservir les pièces* (d'Aviler, 1755). ***Montage n.m.*** *est l'action de monter (et le résultat).*

To assemble. In masonry, it is to lift with machines the prepared materials from the work site. In carpentry and joinery, it refers to assembling the prepared structures and installing them in place (d'Aviler, 1755). **To reassemble** is to put together and reuse the pieces from old machines, attics or timber frames (d'Aviler, 1755). **Assembly** is the action (and the result).

Onglet n. m. *En menuiserie, extrémité d'une planche, d'une moulure qui, au lieu de se terminer à angle droit, forme un angle de 45°. Couper, tailler d'onglet.* ***Faux onglet****. Extrémité coupée entre 45° et 90°.* ***Assemblage à onglet ou en onglet****, celui des pièces qui sont coupées diagonalement ou en triangle (…)* (d'Aviler, 1755).

Mitre joint. In joinery, the end of a plank or moulding that instead of terminating in a right angle forms a 45° angle. **'False' mitre joint.** A joint between 45° and 90°. To cut or create a mitre joint. **Mitred assembly**, that of pieces that are cut diagonally or in triangular section (...) (d'Aviler, 1755).

Opes s. m. pl. *Terme servant à désigner les trous qui reçoivent les poutres, les chevrons, les solives, dans les murs d'une construction, et même les trous disposés pour l'assiette des boulins de l'échafaudage* (Jossier, 1881).

Beam pockets. Terms designating the holes into which beams, rafters and joists were inserted into the building walls, and even the holes created to hold the scaffolding (Jossier, 1881).

Plafond n. m. *Surface plane et généralement horizontale qui, dans la construction, forme la partie supérieure d'un lieu couvert.* ***Plafond à la française.*** *Plafond composé de solives apparentes, généralement en chêne de section carrée ou rectangulaire, et régulièrement espacées d'une distance égale à leur épaisseur. Ces solives peuvent être peintes et/ou moulurées* (CPCD).

Ceiling. Flat and generally horizontal surface which, in buildings, forms the upper part of a covered place. **French-style ceiling.** Ceiling composed of visible joists, generally of oak with square or rectangular sections, regularly spaced at distances equal to their thickness. These joists can be painted and/or moulded (CPCD).

Plancher f. m. *'On pose des solives appuyées sur les murs, et sur elles on cloue des planches minces des deux côtés, afin d'empêcher qu'en se tourmentant elles ne s'élèvent par les bords : on couvre ces planches de fougère, ou de paille, pour les garantir de la chaux qui les gâterait ; après quoi on met une couche de grosse maçonnerie, composée d'une partie de chaux* […]' (d'Aviler, 1755). *Un plancher peut être à un système lorsqu'il ne comporte qu'un niveau de solives à deux lorsqu'il comprend un rang de poutres pour soulager le solivage et enfin un plancher peut être à trois systèmes lorsque les deux niveaux de poutres se superposent pour soutenir le solivage (Bouticourt, 2014).*

Floor. 'One places the joists against the walls and on them one nails thin planks on both sides to prevent warping: these planks are covered with bracken or hay to protect them from the lime that could damage them; afterwards one adds a coarse masonry layer composed in part of lime […]' (d'Aviler, 1755). Floor is a single floor system when it has only one row of joists, a dual system when it includes a row of beams to support the joists and a triple system when the two rows of beams are superimposed to support the joists (Bouticourt, 2014).

Plane n. f. *Outil composé d'une lame tranchante munie de deux poignées* (Baudry and Bozo, 1978) *utilisé pour aplanir, amincir ou lisser/corroyer une surface de bois.*

Drawknife. Tool composed of a sharp blade with two handles (Baudry and Bozo, 1978) used to flatten, thin or smooth a wood surface.

Poutre n. f. *Pièce de charpente d'un fort équarrissage qui, dans un bâtiment, sert à porter les travées d'un plancher, et dont il est fait usage dans un grand nombre de constructions* (Jossier, 1881).

Beam. Well-squared carpentry element that, in a building, serves to support the spans of a floor, thus common in many buildings (Jossier, 1881).

Poutre menuisée ou fausse poutre. *Poutre creuse formée par deux planches (entretoises) posées de chant et fermées en sous-face par un corps de moulure* (Bouticourt, 2014).

False beam. Hollow beam formed by two planks (struts) posed at angles and closed on the undersurface by a moulding element (Bouticourt, 2014).

Rabot n. m. *Outil à fût utilisé pour corroyer une pièce de bois. Le rabot se compose d'un fût percé d'un trou appelé lumière dans lequel passent le fer et le contrefer serré par un coin placé à 1 mm du tranchant. Les rabots en bois durs sont munis d'une poignée et servent à planer le bois. Le rabot ne diffère de la varlope et du riflard que par ses dimensions : il ne dépasse pas 25 cm de long. Le rabot peut avoir un fer bretté* (Baudry and Bozo, 1978).

Smoothing plane. Bladed tool used to smooth a piece of wood. The plane is composed of a wooden sole perforated with a hole called the mouth through which the iron passes and the counter-iron tightened by a wedge placed 1 mm from the cutting edge. Hardwood planes have a handle and are used to smooth the wood. A smoothing plane differs from the jointer plane and the scrub plane only by its size: it is not longer than 25 cm. The plane may have a striated iron (Baudry and Bozo, 1978).

Riflard n. m. *Outil à fût muni d'une poignée qui sert à dégrossir le bois et dont les dimensions sont intermédiaires entre celles du rabot et celles de la varlope (de 55 à 60 cm de longueur). Le tranchant du fer du riflard est généralement semi-circulaire* (Baudry and Bozo, 1978).

Scrub plane. Bladed tool set in a sole having a handle used to remove large amounts of wood to smooth a surface. Its dimensions are intermediate between a smoothing plane and a jointer plane (55-60 cm long). The edge of the iron is generally semi-circular (Baudry and Bozo, 1978).

Solive n. f. *Les solives sont les pièces horizontales d'un plancher posées à distances régulières les unes des autres, sur lesquelles on établit l'aire du parquet, du carrelage, etc.* (Pérouse de Montclos, 1972).

Joist. Joists are horizontal elements of floor placed equal distances apart on which the parquet, tiling, etc. is installed (Pérouse de Montclos, 1972).

Notes

1 See the definitions of floor and ceilings proposed in the *Principes d'analyse scientifique* devoted to architecture. In this reference work, the floor is considered 'the structure separating the stories of a building' and the ceiling its 'lower flat and unobstructed surface', that is, the upper limit of a covered space (Pérouse de Montclos, 1972: 139, 275).

2 Author's translation of: '*sol sur lequel on marche […] que de ce qui est sur la tête*'. In the *Dictionnaire de Trévoux* it is also noted that the 'ceilings are made to hide the beams and joists'.

3 The study in question was the focus of my doctoral research (Bouticourt, 2014).

4 Medieval written sources also support this argument. Most of the data come from the *Ligna* working group. This programme is directed by Philippe Bernardi, Anna Boato and Jean Domenge, and includes LAMOP, the Laboratorio di Archeologia dell'Architettura del Dipartimento di Scienze, perpendicularly the Architettura of the University of Genova and the Department of Art History of the University of Barcelona. Its goal is to create a dictionary of the vocabulary of ancient carpenters of the Mediterranean.

5 The most common species of wood used are fir, larch and spruce. They come from the Alps and were transported along the Rhone and its tributaries (Bouticourt, 2014: 63-105).

6 See the dendrochronological report, F. Guibal (CNRS/IMBE) *in:* Bouticourt, 2014: 633.

7 See the dendrochronological report, F. Guibal (CNRS/IMBE) *in:* Bouticourt, 2014: 838.

8 See the reproduction proposed *in:* Binding, 2001: 49.

9 See the dendrochronological report, F. Guibal (CNRS/IMBE) *in:* Bouticourt, 2014: 597.

10 Dendrochronological analysis, F. Guibal (CNRS/IMBE) *in:* Bouticourt, 2014: 127.

11 Dendrochronological analysis, Archéolabs 1990.

12 Dendrochronological analysis, F. Guibal (CNRS/IMBE) 1990.

13 From the dictionary of Pansier (1927): '*bordonar* (1473) *v. faire les moulures aux solives*'. Although used most frequently in the Latinized form *bordonare*, this verb appears to be Provençal and formed from the word *bordon* (derived from the Latin *burdo*) designating a baton and, in this specific case, a moulding in the form of a baton, a kind of torus. The act of *bordonar* would correspond to decorating wood moulding elements of torus form. It is, however, in its past participle form, used as an adjective, that we encounter the term. Definition extracted from the *Ligna* research programme.

14 Dendrochronological analysis, F. Guibal (CNRS/IMBE) *in:* Bouticourt, 2014: 713.

15 Avignon, Eglise Saint-Agricol: Archives départementales, fonds de l'hôpital, Aumônes de la Fusterie, E 10, fol. 78.

16 The term *buget* appears in 1365 in the written sources inventoried by the *Ligna* research group (AC Marseille: BB 25, fol. 59 - 209).

17 In the *Glossaire du charpentier*, the Compagnons define the term *closoir* or *clausoir* as a '*type de cache moineaux que l'on place en contre-profil des matériaux de couverture, pour en clore les raccords avec le bardage*' (Compagnons Passants Charpentiers du Devoir, 1980: 36). In the volume *Les plafonds et les planchers*, published ten years later, the authors use the term *closoir* to designate the planks between the joists and beams (Compagnons Passants Charpentiers du Devoir, 1990: 16).

18 See, for example, the publication of Bruguier-Roure, 1886: 309-352.

19 See the prices (*prix-faits*) *in*: Pansier, 1931: 100-101 and Bernardi, 2011: 158-159.

20 On this topic, see the example of Aix-en-Provence *in*: Bernardi, 1995: 25.

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Summary

Medieval buildings in the Rhone region in the south of France contain many floors dated to the 14th and 15th centuries. The inventory includes entirely preserved works as well as others that are partly or completely damaged. Based on the archaeological study of several floor systems and their lower surface (the ceiling), this article presents an overview of the skills of the wood craftsmen termed *fustiers** responsible for building these wooden structures. It will be shown that in the 14th century the practice of this craft required mastery of both the structural construction work and the installation of the most fragile joinery prepared in advance. Finishing work is seen in particular underneath the 15th-century floors with the increase in the number of moulded elements attached to their undersurface. The use of these finished pieces was a solution applied by the craftsmen to respond to changes in architectural forms and also evidences the diversification of their activities.

2.1

2

Structural timber in 15^{th}- and 16^{th}-century town houses in 's-Hertogenbosch (The Netherlands): Recent research on supporting structures

Maarten W. Enderman[1]

Key words
Carpentry / Building trends / Timber frame / Dovetail joists / Representative supporting structures

Introduction

The municipality of 's-Hertogenbosch has employed a building historian since 1975 to research the history of structures scheduled for alteration or demolition. In most cases, such research focuses on domestic properties in the historic town centre. After a series of publications during the 1980s and 1990s and a doctoral thesis by van Drunen in 2001 (van Drunen, 1990; van Drunen, 2006; Boekwijt, 1999), research on the 15^{th}- and 16^{th}- century houses typical of 's-Hertogenbosch appeared to have run its course. By then it had been established that this type of building, built at right angles to the street, usually included a ground floor, an upper floor and a gabled roof, and divided into a front part directly attached to a rear part over a cellar (fig. 2.1 and 2.2). To the rear of the front part, and separated from it by a brick or timber-framed partition wall, there was a partial floor below which the 'inside hearth' was located, actually a room used for cooking and other domestic activities. The supporting structure consisted of compound floors (crossbeams supporting smaller joists) forming part of a lightweight oak timber frame that did not support the side walls. Like the stairs, the fireplaces were usually located against the wall separating the front and rear parts of the house.

Recent research in the past five years has revealed that the existing interpretation of these houses needed to be adjusted on several points, and that this type of house is more diverse. This raises new questions about previous structural

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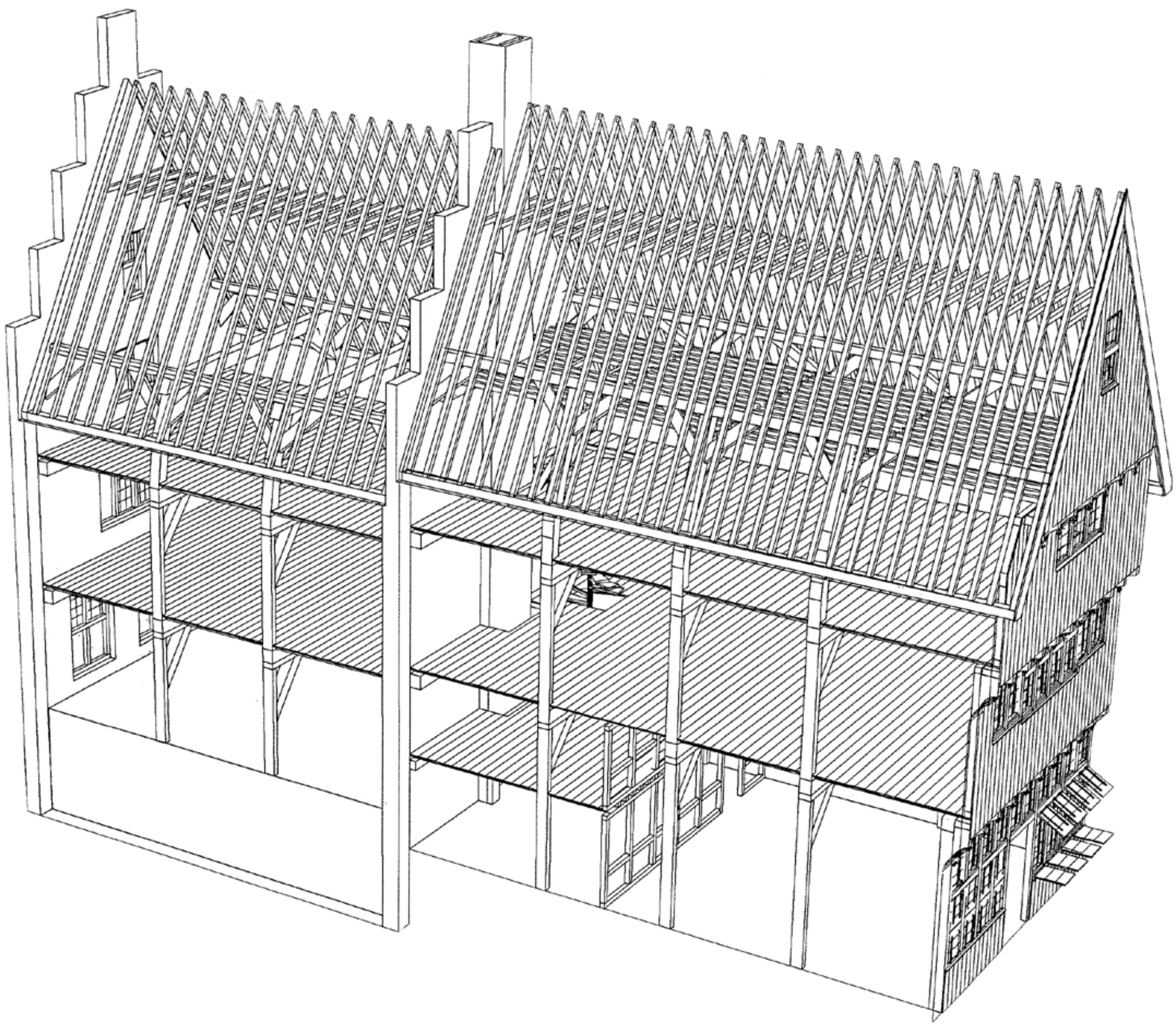
Fig. 2.1. The house 'Het Fransche Kabinet' at Kerkstraat 73-75 a few years before the wooden facade from c. 1472 was demolished in 1878. Image: courtesy of the City Archive of 's-Hertogenbosch



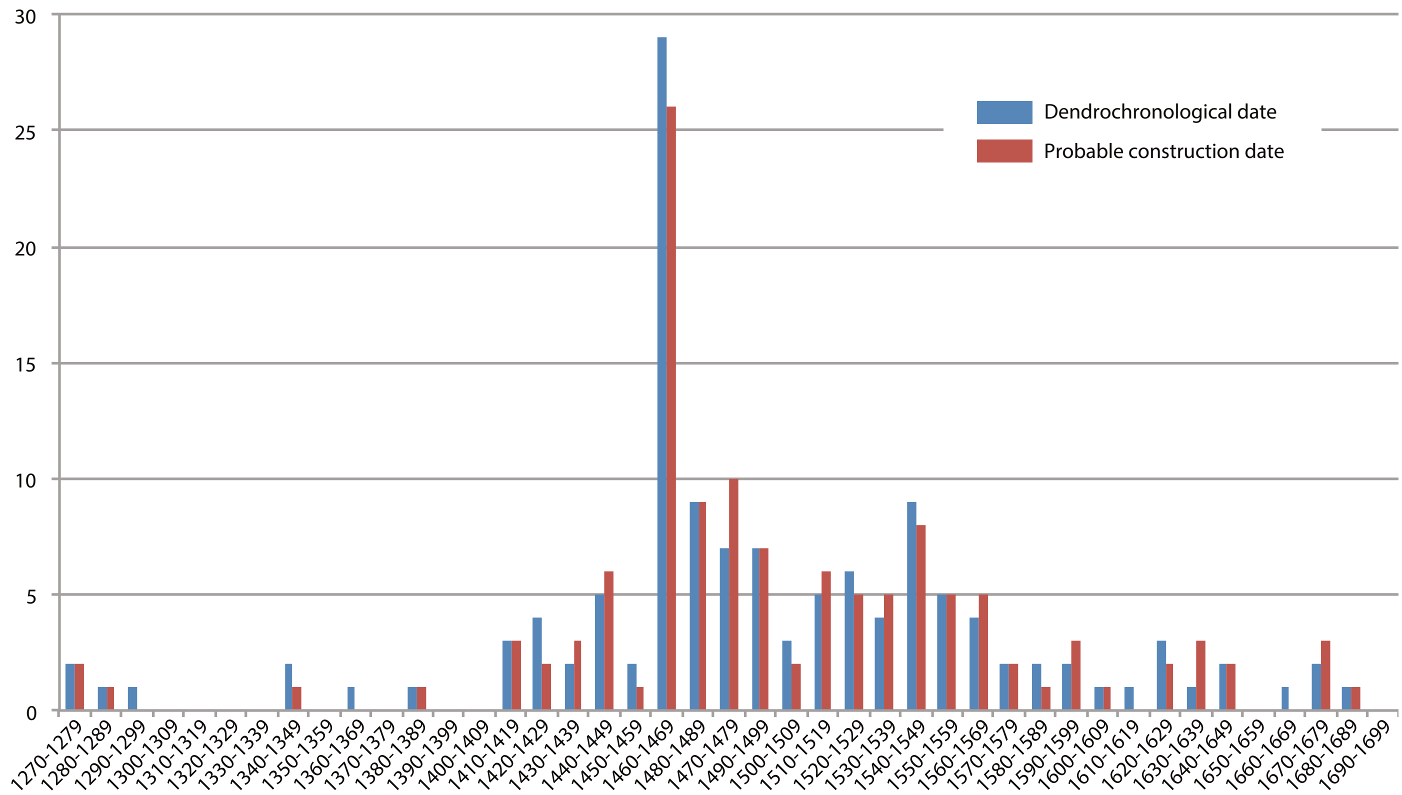
2.2

considerations. As part of this continuing research effort, a survey was launched to catalogue existing supporting structures and their properties. The dendrochronological dating of 134 houses enables us not only to describe structural details as phenomena *per se*, but also to place them within a chronological context and to reveal practices in construction largely unexplored until now.

Dendrochronology and building trends

Between 1991 and June 2014 a total of 1058 timber samples were collected from 192 buildings in the historic town centre of 's-Hertogenbosch. Of these, 659 samples yielded a result, allowing single or multiple dates to be attributed to 169 houses.[1] For 35 cases, only a *terminus post quem* could be established. In

Fig. 2.2. A typical example of 15th- and 16th-century houses found in 's-Hertogenbosch. Image: Municipality of 's-Hertogenbosch SO/BAM



2.3

the remaining 134 results, two years were added to arrive at the probable construction date of the house, taking into account the time spent to transport and process the timber (de Vries, 1994: 26) (fig. 2.3).

The dating of these houses provides an indication of building activities in the town between 1400 and 1600. The timber analysis yields little reliable information for the first two centuries after the town was granted its charter sometime around 1190. For instance, only two buildings yielded dates in the last quarter of the 13th century that can be attributed with any certainty to initial construction or a major conversion.[2] What little timber that was dated to the 14th century had been reused later, and in only a few cases may have been part of the original house itself. The lack of 14th-century timber is remarkable, as the town prospered during this time, increasing its area more than 13-fold. Further, historical building research regularly finds masonry from this period, showing that the number of brick-built houses in the town must already have been considerable at the time.

The lack of 14th-century timber may in part be explained as the result of two major fires, first in 1419 and again in 1463 (fig. 2.4). The survey dates might lead one to conclude that the impact of the second fire far exceeded that of the first. However, the extent of the fires appears to have been similar. The larger number of newly built houses after 1463 was in fact the result of municipal policy. Almost immediately after the second fire, regulations were introduced to promote reconstruction. In addition, house owners were given ten years to replace thatch with hard roofing materials (Vink, 2013: 21-23). To facilitate this process, grants were provided to alleviate the cost of slate or tiles. Surviving accounts

Fig. 2.3. Frequencies of dendrochronologically dated houses by decade up to 1700, showing the timber's dendrochronological date in blue, and in red the probable construction time of the houses two years later.

2.4

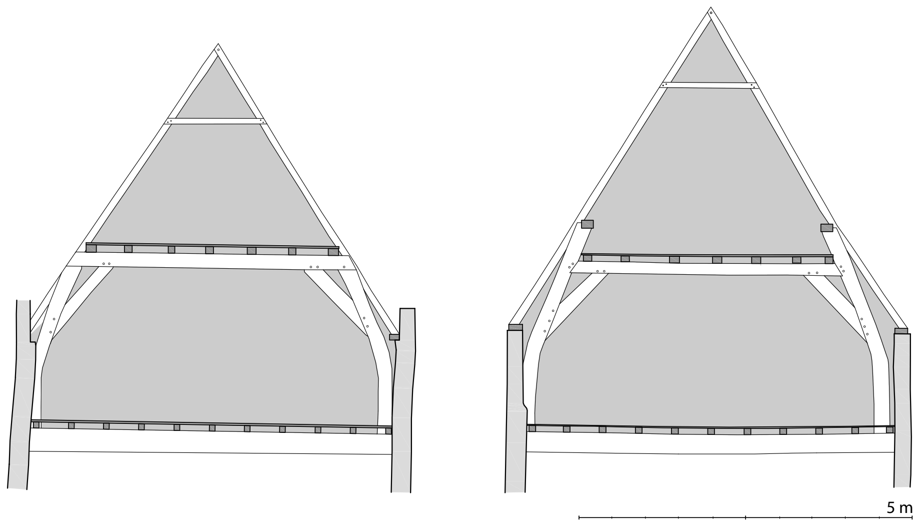
Fig. 2.4. A 1545 map of 's-Hertogenbosch by Jacob van Deventer, with the areas affected by the great fires of 1419 and 1463 superimposed in colour. Map: Albert I Royal Library, Brussels, adapted by the author

of the time show that at 85% the more expensive but also more representative slate was by far the more popular option (van Oosten, 2014: 189; de Vries, 1994: 80). Although roof tiles are almost twice as heavy as slate, this difference seems to have had no impact on the type, size and construction method of the roof.

In addition to the number of successfully dated houses, other factors exist to indicate the scope and rate of reconstruction work. For example, many of the houses built shortly after 1463 used timber that had been felled some ten years before or even earlier. This is remarkable as construction timber was generally used within a few years of felling. This means that a supply of timber must have been available to cope with the sudden demand.[3]

The exceptional demand for timber is also revealed by the fact that some samples indicate origins from as far as Normandy while most wood typically comes from the more local surrounding regions. It would also have taken a considerable number of carpenters to process all of the timber. The lack of sufficient skilled labour within the town itself, attracting reinforcements from the Lower Rhine and Meuse regions, may be deduced from the introduction of a hitherto unknown type of roof construction using link-beam trusses (fig. 2.5).[4]

It is doubtful whether the town's authorities actually managed to achieve their aims within ten years. As the grant system came to an end in 1474, house construction reached a turning point. Even so, the dendrochronological dates show that new houses were still being built in the area devastated by the fire. However, this was followed by economic recession and, in 1492, a new war with the Duchy of Guelders that resulted in a low point in the first decade of the 16$^{\text{th}}$ century. At the same time, as revealed by five hearth counts held between 1464 and 1526 for taxation purposes, the town's population almost doubled (van Oosten, 2014: 307). It is possible that many of the so-called rooming houses were built during this period, a type of rented accommodation for the poor in alleys and back streets. Today these houses have practically disappeared in 's-Hertogenbosch. On the other hand, still existing larger houses may have been used differently, a possibility that cannot be verified from the surviving building structure.



2.5

The subsequent increase in house production, a trend beginning in the second decade of the 16th century and continuing for the next 50 years or so, could be construed as a response to a recovering economy and improved political stability. Following the ransacking of ecclesiastical buildings in 1566 that ushered in the Eighty Years' War, social unrest and religious upheaval in the town meant that the population waxed and waned, reaching its nadir at the start of the 17th century (Kuijer, 2000: 544-545). Such change appears to be echoed in the number of houses built, although it should be noted that dendrochronological analysis of 17th-century houses (built at the time with softwood instead of oak) remains limited. In addition, the 17th-century houses are often straightforward to date on the basis of decorative elements. The frequent occurrence of such distinguishing features indicates that much house reconstruction and alteration work took place, in particular after the siege of the town in 1629. Of course, the grant system introduced to promote the replacement of timber facades with brick structures may also have played a role.

Timber from nearby and from far afield

The reference chronologies used for the dendrochronological dating of the structures give an indication of the provenance of the oak timber used in the centuries.[5] Generally speaking, we can distinguish three regions in modern Germany, three in the Netherlands, one in Belgium [15th-17th], and one in France.

Based on the proportions in which the various regions supplied the timber over a succession of 25-year intervals, the general impression is one of the growth and decline of timber trade flows (fig. 2.6). None of the regions shows a constant market share throughout the period. With regard to the timber imported from north-west Germany, the market decrease towards the end of the 15th century and the increase in the second half of the 16th century are borne out by historical research (Vink, 1993: 136; Weststrate, 2008: 144, 209). From

Fig. 2.5. A cap-beam truss (left) and a link-beam truss (right) used in the same house at Hinthamerstraat 119. Drawing: G. Korenberg

the 17th century onwards, most of the structural oak came from this region. The earlier decline in its use may have been compensated by using timber from further upriver in Germany or from the eastern part of the Netherlands.

The increasing use of German timber in the 16th century more or less coincides with decreasing use of timber from Brabant, the eastern Netherlands and eastern Belgium. The latter, transported via the Meuse River, accounts on average for some 12% throughout the 15th century, making the contribution during the first quarter of the 16th century, more than triple of this percentage, stand out all the more. This would appear to be correlated with a proportional decline in the use of timber from Brabant. Although it is impossible to be certain, we cannot rule out the possibility that hostilities between Brabant and Guelders were the cause of this.

The large proportion of timber from Brabant used during the 15th and 16th centuries may be linked to freedom from timber tax granted in 1356 (Spierings, 1984: 39). It remains unclear what may have caused the peaks occurring during the last quarter of the 15th and the second quarter of the 16th century. These were perhaps a reaction to insufficient supplies from other sources. It is still unknown to what extent cost may have played a role in favouring some timber sources over others, or indeed with regard to other fluctuations in timber supplies. The gradual decrease of structural timber from Brabant relative to German timber in the second half of the 16th century, and its near disappearance in the 17th century, may probably be attributed to the hostilities that affected the region at the time.

Until the 17th century, timber brought in from the eastern Netherlands accounts on average for about 14% of the total volume, with a peak during the reconstruction period following the second great fire. This may be associated with the relatively short transport distance and the sudden increase in demand. The slight decrease in the 50 years that followed may well be attributable to the continuing hostilities with Guelders.

Timber frame or not?

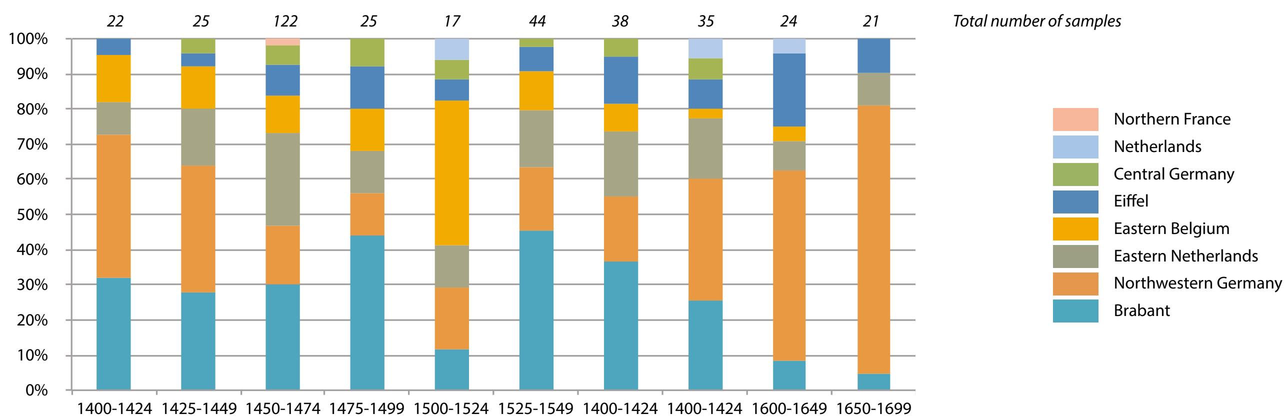
The houses of 's-Hertogenbosch show a succession of two main types of supporting structure. Up to the second quarter of the 17th century we find only compound floor structures consisting of heavy crossbeams supporting smaller joists. The youngest example of this type dates shortly after 1694. With the introduction of pine from southern Norway and Sweden around 1640, the first floor structures using a single size of beam start to appear. These put the town considerably behind the towns of Holland (van Tussenbroek, 2012: 21; Weve, 2013: 211).[6] The fact that 's-Hertogenbosch spent much of the Eighty Years' War under Spanish rule will certainly have contributed to this.

Until the 17th century, the floors covering the beams were made from oak planks from 20 to more than 50 cm wide with half-lap joints. So far only a single softwood floor has been found with a type of joint that may point to a date of 1464.[7] From the 17th to the 19th century, floors seem exclusively made of pine planks joined by loose tongues. These planks measure no more than 35 cm wide.

Fig. 2.6. Proportional representation of the regions of origin for samples of 15th- to 17th-century oak timbers (the 15th- and 16th-century samples are shown in 25-year intervals; as only 6 samples were collected from the first quarter of the 17th century and 8 from the last, these samples are shown in 50-year intervals).

Fig. 2.7. Use of timber frames in houses dated between 1400 and 1700.

In many cases, compound floor structures formed part of a timber frame (fig. 2.2 and 2.7). For the houses in ’s-Hertogenbosch, this involved a structure consisting of wall posts with braces and corbel pieces, in which the flat-faced wall posts did not support the outer walls. This construction method remained in common use until the first half of the 17th century. The lack of sufficient dated samples leaves it unclear whether the system gradually gave way to compound floor structures without a timber frame, nor do we know whether a shift occurred from a full timber frame to the use of timber frames for upper floors only, as appears to have been the case in the western Netherlands (Meischke *et al.*, 1997: 35-37; Weve, 2013: 203; Glaudemans and Smit, 2003: 30).



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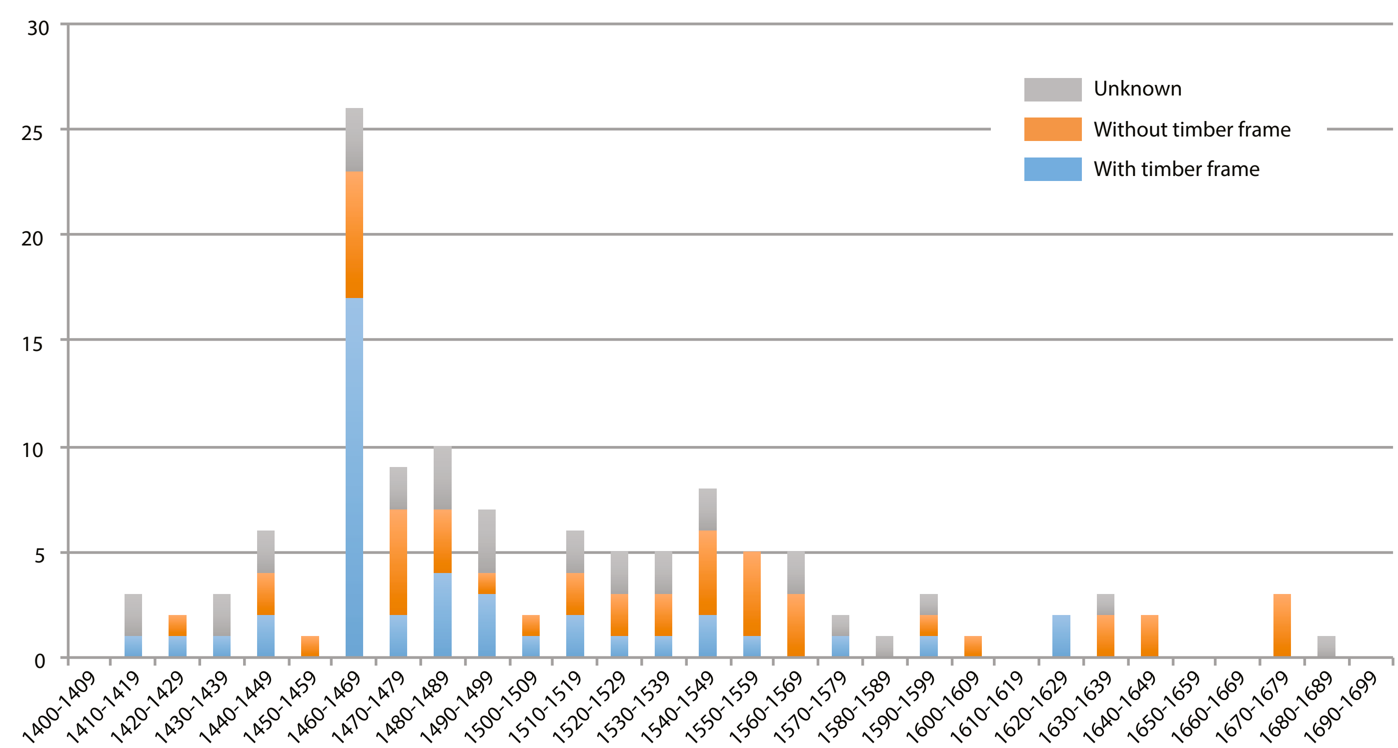


2.7

The contemporaneous occurrence of houses with and without timber frames begs the question of why the method was used or not. It is generally assumed that the use of timber frames as found in 's-Hertogenbosch is dictated by the floor span and the need to take up lateral forces. The load-bearing capacities of the brick side walls, which were thinner than their 14th-century counterparts, also played a role.

To gain insight into the use of timber frames, a comparative study was made of 29 of the 34 houses dating from the third quarter of the 15th century. In all but two cases, these houses consist of a ground floor and an upper floor, and 65% are either detached or semi-detached. Where houses feature a full timber frame, this situation even applies to ten out of 11 cases. The average width of the houses is over 6 m, whereas in the nine houses with only an upper-floor timber frame and in the nine without any timber frame at all, the average span is less than 5 m. The use of a full timber frame would therefore appear to be related to both the floor span and the need for stability. Two houses with full timber frames stand out because the structure features in only one half of the building. In the house at Korenbrugstraat 16 (1465d ± 4) (fig. 2.8), this is the front part of the house, in which the upper floor and the attic may have been used for storage purposes. In the house at Vughterstraat 46 (1461d), the timber frame is limited to the rear part, which was certainly intended for domestic use.

Of the 11 surveyed houses with full timber frames, eight were built against or between existing side walls, mostly 14th-century walls 45 or 60 cm thick. The newly added facade is often of comparable thickness, although sometimes no more than 24 cm (the length of a single brick) across. In the nine narrower houses with upper-floor timber frames, less than half use older walls onto which a new storey was built with the thickness of a single brick's length. In these cases the timber frame appears to have been used to add stability to the lighter, free-standing brick walls. Newly built houses with timber frames on the upper floor also feature single-brick walls on the ground floor, and all are semi-detached. Perhaps it was thought that the adjacent structure would provide sufficient stability. This aspect also appears to play a role in houses without any timber frame at all, which in other respects do not differ greatly from the houses with only upper floor timber frames. Just over half of the houses without a timber frame were built against existing side walls, and in most cases are semi-detached. The reasons for using a timber frame in some cases and not in others remain unclear. It may well be that the choice depended on several factors, which in addition to the opportunity of using existing side walls or erecting shared side walls may have included the experience and traditions of the builders as well as the financial situation of the principal.

Two of the houses, which only have frames on the upper storey, share the curious phenomenon of having wall posts and braces on only one side of the house.[8] This situation is all the more remarkable because the side where the timber frame is missing also happens to be the side with a free-standing side wall. An explanation for this has yet to be found. However, it does rather undermine the theory that the timber frame also helped to stabilise the side walls (Janse, 1964: 305).

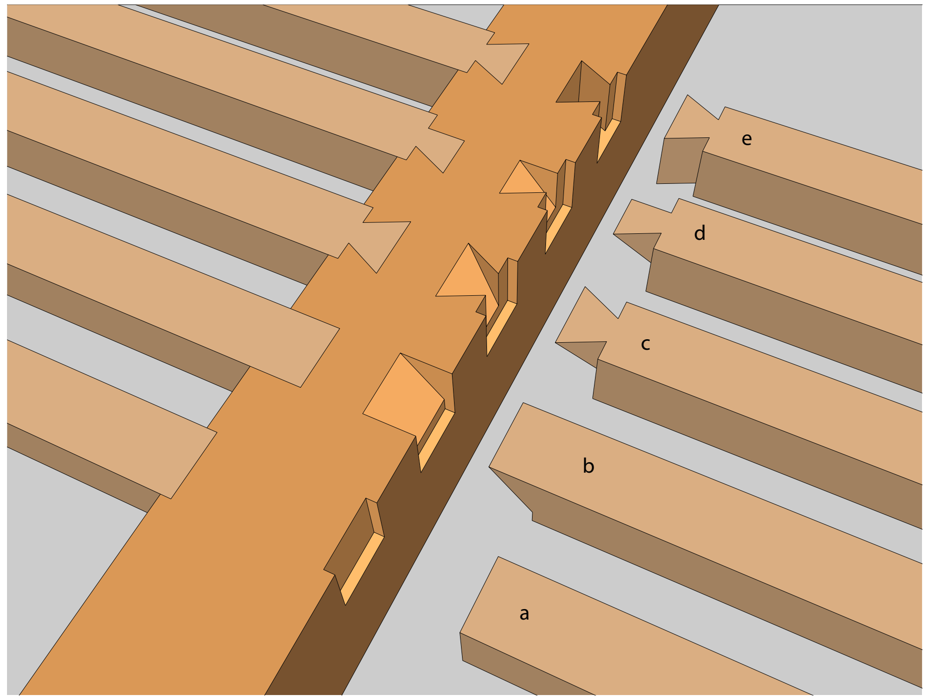
2.8

As with the full timber frame, upper-storey frames may occur in only part of the house, and may be missing below some of the crossbeams. In the house at Vughterstraat 48 (1465d ± 6) for example, the front part of the house features an upper-storey timber frame, whereas the room looking out on the street does not. Evidently the remaining two frames and the wall separating the front and rear parts of the house were considered sufficient to provide stability.

Tension joists between crossbeams[9]

Regarding the joints between the crossbeams and the lighter joists, we can distinguish between floor structures in which the joists have been laid on top of the crossbeams, and floors in which they have been let into the beams using a notched joint. Both types may be found within the same house, and even within the same floor structure.[10] Where the use of slightly curved timber has made the crossbeams irregular in shape, a combination of top-laid and notched joints may occur, with partial notches cut into the crossbeam and the end of the joist cut to a lip to fit the notch. In this way the curvature of the crossbeam timber could be corrected to create a horizontal floor surface.

Fig. 2.8. The house 'De Drie Kroonen' at Korenbrugstraat 16 (1465d ± 4) with only a timber frame in the front part of the house, in which the upper floor and the attic may have been used for storage purposes.



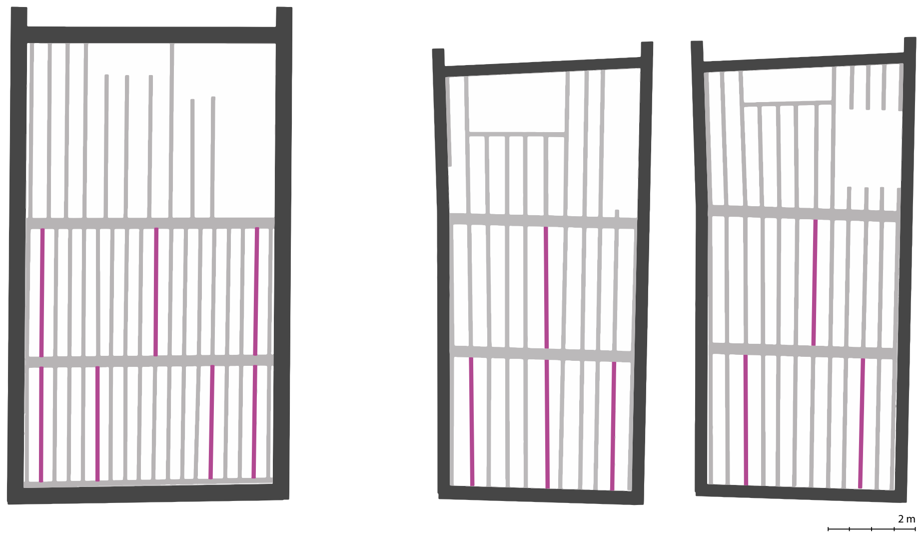
2.9

The simplest solution was to lay the joist ends on top of the crossbeam, where they were secured with a wooden peg. This method appears to have been abandoned after 1600. Notched joist joints can be sub-divided into those with and those without a lip (fig. 2.9a and 2.9b). The lip provided a surface through which the joist could be fastened to the crossbeam, which was partially cut away to receive the lip. After 1600 the lip dropped from use, a development that would appear to have started during the second half of the 16th century. From then on, the only means of supporting the joists consisted of a 1 to 2 cm deep notch cut into the side of the crossbeam.

In several cases where notched joists were used, some of the beams were given dovetail ends to create tension joints between two crossbeams or between a crossbeam and an end wall (fig. 2.9c, 2.9d and 2.9e). The limited research covering this phenomenon shows that dovetails were used only on oak joists, and that with a single exception the use of this type of joint was limited to compound floor structures that did not form part of a timber frame.[11] This type of joint was used from the 15th century to the end of the 17th century, but appears to have been most common in the 16th century.

Dovetailed joists were laid in two different patterns, either continuous or staggered. The latter pattern appears to have been more popular in the middle of the 16th century (fig. 2.10). The staggered pattern is limited to two sections of joists behind the front or rear wall of the house. In most houses in which it was used, the wall involved was brick-built. This supports the idea that the pattern may be related to this fact, which is remarkable in view of the many timber facades that at one point existed in the town. It might indicate that during the first half of the 16th century the popularity of timber front and rear facades gradually faded in favour of brick-built facades (Kolman, 1989: 85).

Fig. 2.9. Detail of the first floor structure in the front part of the house at Vughterstraat 122-124 (1566d ± 6) and drawing of notched joists with: a) no lip; b) recessed lip; c) dovetail lip; d) half dovetail lip; e) full dovetail. Image: courtesy of the Municipality of 's-Hertogenbosch SO/BAM; drawing: author



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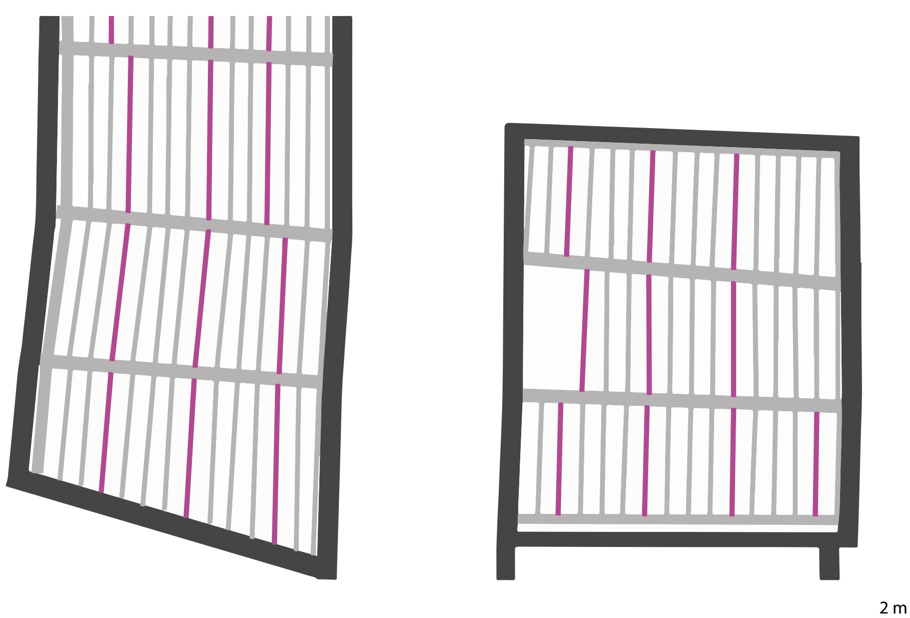


2.11

When laid in a continuous pattern, the tension joints always cover more than two sections, which is probably to do with the load-bearing capacity of the floor (fig. 2.11). Over the course of the 17th century the dovetail joints gave way to iron strip anchors laid across the crossbeam and fixed to the joists.

Evidence in the supporting construction indicating an original wooden facade has not as yet been found. Joists have sometimes been re-used with mortises for braces to support the jetty. Another way to construct the jetty was with brackets, which were penned in the storefront beam. This was very likely the solution at Kerkstraat 73 (fig. 2.1). The choice of one or the other was due to the layout of the storefront below (Schaars, 2014).

Fig. 2.10. Dovetailed joists (purple) laid in a staggered pattern in the upper floor of the house at Kerkstraat 71 (left, 1549d ± 6), and in the upper floor and attic floor of the house at Hinthamerstraat 138 (centre and right, 1546d).

Fig. 2.11. Dovetailed joists (purple) laid in a continuous pattern in the attic floor of the front part of the house at Vughterstraat 122-124 (left, 1566d ± 6), and in the attic floor of the rear part of the house at Kruisstraat 12-14 (right, second half of the 15th century).

Timber cosmetics

A striking phenomenon in the compound floor structures found in 's-Hertogenbosch is the use of differently processed timbers for the joists. Some of the joists are squared trunks, while others are made of sawn timbers. The former type was also used for the roof rafters. The impression gained is that this relatively thin timber of about 15 cm thick was especially grown for its length over a period of 30 to 50 years.[12] The timbers are easily recognised by their rounded edges and often a slightly undulating shape, unlike the sawn timbers, which are straight and have sharply defined edges.

The two types of joists were not mixed in the same floor section, although adjacent sections may contain different types of joists. The option of using either type of joist was available throughout the 15th and 16th century and appears to be unrelated to the structural function of the floor. In contrast, the type of joint used to connect the joists to the crossbeam does appear to be significant.

The examples show that the choice of joist type was dictated by the status of the house and the rooms within. It will not come as a surprise that squared trunks were considered inferior to sawn timbers. The presence of squared joists throughout a floor, in both the front and rear parts of a house, has so far only been confirmed in the houses at Putgang 6-8 (1553d ± 6) and Vughterstraat 155 (1469d ± 6). The first is known to have had only a single level, and this is probably true for the latter as well. Squared trunk joists do not appear to have been used in the first floor structures in the rear part of houses. For attic floors, the entire structure may use squared trunks, as in the house at Lepelstraat 45 (1429d), or their use may be limited to the front part of the house, as at Hinthamerstaat 119 (1468d).

A possible example of a transition from squared trunks to sawn timbers was found in the first and second floor structures of the front part of the house at Hinthamerstraat 184 (1438d) where the joists consisted of thicker, squared trunks that had been quartered. The joists of the first-floor structure had been tailed into the crossbeams. The only other house in which tailed-in squared trunks have been found is at Kerkstraat 71 (1552d ± 2). In most cases, the shape of the timbers meant that they were simply laid on top of the crossbeam.

In the front part of the houses at Kerkstraat 71 and Vughterstraat 46 (1461d), the upper floor structures contain a combination of sawn and squared joists. In both houses the floor consists of three sections, the frontmost two of which use sawn timbers, while the rearmost section contains squared timbers (fig. 2.12). The difference stems from the sub-division of this part of the house into a front room and a separate back room (the 'inside hearth'). Unfortunately, it cannot be said that houses that do not show a similar use of different timbers did not feature an inside hearth. The absence of an inside hearth is confirmed for the house at Hinthamerstraat 184 and the houses at Hooge Steenweg 19 (1463d ± 6) and 21 (second half of the 15th century). However, the house at Hinthamerstraat 119, with its uniform upper floor structure, did originally feature a sub-divided front part. The reason for the partition may have been the presence of a partial floor over the inside hearth.

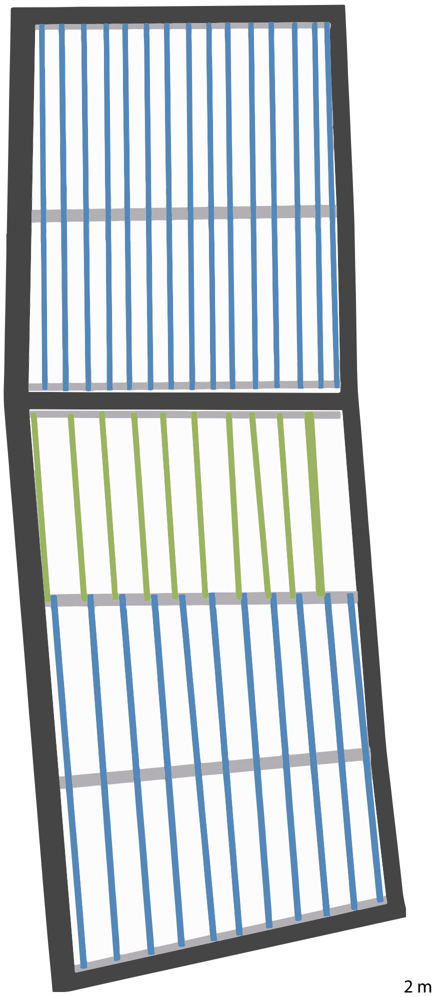
2.12

Despite the similarity in the type of timber used, the front parts of the houses at Kerkstraat 71 and Vughterstraat 46 differ regarding the method of construction and number of joists. The Vughterstraat house has equal numbers of each type of joist laid onto the crossbeams, whereas the Kerkstraat house has tailed-in joists, 18 above the front room and 13 above the inside hearth. A similar difference in numbers is however found between the front and rear parts of the house at Vughterstraat 46, the former having 11 joists, and the latter 15 (fig. 2.13). Sometimes the numbers differ only slightly, as at Kolperstraat 30 (1463d), with 12 squared joists laid onto the crossbeams in the front part of the house, and 13 tailed into the crossbeams of the rear part.

Where the same types of joists were used, different numbers expressed the distinction between the various rooms. This is evident in the house at Hinthamerstraat 184, where the attic floor contains only 11 joists above the front part of the house, whereas the rear part of the house has 14. Looking at the first floor structure of the house at Vughterstraat 48 (1465d ± 6), the different numbers of joists enabled the original presence of a front room to be deduced, its ceiling containing 12 joists as opposed to the ten joists in the space behind it. A similar setup was found in the attic floor structure of Hinthamerstraat 163 (1543d), in which the front room ceiling contained 14 tailed-in joists, whereas the sections behind it contained 12 laid-on joists.

We can deduce from the various examples found in the town that sawn timber carried more status than squared timber, as did higher numbers of joists. In addition to the number of joists, their size would also appear to play a role. In some cases the joists are even laid flat to make them appear bigger. Larger sizes of timber would have been more expensive, which would have made a high crossbeam with tailed-in joists convey more status than a lightweight crossbeam with laid-on joists. This distinction is even made within the supporting structure of one part of the house. For example, at Hinthamerstraat 111 the part of the joisting above the former retail space on the street shows a crossbeam with

Fig. 2.12. View of the upper floor structure in the front part of the house at Kerkstraat 71 (1552d ± 2), looking towards the front. The section over the inside hearth contains fewer joists, and these are made of squared trunks. Image: courtesy of the Municipality of 's-Hertogenbosch SO/BAM



2.13

tailed-in joists, while behind, in the domestic 'inside hearth' area, the joists rest on a lower crossbeam. The status of a higher crossbeam with tailed-in joists sheds new light on the use of filler boards to close the gaps between laid-on joists above the crossbeam. These small oak panels, which are placed in sawn grooves in the joists, make the joist look as if they are tailed-in, thereby suggesting the presence of a higher and more expensive crossbeam (fig. 2.14).[13] It is striking that in this context the timber frame does not appear to form any part of this 'language of wood'. This can be deduced from the absence of any such structure in the first floor front room at Vughterstraat 48 and in the rear part of the house at Korenbrugstraat 16.

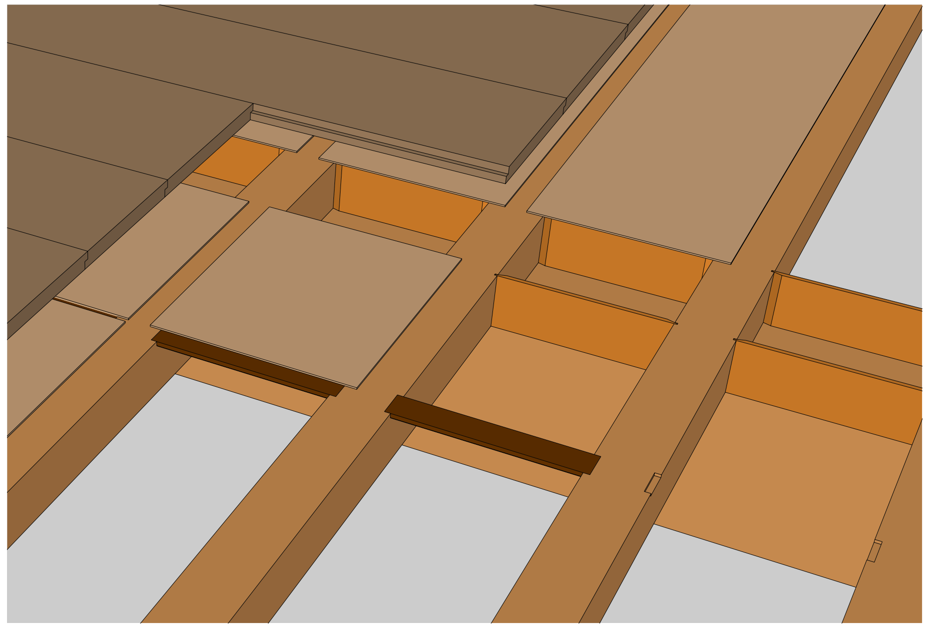
It should be noted that filler boards were often combined with a veneer-cut oak ceiling panelling between the joists to hide the floor planks. This was surely the ultimate demonstration of conspicuous consumption of wood. Its use is often restricted to the room in the rear part of the house, as at Lepelstraat 45 and Orthenstraat 336 (1465d ± 6 d). In more extreme cases the front part of the house was treated in the same way, as at Hinthamerstraat 119 and Hooge Steenweg 21. Interestingly, in many cases the length of the panels, that in width are no more than the space between two or three joists, does not cover the entire space between two crossbeams, so ornamental panel slats were used to conceal the joints (van Drunen, 1995) (fig. 2.14). This would seem to indicate that the wood used for the panelling was available in limited lengths only.

In the houses of 's-Hertogenbosch, the wood used for the late medieval supporting structures, with respect to quantity, size and operation, appear to have been selected with the function and status of each room in mind. Despite the outward differences of grain texture and colour, the wood almost always remained unpainted. Decorative colour finish seems with a few exceptions to have arisen in the late 16th century and it became especially prevalent in the 17th century. This was mainly due to softwood floors being used instead of traditional oak floors.

The main chamber of the house must have been the room to the rear above the cellar. This, more often than not, had the most sawn joists. The status of the space was emphasized by the presence of mural paintings, which were often more opulent than elsewhere in the house. A room on the first floor above the main chamber could also have the same expensive supporting structure and was perhaps as important as the main chamber itself.

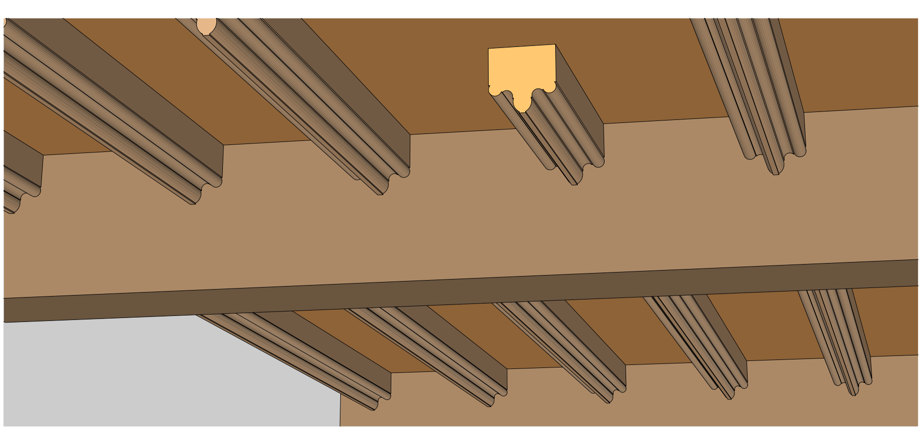
If exceptionally a chamber at the first floor in front of the house was present, then it was also a higher status room. For Hinthamerstraat 90 (1516d ± 6), it may have even been the best room in the house, because the supporting structure above it was made with joists elaborated with a fine profile (fig. 2.15). This is the sole example in 's-Hertogenbosch of this kind of processing. Mostly in the front room only, the number of joists in the ceiling differs from the joists above the adjacent space which acted as a passage. At ground level the shop or workspace facing the street may show a similar status, not as high as the room to the rear but higher than the middle room known as the inside hearth. The inside hearth, as a kitchen, can be considered the least representative living space in the house. Often the squared trunk joists in the ceiling above it are darkened by smoke.

Fig. 2.13. The upper floor structure of Vughterstraat 46 (1461d), showing the squared joists in green and the sawn joists in blue. Note the difference in numbers of joists in the front and rear parts of the house.



2.14

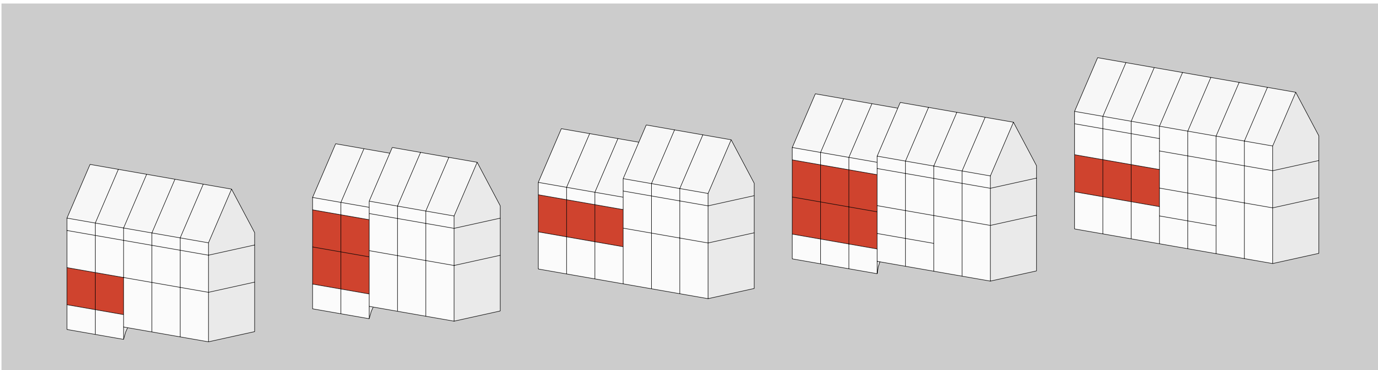
Above the ground floor of the house, either sawn or squared trunk joists can be employed to the full depth of the front part. Sawn joists may indicate the presence of a partial floor over the inside hearth. For squared trunk joists, no wall separated the front room and the inside hearth. This suggests that the entire front part was used as commercial space or a workshop. Whether food was prepared here or elsewhere in a detached kitchen is not known. It



2.15

Fig. 2.14. Detail of the first floor structure in the rear part of the house at Orthenstraat 23-25 (1469d) and drawing of the layout, showing the use of filler boards to close the gaps above the crossbeam between the joists. Over the joists an ornamental ceiling panelling was laid with slats to cover the seams. Image: courtesy of the Municipality of 's-Hertogenbosch SO/BAM; drawing: author

Fig. 2.15. Detail of the rare supporting structure above the formal room facing the street at the first floor of Hinthamerstraat 90, where the ceiling has decorative moulded joists. Image: courtesy of the Municipality of 's-Hertogenbosch SO BAM; drawing: author



2.16

is striking that in larger houses, the number of representative rooms did not increase (fig. 2.16). This raises the question whether certain houses were built for a more specific profession. In addition, the presence of more rooms of status may be, for example, an indication of occupancy by several members of a family. Historical research on residents and their professions would possibly provide more clarity but this is complicated by the fact that the vast majority of houses in the city were rented.

Conclusion

Dendrochronological research shows that the city fire of 1463 and the subsequent actions of the City Authorities were of major influence on construction activity in 's-Hertogenbosch over a period of ten years. After that time, house building slowly but surely decreased, reaching its lowest point at the end of the 16th century. In the period immediately after the fire, there was both new construction and reconstruction.

It is striking that even in the often originally 14th-century stone houses outside the disaster area the supporting beams were replaced. In two-thirds of the cases, the new supporting structures were part of a timber frame that had no supporting function for the outer walls. Where houses were detached or semi-detached and had a width of more than 6 m, a full timber frame was applied for stability and to reduce the crossbeam length. In houses with an average width of less than 5 m, no timber frame was applied on the ground floor but was sometimes used on the first floor. Explanation for this seems partly to be attributed to the construction of neighbouring buildings but could also have been a financial issue.

Strangely enough, the supporting timber frame was not included in the way in which ceiling joists were differently designed for the purpose of status. This would have been expected within the context of 'the more wood the more status'. One explanation may be that the braces in the construction of supporting timber frames both practically and visually narrowed the rooms. It may also have played a role in the fact that the presence of a wooden frame in the homes of the nobility had fallen out of fashion (Meischke *et al.*, 2000: 52).

For 's-Hertogenbosch, the late medieval supporting structures provide understanding as to the original use of space in the houses in different ways.

Fig. 2.16. Schematic representation of some 15th-century houses, showing in red the representative chamber(s) in the rear part of the house (left to right: Lepelstraat 45, Vughterstraat 84, Postelstraat 36, Hinthamerstraat 119 and Vughterstraat 43).

The manner in which joists are processed, the number of joists and the connection with the crossbeams make the difference in status visible between the rooms themselves and, possibly by extension, the status of a house in the street. When dovetails were used for the connection of joists with the crossbeams, from the pattern in which the tension joists were applied, it can be deduced whether the house originally had a stone facade or an upper floor or attic which was suitable as a storage space for heavy goods.

As these results show, the final word on the history of timber and supporting structures in late medieval houses in 's-Hertogenbosch has not yet been spoken. Many aspects of their use, for instance regarding upper-floor timber frames, will need to be considered in a broader context, taking urban development into account, if we are to increase our understanding of the various decisions made regarding their application. The urban research initiated by van Drunen forms a good starting point, provided it can be combined with dendrochronological analysis (van Drunen, 2006: 29-31). This also applies to the use of floor structures to convey status. An in-depth survey to map the locations of houses with more or less richly constructed floor structures may be able to provide insight into the distribution of social groups within the town by providing a new basis for research into the history of house owners and occupants. The use of dovetail joints also raises new questions. Their presence in combination with the absence of border joists has not yet been addressed, and this calls for further research into the floor structures of houses with timber facades.

Notes

1 Most samples were analysed by Pressler GmbH, a smaller subset by BAAC B.V., 's-Hertogenbosch, and by Stichting RING, Amersfoort.

2 These are the houses at Markt 79-85 ('De Moriaan', dated 1277d) and at Pensmarkt 16-20 (dated 1287d ± 6).

3 Timber from the 1450s in combination with timber dated to shortly after 1463 was found in seven houses. In Amsterdam the same phenomenon was observed in buildings constructed during the third and fourth expansions of the town (van Tussenbroek, 2012: 29).

4 For a graphical representation of the occurrence of the link-beam truss, see: Boekwijt and van Drunen, 1996: 22.

5 An important part of dendrochronology is to specify the regions of origin of the wood, termed 'dendro-provenancing' (for example Bonde *et al.*, 1997; Jansma and Hanraets, 2004; Eckstein and Wrobel, 2007; Eissing and Dittmar, 2011). For this article only the reference chronologies mentioned in dendrochronological reports have been used without further investigation of whether the areas to which they refer are actually the areas of origin or places of timber trade. Therefore interpretation of wood source regions should be considered indicative and deserves further refinement in the future.

6 In Amsterdam, the earliest dendrochronological date for pine, also from Sweden, is 1603 (felling date). Floor constructions of single beams are in Delft, already known from the 16th century.

7 Upper floor of the house at Vughterstraat 43. The planks were not sampled for dendrochronological research.

8 Houses at Hinthamerstraat 113 (1464d) and Kolperstraat 5 (1466d).

9 For a more exhaustive description of this subject, see: Enderman, 2014.

10 This was found in the attic floor structure in the front part of the house at Hinthamerstraat 163 (1543d) and in the upper floor structure of the front part of the house at Hinthamerstraat 111 (1536d ± 6).

11 In the house at Orthtenstraat 23-25 (1464d), this type of joint was found in an attic floor structure forming part of a timber frame.

12 Two-thirds of the dated rafters were grown during this period. The highest number of growth rings in the remaining third is 90.

13 The size of the filler boards is determined by the height and distance between the joists. The panels are approximately 0.5 to 1 cm thick and chamfered at the ends at the back to allow them to slide into the sawn grooves in the joists. It is known that wood was re-used for the boards, such as in the house at Kerkstraat 73 (fig. 2.1) where sawn drapery panels on the back side were found.

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Summary

In the decade after the town fire of 1463, at the behest of the city authorities the thatch roofs of houses in the town were replaced with hard roofing material. Widespread rebuilding and restoration took place, both inside and outside the disaster area. In the subsequent period to the end of the 16th century, home-building gradually but steadily decreased. Depending on the circumstances for building new houses, lightweight timber frames were used. The construction of supporting structures was aligned with a stone rather than a wooden facade and in connection with the use of the different rooms in a house with a more or less standard layout.

3.1

3

Ceilings and floorings in Austria: Types, dating and wood species

Michael Grabner[1], Andrea Klein[2],

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Key words

Dendrochronology / Wood species / Wood utilisation / Building history / Ceiling / Flooring

Introduction

Wood was and still is one of the most important building materials (Klein, 2004; Nicolussi, 2006; Grabner and Karanitsch-Ackerl, 2011). Not only in log houses, but also in brick and stone houses, many different wooden elements can be found. The most prominent of these are usually the roof constructions. Much information about this important part of the building is therefore available (e.g. Binding, 1991; Alcock *et al.*, 1996; Fischer-Kohnert, 1999; Zalewski, 2009; Hoffsummer, 2009).

In contrast, analyses of ceiling and flooring constructions are scarce. Often the construction itself is hidden by plaster work or wooden boards, preventing identification of the type of ceiling construction. Unlike wooden constructions, arches were one of the rare means to construct ceilings made of bricks and/or stones.

Dendrochronology is often used to study building history (e.g. Stanzl, 2004; Eissing, 2004; Eissing, 2005; Nicolussi, 2006; Molyneux, 2011; Heymans and Sosnowska 2011). Dendrochronological data and wood identifications obtained from different buildings in Austria were used to compile a database of ceiling and flooring constructions. The analyses were done at the Tree Ring Laboratory of the University of Natural Resources and Life Sciences – Bodenkultur (BOKU), Vienna, Austria. A major part of the work is service, which provides only a dendrochronological date. In such conditions, the only

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Fig. 3.1. *Balkendecke* from the Gozzoburg in Krems, Austria, dated to 1254d.

other information usually provided is the type of wooden element (roof construction, ceiling, etc.).

As there is no overall synthesis as yet available for ceiling and flooring constructions in Austria, the goal of this paper is to consolidate all of the information available from case studies (i.e., dated by dendrochronology) concerning type, species and age of these elements. See, for example, one of the oldest examples from the Gozzoburg in Krems, Austria, dated to 1254d (fig. 3.1).

In the present study, flooring is defined as simply the covering of the subfloor with wooden boards. These boards can be nailed to beams, laid on the ground floor or on a bed of sand. A review of the historical literature (Böhmer, 1799; Bechstein, 1812; Dempp, 1842; Heß, 1895) discussing the utilisation of wood shows that the use of silver fir (*Abies alba* Mill.) was unclear. Dempp (1842) described silver fir as the best choice to produce floorings due to low warping, low number of knots and for its durable whitish colour, while Heß (1895) mentioned that silver fir is not suitable for floorings because it is hard to plane, splits easily and turns greyish over time.

Due to this disagreement, a case study at the Austrian Open Air Museum Stübing (Styria) was conducted to investigate historical wooden floorings. The goals of this study were to obtain information about wood species selection, to date these floorings and better estimate their degree of abrasion.

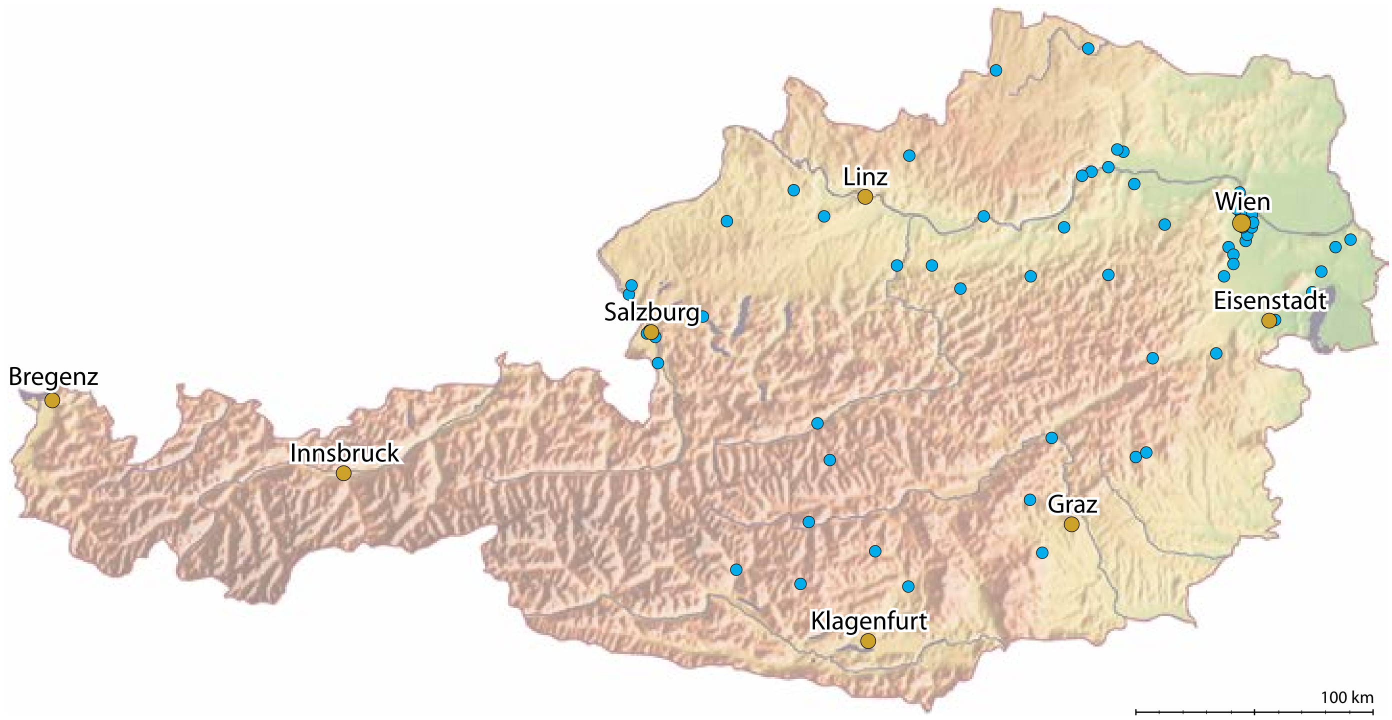
Material and methods

For ceiling constructions

More than 1300 sites of living trees as well as historical and archaeological objects have been dated in our laboratory over the last 20 years. The main area of investigation includes Vienna, Lower Austria, Upper Austria, Salzburg, Carinthia, Styria and Burgenland (with just a few exceptions). For 142 objects (buildings), at least one dated ceiling construction was available in the database (fig. 3.2). From these, 1538 dendrochronological samples could be dated. Only samples with a waney edge (*Waldkante*)[1] were taken into account for this study. That means that the outermost dated tree ring gives the felling date of the tree (Grabner and Karanitsch-Ackerl, 2011). However, as usually just small parts of the ceiling construction are accessible for sampling, it is not always possible to determine if the dated timber is original or re-used.

Most of the samples were taken from large buildings (*Bürgerhäuser*) in the cities of Vienna, Klosterneuburg, Krems, Graz and Salzburg while at the Austrian Open Air Museum Stübing it was possible to date ceilings from six rural buildings (farmhouses). These are found throughout the entire study region described above – alpine buildings are included as well as lowland city buildings. Austria is a topographically, ethnographically and climatically diverse country. As a consequence, building traditions vary from one valley to another (Holzmeister, 1934). Moreover, there is variation in wood species growing in Austria from east to west and at different altitudes (Schadauer, 1994).

All samples were dated using dendrochronology, a dating method which uses annual tree-ring width as a parameter for a year-to-year record of growing



3.2

conditions (e.g. Baillie, 1995; Stokes and Smiley, 1996). Wood sample cores were obtained using a borer (16 mm diameter) with a hollow shaft of 7 mm diameter. These cores were then glued onto a wooden strip and sanded so that the ring pattern becomes visible. First, the wood species was determined by anatomical features using a reflecting light microscope (Wagenführ, 1989). Ring widths were then measured to an accuracy of 0.01 mm, using a LINTAB (for 'Linear table') measuring device (www.rinntech.de). The ring series were dated by calculating statistical values, including t-values and the *Gleichläufigkeit* value, using the Time Series Analysis Platform (TSAP) software (www.rinntech.com) and visual checking.

The main type of ceiling construction was described at the meta-data level of buildings and samples. As there could be small shifts in the results due to different numbers of samples per ceiling construction, the analyses were done for the dated samples (with waney edge) and for the buildings.

The number of samples per calendar year was determined by counting all cores with the same date for the bark ring (waney edge).

For floorings

A case study at the Austrian Open Air Museum Stübing was conducted to study historical wooden floorings. Buildings from across Austria were brought to Stübing, so the museum represents all regions of Austria.[2] In this context, 105 small samples from 60 floorings out of 29 buildings were extracted and species determined as described above.

To protect the floorings from damage, coring was not permitted for dendrochronological dating. Therefore, well-orientated softwood boards (radial boards) were measured directly on the flat surface. Calibrated digital images were made to measure the ring widths (for details see: Klein *et al.*, 2014).

Fig. 3.2. Austria, map of the sampled buildings.

3.3

Moreover, for 21 buildings, the degree of abrasion was measured. This was defined as the difference between the height level of the knots, which are harder than the wood and have little or no abrasion, and the surface of the boards (fig. 3.3). Several measurements per room were made on different boards and averaged.

Results and discussion

Types of ceiling construction

From the 142 buildings studied, it was possible to define three main types of ceiling construction. As there are no translations for the different types of ceilings available, the German words will be used.

1) Beamed ceiling *Balkendecke* (fig. 3.4): Wooden beams bridge two walls. The upper part is covered by boards, which are laid perpendicular to the beams (fig. 3.5). The boards are fixed with wooden or iron nails. This is the simplest way to build a wooden ceiling. The waney edge can sometimes be found at the uppermost part, where the logs were not perfectly squared.

2) A special type of beamed ceiling *Riemenbalkendecke* (fig. 3.6): Wooden beams, specially shaped to support boards parallel to them, bridge two walls. The boards are often attached with pegs. The ceilings (beams and boards) are often carved or painted on the lower side. The pith of the tree is usually located at the lower part of the beams. To prevent this surface from cracking, wood wedges were driven into the logs from the upper surface (fig. 3.7), typically the waney edge. This creates a flat smooth surface on the lower side (allowing carving and painting).

3) *Dippelbaumdecke* (fig. 3.8): Partly hewed logs bridge the walls, lying side by side. The entire ceiling is covered by the logs, no boards being necessary (fig. 3.9). However, this type of ceiling requires a lot of timber. The beams are connected to each other with pegs, which give the name to this type of construction (*Dippel* is the old German word for 'peg'). The logs are usually hewn and flattened on the lower side and partially on the vertical sides – ensuring a closed, even surface for the lower side, which was then often covered by mats of straw and plaster.

52% of the analysed buildings, representing 63% of the samples, were of the *Dippelbaumdecken* type. The *Balkendecken* type was identified for 35% of the buildings (28% of the samples). The special *Riemenbalkendecken* type was identified for 13% of the buildings (9% of the samples). The difference between the numbers per building and per sample is due to the different quantities of dated samples with waney edge. These are common for *Dippelbaumdecken*. For *Balkendecken* and *Riemenbalkendecken*, usually fewer samples can be taken due to the limited size of the area of investigation; moreover, the potential of finding beams with a waney edge is lower.

Wood species for beams

Norway spruce (*Picea abies* L.), silver fir (*Abies alba* Mill.), European larch (*Larix decidua* Mill.), pines (Scots pine and Black pine – *Pinus sylvestris* L. and

Fig. 3.3. Measurement of abrasion, defined as the height difference between the knots and the surface of the boards.

Fig. 3.4. Sketch of the *Balkendecke*. Beams bridge the walls and are covered by perpendicular lying boards.

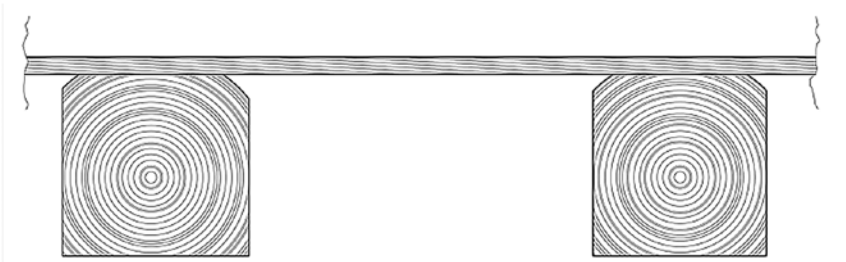
Fig. 3.5. Partially visible *Balkendecke* after removal of the upper layer of boards.

Fig. 3.6. Sketch of the *Riemenbalkendecke*. Specifically processed beams bridge the walls. The boards lie parallel to the beams and are attached with pegs.

Fig. 3.7. A beam of a *Riemenbalkendecke* with an inserted wedge at the upper side to prevent the lower side from cracking.

Fig. 3.8. Sketch of the *Dippelbaumdecke*. Partially hewn beams lie next to each other and bridge the walls.

Fig. 3.9. *Dippelbaumdecke*, where the ballast was partially removed (after coring).



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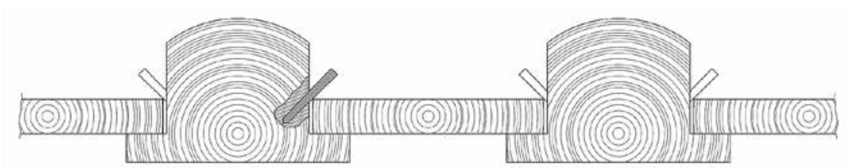

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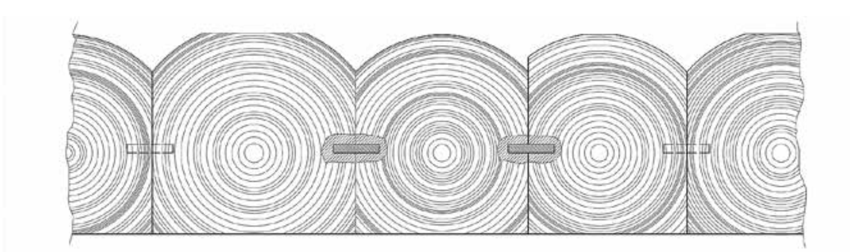

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Pinus nigra Arn.) and oaks (Pedunculate oak and Sessile oak – *Quercus petraea* Liebl. and *Quercus robur* L.) were all determined as species used for beams. It is not possible to differentiate between the two pine species, or between the two oak species; therefore, these are listed as pine and oak.

In general, Austria is dominated by the utilisation of softwoods for building purposes (Klein and Grabner, 2014a). 59.1% of the samples (mostly from beams, almost no boards) were made of Norway spruce, followed by 34.9% silver fir, 5.3% pine, 0.5% European larch and only 0.2% oak. The *Balkendecken* show the highest variability in wood species. The highest amount of Norway spruce wood is found in *Dippelbaumdecken* (for details, see table 3.1).

As mentioned above, wooden buildings (mainly roof constructions and log houses) in Austria are dominated by softwood species (Grabner and Karanitsch-Ackerl, 2011; Klein and Grabner, 2014). From this study, the same trend is found for ceiling constructions. Even in the lowlands and big cities, such as Vienna, softwood timber was used to build ceilings, which is partly contradictory to known wood species and the common use of hardwoods in other Western European countries (e.g. Hoffsummer, 2009).

Dating of the ceiling constructions

The ending dates of the 1538 dated samples represent the felling dates of the trees used for the ceiling constructions. These vary between 1137 and 1942, which was the case for the *Balkendecke*. In our case studies, the *Riemenbalkendecke* were built between 1369 and 1685, and the *Dippelbaumdecke* between 1441 and 1906.

Figure 3.10 shows a more or less constant distribution of felling dates for the *Balkendecke* (n=49 buildings) from the 12th to the 20th century. The *Riemenbalkendecke* were found only in 18 objects and built mainly in the 16th century. The *Dippelbaumdecke* were the most frequent (n=75) and mainly used in the 18th and 19th centuries.

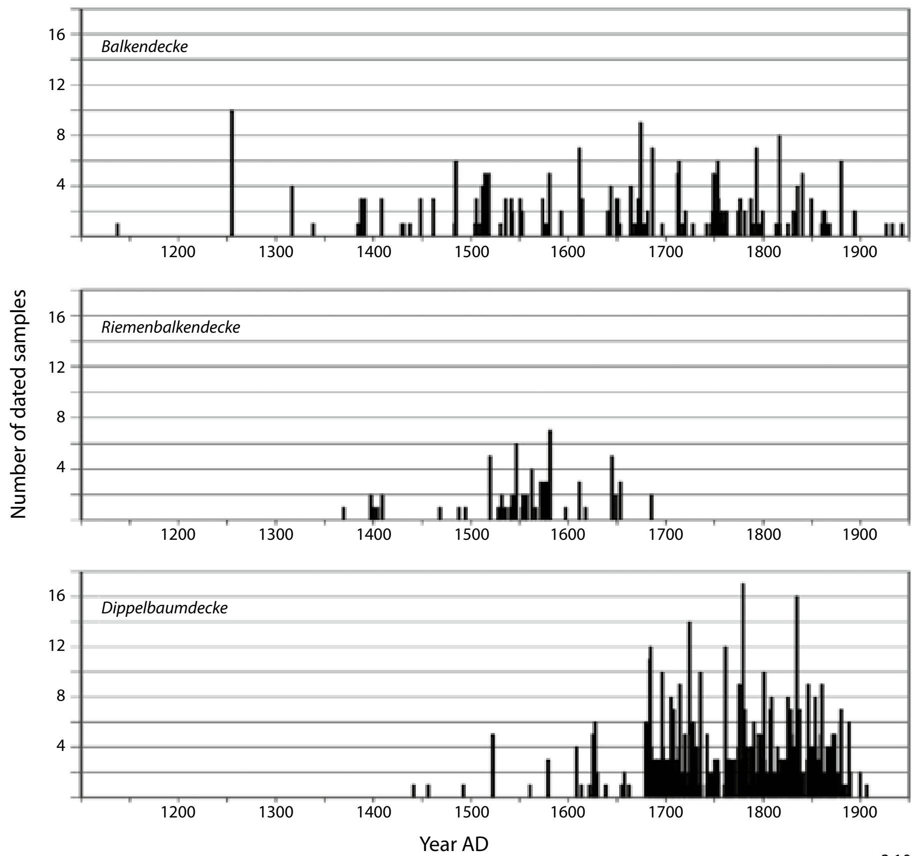
In one object from the city of Salzburg, it was possible to see that old beams from a *Riemenbalkendecke* were used as *Dippelbaumdecke*. Old re-used beams could thus explain the rare early dates (15th to 17th century) of the *Dippelbaumdecke*.

Wood species used for floorings

46.7% of the 105 sampled boards were Norway spruce, followed by 33.3% European larch and 20% silver fir. The harder larch wood was mainly used for entrance rooms. The amount of spruce used as flooring is more than twice that of fir. It is thus not possible to draw a more precise image than can be found in the literature about the utilisation of silver fir. The amount of fir wood in floorings is higher than for roof constructions (Klein and Grabner, 2014a) but lower than for ceilings (see above).

Dating of floorings

It was possible to date 18 boards from seven rooms (out of 41 sampled rooms from nine buildings). The oldest flooring was from the late 17th century (see table 3.2 for details). Most of the boards show very similar ending dates per room (object). This coincides with analyses of the inventory (cupboards, barrels, etc.)



3.10

	Norway spruce	Silver fir	Pines	European larch	Oaks
Balkendecke	49.7	37.6	11.7	0.5	0.5
Riemenbalkendecke	61.4	35.6	0.0	3.0	0.0
Dippelbaumdecke	63.0	33.5	3.2	0.2	0.1

Tab. 3.1

Object no.	Object name	No. of samples	Dating of the last ring of the sample(s)	Dating of the building
27	granary	1	1886	1747
29	residential building	5	between 1671 and 1687	1775
32	granary	2	between 1820 and 1825	1837
41	granary	2	between 1710 and 1713	1724
51	granary	3	between 1835 and 1838	1713
67	granary	2	between 1811 and 1814	1565
79	residential building	3	between 1775 and 1866	1819

Tab. 3.2

Fig. 3.10. Distribution of felling dates of beams separated into *Balkendecke*, *Riemenbalkendecke*, *Dippelbaumdecke*

Table 3.1. Percentages of wood species of the analysed samples separated into *Balkendecke*, *Riemenbalkendecke* and *Dippelbaumdecke*.

Table 3.2. Dendrochronological dating of the flooring boards in comparison to the building. The date of the outermost ring per board is given

in Stübing, where many different boards with sharp edges (i.e., without waney edge) were dated (Klein *et al.*, 2014). In these cases, minor differences in the ending dates (outermost ring and no waney edge) of the single boards were found, indicating that these boards were processed similarly, removing only a few tree rings. The outermost ring provides thus a date very close to the felling date (Klein *et al.*, 2014). The only exception is object no. 79, for which a large difference is seen in the ending dates provided by the dated boards (1775 to 1866). This could be due to a renovation of the flooring. In contrast, for object no. 29, the flooring is older than the building (flooring 1671-1687; building 1775). This might be due to the reuse of the flooring from another building. For buildings no. 32 and 41, the construction of the building and the outermost tree ring of the flooring coincide well, with only a difference of a few years, due to the loss of wood during sawing and planing (no. 32: flooring 1820-1825, building 1837; no. 41: flooring 1710-1713, building 1724). For objects no. 27, 51 and 67, the flooring was installed later than the building (no. 27: flooring 1886, building 1747; no. 51: flooring 1835-1838, building 1713; no. 67: flooring 1810-1814, building 1565 and 1850).

Abrasion of the wooden flooring

Based on the different descriptions in the literature of the wood characteristics (hardness, colour, ability to plane, etc.) for softwood species used in floorings (spruce, larch and fir), abrasion was determined at 183 studying points. The overall mean value is a difference of 7.2 mm between the knots and the lowest part of the surface of the boards, but the variability is quite high: 0.2 to 53.2 mm. It should be noted that it is not possible to clearly distinguish differences in abrasion between wood species for different reasons: in some cases, species are mixed within a single room; the age of the boards overall (and so the time of abrasion) can be quite different; the use of the rooms varies (entrance, working room, living room) and abrasion occurred both when the buildings were in use as well as subsequently as museum objects. Such circumstances make it very difficult to make a clear argument regarding abrasion in relation to wood species and/or age.

However, the fact that the mean value of abrasion in rooms open to museum visitors is 9.9 mm and only 5.0 mm in rooms not open to visitors indicates that the problem of abrasion of wooden floorings is an issue that should be addressed in museums.

Conclusion

From the 142 buildings studied in eastern Austria, it was possible to define three main types of wooden ceiling constructions: *Balkendecke*, *Riemenbalkendecke* and *Dippelbaumdecke*. These three types differ temporally in their implementation: the oldest type is the *Balkendecke*, dated between 1137 and 1942; the *Riemenbalkendecke* between 1369 and 1685 and the *Dippelbaumdecke* dated between 1441 and 1906.

All three types of ceiling constructions were dominated by Norway spruce, as previously observed in Austrian roof constructions.

Norway spruce was also the most frequent species found for floorings, followed by silver fir and European larch. These findings coincide with the ambiguous image given by historical literature about the utilization of different softwood species for floorings, especially the role of silver fir. The oldest flooring was from the late 17th century. Measurements of abrasion highlight a problem for open air museums. More work must be done to understand the abrasion process and the influence of visitors on the abrasion of the floorings.

Acknowledgements

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Notes

1 The waney edge is the bark edge, i.e., the edge that follows the natural curve of the tree (with or without presence of bark).
2 See the contribution no. 9 in this volume (Nemesthoty *et al.*) for a presentation of the museum.

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Summary

Ceiling constructions are an important part of the history of a building. Their wooden elements are often sampled for dendrochronological analyses. In eastern Austria, 142 buildings (1538 samples) with different ceiling constructions were analysed.

In 75 buildings (or rooms of buildings), the called *Dippelbaumdecken* (whole logs, squared by broad axe, lying next to each other) have been dated between 1441 and 1906. This type of ceiling construction was made of 63% Norway spruce (Picea abies L.) and 34% silver fir (Abies alba Mill.) (970 samples in total). *Balkendecken* (boards lying perpendicular to the beams) seem to be an older type, dating back to 1137. Another type is the *Riemenbalkendecke* (boards lying parallel to the beams, which are processed especially to support these boards). The oldest construction of this type dates to 1369. These two latter types of beam constructions were found between 1137 and 1942. The main wood species were Norway spruce (52%) and silver fir (37%).

A review of the older literature discussing the utilisation of wood shows that the use of silver fir was unclear, sometimes described as the best choice to produce floorings, sometimes as unsuitable for this aim. In order to clarify this, 60 floorings from 29 rural buildings from the Austrian Open Air Museum Stübing (Styria) were analysed. In this study, wood species, age (dendrochronology) and abrasion were determined, the oldest flooring dated back to 1687.

4.1

4

Contribution to the history of Brussels floorings, Belgium (16th-19th centuries): Initial results of an archaeological and dendrochronological investigation

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Translation from French: Rebecca Miller

Key words

Floor, Flooring / Brussels Capital Region / Scots pine / Poplar / Assemblages / Ancient treatises / Ancien Régime / Typo-chronology

Introduction

The aim of this contribution is to present the main results of a study conducted on the use of wood planks as floorings in Brussels between the late 16th and 19th centuries. The work is part of doctoral research on construction materials, principally wood and brick, conducted at the Research Centre for Archaeology and Heritage at the Université libre de Bruxelles (Sosnowska, 2013). It benefits from a collaboration with the department of Archaeological Heritage of the Regional Public Service of Brussels (SPRB) and, for some cases, with the Royal Museums of Art and History (RMAH), including in particular the execution of detailed study of several archaeological sites in the territory of the Brussels Capital Region. These operations allow recording of abundant technical data

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Fig. 4.1. Site of the Hôtel de Merode, Brussels: flooring on the 1st storey. Photo: P. Sosnowska © DMS/RMAH

on these wooden structures via an *in situ* archaeological study, but also by the sampling of planks in order to complement the archaeological data with dendrological and dendrochronological analyses.[1] These were conducted for the most part by the Royal Institute for Cultural Heritage (KIK-IRPA; Fraiture *et al.*, 2013), but also by the European Centre for Archaeometry at the University of Liège (Gerrienne, 2009; Weitz and Gerrienne, 2011).

It should be noted at the outset that this research is not exhaustive and covers a fairly limited dataset of floorings, with ten sites studied (Sosnowska, 2013: 130-131). These sites are, however, sufficiently well-documented and dated to set the foundation of a synthetic approach for a detailed study of such structures and to demonstrate the interest in a better comprehension of craftsmen's skills during the *Ancien Régime* (fig. 4.1).[2] We thus examine in turn different approaches and questions. After description of the study subject, the dataset and the methodological aspects of the archaeological and dendrochronological analyses, we discuss the wood species exploited (Scots pine, poplar, spruce and elm), the qualities of each and their means of supply. This is followed by the description of the modes of cutting and shaping planks, assemblage techniques and changes in these through time. Finally, we examine some aspects of the installation and finishing of the planks, as well as means of attachment to the supporting structure. Throughout this article, the archaeological documentation is put into perspective with written sources, which include treatises and archival documents.

Apart from a few case studies, the scientific literature on the production of floorings and shaping of planks for floorings is poorly developed for Brussels cultural heritage and nearly non-existent for the Southern Netherlands. Archaeological research published on wood is in majority from the study of roof frames and timber-frame housing and concerns the study of structural work in oak (e.g., Hoffsummer, 1999; Hoffsummer, 2002; Houbrechts, 2008). For finishing work, parquet floors have most attracted the attention of historians of construction and art historians given the sumptuousness of their workmanship.[3] Our analysis does not directly involve this kind of flooring. This choice results in part from the low number of parquet floors in the dataset since, to date, only a single 18th-century parquet has been comprehensively studied (Taeymans, 2006a; Taeymans, 2006b), and in part from significant differences in implementation between a parquet and a plank flooring. These differences are observed both in the more complex execution of a parquet (which sometimes includes the installation of a subfloor, sleepers, plaster, etc.) and in the choice of materials utilised, and particularly in the much greater variety – and the precious value – of wood species used for their creation. Heritage and dendroarchaeological studies of finishing work in these regions are extremely rare. These include a few case studies (Buijs and Bergmans, 2010; Sosnowska, 2011: 177-193; Fraiture and Crémer, 2014; How *et al.*, 2016), with rare exceptions of attempts to produce a synthesis (Fraiture, 2015). We note in addition that studies undertaken on species other than oak in the Southern Netherlands have slowed to a trickle, whether with respect to dendrochronology, archaeology or history. Further, the lack of interest in wood finishing work in general is surprising considering that it is crucial for the spatial organisation of a building (staircases, doors, walls, etc.), the creation of elements of comfort (window frames, built-in cabinets, etc.) and decoration (panelling, ceilings, etc.).

Definitions of plank and parquet floorings

The term *plancher* in French is applied to two different but complementary structures. On one hand, it refers to a horizontal component of the frame separating the stories of a building (i.e., subfloor) and supporting a floor covering (i.e., flooring) (Chabat, 1881, vol. IV: 12; Pérouse de Montclos, 2011: 142). When it is exposed and horizontal, the lower surface of the *plancher* is called the *plafond* (ceiling) (Pérouse de Montclos, 2011: 142). It can also refer to a particular type of more rudimentary parquet, characterised by the successive juxtaposition of planks via tongue-and-groove assemblage, 'squared across their entire width or recut with a width of three or four inches'[4] (Roubo, 1769: 154).[5] A parquet flooring *sensu stricto* is an assemblage of wooden elements joined by the tenon-and-mortise technique to form different blocks or compartments (Roubo, 1769: 154). This distinction is accepted by Pierre Chabat, but with a few qualifications with respect to the kinds of assemblages and a clear differentiation in the thicknesses of each kind of flooring. For Chabat, a plank flooring is an assemblage of 22 cm wide planks with butt joints while parquet floorings are composed of thin wood pieces 7-12 cm wide with tongue-and-groove joints (Chabat, 1881, vol.3: 543).[6] The floor as a supporting structure is part of structural work components since it contributes to the stability of a building, while floor coverings are part of finishing work.[7]

According to Roubo, the installation of wooden floorings is part of the joinery arts, and more specifically the fixed joinery of assemblage (Roubo, 1769: 1). The definition proposed by the author raises the difficult problems of the division of the execution of floorings between carpentry and joinery. Such precepts in Brussels should be qualified as multiple conflicts in the 15th century between the corporations of joiners and carpenters have been documented (Janssens, 1988: 22-24). Indeed, the professions regularly departed from their respective spheres of activity, carpenters acting as joiners, joiners becoming carpenters (Paquay, 2002: 385). To resolve these disputes, the Magistrate of the city promulgated a series of ordinances with a list of works proper to each corporation.[8] For example, it was forbidden for joiners to build staircases, doors, windows, ceilings, etc.[9] In this specific case, the term ceiling (*plafond* in French, *solre/solringe* in Middle Dutch; Verdam, 1932: 556; gtb.inl.nl),[10] refers to both the area of circulation – the flooring – and the covering of a room – the ceiling. No semantic distinction was thus made between these two structures. This duality ultimately expresses a quite material reality, that of the non-existence of a structural difference between a floor covering and a ceiling, the latter being only the under-surface of the first (Pérouse de Montclos, 2011: 272). We note, in fact, that until the early 18th century, ceilings with 'exposed' joists were the most common in the ordinary Brussels houses (fig. 4.2) (Sosnowska, 2013: 163-165).

4.2

Archaeological dataset

The study of these structures was conducted using archaeological methodology. The zone to be studied was cleaned, a plan drawing was made of the flooring at a 1:20 scale, allowing relatively rapid and simple execution while providing the necessary precision for the recording of the smallest details (e.g., nails, nail holes, plugs and wooden grafts) and finally, data recording by stratigraphic unit was done using the methodology we have developed (Sosnowska, 2013) (fig. 4.3). When a flooring was to be demolished, dismantling according to the structure was done to draw and study the supporting structure. Particular attention was given to the position of nail holes, bent nails, laths serving as wedges to heighten the flooring, etc. These details are crucial to determine the original state of the floor covering, and even more so in the construction of a typo-chronology for this kind of covering. Planks were sampled by taking slices to identify the wood species used, the types of cutting and shaping of the assemblages and, when necessary, for dendrochronological analysis.

Fig. 4.2. Site of the Hôtel de Merode, Brussels: view of a ceiling with visible joists covering the 1st storey. Photo: P. Sosnowska © DMS/RMAH

4.3

The dataset of floorings studied is composed of structures from ten sites, including, in some cases, several different phases. Samples of the planks were collected for eight of these sites (table 4.1). However, sampling could not be done entirely systematically or logically as it was dependent on the administrative form of the intervention (preventive archaeology, programmed archaeology in a classified building, etc.) and on accessibility to the structures. In total, 103 wood samples were collected. These cover four centuries, from the late 16th to the 19th century. Most are from modest, ordinary or privileged houses; one sample, however, is from a religious institution and another from a farm.

Dendrochronological study of the planks

The dendrochronological study of the floorings in Brussels is new in the sense that no date on Scots pine (*Pinus sylvestris* L.) had ever been made previously in Belgium. This is primarily due to the predominant use of oak in architecture in these regions (see below), which has thus been the focus of dendrochronological research here, unlike other regions where coniferous woods were more commonly exploited.[11] We clarify, however, that some countries in Western Europe similar to Belgium with respect to choice of wood species (England, Scotland, the Netherlands) had previously addressed the question of the use of coniferous woods in architecture using dendrochronology. Some studies were specific, dependent on opportunity (Groves, 1997; Crone and Sproat, 2011; Domínguez Delmás *et al.*, 2011), while others were programmed in view of the potential of the information obtained.[12] We hope that this initial research on Belgian architectural material of Scots pine will lead to systematisation of the dendrochronological study of coniferous woods.

Fig. 4.3. Site at Rue Notre-Dame du Sommeil 17, Brussels: detail showing the stratigraphy of the different floorings on the 1st storey (17th-20th century). Photo: P. Sosnowska © DMS/ULB

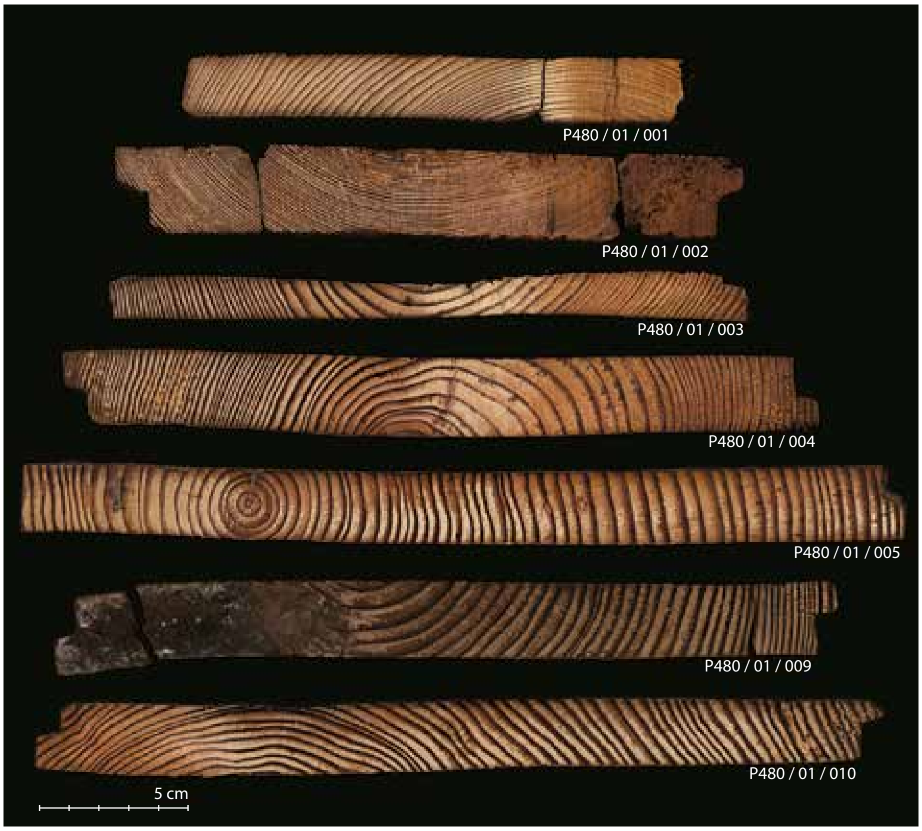
Sites	Plank width (cm)	Plank thickness (cm)	Assemblage type	Sawing type	Distance between striations (mm)	Plank type			Wood species	Date
Musée du Béguinage, Rue du Chapitre 31, Anderlecht	21.7 to 25.3	2.1 to 2.9	slip tongue-and-groove	mechanical	1 to 2	7 Slab	2 semi-radial	1 radial	Scots pine	1792-1814d
Maison (of Hôtel) Dewez, Rue de Laeken 73 and 75, Brussels	25.5	2.4	slip tongue-and-groove	mechanical	?	1 Slab			spruce	Late 18th century
Hôtel La Traviata, Rue des Pierres 34, Brussels	21.4 to 29.6	2.2 to 2.6	half-lap joint in S-profile	manual	1 to 6	4 Slab	1 semi-radial	1 radial	Scots pine	1st third of 18th century
House, Quai aux Bois-de-Construction 3, Brussels Phase 1	26.7 to 31	2 to 2.3	half-lap joint in S-profile	manual	2 to 7			8 radial	poplar	18th century
House, Quai aux Bois-de-Construction 3, Brussels Phase 2	20.8 to 26.2	2.3 to 3	slip tongue-and-groove	mechanical	2 to 3	5 Slab			Scots pine	19th century
Hôtel de Merode, Rue aux Laines 35, Brussels Phase 1	25.9 to 38.2	2.5 to 3.2	half-lap joint in T-profile	manual	1 to 4	2 Slab	1 semi-radial	6 radial	Scots pine	1570-1610d
Hôtel de Merode, Rue aux Laines 35, Brussels Phase 2	28.5 to 37.3	2.2 to 2.9	half-lap joint in T-profile	manual	3 to 8	?	?	?	poplar	1674d
Hôtel de Merode, Rue aux Laines 35, Brussels Phase 3	25.9	2.9	slip tongue-and-groove	mechanical	2			1 radial	Scots pine	19th century
House, Rue du Chevreuil 21, Brussels	19.2 to 32.1	2.2 to 2.6	half-lap joint in S-profile	mechanical	2 to 3	?	?	?	poplar	1774d
House, Rue Notre-Dame du Sommeil 17, Brussels	36.5 to 42	2.2 to 2.4	half-lap joint in T-profile	manual	1 to 5	?	?	?	poplar	17th century
Ferme Rose, Avenue De Fré 44, Uccle	15.1 to 45.4	1.9 to 2.4	half-lap joint in S-profile	manual	1 to 8	2 Slab			poplar	18th century

Tab. 4.1

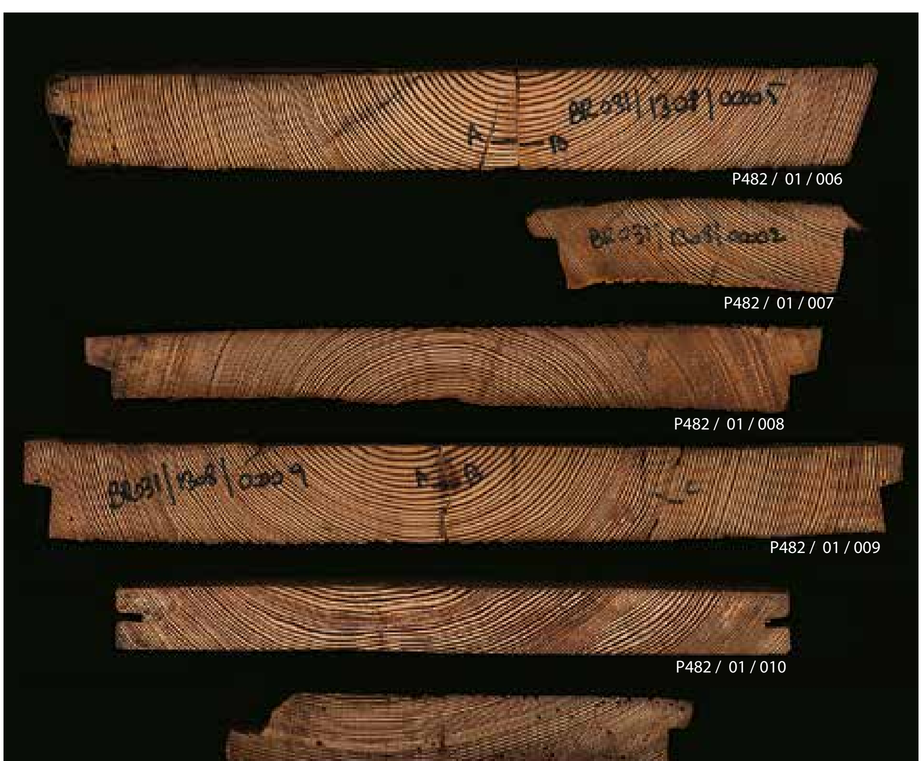
Table 4.1. Dataset of the floorings studied.

Methodology

Dendrochronological sampling consisted in removals of slices cut with a ribbon saw along the width of the planks to obtain the transversal section of the trunk. Preparation of the surface to be measured was done by sanding with increasingly fine-grained discs (from P40 to P1200) to make the limits between tree rings completely clear. The prepared samples were scanned at high resolution (800 or 1000 dpi; fig. 4.4 to 4.6), with calibration at a millimetre scale. Tree-ring widths were then measured on the computer screen via these digital files.[13] For samples showing very slow growth (very narrow tree rings), a second series of measurements was made using a binocular microscope to provide a set of observations of the tree rings independent of those made on the scans.[14] The measurement series, both onscreen and by microscope, have a precision of 1:100 mm.



4.4



4.5

Fig. 4.4. Scan of the samples of planks from the Hôtel La Traviata, Brussels: rapid growth rhythm; planks cut by through-and-through sawing (the orientation of the tree rings indicates the original position of the planks which come from the entire log, at different distances from the tree's centre); assemblage with S-profile. Scans: S. Crémer and P. Fraiture

Fig. 4.5. Scan of the samples of planks from the site of the Hôtel de Merode, Brussels: extremely slow growth rhythm; most planks produced by through-and-through sawing, originating from the part near the centre of the log (except for sample no. P482-01-005, slab plank from near the periphery of the trunk); assemblage with T-profile. Scans: S. Crémer and P. Fraiture

4.6

Fig. 4.6. Scan of the samples of planks from the site of the Musée du Béguinage, Anderlecht: extremely slow growth rhythm; planks produced by through-and-through sawing, originating from the entire log, at different distances from the tree's centre; slip tongue-and-groove assemblage profile. Scans: S. Crémer and P. Fraiture

Synchronisation calculations for relative and absolute dating were done using the *Dendron* system (version IV), after having calibrated the dendrochronological series by the adjusted corridor transformation developed by Lambert (Lambert, 2006).[15] The correlations are based on a statistical test derived from the Student test, calculated using two correlation coefficients (Lambert, 2006); visual verification and replication provide further support to guarantee a date.

Sample set

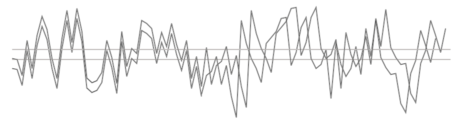
The dendrochronological sample set is composed of 95 planks from six sites (table 4.2). Variability in preservation of the floorings played a considerable role in the quality of the samples. The Hôtel La Traviata provided 15 planks for the dendrochronological study, the Hôtel de Merode 17, the Musée du Béguinage in Anderlecht 23 and the house at Quai au Bois-de-Construction only three, while the sites of Rue Notre-Dame du Sommeil and Rue du Chevreuil provided five in total and the Maison Dewez a single sample. However, a date is more reliable when several individual series can be grouped in a dendrochronological mean, i.e., a 'chronology'.

The diversity in wood species used also affected the analysis (table 4.1), in particular the use of poplar which is not compatible with dating by dendrochronology (see below). As such, a third of the planks could not be analysed, again limiting the number of samples for certain sites (e.g., 18 planks from the house at Quai au Bois-de-Construction are of poplar, six for the Hôtel de Merode), but especially eliminating any possibility for dating the sites of Rue Notre-Dame du Sommeil and Rue du Chevreuil since all of the planks were of poplar.

An additional constraint results from the number of tree rings present on the planks. This depends in part on the growth rhythm of the tree since, with equal dimensions, a plank with rapid growth will have fewer rings than one with slow growth (fig. 4.4 versus 4.5), and in part on the original position of the plank in the trunk, since a plank from near the centre of the tree will include more rings than one cut along the outer edge of the tree (slab boards) (fig. 4.5, sample no. P482/01/005). The only sample available for the Maison Dewez contains only 40 rings, due to rapid growth. Since a reliable date for a single sample requires a minimum of 80 or 100 rings, the chance of obtaining a valid result for this site is practically impossible. More generally, of the 46 Scots pine planks retained for the analysis, only eight had more than 80 rings (table 4.2).

Next, the capacity of Scots pine to form 'false' tree rings or to not form a ring in a given year ('missing' tree rings) complicated the analysis.[16] As these growth irregularities can be identified by crossdating, two samples were collected on the planks when possible, and up to four different radii were measured. When the correlations between these different measurements account for shifts that reflect the presence of such irregularities, the difficulty lies in the identification of the correct series and those that are not strictly annual (fig. 4.7). As a result, inevitable complications occur when constructing chronologies within a site. At the Hôtel de Merode, only four planks could be grouped in a mean from the ten retained for study and the case of Anderlecht is even worse since, of the 16 individuals inventoried, no synchronisation was successful! Finally, for the house at Quai au Bois-de-Construction 3 (two planks of eight were assembled in a chronology) and the Hôtel La Traviata (five planks of ten were grouped), the short lengths of the individual series limited the construction of chronologies with a significant number of individuals (table 4.2).

All of these factors affecting measurement and synchronisation in the sample set had repercussions on dating. First, the limited number of samples and problems of crossdating meant that most of the tree-ring series had to be dated individually. This procedure is generally difficult, in particular when the climatic signal of the series is not strong – grouping individual series in a chronology allows this signal to be reinforced – and for short series, which is primarily the case here. Indeed, none of the planks from the Hôtel La Traviata have more than 67 tree rings and only one of the pine planks from Quai Bois-de-Construction 3 numbered 80 tree rings. In contrast, eight planks from Anderlecht and nine from the Hôtel de Merode go significantly beyond this threshold and have up to 150 tree rings for the first and 280 for the second site (table 4.2). These two sites were also the only ones to have been dated with certainty (see below).



4.7

Fig. 4.7. Drawing of two dendrochronological series showing a shift due to a 'false' tree ring on one series or a 'missing' tree ring on the other. Drawings: S. Crémer and P. Fraiture

Hôtel La Traviata, Rue des Pierres 34, Brussels					
ID dendro KIK-IRPA	**No. of measured rings**	**Mean ring width (in mm)**	**No. of visible sapwood rings**	**Cambium**	**Dating result**
P480/01/003	41	2.09	/	/	P480-M3, dendrochronological mean of 5 planks, undated
P480/01/004	59	1.93	/	/	
P480/01/005	54	4.02	/	/	
P480/01/007	33	3.60	/	/	
P480/01/010	74	3.45	/	/	
P480/01/001	44	1.95	/	/	undated
P480/01/002	67	0.93	/	/	undated
P480/01/006	41	3.65	/	/	undated
P480/01/008	37	3.25	/	/	undated
P480/01/009	38	3.64	/	/	undated

House, Quai aux Bois-de-Construction 3, Brussels					
ID dendro KIK-IRPA	**No. of measured rings**	**Mean ring width (in mm)**	**No. of visible sapwood rings**	**Cambium**	**Dating result**
P481/01/009	80	1.26	/	/	P481-M1, chronology grouping 2 planks, undated
P481/01/012	76	1.23	21	/	
P481/01/010	55	2.03	/	/	undated
P481/01/011	50	1.81	/	/	undated
P481/01/013	54	2.20	/	/	undated
P481/01/018	45	2.16	/	/	undated
P481/01/019	44	1.97	/	/	undated

Hôtel de Merode, Rue aux Laines 35, Brussels					
ID dendro KIK-IRPA	**No. of measured rings**	**Mean ring width (in mm)**	**No. of visible sapwood rings**	**Cambium**	**Dating result**
P482/01/001	224	0.73	58	/	P482-M2, chronology grouping 4 planks, dated: felling between 1570 and 1620
P482/01/002	181	0.98	28	/	
P482/01/004	277	0.58	43	/	
P482/01/008	204	0.59	33	/	
P482/01/003	158	1.03	/	/	undated
P482/01/005	64	0.93	/	/	undated
P482/01/006	102	1.58	/	/	undated
P482/01/007	87	0.99	/	/	undated
P482/01/009	106	1.52	/	/	undated
P482/01/010	87	1.18	/	/	undated

Tab. 4.2

Table 4.2. Dendrochronological sampling.

Maison (of Hôtel) Dewez, Rue de Laeken 73 and 75, Brussels					
ID dendro KIK-IRPA	**No. of measured rings**	**Mean ring width (in mm)**	**No. of visible sapwood rings**	**Cambium**	**Dating result**
P497/01/001	40	3.47	/	/	undated

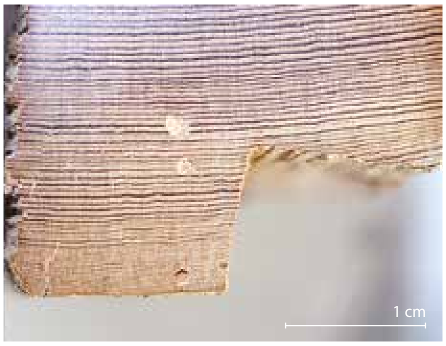
Musée du Béguinage, Rue du Chapitre 31, Anderlecht					
ID dendro KIK-IRPA	**No. of measured rings**	**Mean ring width (in mm)**	**No. of visible sapwood rings**	**Cambium**	**Dating result**
P498/01/002	91	0.76	41	/	P498/01/008-002-ech (2 planks from the same tree), dated:felling between 1792 and 1814
P498/01/008	103	0.72	38	/	
P498/01/012	78	1.12	/	/	P498/01/015-012-ech (2 planks from the same tree), undated
P498/01/015	74	1.11	24	/	
P498/01/001	150	0.59	74	close ?	undated
P498/01/003	59	1.35	/	/	undated
P498/01/004	146	0.60	49	/	undated
P498/01/005	77	1.07	/	/	undated
P498/01/006	118	0.83	/	/	undated
P498/01/007	86	0.92	/	/	undated
P498/01/009	59	1.26	/	/	undated
P498/01/010	51	1.41	/	/	undated
P498/01/011	110	1.17	/	/	undated
P498/01/013	58	1.36	/	/	undated
P498/01/014	86	1	/	/	undated
P498/01/016	52	1.45	/	/	undated
P498/01/017	56	1.65	/	/	undated
P498/01/018	54	1.21	/	/	undated

Tab. 4.2

Reference chronologies

The database of absolute chronologies for coniferous woods (Scots pine and spruce), constructed through the collaboration with many European laboratories, covers several centuries and two broad geographic zones.[17] One roughly covers Switzerland, eastern France, southern Germany, Slovenia and Spain. The others includes chronologies representative of the Scandinavian and Baltic countries, Poland and Russia. These chronologies were produced from living or standing dead trees, and wood from archaeological material potentially transported over more or less long distances.[18]

It should be noted that our database of coniferous chronologies does not include all of the possible provenance areas for the trees used in the Brussels floorings. Supply sources such as North America (Groves, 2000: 60)[19] and Central Europe can however be explored in other laboratories by comparing our chronologies with their own datasets.[20] Nevertheless, the hypothesis of exploitation of native pine around Brussels cannot be verified before the creation of absolute chronologies specific to this region.



4.8

Interpretation of a dendrochronological date

The date obtained for the last tree ring measured on a sample indicates the felling time for the tree, which will be determined with varying precision depending on the state of preservation of sapwood on the samples dated (absent, partial, complete). However, no cambium was identified on the sampled planks; sapwood is thus considered to be incomplete. It should be clarified that unlike oak sapwood, Scots pine sapwood does not decay. Wood craftsmen therefore did not need to remove it for the use the wood in floorings.[21] It should be noted, however, that squaring of long planks like those analysed may have caused the loss of the final tree rings, depriving us of some or all of the sapwood on the samples collected. For cases of extremely slow growth, the loss of 2-3 mm of wood can result in the loss of 25 rings (fig. 4.8). At this stage, the obstacle thus lies in determination of the proportion of missing rings. This estimation is difficult since the number of sapwood rings can vary from one tree to another and even within a single trunk. In addition, unlike oak, very little statistical data is available concerning the number of sapwood rings for Scots pine, according to age, growth rhythm and provenance.[22]

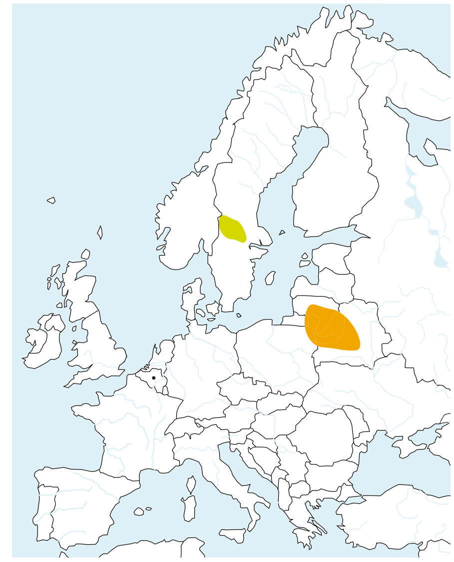
Finally, it must be emphasised that the dates provided by dendrochronology correspond to the felling of the trees and not their utilisation. The time elapsed between the felling period and use of the wood must therefore be estimated. This interval is generally short for carpentry, from six months to a year after felling, in the majority of cases (Hoffsummer, 1995; Hoffsummer, 2002; Hunot, 2001; Épaud, 2011 Houbrechts, 2008). In contrast, it is inevitably longer for joinery products because, in addition to squaring and transport, one must add the time needed to cut and dry the planks and make the woodwork.[23] For oak, historical and archaeological research suggests that for the period from the 15th to 17th century, the time elapsed between felling and use could be only a few months (Fraiture and Haneca, in press). However, some dendrochronological studies have shown a longer interval between the dendrochronological date and the known or estimated use date (Fraiture, 2012).[24] For pine, no large-scale study on this subject is known to the authors. This interval is therefore considered to be highly variable and cannot be generalised. The dendrochronological result proposed for felling is thus also provided as a *terminus post quem* for the installation of the structure.

Dating of the Brussels floorings

At the Hôtel de Merode, ten of 11 Scots pine planks from one of the floorings were retained for dendrochronological analysis; these have between 60 and 280 rings. Four ring series were crossdated and the resulting chronology (277 rings) was dated with a final tree ring in 1563 (table 4.2).[25] The trees from which these planks were cut come from Scandinavia, most likely in central Sweden (table 4.3a and fig. 4.9).[26] It is of interest that central/west Sweden-Norway was an area known for the export of deals (boards) more than of baulks (Groves, 2000: 63). Since sapwood was visible on four samples, a chronological range for felling is estimated between 1570 and 1610.[27] The dendrochronological result could associate part of the dated flooring to a work campaign conducted from 1616-1618 (Sosnowska, 2008: 15, 27) if we consider the time that could have elapsed between felling and use of the wood.

Fig. 4.8. Detail of the end of growth for a Scots pine sample with very slow growth: 2-3 mm of wood containing more than 30 rings (Hôtel de Merode, sample no. P482-01-001). Photo: S. Crémer and P. Fraiture

Hôtel de Merode, Rue aux Laines 35, Brussels						
P482-M2 : 1287 – 1563 AD						
Student's *t*	**Corr. coeff. 1**	**Corr. coeff. 2**	**Probability/ security**	**Overlap**	**Repository chronology**	**© reference**
8.23	0.4	0.56	0.999995	174	GvleC-PISY-1383-2011-Gavle-Suede	Larsson (www.cybis.se/forfun/dendro)
6.09	0.25	0.42	0.99999	266	Alvdalen-PISY-1168-1768-Dalarna-Suede	Larsson (data by Bertil Israels and Torbjörn Axelson)
5.76	0.29	0.42	0.999982	203	London-West-minster107Jer-mynStreetJemGrp02	Groves and Locatelli, 2005
4.33	0.28	0.31	0.999921	182	NLPISYv1.7-SvD	van Daalen Dendrochro-nology, unpublished (former BAAC bv, NL)
4.23	0.25	0.24	0.999918	267	RangersHouseGreenwich-ParkLondonRANGR-P1	Tyers, forthcoming
4.07	0.31	0.35	0.9999	121	Kungsberg-PISY-1441-2005-Dalarna	Larsson (www.cybis.se/forfun/dendro)



4.9

Musée du Béguinage, Rue du Chapitre 31, Anderlecht						
P498/01/008-002-ech : 1685-1791 AD						
Student's *t*	**Corr. coeff. 1**	**Corr. coeff. 2**	**Probability/ security**	**Overlap**	**Repository chronology**	**© reference**
7.13	0.45	0.59	0.999992	102	NYorkshireBishopthorpePa-laceBishopthorpebsta-T5a	Arnold *et al.*, 2008 (English Heritage, UK)
5.15	0.27	0.57	0.999958	104	ZP06PSC425_Vilnius_RP	Pukienė R., unpublished (National Museum, Palace of the Grand Dukes of Lithuania, LT)
4.77	0.24	0.55	0.999945	104	zpMLpsc7323_Vilius_refRP	Pukienė R., unpublished (National Museum, Palace of the Grand Dukes of Lithuania, LT)
4.25	0.27	0.46	0.999911	104	DevonWarleighHouseTamer-tonFoliottmfasq05	Howard *et al.*, 2006
4.12	0.34	0.37	0.999903	104	SWED022	Schweingruber, ITRDB

Tab. 4.3

At the Musée du Béguinage in Anderlecht, 23 planks were recovered. All are of Scots pine and 18 of these were studied, those with 50-150 tree rings (table 4.2). Crossdating revealed twice that two planks originated from the same tree. Apart from this, no other synchronisation could be found between the planks. All of the individual series were thus compared to the reference database and only one could be reliably dated, using the Baltic chronologies.[28] Since sapwood was present, the range of 1792-1814 is proposed for felling (last tree ring measured dating to 1791; table 4.3b and fig. 4.9).[29] The lack of correlation between the individual series from the site and the dating of a single sample prevents confirmation of the homogeneity of the flooring proposed on the basis of the typology of the assemblages.

Table 4.3. Dating results for the planks from the Hôtel de Merode, Brussels (4.3a) and the Musée du Béguinage, Anderlecht (4.3b) compared to the KIK-IRPA reference database for conifers.

Fig. 4.9. Geographic provenances identified by dendrochronology for the dated planks of floorings from the Hôtel de Merode (in green) and the Béguinage of Anderlecht (in orange). Map: S. Crémer and P. Fraiture

From the tree to the plank…

Selection of wood species to create the flooring planks

Both treatises on architecture and joinery and carpentry studies describe the attention paid by the construction sector to the choice of wood species and the different qualities of the wood used in buildings (Houbrechts, 2008: 17; Épaud, 2011: 30-32; Touzé, 2011: 23-24, Hunot, 2001: 41). While, based on Hoffsummer (2002), oak was the most common used for structural work in the Southern Netherlands, archaeological and dendrological studies in the Brussels region have also revealed the use of cherry wood, ash, poplar and elm in carpentry (Charruadas and Sosnowska, 2013: 34-36; Sosnowska, 2013: 15-16; Weitz *et al.*, 2015: 200-201; Weitz *et al.*, 2016).

With respect to floorings, only spruce (*Picea* sp.), elm (*Ulmus*), poplar (*Populus*) and Scots pine (Pinus sylvestris) have been identified in Brussels; no evidence of oak or other species is found in our dataset (Gerrienne, 2009; Weitz and Gerrienne, 2011: 3; Fraiture *et al.*, 2013) (table 4.1). Poplar and Scots pine are representative of the 16th-18th centuries while elm has been identified in a building from the first third of the 18th century, alongside Scots pine, and spruce appears only in a context built in the late 18th century (Sosnowska, 2011: 190; Gerrienne, 2009). We stress that the very low representation of elm and spruce in the dataset at present prevent establishment of a broader consideration of the use of these two species. As a result, they will no longer be discussed in this article.

From the published contracts awarded in Brussels, coniferous woods were the only choice indicated for floor coverings. The specification for the construction of the refuge at the Dieleghem abbey, for example, mentions a series of works that were to made of pine (*denen*): the doors of the rooms on the first storey were to made of *widt denen* ('white fir') and the floorings of *goedt denen*, without further clarification of the exact nature of the wood (Van den Haute, 1968-1969: 42). In addition, some construction accounts indicate the use of red fir (*roode denen*) (Hennaut, 2011: 84; Culot, 1992: 175, 264-265). Caution is needed in the interpretation of the descriptions of colour. However, if we compare these terms to modern references, red fir may correspond to Scots pine (*Pinus sylvestris* L.), also called northern red fir (Rameau *et al.*, 2008: 347) given its more or less dark salmon pink colouration (Barry-Lenger *et al.*, 1999: 94-95). In contrast, white fir may be identified as silver fir (*Abies alba* Mill.) whose wood is a creamy pinkish white (Barry-Lenger *et al.*, 1999: 94-95).

This use of white wood and conifers differs from the practices observed at sites in Liège[31] and the southern Brabant (Fraiture and Crémer, 2014) where oak dominates. Brussels is also at odds with some French treatises of the *Ancien Régime*, although far from the geographic context of this article, which also consider oak as the ideal species. Roubo (1769: 162) thus prescribes oak and even insists that, for floorings, one should never use 'pine, because this wood is too soft and shrinks too much'.[32] However, other treaties of the *Ancien Régime*, but especially those from the 19th century, qualify these writings.[33] Philibert Delorme (1561: f°3) points out that if oak is unavailable, beech, poplar, ash, elm, pine, fir, chestnut, etc. can also be used.[34] Similarly, pine is described as being very good for frames and poplar suitable for joinery or carpentry depending on the species (Nosban, 1827: 47-48; Garraud, 1869: 171).

We note from the outset that poplar is the dominant white wood species in the region studied. Two species were used: European aspen and white poplar.[35] While both were used in joinery, white poplar appears to be better adapted for construction (Garraud, 1869: 171-172, 174-175): cut into small planks, in Flanders it was used to 'make beautiful parquets' and lends itself well to the assemblage (Nosban, 1827: 47). Based on Bosc and Baudrillart (1821: 645), this species was used in rural buildings and all kinds of planks of different thicknesses were cut from the trunks 'for use in the interior'. The rapid growth of this species allows the trunk to obtain its optimum between 20 and 30 years, which is not the case of oak and beech for example, which are slower growing trees (Nosban *et al.*, 1929: 4).[36] Its use, as well as birch, ash and beech, is very often observed in construction, particularly in the ancient palace of Dukes of Brabant (currently Palace of Coudenberg), in secondary buildings or constructions of lesser importance: stables, mills, scaffolding, roofing material and other parts of building made of whit wood, etc. (Rochette, 1960: 73). Poplar is also abundantly used in vernacular architecture, according to written sources (Pierron, 1905 142-143, 243). Its use is attested since at least the 15th century and thus evidences a long tradition in construction.

Pine is an imported species that seems to have been exploited in the Southern Netherlands, and more specifically in the northern Campine region, from the early 17th century, if we accept Gobelet d'Alvillea (1927: 409). It was not, however, used in Brussels or its immediate periphery before the turn of the 20th century (Charruadas, 2012: 103). The dendrochronological study of the flooring of the Hôtel de Merode, dated to the late 16th or early 17th century, shows the use of Scots pine from Scandinavian countries, while the flooring in the Béguinage of Anderlecht, dated to the late 18th or early 19th century, is of Scots pine from Baltic provenance (see above; fig. 4.9 and table 4.3). The simultaneous use of pines from these two large provenance zones has also been demonstrated in England in a single building (Groves, 2000), and in Scotland in different buildings (Crone and Mills, 2012).

It should be noted that these dated planks come from trees of more than a hundred years old, with slow growth (table 4.2; fig. 4.5 and 4.6). At present, no pine plank originating from the Southern Netherlands has been identified at Brussels sites after the 18th century, which is due to the fact that there is currently no dated pine chronology for our regions. Yet it is plausible that planks in the dataset, in particular those with rapid growth very different from the imported ones, come from regional exploitation (fig. 4.4). This was demonstrated in the Netherlands for constructions in the late 19th century at the earliest (Sass-Klaassen *et al.*, 2008), and in Scotland where the 'commercial exploitation of native Scottish pinewood began in earnest in the early 17th century' (Smout *et al.*, 2007: 193 cited in Crone and Mils 2012: 334). This issue could be explored through historical research, coupled with targeted dendrochronological sampling campaigns.

Several arguments shed light on the reasoning behind wood species selection, first from a structural viewpoint. We point out their relative lightness in comparison to oak, reducing the weight exerted on the exposed beams and thus an ideal material to create floor coverings. Dendrological studies show that oak is one of the heaviest species and the Scots pine and poplar among the lightest (Barry-Lenger *et al.*, 1999: 94-95).[37] These same studies also demonstrate that pine is highly resistant, easy to nail and holds nails well. It is also less susceptible than oak to shrinkage and swelling (Barry-Lenger *et al.*, 1999: 128-131), making it a material particularly well-adapted for cutting into planks.[38] Poplar does not have all of these qualities since it is softer, more fragile and has little tendency to split, but is excellent for nailing, resists splintering (Barry-Lenger *et al.*, 1999: 94-95) and also undergoes less movement than oak.[39] Poplar also allows the cutting of wider planks than other species (see above).

It remains to consider the difficult question of the cost of the product by species – poplar, pine or oak – in the context of Brussels in the 16th-19th centuries. Pertinent data is relatively rare. For example, written sources indicate that poplar had little value and was frequently the object of gracious donations to village communities or some congregations for rural timber-frame construction (Charruadas and Sosnowska, 2013: 35-36). The same observation appears for the Duchy of Brabant (De Jonge *et al.*, 2009: 176). One can also envisage efficient management of resources for construction timber in Brussels, dependent on the availability of different species on the market. In a forested context less abundant than the rich regions situated south of the Sambre and Meuse band, it is plausible than oak was reserved for structural work and poplar for floorings. With respect to Scots pine, one should distinguish that produced locally, or at least regionally, from that imported from northern countries, the transport cost representing the majority of the price of timber (Tossavainen, 1994: 1.2; Sosson, 1996: 752). Regardless, a systematic survey of the Brussels archives would certainly provide a clearer picture of the cost and modes of wood supply for the production of floor coverings.

Finally, we note that oak is not entirely excluded from the creation of floor covering since it is cut into thin strips to be used in the installation of slip tongue-and-groove floorings. This specific use may be linked to the high resistance and density of oak wood.

Cutting of the planks

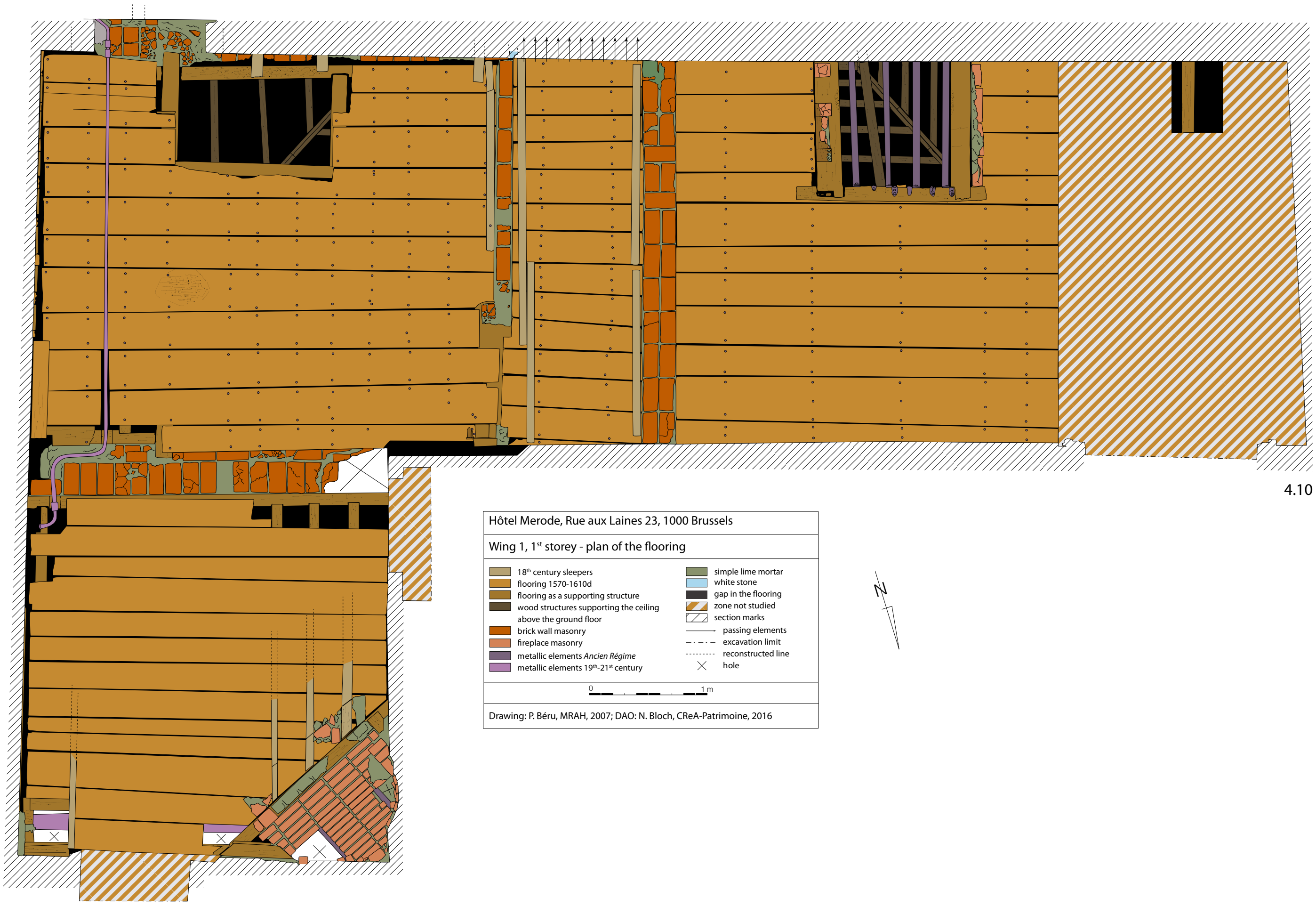
In Brussels, it appears that wood cutting was done primarily, if not uniquely, by through-and-through sawing, at least until the 18th century. This allows the archaeological analysis of the planks using the following indices: variability in the widths of the planks within a single flooring, differences in dimensions at the ends of a single plank and the nearly trapezoidal section of some planks that follows the initial conical form of the trunk.[40] These data are corroborated by ancient joinery treatises (Roubo, 1769: 32-33).

This cutting technique is time-efficient and easy to implement. The work is executed in three stages: bark removal, placement of lines for cutting the planks and sawing itself. This results in all of the planks being utilised, even the slab planks coming from the edges of the log, which are the most likely to become deformed. Indeed, the latter are present when making floorings, alongside radial- and semi-radial-cut planks. A high disproportion between the planks of each type can be seen in some cases, perhaps related to the species utilised. For pine floorings, the number of slab planks is relatively high, with the exception of the Hôtel de Merode which is composed of planks coming in majority from near the centre of the log (fig. 4.5). The site of Quai aux-Bois-de-Construction 3 contains six slab planks from a set of 13 planks in total. At the same site, another flooring in poplar has no slab planks in 12 samples. A similar observation can be made for the Scots pine flooring at the Hôtel La Traviata which has a higher number of slab planks (fig. 4.4). Two reasons, perhaps connected, can be proposed to explain such use: the low shrinkage of pine that makes slab planks less subject to buckling and the selection of planks of the best quality (radial and semi-radial planks) for more refined works, such as parquet floorings. These are, however, preliminary observations that should be tested by future studies.

At the Hôtel de Merode, the planks are of trapezoidal and non-parallelepiped format, due to the longitudinal conical section of the tree trunk. The ends of the planks have differences in width between 6 to 11 cm from one side to the other, with respective lengths of 3.24 m and 3.80 m. They thus were not squared, probably to economise labour and materials. However, in contrast, their installation would have been more complicated given the irregularity in the planks to be assembled. This implementation is even more surprising since this is an aristocratic house and the rooms with this kind of flooring are found on the main storey and decorated with wall paintings (Sosnowska, 2008: 22, 27-28). From this viewpoint, the Hôtel de Merode is an exception since it varies so highly, most of the sites studied having only slightly trapezoidal planks. We note that no evidence has been found to indicate that this was a subfloor that would have been overlain by another floor covering, whether in wood or architectural *terra cotta*, for example. This installation may be explained by the dimensions of the rooms in which the width is not greater than the length of single planks. The irregularities in the planks are therefore not directly visible (fig. 4.10).

We assume that flat sawing was also employed. This is identical to the preceding technique (through-and-through sawing) except for the preparation of the log, which was first squared to remove the four slab planks. All of the planks obtained thus have an identical width, unlike the first method that produces narrower slab planks (at the edges) than those from the centre of the log.

Cutting was done manually or mechanically by hydraulic force. The first assumes attaching the log onto a tripod, followed by sawing along its length with a saw held by two men, one above the log and the other below. Attached by a chain, the log is positioned by cantilevering it on the tripod, horizontally or slightly angled and held in place by the counterweight of the log. The sawing angle is 70-80°. It is done at the end of the cantilevering near the centre, then the log is pivoted 180° and sawn from the other end to the centre. Part of the log thus remains unsawn and is split once the log is on the ground, leaving a typical V-shaped mark (Bláha *et al.*, 2008: 126; Fraiture, 2007: 34) (fig. 4.11). In some cases up to three different sawing planes can be observed on the planks, making it possible to follow the movement of the saw from the edges of the log to the centre. On the samples studied, the distance between the striations most commonly ranges between 2 and 7 mm but can be up to 1 cm.



4.10

Fig. 4.10. Site of the Hôtel de Merode, Brussels, 1st storey, eastern wing: drawing of a flooring dated between 1616 and 1618. Drawing and CAD: P. Béru © DMS/RMAH

This irregular pattern is clearly differentiated from that created by a mechanical saw which leaves regular traces produced at a constant rhythm. At Quai au Bois-de-Construction 3, the distance between striations is nearly constant at 2-3 mm (fig. 4.12). In addition, at hydraulic sawmills, the plank does not have the sawing V-shaped mark since the saw passes entirely through in one pass without turning the log.

The width of the planks varies with the wood species used (table 4.1). For Scots pine, widths are generally 20-30 cm. Planks have fairly similar widths within a single lot. This is the case at the Béguinage of Anderlecht and Quai au Bois-de-Construction 3 for planks dated to the 19th century. For the first site, these range between 22 and 25 cm, for the second, between 23 and 26 cm. The single exception, once again, is the Hôtel de Merode, which has planks between 28 and 38 cm. For poplar, widths are more variable. The Ferme Rose in Uccle has planks between 15 and 45 cm, with most greater than 28 cm. The same observation is made at Quai au Bois-de-Construction 3 and the Hôtel de Merode[41]. It is also likely to be true for Notre-Dame du Sommeil 17, which provided samples in the same range, with planks up to 40-45 cm.

The thickness is generally between 2 and 3 cm,[42] which is more or less the value of the Brussels inch estimated at 25.068 mm (Ghiesbrecht, 1801-1802: 166). The Hôtel de Merode yet again differs from the other sites, the thickness of the planks reaching 3-4 cm for the oldest. Several hypotheses can be proposed

4.11

4.12

to explain this difference, such as a supply of more robust planks (but more costly) for a prestigious building, the availability of imported planks of larger dimensions in the late 16th-early 17th century compared to the more recent periods at the other sites studied or specific technical modalities of the period and/or the import region. The continuation of our investigations should provide evidence to support one or another of these possibilities.

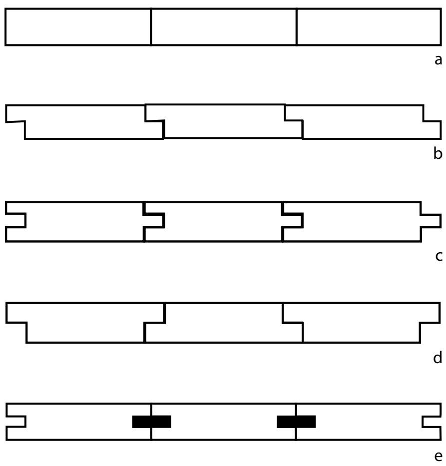
The lengths of the planks for the two species are systematically less than six metres (slightly less than 22 Brussels feet)[43]. In some cases, this constraint required the planks to be laid end to end to cover the surface area. For example, a street-side room on the second storey of the Quai au-Bois-de-Construction 3 building, 7.75 m long, was covered with a series of planks c. 5.30 m long and another series c. 2.40 m long.

Layout of the assemblages: Establishment of a preliminary Brussels typo-chronology

The installation of the plank assemblages of the floorings has been a specific focus in this study, considering its key role in the endurance of the floorings. The assemblages attenuate deformations of the planks subject to movement (shrinkage, swelling, splitting in the middle) by forcing their horizontal

Fig. 4.11. Site at Quai aux Bois-de-Construction 3, Brussels: detail of an 18th-century plank with the typical V-shaped mark from manual sawing. Photo: P. Sosnowska

Fig. 4.12. Site at Quai aux Bois-de-Construction 3, Brussels: detail of saw marks with regular oscillation indicating the use of machine to cut the planks. Photo: P. Sosnowska



position, either by overlapping assemblages – with half-lap joints – or by interlocking the elements. Whether shaped by carpenters or joiners, these assemblages changed over time to improve the system to support all of the elements by reducing the fragility of the assemblages themselves. Five types of assemblages have been identified at present in Brussels, in buildings made between the late 16th and the 19th century. Their presentation below demonstrates a trend towards growing complexity (fig. 4.13). It is to note that this part of the study includes seven additional floorings examined only *in situ*.

Butt joint assemblage

The first type is not a strictly speaking an assemblage since it is made with butt joints. The planks are thus not secured to one another; they are simply nailed to the joists. Few examples have been encountered, except in contexts of repairs or installation of staircase landings, for example at Notre-Dame de Bon-Secours, Rue du Marché-au-Charbon and Place du Grand Sablon 49. Its simplicity explains why it was used during the *Ancien Régime* and until the 19th century.

Half-lap joint in T-shaped rabbet assemblage

In half-lap joint in T-shaped rabbet assemblages, the disposition of the planks and the orientation of the assemblage faces are reversed each time. The height of the rabbets depends on the thickness of the plank but is never more than half the plank's thickness and is most commonly smaller. They generally have a depth of 10 mm. Some assemblages are bevelled and most are smooth.

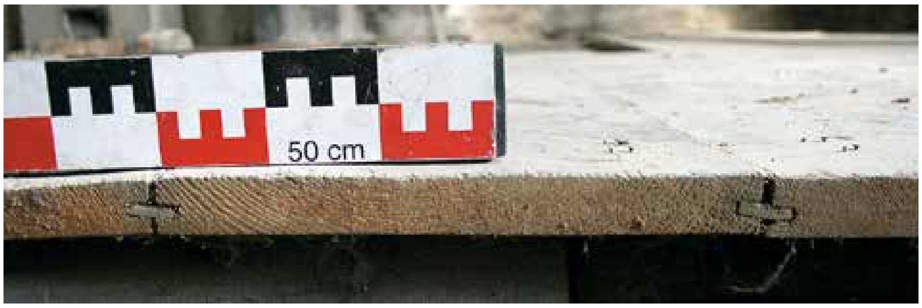
The earliest example was seen at the Hôtel de Merode, dated to late 16th-early 17th century (1570-1610d). It is also found in the 17th century in more modest sites (Rue Notre-Dame du Sommeil 17) and up until the turn of the 18th century (Rue du Marché-aux-Herbes 50).

Half-lap joint in S-shaped rabbet assemblage

Half-lap joint in S-shaped rabbet assemblages allow interlocking of the elements and greater resistance to wood movement and crushing due to successive overlaps of the rabbets, each plank blocking by its assemblage the plank that it covers. This type appears in the late 17th century, as evidenced by recent research on houses dating to the reconstruction of the city centre after the 1695 bombardment (Rue du Marché-aux-Herbes 8-10; Rue du Marché-aux-Herbes 46). It was in common usage throughout the 18th century where it was seen in all of the architecture studied for this period: Musée du Béguinage in Anderlecht, Ferme Rose in Uccle (Sosnowska, 2013), Hôtel La Traviata (first third of the 18th century; Hoffsummer and Weitz, 2013), house Rue du Chevreuil 21 and Maison Dewez, dated by their roof frames to 1774d and 1774-1776d respectively (Hoffsummer and Weitz, 2012; Eeckhout, 2004; Perrault, 2008; Sosnowska, 2011).

It should be noted that for the S- and T-shaped rabbet joint assemblages, the planks placed at the end of the floor covering and touching the walls have a rabbet only on the lateral face, the other being a butt joint. This systematic observation indicates that the work to shape the planks was calibrated to the structural needs of the floor covering in preparation.

Fig. 4.13. Schema of the different types of assemblages of planks documented in the Brussels floorings. Drawings: P. Sosnowska



4.14

Slip tongue-and-groove assemblage

The fourth type of assemblage, using slip tongue-and-groove joints, requires a somewhat more complex preparation than the others. Each edge of the plank must be carved with a groove to receive an independent tongue that will reinforce two adjacent elements (fig. 4.14). The groove is not centred but slightly offset, always towards the bottom, leaving more thickness in the upper part. This arrangement is done to reinforce the operational face of the plank at its most vulnerable zone. While the groove has a variable thickness, its depth appears to be constant at 0.9-1.0 cm. The ridges of the opening may be bevelled. No tool marks were observed.

This type appears to have been in usage at the latest from the extreme end of the 18th century, evidenced by a flooring in the Maison Dewez (Perrault, 2008; Sosnowska, 2011); it was then commonly used at least during the first half of the 19th century, for example in an 1829 building at the Godin factory in Laeken (Quai-aux-Usines 158).

Tongue-and-groove assemblage

Finally, in tongue-and-groove joint assemblages, the two lateral sides of the plank are shaped differently. The groove is carved in one and the tongue in the other such that the tongue is centred and will interlock with the groove on the adjacent plank. This assemblage mode, observed in the second half of the 19th and the 20th century, is recent.

Assemblages in treatises

The brevity with which treatises address this subject contrasts with the diversity of assemblages demonstrated by our archaeological research. Rondelet reports that floorings *sensu stricto* are 'nothing more than a jointed assemblage of oak or pine planks [...]'[44] (Rondelet, 1834: 211) and indirectly specifies that parquets should be mounted on 'tongue-and-groove' floorings (Rondelet, 1834: 213). The *Encyclopedia* mentions the existence of rabbet assemblages that correspond to half-lap joints, but without indication of the arrangement of the assemblages. Slip tongue-and-groove joint assemblages are not mentioned either in the *Encyclopedia* or in Roubo's treatise (Roubo, 1769: 153-164).

Fig. 4.14. Site at Quai aux Bois-de-Construction 3, Brussels, 1st storey: slip tongue-and-groove joint assemblage. Photo: P. Sosnowska

The installation and attachment of the planks of floorings

The art of installing a flooring and its finish

The installation of floorings is done on the beams perpendicular to the joists when this is done in a single work campaign. New floorings, in contrast, may be installed directly onto the area of circulation or on the beams; these do not necessarily follow the orientation perpendicular to the joists.

We also point out that the lateral planks of the floor covering, along the walls, are not directly laid against the masonry but with a gap of 1 to nearly 2 cm that has often been documented (Rue des Pierres 34; Quai aux Bois-de-Construction 3; Maison Dewez; Ferme Rose in Uccle). This would allow a degree of movement of the structure, a margin for the movement of the wood to avoid removal of the planks. In the same spirit, the construction archives for a house situated on the *steenwegh* ('paved road') stipulates that after the floorings are laid, a delay of six months should occur before the final nailing of the planks so that the structure can take its definitive form (Hennaut, 2011: 84). Such a gap would then require the installation of a plinth or panelling to mask it.

The original finish of the circulation side of a flooring is difficult to determine. Wear and maintenance, even sanding, have most often effaced, or at least altered, the first layers of protection of the wood. Research by Bruno Togni provides an interesting look at this subject, particularly on the planing and oiling techniques (Togni, 2012: 31-32). In our dataset, it seems that some of the treatments identified by Togni were not systematically executed. For example, scraping to erase saw marks and smooth the circulation surface to the same level was visibly not done in the attics of ordinary houses (Place du Grand Sablon 49; fig. 4.15) or in a building destined for storage or industrial use (Rue du Chevreuil 21) (Claes and Gautier, 2012: 75, 80); the non-domestic or formal usage of these spaces is clearly the reason for this savings in labour and cost.

The use of nails

The assemblages between planks insufficient in themselves, for the endurance of the flooring, it was necessary to attach the planks to the structural frame. In general, they were nailed to all of the joists with two nails set c. 3-5 cm from the ridges and the widest planks could have a third nail for reinforcement. To date, no nail has been found in a joint assemblage, which appears to reflect a concern to not weaken or deteriorate the assemblages.

Our observations have not shown attachment of planks with wooden pegs. The practice, longer and more inconvenient than the use of nails, exists, however, in other regions, such as France (Togni, 2012: 30). Does this reflect a question of cost, supply, aesthetics or a technical or technological choice?

Two broad categories of forged iron nails have been identified: 'round-headed' nails and 'flat-headed' nails using Roubo's terminology (Roubo, 1769: 259), or 'flattened head' according to the *Encyclopedia* (Diderot and d'Alembert, 1765: 565).[45] The first category is characterised by a circular head and a slightly conical upper face. After nailing, the head remains visible; it is not always at the same level as the wood but somewhat protruding. None of the examples

4.15

examined show the preparation of a small mortise that would allow the entire nail to be inserted. This kind of nail and its use was observed at the Hôtel de Merode for the floorings dated to the first and last quarters of the 17th century, as well as at the two 17th-century houses (Rue Notre-Dame du Sommeil 17, Place du Grand Sablon 49). The nails have a head of 10 × c. 5 mm, a point with maximal section of 4 × 4 mm and a length – for the different elements that could be measured – of 70 to 80 mm.

The iconography confirms this archaeological evaluation, for example on the right lateral panel of the *Annunciation Triptych* (Merode Altarpiece) (Metropolitan Museum of Art, New-York, inv. 56.70a-c) painted by Robert Campin (c. 1378-1444), dated between 1427 and 1432 and representing saint Joseph in his workshop. In addition to the carpenter's tools, the painter represented the flooring and the ceiling in minute detail. The upper side of the flooring is dotted with round-headed nails, arranged linearly three by three and flush with the wood. Their spacing corresponds to the position of the joists, if we refer to the arrangement of the ceiling joists above the workshop. The *Polyptych of the Life of the Virgin* (c. 1541-1560) conserved in St Denis' Church in Forest shows an identical arrangement (fig. 4.16). Numerous 17th-century paintings with interior themes also evidence this practice: in paintings of this type by Jan Steen (c. 1626-1679)[46], Jan Siberechts (1627-1703)[47], in portraits by Cornelis de Vos (1584-1651; fig. 4.17)[48], Jan Cossiers (1600-1671)[49], etc.

Fig. 4.15. Site at Place du Grand Sablon 49, Brussels, storey under the rafters: detail of the upper side of the floor covering showing oblique saw marks. Photo: P. Sosnowska © DMS/ULB

4.16

Fig. 4.16. Reverse of the right wing of the *Polyptych of the Life of the Virgin*, anonymous, c. 1541-1560, St Denis' Church, Forest, oil on wood, 166 × 84 cm (closed) © KIK-IRPA (X003707)

4.17

The second category of nails, with flat heads, is characterised by a head with an oblong T-shaped form for which one of the width of the head is aligned with the point of the nail (fig. 4.18)[50]. It has been observed many times at the Hôtel de Merode in floorings dated to the 18th and 19th centuries, as well as in several more modest buildings, the earliest of which dates to the late 17th century (Rue des Éperonniers 47; Rue du Marché-aux-Herbes 46 and 50), and others of the 18th century (Rue des Pierres 34; Quai au Bois-de-Construction 3; Rue du Chevreuil 21; Maison Dewez). For the Hôtel La Traviata, the nails are c. 60-65 mm long with a nearly square section of 3.5-4 × 3.5-4 mm. The head has a section of 10 mm and a height of 5 mm. At the Maison Dewez, the nails have a length between 60 and 70 mm; their section is relatively square with a thickness varying between 4 and 6 mm; their heads measure between 10 and 12 mm long while their height is between 5 and 7 mm. For each of these sites, the entire nail was embedded in the wood, and the empty space between the head and the surface of the planks could be filled with a small wooden plug. This practice is mentioned in Roubo (1769: 259).

Conclusion

Despite a small dataset, dated between the late 16th and 19th centuries, this study lays the basis for new considerations on a rarely studied type of structure. It is to be hoped that ultimately the Brussels archaeological and dendrochronological studies will expose older examples of floor coverings to enrich the dataset and, as a result, expand our knowledge on the development of floorings. However, the generally poor state of preservation of these coverings, the high real estate pressure in the Brussels Capital Region and, it must be admitted, a certain disinterest or ignorance of this material by architects and other heritage

Fig. 4.17. Cornelis De Vos, *Portrait of a Family*, 1631, Royal Museum of Fine Arts Antwerp, oil on canvas, 165 × 235 cm, and detail of the flooring. Photo © KIK-IRPA, Brussels (B115280)

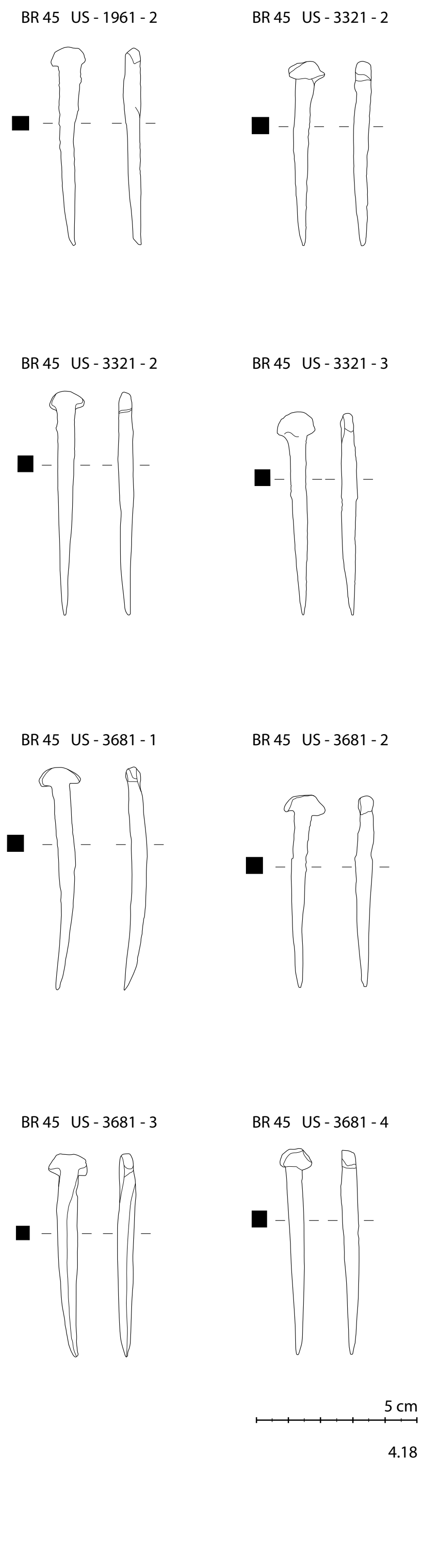


Fig. 4.18. Site of the Maison Dewez, Brussels: flat-headed nails dated to the last quarter of the 18th century. Drawing and CAD: A. Haouata © DMS/RMAH

actors lead most of the time to their disappearance, or to at least major alteration during renovation and restoration projects.

Both recent and older historiography stress the attention paid to the choice of wood species and their specific qualities, as well as the care given to the execution of the different wooden elements of a *plancher*, whether structural or finishing work. The creation of floor coverings did not, however, catch the attention of theoreticians, and even practitioners of the *Ancien Régime*, before the 18th century. We point out, nonetheless, strong disagreement between authors, particularly concerning the usage of recommended species: some, Roubo at the head, show a clear preference for oak, while others propose a wider range of solutions, including coniferous trees and other white woods such as poplar.

In Brussels, the choice of Scots pine and poplar rather than oak may be explained by different, closely linked, factors. The first concerns the anatomic characteristics and technological properties of the two species, suitable for use as planks because they are light and less susceptible to wood movement than oak. They therefore lessen the weight on the beams and provide a better support for the floor covering by limiting deformations in the wood. Scots pine offers more than good resistance to crushing, unlike poplar, which appears more fragile. For the latter, it would be rather the possibility of obtaining wide planks on the local market, at low cost that would explain its use. We note, however, that poplar was used as much in modest houses as in prestigious ones. The second factor explaining the choice of these two species may be connected with the Brussels forested environment in which oak resources were not sufficient to meet all needs. In contrast, poplar was an omnipresent white wood in the regional forest since the medieval period, and imported Scots pine, ideally suited for this usage, was available on the Brussels market from at least the late 16th-early 17th century.

In general, alongside a local supply source, at least for some species, wood was a major part of international commerce, especially from the Baltic countries and Scandinavia. The importation of oak is already largely attested both in written archives and by dendrochronology, particularly in Brussels. Our study has enabled identification of the use of Scots pine from Scandinavia in a case dated to the late 16th-early 17th century and from the Baltic countries in another case dated to the late 18th-early 19th century to make floor coverings. On the other hand, these results stimulate research concerning the organisation of a regional commerce for pine, given that its forest exploitation in the Southern Netherlands could date back to the 17th century based on written sources. The differences in growth typologies documented between sites, and even within a single site, in particular the use of pine of rapid and/or irregular growth alongside individuals of very slow growth, could correspond to 'local' conifers. The systematisation of the dendrochronological study of pine for structural and finishing components of buildings and, through this, the construction absolute regional chronologies would considerably enrich the state of our knowledge of forest resources in our regions during the periods concerned.

In addition to dating and determination of the geographic provenance of the wood utilised, the dendroarchaeological examination contributes to different questions addressed in the history of techniques, such as the selection of materials, their preparation – for example by the systematic documentation of the preservation of bark/cambium/sapwood – and the time elapsed between felling in a forest and the use of a plank.

The development of the assemblages between the late 16th and the 19th century evidences, in our view, the desire of builders to increase the support and performance of the planks. The objectives of these changes were to increase their resistance at their weak points, in particular to crushing. We note that the diversity in the types of joints observed archaeologically does not appear in ancient treatises, which indicates that the skills of the joiners went further than the theoretical framework of these treatises – although regional preferences also probably played a role. Change also occurred in the types of nails used for floorings in the main rooms: round-headed nails until the turn of the 18th century and flat-headed nails from the late 17th century, the appearance of the second overlapping the end of the use of the first. This adaptation likely reflects an aesthetic development and a search for practicability since it allowed the complete insertion of the nails into the wood.

Finally, in the light of these observations, it is apparent that this kind of component is far from being a simple juxtaposition of planks. The modes of construction employed reveal even more clearly their complexity, from the choice of species to the installation of the planks and the finish on the circulation surfaces. Their examination has thus revealed some of the technical research done by carpenters and joiners of the *Ancien Régime* and highlights the wealth of skills of these craftsmen.

Acknowledgements

We thank Michel de Waha (ULB) for his abundant advice that helped mature this research as well as his enlightened proofreading of this contribution. We also thank Paulo Charruadas for his expertise on the management of regional forests.

Notes

1 These analyses were funded by the ULB with the assistance of the Fonds d'Encouragement à la Recherche.

2 Since 2015, this research theme has been integrated within a project on construction materials at the ULB subsidised by the Direction des Monuments et Sites (DMS) of the SPRB. The results obtained will ultimately contribute to the considerations raised in the present article.

3 For Belgium, we cite the example of the exhaustive study conducted on the Notelaer pavilion in Hingene (Buijs and Bergmans, 2010). A preliminary historical and technical overview of the history of floorings in France has been published in the Albums collection of the Centre de Recherches sur les Monuments Historiques (Togni, 2012).

4 Authors' translation in the text of: '*corroyées de toute leur largeur, ou refendues à la largeur de trois ou quatre pouces*'.

5 The *Encyclopedia* differentiates the two types by also specifying that the execution of plank floorings is less expensive than parquet floorings (Diderot and d'Alembert, 1765, vol. 10: 353).

6 It should be noted that this definition of plank flooring as an area of circulation is not accepted by Jean-Marie Pérouse de Montclos. He distinguishes plank flooring as a supporting structure from parquet flooring that includes all areas of circulation made of wood (Pérouse de Montclos, 2011: 167). For him, Roubo's rudimentary plank flooring refers to the typology of parquet floorings without sleepers (Pérouse de Montclos, 2011: 167).

7 Consideration should be given to the structural role played by the planks of a flooring in a timber-framed building.

8 This involved two ordinances: Ordonnance du 13 octobre 1423, Archives de la Ville de Bruxelles, Fonds de l'Ancien Régime, no. 1447, fol. 16r-17r, and an undated ordinance, Archives de la Ville de Bruxelles, Fonds de l'Ancien Régime, no. 1447, fol. 17v-18v, cited in Janssens, 1988: 22.

9 Ordonnance du 13 octobre 1423 (Janssens, 1988: 22).

10 For *solre*, see: http://gtb.inl.nl/iWDB/search?actie=article&wdb=MNW&id=53274 ; for *solringe*, see: http://gtb.inl.nl/iWDB/search?actie=article&wdb=MNW&id=53279&lemma=solringe

11 For example, Siebenlist-Kerner, 1984 or Nicolussi and Patzelt, 2000 in the Alps; Thun, 2002 in Scandinavia; Zunde, 1998 or Läänelaid and Eckstein, 2003 in the Baltic countries.

12 For example, Groves, 2000 in England; Crone and Mills, 2012 in Scotland; Sass-Klaassen *et al.*, 2008 in the Netherlands.

13 The measurement was done onscreen by a specific procedure in *Adobe Photoshop*. The data were then reconstructed and converted to 'Besançon' format by a programming tool *TakeMeasuresFromAdobePhotoshop* (Lambert G.-N., version 20120113, KIK-IRPA).

14 The microscope is coupled with a tree-ring measuring station (*LINTAB 6*, RINNTECH e.K) hooked to a computer with the *TSAP-Win Professional* program that records the tree-ring widths and converts them to dendrochronological format.

15 See Lambert, 2006 (Centre National de la Recherche Scientifique – Laboratoire de Chrono-Écologie de l'Université de Franche-Comté – UMR 6249) for the first working version of *Dendron*. Version IV, used here, is a later upgrade, also by G.-N. Lambert (University of Liège, scientific collaborator).

16 A 'false' tree ring is one in excess, apparently complete with clearly marked limits, which is formed during the same vegetation period as the 'true' ring (as two rings were formed in a single year). 'False' tree rings are not morphologically different from true rings. A 'missing' ring is one absent in a sample due to a failure in cambial activity. Kaennel and Schweingruber, 1995: 135, 232-234.

17 The KIK-IRPA Dendrochronology Laboratory thanks the following laboratories for the chronologies they provided to create this database: Thomas Bartholin (Sveriges lantbruksuniversitet, SE), Marta Domínguez Delmás (formerly of *Stichting RING*, NL), Patrick Gassmann (formerly of the Laboratoire de dendrochronologie, Office du Patrimoine et de l'Archéologie, Neuchâtel, CH), Georges-Noël Lambert (formerly of the Centre National de la Recherche Scientifique – Laboratoire de Chrono-Écologie de l'Université de Franche-Comté – UMR 6249), Lars-Åke Larsson (www.cybis.se/forfun/dendro), Rūtilė Pukienė (National Museum – Palace of the Grand Dukes of Lithuania, LT), Cathy Tyers (University of Sheffield, GB), Sjoerd van Daalen (Van Daalen Dendrochronologie, Deventer, NL, formerly of BAAC bv) and Maris Zunde (University of Latvia, LV).

18 See for example Groves, 1997; Groves, 2000; Sass-Klaassen *et al.*, 2008; Domínguez Delmás *et al.*, 2011; Crone and Sproat, 2011.

19 Mention of the use of American pine, for example, from 1765 in England (Hubbard, 1981: 153).

20 The following laboratories have directly compared our data to be dated with their datasets: Thomas Bartholin (Sveriges lantbruksuniversitet, SE), Claudia Battinger and Niels Bonde (National Museum of Denmark, DK), Anne Crone (AOC Acrhaeology, Edinburgh, GB), Sebastian Luke (Pressler GmbH, DE), Ute Sass-Klaassen (Wageningen University, NL), Willy Tegel (*DendroNet*, DE) and Sigrid Wrobel (Hamburg Universität, DE).

21 References in treatises and rules of the guilds provide many examples, for common joinery and art. For example, a 1508 regulation for the corporation of painters and image sculptors of Abbeville specifies that 'the said sculptors will make images, altar tables... only in good oak wood or *wood from Ireland* without sapwood (Thorel, 1915: 53-79) (authors' translation of: '*les dits tailleurs ne feront images, tables d'autels… que de bons bois de quesne (chêne) ou* bois d'Irlande, *sans nul obel (aubier)*'). Roubo clarifies the importance of removing sapwood 'because if one leaves it, it will soon be riddled with woodworm and crumble into dust' (Roubo, 1769: 25-26) (authors' translation of: '*parce que si on en laissoit, il seroit bien-tôt vermoulu and tomberoit en poussiere*'). In practice, examination of oak floorings and ceilings reveals that the recommendation was generally well-followed, even if some small fragments of sapwood sometimes escaped the vigilance of the craftsmen (e.g., Fraiture, 2015).

22 Numerous statistical studies exist that allow estimation of oak sapwood (e.g., Hollstein, 1978; Hughes *et al.*, 1981; Hillam *et al.*, 1987; Durost and Lambert, 2007; Sohar *et al.*, 2014), while for pine, the only information comes from experimental observations of colleagues working on Scandinavian (Bartholin T., Sveriges lantbruksuniversitet, and Wrobel S., Hamburg Universität, pers. comm., 06/09/2012) and Baltic pines (Pukienė R., National Museum – Palace of the Grand Dukes of Lithuania, pers. comm., 02/10/2012).

23 Treatises are common on the importance of using well-dried wood for joinery (e.g., Roubo, 1769: 1; Diderot and d'Alembert, 1765, vol. 10: 347). However, it is of use to clarify that one year may be sufficient for drying oak or beech planks up to 5 cm thick if good natural drying conditions are met and less still for softer woods such as conifers (Hoadley, 2000).

24 The difference between the date of the last ring measured on a piece of joinery or art (generally without sapwood) can be up to several decades (Fraiture, 2012).

25 These were dated by Swedish chronologies from the Dalarna region, a historical province or *landskap* in central Sweden, and the city of Gävle in central Sweden at the mouth of the River Dalälven that drains into the Baltic Sea (www.cybis.se/forfun/dendro). This date is confirmed by English (University of Sheffield, GB) and Ducth chronologies (Van Daalen Dendrochronologie, Deventer, NL, former of BAAC bv) composed of imported material.

26 Bartholin T., Sveriges lantbruksuniversitet, and Wrobel S., Hamburg Universität, pers. comm., 06/09/2012; Baittinger C. and Bonde N., National Museum of Denmark, pers. comm., 14/09/2012; Sass-Klaassen U., Wageningen University, pers. comm., 30/08/2012.

27 Estimation based on sapwoods of 50 to 110 tree rings, applicable to multi-centennial northern Scots pines (Pukienė R., National Museum – Palace of the Grand Dukes of Lithuania, pers. comm., 02/10/2012; Bartholin T., Sveriges lantbruksuniversitet, and Wrobel S., Hamburg Universität, pers. comm., 06/09/2012).

28 These were dated by English chronologies (University of Sheffield, GB) composed of imported material, as well as by archaeological material found in Vilnius at the confluence of the Vilnia and Neris Rivers, Lithuania (National Museum – Palace of the Grand Dukes of Lithuania).

29 Estimation based on sapwoods of 50 to 80 tree rings, applicable to northern Scots pines 100-150 years old (Pukienė R., National Museum – Palace of the Grand Dukes of Lithuania, pers. comm., 02/10/2012).

30 Roubo (1769: 26) and Nosban (1827: 51) also use this qualification to describe pine.

31 For example, in a house Rue Saint-Hubert, Liège, for a 17th-century flooring (archaeological investigation conducted by Mora-Dieu *et al.*, 2004), and on Gérardrie, Liège, for a 19th-century flooring (archaeological investigation conducted by Mora-Dieu, 2014).

32 Authors' translation in the text of: '*de sapin, parce que ce bois est trop tendre et se retire trop*'. For poplar, Roubo (1769: 27) states generally that 'this wood is soft, difficult to work and is used only rarely' (authors' translation of: 'ce bois est mou, difficile à travailler et ne s'emploie que rarement'). For pine, we emphasise that the faults presented by Roubo, particularly shrinkage, are in contradiction with the results of engineering studies since these demonstrate that fir and pine undergo less shrinkage than oak, for example (Barry-Lenger et al., 1999: 124-131).

33 The difference can be striking between the appreciation of the qualities of the wood species used described in treatises from the second half of the 18th century and the treatises of Vitruve, de La Hire and 19th-century treatises, the latter not only not excluding the use of species other than oak but rather the opposite: '*Namque non potest id robur, quod abies, nec cupressus quod ulmus, nec cetera easdem habent inter se natura rerum similitates, sed singula genera principiorum proprietatibus comparata alios alii generis praestant in operibus effectus*' (Vitruve, text established and translated by Callebat L., 2003: 38).

34 Authors' translation in the text of: '*Et au lieu qu'on ne trouvera du Chefne, qu'on y mettre du Eftre, du Rouure, du Peuplier, Til, du Fresne, de l'Aulne, du Pin, and des Sapins, qui font meilleurs, & Chafteigniers tres bons*' (Delorme, 1561: f°3).

35 Charruadas P., ULB, pers. comm., 09/02/2016.

36 It is specifically this 'economic' quality that excludes it from dendrochronological studies since a date requires more than 20-30 tree rings.

37 Oak has a mean volume weight of 600-800 kg/m^3 with a moisture content of 12%, pine 500kg/m3 and poplar 350-450 kg/m^3 (Barry-Lenger *et al.*, 1999: 44-45).

38 Oak undergoes a total tangential shrinkage of 10%, radial shrinkage of 5% and total volume shrinkage of 15%; Scots pine has a tangential shrinkage of 8%, radial shrinkage of 5% and total volume shrinkage of 13% (Barry-Lenger *et al.*, 1999: 131).

39 Poplar undergoes a total tangential shrinkage of 9%, radial shrinkage of 5% and total volume shrinkage of 14% (Barry-Lenger *et al.*, 1999: 131).

40 A similar observation is made by Sebastian Nemestothy (see article no. 9).

41 Such plank widths were also recorded at the Hôtel de Merode in one of the angle pavilions built during the last quarter of the 17th century and at the Ferme Rose in Uccle during 18th-century renovations.

42 Of a sample of 93 planks, 91% have a thickness between 2 and 3 cm while 3% are less than 2 cm and 5% are between 3 and 4 cm (Sosnowska, 2013: 54-55).

43 It would be tempting to apply this width range for Brussels buildings in general. Out analyses show that, of 41 buildings, 58% have widths between 5 and 7 m; to these values can be added buildings less than 5 m which represent 14% of the group studied (Sosnowska, 2013: 51-52).

44 Authors' translation in the text of: '*autre chose qu'un assemblage jointif de planches de chêne ou de sapin* […]'.

45 Authors' translation of: '*à tête rond*', '*à tête plat*' (Roubo, 1769: 259) and '*à tête rabattue*' (Diderot and d'Alembert, 1765: 565).

46 For example *Prinsjesdag. Herberginterieur met een gezelschap dat de geboorte van prins Willem III viert*, 1660-1679, Rijksmuseum, Amsterdam, NL; *Jonge vrouw spelend op een klavecimbel* (acta virunt probant), The National Gallery, London, GB; *Het doktersbezoek*, 1660-1665, Philadelphia Museum of Art, John G. Johnson Collection, Philadelphia, US.

47 For example in a bourgeois interior dated to 1671 and conserved in the Staten Museum for Kunst, Copenhagen, DK.

48 For example in a family portrait dated to 1631 and conserved in the Koninklijk Museum voor Schone Kunsten Anwterpen, Antwerp, BE.

49 For example in his portrait of the Flamen family dated to 1637 and conserved in the Openbaar Centrum van Maatschappelijk Welzijn, Herentals, BE.

50 Roubo describes nails as follows: 'it has only a width similar to the thickness of the nail, and the ordinary width of the other. These nails were used to attach parquets and floorings, and even any other work for which one does not want the heads of the nails to be visible' (authors' translation of: '*elle n'a de largeur sur un sens que l'épaisseur du clou, and la largeur ordinaire de l'autre. Ces clous servent à attacher les parquets and les planchers, and même tout autre ouvrage où l'on veut que la tête des clous ne soit pas apparentes*') (Roubo, 1769: 259).

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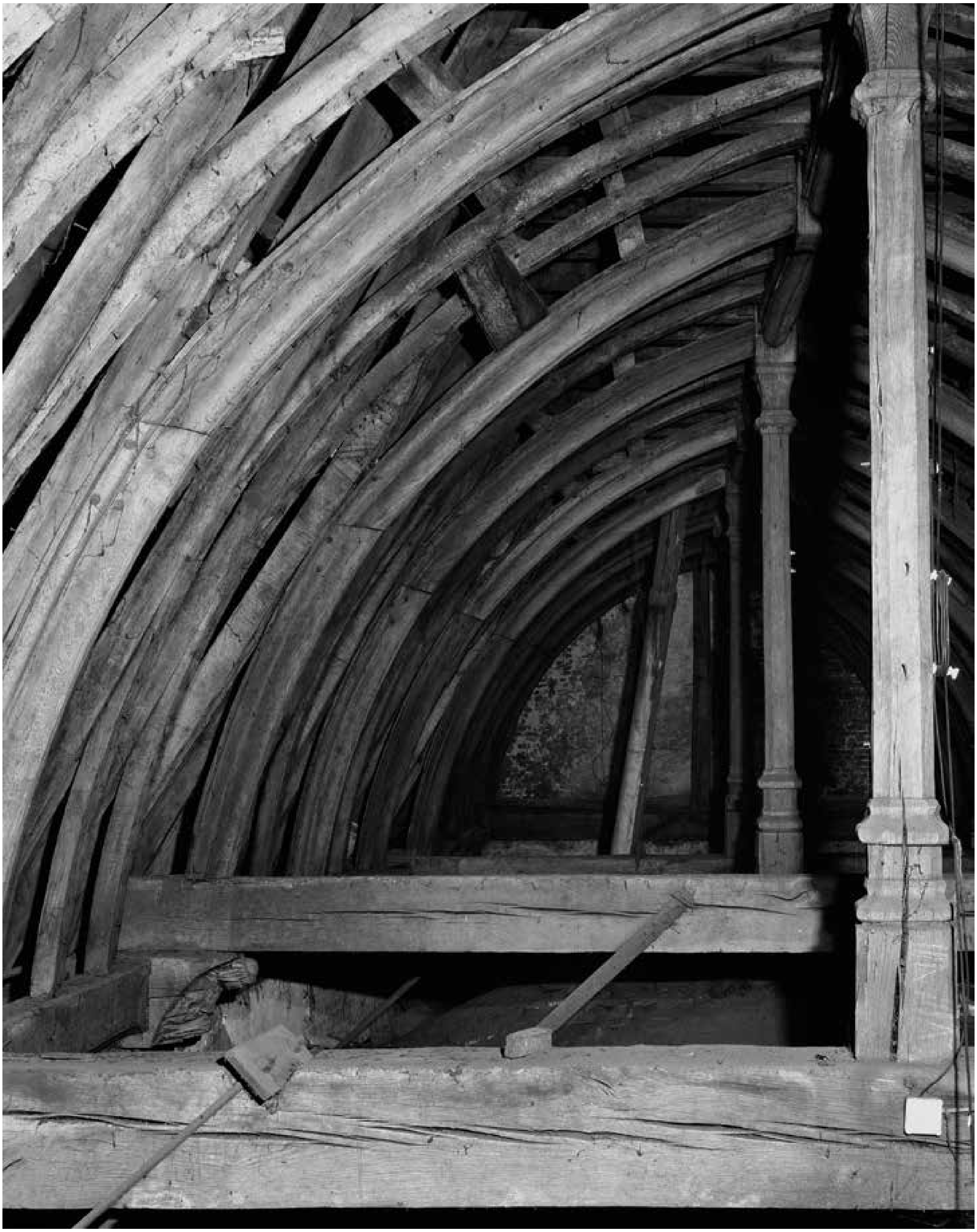
Summary

This contribution presents the main results of a study conducted on the use of wood planks as floorings in Brussels between the late 16th and 19th centuries. The dataset of ten sites was examined via an in situ archaeological study, and dendrological and dendrochronological analyses. The floorings were documented with respect to the choice of wood species utilised, primarily Scots pine and poplar, cutting modes and shaping of the planks, and assemblage techniques for the floorings. These have enabled the establishment of a typo-chronology whose variants reflect the desire of the builder to increase the resistance of the structures, a development that does not appear in ancient treatises. Some aspects of attachment and finishing work are also addressed. Alongside an until now poorly documented local supply source, dendrochronological dates have shown the use of resinous woods obtained via international commerce with Northern Europe, particularly Scandinavia and the Baltic countries. The corpus, both well-documented and dated, is used as a basis for new considerations of a rarely studied type of structure, and underlines the technical research done by the carpenters and joiners of the Ancien Régime, demonstrating the richness of the knowledge and skills of these craftsmen.


5.1

5

Panelled frames, modes of use: A technological and typological study of several roof frames in the Hainaut (Belgium)

Jean-Louis Vanden Eynde[1]

Translation from French: Rebecca Miller

Key words

Roof frames / Panelled frames / Gothic frames / Panelled barrel vaults / Common rafter roof

* An asterisk in the text refers to the glossary at the end of the article (fig. 5.14).

Introduction

The restoration of roofs offers an exceptional occasion for the detailed study of the frames in places that are rarely visible and often inaccessible. Dismantling of the rotted parts exposes the assemblages and opens the door to the constructive logic of the architecture. However, the systematic drawing of the different components has meaning only when the synthetic drawing is produced. It is then that questions arise, requiring a return to the location and more in-depth observation.

Panelled frames have not been well documented although they are a pinnacle in the art of carpentry (fig. 5.1). Their most common denomination, used in this article, designates the finishing of the interior side, made of thin battens that follow the round-arched or ogival vaulted form of the frame's trusses (*fermes**).[1]

Eugène Viollet-le-Duc stressed the economic nature of this process for covering large spaces (Viollet-Le-Duc, 1875: 26): 'by this he avoided the building of masonry vaults, the buttresses needed to take the lateral thrust, and by this

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Fig. 5.1. Attic of the nave of St Géry's Church in Boussu. Photo: KIK-IRPA (M93731)

he lost none of the space between these vaults and the ridge of the attics'.[2] It may be *a priori* unexpected that a work of carpentry, for which the logic is triangulation, borrows the vaulted form from a masonry structure in compression.

With respect to already published studies,[3] our questions were:
- Are panelled frames a rare or common structure, limited to a geographic area or widespread, and built during a short or long chronological period?
- Did a master typology of variants exist, or was there a range of forms that were used?

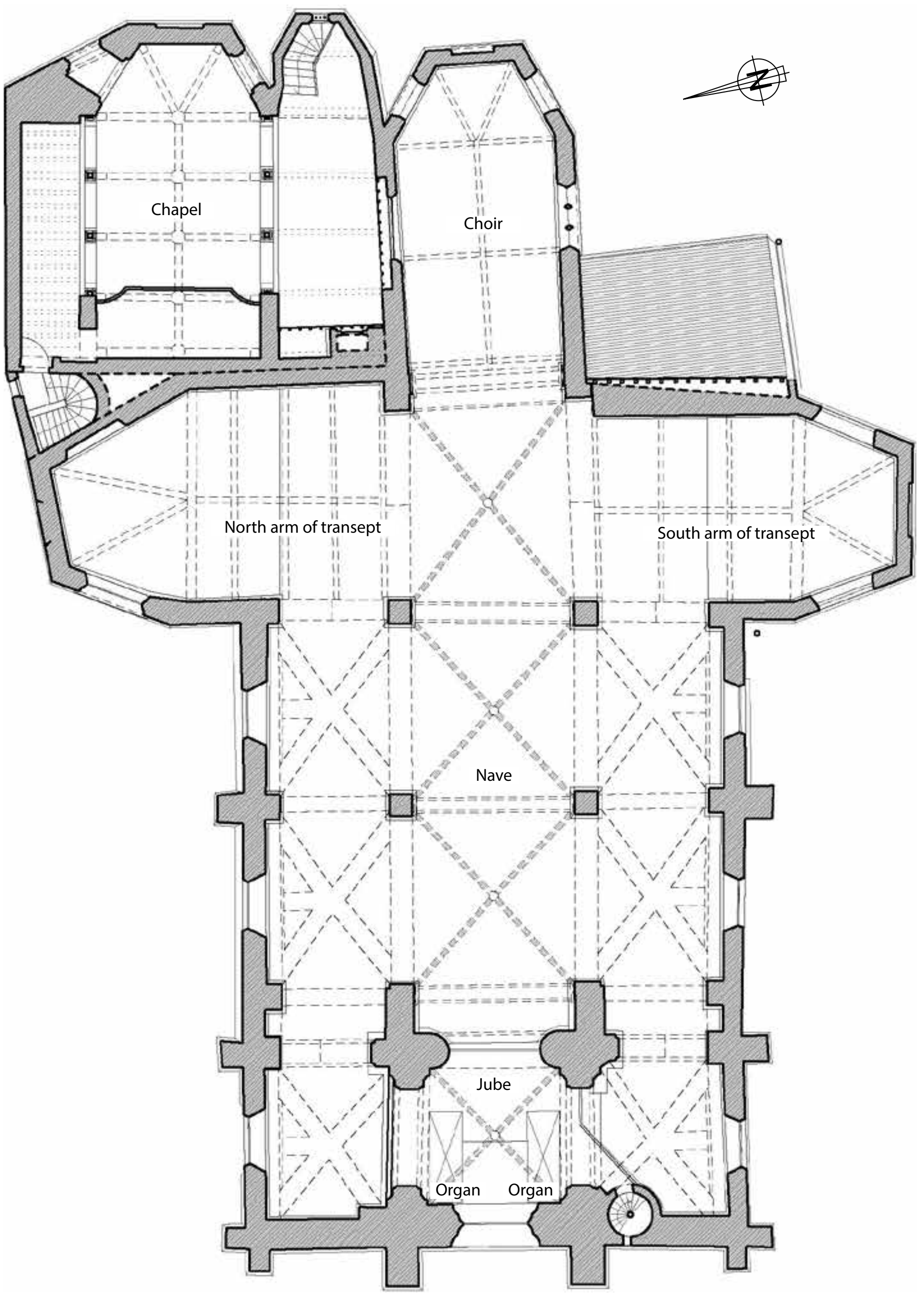
Based on the available publications, we consider the following responses as well-founded:
- The geographic area is vast, from Burgundy to Scandinavia, from Great Britain to eastern Europe.
- In present-day Belgium only, the Gothic examples from Liège and Gent from the 13th and 14th centuries[4] and the 17th-century Baroque examples from Enghien[5] reflect the extent of this kind of covering through time. Masonry vaulting built later below the preserved frames, in the 17th and 18th centuries, show the disinterest in panelled barrel vaults. Between the second half of the 17th century and the advent of the Neo-Gothic in the 19th century, barrel vault frames disappeared completely.[6]
- A complete inventory has not been made but, insofar as this is not a rare system, we note that it is broadly found across the territory of modern Belgium.

The second question, whether a typology of mastered variants existed or whether there was simply a range of frame forms used, will be addressed in the conclusion of this article.

We have chosen to illustrate this study with the framework of St Géry's Church in Boussu (province of Hainaut, Belgium) (fig. 5.2) and that of the adjoining funerary Chapel of the lords of Boussu.[7] Their state of preservation and accessibility make them an ideal choice and the worksite in progress has allowed many observations to be made that would have been impossible at any other time. In addition, these are two buildings close in time and space with two different typologies, but identical construction modes.

Construction of a panelled frame: The nave of St Géry's Church in Boussu

The tops of the lateral walls were capped, in the external plan of the building, by brick corbelling and a stone cornice, in the absence of a water collecting system (Genicot, 1972).[8] The thickness of the walls observed, without cornice, is on average 60 cm or two feet. In all of the cases studied (fig. 5.3),[9] two wall plates were laid in parallel on each wall, one plumb with the interior and the other a foot away. The wall plate sections were assembled in scarf joint pairs with a *trait de Jupiter* (fig. 5.4, I.1).[10] Transversally, the paired wall plates were half-notched in opposing dovetail joints at each principal truss (*ferme principale**) with a



5.2

tie-beam (*entrait**), principal truss resting on projecting sole pieces (*blochets**) with a section identical to that of the tie-beams, and secondary trusses (*fermes secondaires**) (fig. 5.4, I.2). The two wall plates, strengthened with these elements, form a sort of flat ladder, a horizontal beam with high inertia able to take the efforts of bending engendered by horizontal pressures without excessive deformation. The paired wall plates are all linked on average every 4.5 m by tie-beams for which the lower side is also cut in dovetail joints. Halfway, figured projecting sole pieces also group paired wall plates. Border joists (*lambourdes**) are found between the tie-beams and the sole pieces (fig. 5.4, I.3), forming a

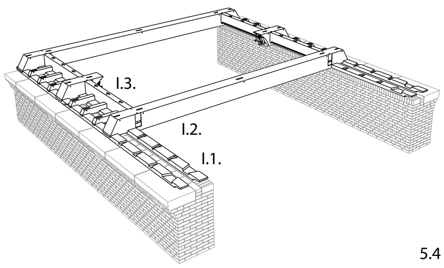
Fig. 5.2. Oriented plan of St Géry's Church in Boussu. Drafts and drawings: J. Parmantier, D. Coster and J.-L. Vanden Eynde (Wautier and Vanden Eynde architects); axonometrics: M. Vandevoorde (Wautier and Vanden Eynde architects)

5.3

Fig. 5.3. Geographic location of Belgian sites mentioned in the text.

cornice in relief with respect to the interior plan of the walls. The border joists are terminated at their ends by tenons inserted in the cuts and mortises made in the sides of the tie-beams and the sole pieces. The space between sole pieces and the tie-beams is again re-divided into four by three longitudinal bracings that are assembled with dovetail joints with paired wall plates and a tenon in the mortises of the border joist.

To construct the principal trusses, crown posts (*poinçons**) are erected on the tie-beams (fig. 5.5, II.1) for which the base with a tenon fits inside the mortise of the tie-beam. We note that the peg of this assemblage cannot resist any stress, due to the bending strength of the tie-beam. The vertical support plan is then made by successively associating a curved ashlar piece (*jambette courbe**) (fig. 5.5, II.2), an arch-brace (*aisselier courbe**) (fig. 5.5, II.3), two levels of collars (*faux-entraits**) or raised tie-beams (*entraits retroussés**) (fig. 5.5, II.4) and finally the principal rafter (*arbalétrier**) (fig. 5.5, II.5) to the crown post. The ashlar piece is assembled with a scarf joint to the arch-brace by a tenon and mortise. An inserted tenon also connects them to the principal rafter. Small braces



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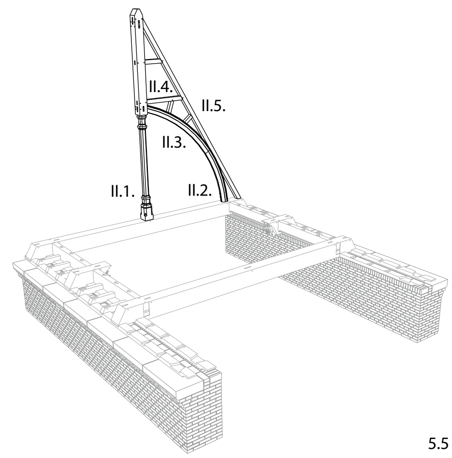

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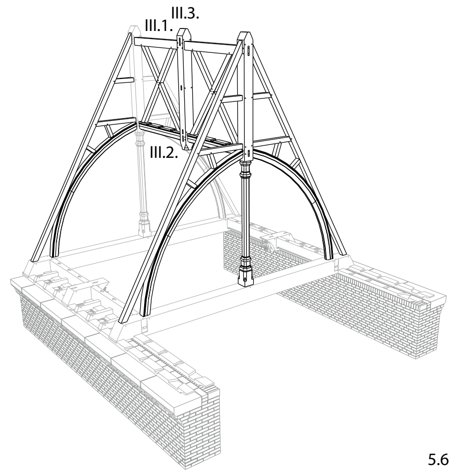

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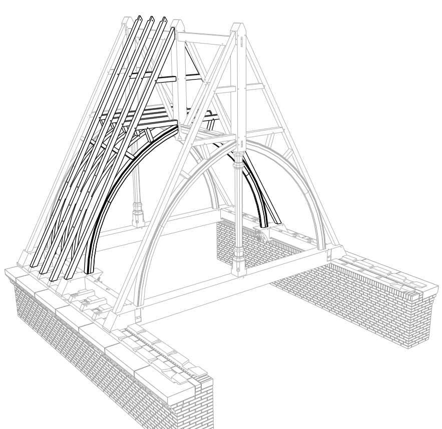

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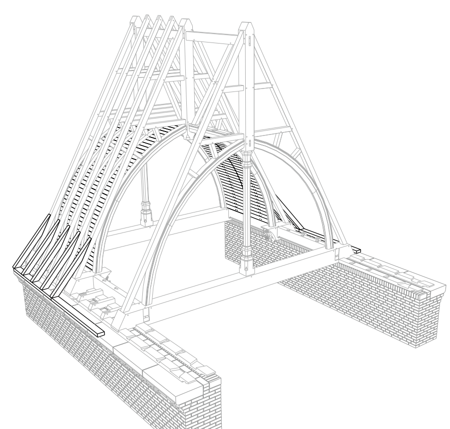


5.8

stiffen the rafter and the arch-brace. These small braces have tenons at both ends. When all of the assemblages are adjusted and work only under compression, this vertical plan cannot be deformed.

As principal trusses became developed, the ridge piece (*faîtière**) (fig. 5.6, III.1) and sub-ridge (*sous-faîtière**) (fig. 5.6, III.2) were placed, interrupted by the central crown post of the principal truss with projecting sole piece (fig. 5.6, III.3), blocked by the Saint Andrew's crosses. All of the elements of the ridge piece have tenons fitted into the crown post mortises. The sub-ridge beam remains visible at the top of the barrel vault and thus also serves as lierne rib.

The Saint Andrew's crosses, whose arms are assembled in halved joints, and attached to the ridges and sub-ridges by tenon and mortise, give this vertical plan a high triangulated beam resistant to bending. It contributes not only to bracing perpendicular to the principal trusses but also to the load at the top of each secondary truss (fig. 5.7).

The principal truss with projecting sole pieces is made in the same way as the principal one with tie-beam, except for the tie-beam and the lower part of the crown post. We note here the section of the curved ashlar piece and the arch-brace, which has a profile of a vault rib and an almond-shaped torus on

Fig. 5.4. Placement of paired wall plates, tie-beams and sole pieces. Drafts and drawings: J. Parmantier, D. Coster and J.-L. Vanden Eynde (Wautier and Vanden Eynde architects); axonometrics: M. Vandevoorde (Wautier and Vanden Eynde architects)

Fig. 5.5. Creation of a principal truss. Drafts and drawings: J. Parmantier, D. Coster and J.-L. Vanden Eynde (Wautier and Vanden Eynde architects); axonometrics: M. Vandevoorde (Wautier and Vanden Eynde architects)

Fig. 5.6. Construction of the ridge. Drafts and drawings: J. Parmantier, D. Coster and J.-L. Vanden Eynde (Wautier and Vanden Eynde architects); axonometrics: M. Vandevoorde (Wautier and Vanden Eynde architects)

Fig. 5.7. Construction of principal trusses with sole pieces and secondary trusses. Drafts and drawings: J. Parmantier, D. Coster and J.-L. Vanden Eynde (Wautier and Vanden Eynde architects); axonometrics: M. Vandevoorde (Wautier and Vanden Eynde architects)

Fig. 5.8. Installation of cocking pieces and the interior panelling. Drafts and drawings: J. Parmantier, D. Coster and J.-L. Vanden Eynde (Wautier and Vanden Eynde architects); axonometrics: M. Vandevoorde (Wautier and Vanden Eynde architects)

the side of which a groove was cut. This was done to insert the panelling battens. The principal rafters, which were not intended to be seen, do not have this groove. The tops of the rafters of the two roof slopes are aligned and assembled in halved joints. From top to bottom, they receive the tenons of the collar beams or raised tie-beams, and braces. Here, the ashlar pieces and arch-braces are not continuous: they become thinner and are embedded below the rafter in a small abutment. They are pegged. At the bottom, the tenon of the rafter is embedded in the end of the tie-beam, the projecting sole piece or the small sole piece.

The collars of these vertical plans pass above the sub-ridge. Even if they are continuous, their pegged ends make them incapable of working in traction. The absence of a tie-beam for two kinds of trusses – principal trusses with projecting sole pieces and secondary trusses – causes horizontal pressure on the paired wall plates (*sablières jumelées**) that could then be deformed between the tie-beams. This is the weak point of this structure.

As indicated above, the bottom of the roof slopes is flush with the edge of the cornice until the mid-16th century. At that time, the cocking piece (*coyau**) made this connection, and even enabled its extension beyond the plan of the wall.

Interior finishing was done by thin battens typically 1 cm thick and around 10 cm wide (fig. 5.8). These were inserted in the grooves of the curved ashlars and arch-braces of the two kinds of principal trusses, while they were nailed under the ashlars and arch-braces of secondary trusses. They are adjacent, sometimes with a tongued halved joint section for longitudinal insertion, sometimes simply side to side. It can be considered that their flexibility allowed them to be bent in order to insert one part or the other into the grooves. At the Couvent des Clarisses in Enghien, the lower moulding of the groove is interrupted at each span for the width of a batten. When the panelling was installed, this interruption allowed each batten to be presented frontally and to slide it toward the top. Once this was done, the upper attic of the roof frame was no longer accessible.

Question of structure

At the beginning of this article, it was unexpected to see that a carpentry construction, whose logic is based on triangulation, borrows the vaulted form from a masonry structure in compression. It can be seen that the load of the roof is uniformly distributed on the rafters. The most efficient natural form of the vault is one that is parabolic – the chainette – because in this case, all of the arch-stones are subject to compression alone. What works for masonry may also work for carpentry.

In what measure can the frames be stable without tie-beams? First we would like to insist on the quality of the assemblages, the precision of the cuts and the near absence of joints between the pieces. Such tightening ensures the non-deformation of the structure. The assemblages are intended to be tightened and cannot work in traction. The appearance of play in the system would be synonymous with dislocation. The example of St Géry in Boussu, shown above, presents an alternation of principal trusses with tie-beam and principal

5.9

trusses set on projecting sole pieces whose appearance suggests a cut tie-beam. The tie-beams hold, every 4 to 4.5 m, the paired wall plates and lateral walls. At St Géry's Church in Baudour, a similar example of alternating principal trusses with tie-beams and principal trusses with projecting sole pieces, we nonetheless see that the pressure from the trusses with sole pieces deforms the border joists, the wall plates and the top of the walls.

Some examples exist, however, for panelled frames without a single tie-beam. At the funerary Chapel of the lords of Boussu, there are five trusses on figured projecting sole pieces and the building seems to have existed without side aisles that would have helped buttress the lateral walls. At the St Martin's Church in Chièvres (fig. 5.9), the entire nave is covered with a panelled barrel vault without a single tie-beam. One out of five trusses lies on a figured projecting sole piece. Even here, we can estimate that the side aisles, covered with small two-sloped roofs perpendicular to the nave, would not have played a role in buttressing.

In contrast, at the Chapel of the House St Augustin in Enghien, the early 17th-century frames adopted the principles of the principal rafter roof system: the trusses without tie-beams but with projecting sole pieces and raised tie-beams are spaced around 3.5 m apart and connected by purlins. The barrel vault covered with stucco hides the panelling. Here, in the absence of tie-beams, the pressure of the frame trusses encountered a counter-mass from the south side where the cloister is found. This led to the buckling of the opposite wall next to the Rue des Augustins to the north, until it collapsed.[11] The projecting sole pieces are undecorated. Given the quality of execution in the preceding examples, specifically on the ends of the projecting sole pieces, it is probable that the system had been originally planned with tie-beams and that these were later cut. At the same time as the tie-beams were removed, the north side aisle was built, and also buckled.

Fig. 5.9. St Martin's Church in Chièvres, panelled frame of the nave above the 17th-century masonry vaulting. Photo: KIK-IRPA (A059026)

5.10

5.11

If the horizontal pressure on the lateral walls was the primary cause of instability, the figures show a second critical point in the secondary trusses where the assemblage of curved ashlar piece and arch-braces is found. Other than the assemblage, which suggests mortises in the rafter, the material is particularly rare for this node.

The triangulated beam of the ridge and the assemblage at the ridge joining the rafters of opposing slopes reduces the resulting oblique load at the bottom of the principal rafters. Further, the drawing of the theoretical trajectory of the forces shows that where the curved ashlar pieces and arch-braces meet, the loads transmitted by the rafter use the ashlar piece and takes the weight of the entire top of the roof due to the triangulation of the base of the truss. An increase in the number of secondary trusses reduces the strain at the node and distributes the load across the length of the wall.

We deduce from this that the common rafter roof system permits the absence of tie-beams via the very broad distribution of tensions and high solidarity between all of the components: principal trusses, paired wall plates, ridge and sub-ridge, principal rafter and ashlar piece.

The specific decoration of panelled frames

At the top of the walls, the border joists form a cornice interrupted by the tie-beams and figured projecting sole pieces. The border joists are in general decorated with a row of continuous mouldings, a cavetto, a torus or one or two ogees of phylacteries per span.

The tie-beams are the choice par excellence for decoration: simple angled moulding, geometric motifs, coils or sculpted heads on the ends. St Géry's Church in Baudour offers the most varied and best preserved range of tie-beam decorations and figured projecting sole pieces (fig. 5.10). These are generally decorated with personages from the Old and New Testaments, bearers of phylacteries and with distinctive attributes (fig. 5.11).

The section of the central crown posts is reduced to an octagon or a circle and the shift from a square section to these figures creates a series of hollow mouldings and annular mouldings.

The ribs, the lierne ribs and, when needed, the intermediary purlins use the same profile as the stone ribs of a vault: an almond-shaped torus with a listel. At their contact, either the pieces are cut following the bisection of the angle and the moulding is continuous, or a sole piece interrupts the moulding; the downward face of the sole piece is decorated with stars and plant motifs. Circular motifs are sometimes set in the hollows of the moulding, including rosettes and medallions. The increase in vault ribbing to make a barrel vault is characteristic of the Renaissance and continued to the second half of the 16th century in Belgium.

The panels are very rarely decorated at their joints. The longitudinal tongue-and-groove joint assemblage with a small decorative element (*mouche* in French) seems to be the marker of the 19th century. The panelling is often natural, sometimes coated and painted, sometimes coated and decorated with stucco. All of the pieces have traces of polychromy.

5.12

A recurrent typology?

At the conclusion of this study of the barrel vault frames, we find that the most structurally complete system is that observed for the nave of St Géry's Church in Boussu (fig. 5.12): an alternation of three kinds of trusses (principal trusses with tie-beams, principal trusses with projecting sole pieces and secondary trusses) (fig. 5.13). Chronologically, this kind of construction was used from the 12th to the early 17th century.

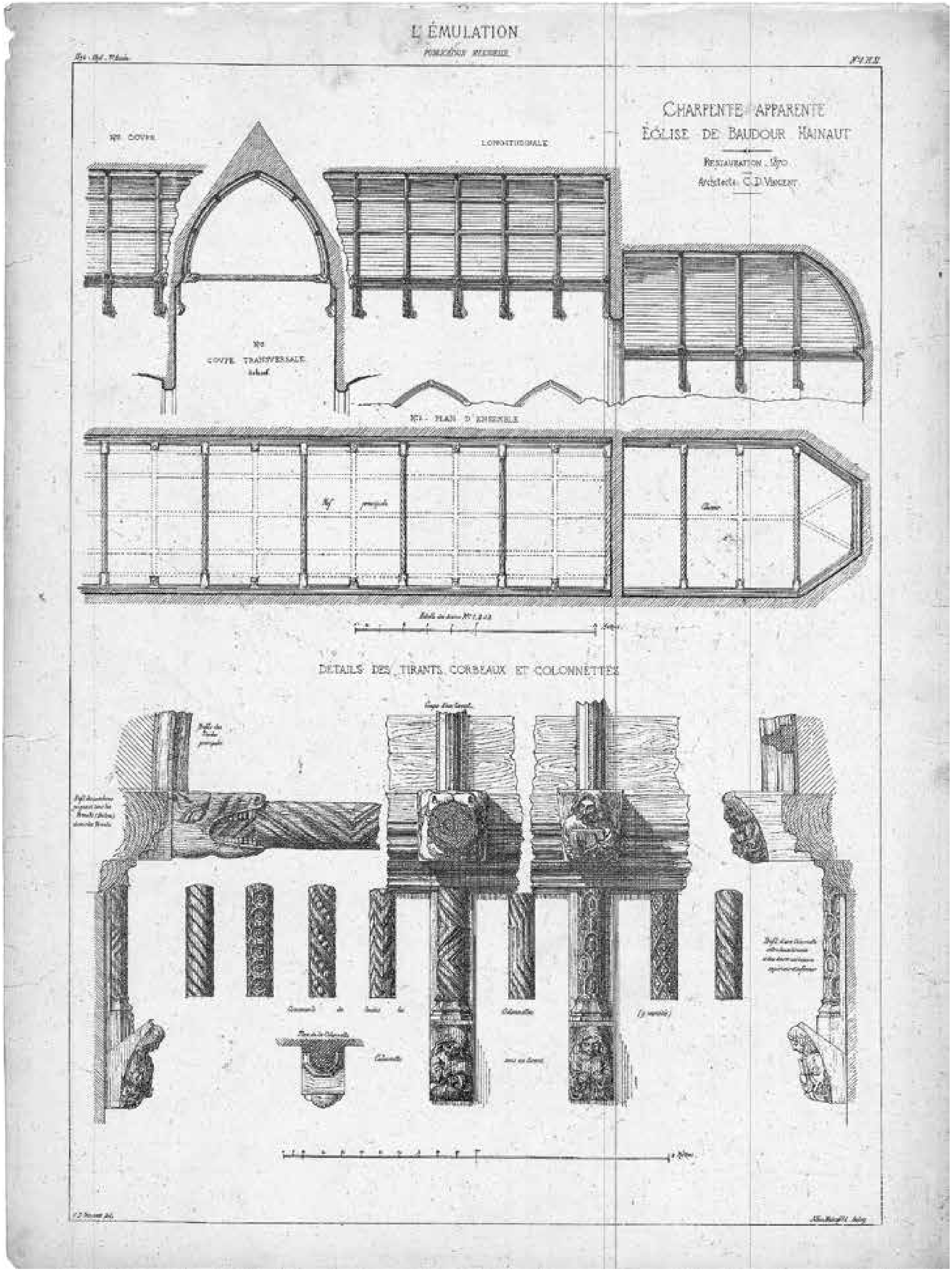
In the current state of our research, the building of a series of frames with common rafter roof system and no tie-beams is part of a rather rare phenomenon, but is not limited to a specific period. It certainly reflects a technical prowess in stabilisation, which may explain the rarity of this type of frame structure.

The principal rafter roof system definitively replaces the common rafter roof system in the second half of the 17th century. From then on, a truss systematically included a tie-beam, and a series of trusses was linked by purlins that supported the rafters. It is only by chance that we find trusses associated with the barrel vault form.

Fig. 5.10. Figured projecting sole piece representing Saint James, border joists and ribbing, St Géry's Church in Boussu. Photo: KIK-IRPA (M93643)

Fig. 5.11. Figured projecting sole piece representing Moses and the Ten Commandments, St Géry's Church in Boussu.

Fig. 5.12. Nave of St Géry's Church in Baudour. Photo: KIK-IRPA (M48027)


L'ÉMULATION
CHARPENTE APPARENTE
ÉGLISE DE BAUDOUR HAINAUT
RESTAURATION 1870
Architecte C. D. VINCENT
COUPE
LONGITUDINALE
COUPE TRANSVERSALE
PLAN D'ENSEMBLE
DÉTAILS DES TIRANTS, CORBEAUX ET COLONNETTES

5.13

Glossary of technical terms (*French* – English)

Based on Pérouse de Montclos (1972: 57-62) and Hoffsummer (2010: 347-353). English translation by the author (fig. 5.14).

1. *Ferme* – truss: Group of elements assembled vertically and transversally along the length of the roof. The simplest truss is a triangle supporting the roof slopes, formed of two principal rafters, a central post and a tie-beam.
1a. *Ferme maîtresse* – principal truss
1b. *Ferme secondaire* – secondary truss

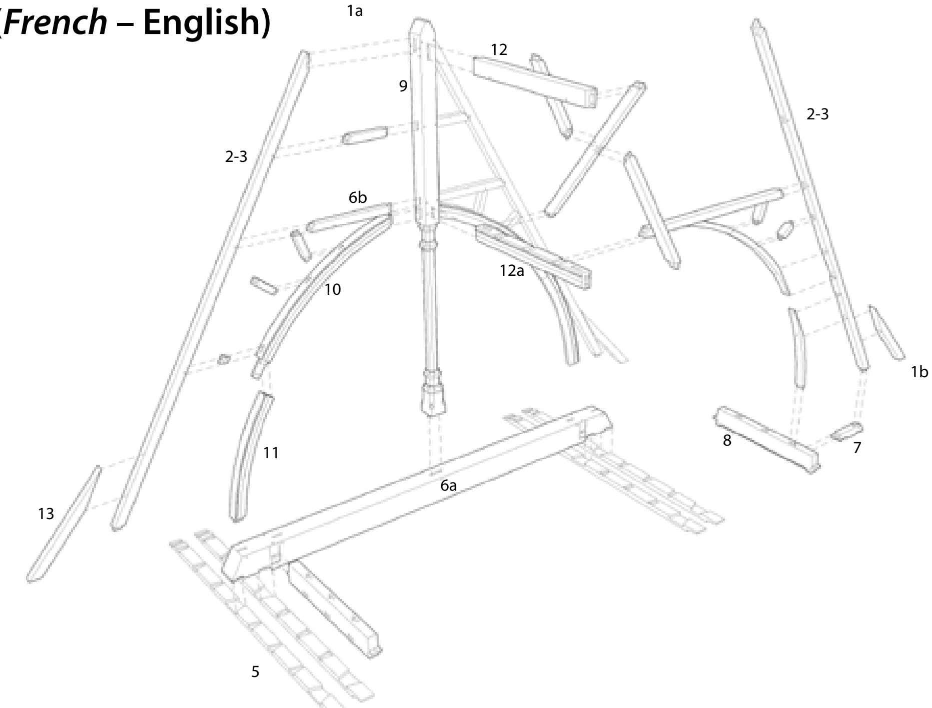
2. *Chevron* – rafter: Element oblique to one of the roof slopes, angled identically to the principal rafter and supporting the covering.

3. *Arbalétrier* or *chevron-arbalétrier* - principal rafter: Element oblique to the truss; the two principal rafters support the roof slopes. They are generally assembled at their base in a tie-beam and at their common top by a central post.

4. *Charpente à chevrons-portant-fermes* – common rafter roof: Roof frame with principal rafters (*chevron-arbalétrier*). In this frame a single element plays the role of principal rafter, which is a truss element, and of common rafter, an element of the covering. This frame does not have purlins and directly supports the covering (not shown).

5. *Sablières jumelées* – paired wall plates: Horizontal master element placed on the thickness of a wall along the same plan.

6. *Entrait* – tie-beam: Horizontal element of a truss in which the bases of the principal rafters or the knee braces are assembled.
6a. *Entrait retroussé* – raised tie-beam: Tie-beam for which the placement is higher than the bottom of the principal rafters to increase the attic space; like the tie-beam it replaces, its function is to prevent the spreading of the principal rafters; its assemblage with these is thus conceived to work in traction.
6b. *Faux-entrait* – collar: Small tie-beam acting in compression.



5.14

Fig. 5.13. St Géry's Church in Baudour (study by C.D. Vincent, 1875). © BAIU Bibliothèque Art & Architecture, Ingénierie architecturale, Urbanisme, Site Saint-Luc Bruxelles

Fig. 5.14. Axonometric view of a principal truss and its components; see the glossary in parallel. Drafts and drawings: J. Parmantier, D. Coster and J.-L. Vanden Eynde (Wautier and Vanden Eynde architects); axonometrics: M. Vandevoorde (Wautier and Vanden Eynde architects)

7. ***Blochet* – sole piece:** Small horizontal element of a truss in the same position as the tie-beam at the bottom of the principal rafter, but stopped at some distance from it. Its length is generally calculated so that it can also receive the base of an ashlar piece; when it is extended beyond the base, it is termed projecting.

8. ***Lambourde* – border joist:** Horizontal timber placed along a wall, between two parallel pieces and perpendicular to them.

9. ***Poinçon* – crown or king post:** Post of a truss joining the middle of the tie-beam where the principal rafters meet.

10. ***Aisselier courbe* – arch-brace:** Curved link working vertically, assisting a horizontal element and supported by a vertical or oblique element.

11. ***Jambette courbe* – curved ashlar piece:** Link working vertically, assisting an oblique element and supported by a horizontal element.

12. ***Faîtière* – ridge or ridge piece, ridge plate:** Master element of the frame placed below the top ridge of the roof.

12a. ***Sous-faîtière* – sub-ridge:** Horizontal element placed below the ridge in the same vertical plan. The first sub-ridge of a panelled barrel vault frame is termed the tertiary rib (lierne) when it appears along the line of the ridge of this barrel.

13. ***Coyau* – cocking piece or sprocket:** Small oblique element of one slope of the roof, supported on the base of the rafters and lessening the angle of the roof in its lower part.

***Lambris en voligeage jointif* – jointed batten panelling** (not shown)

Notes

1 We will use as reference Pérouse de Montclos (2001) or the first edition (Pérouse de Montclos, 1972: 57-62).

2 Author's translation in the text of: '*en ce qu'il évitait la construction de voûtes en maçonneries, les contre-forts nécessaires pour les contrebuter, et en ce qu'il ne perdait pas tout l'espace compris entre ces voûtes et le faîte des combles*' (Viollet-Le-Duc, 1875: 26).

3 See bibliography at the end of the article.

4 Hoffsummer (1999) cites the panelled frames of Seraing, Val Saint-Lambert (1233-1234d); Liège, St Antoine's Church (1247-1255d); Gent, ancient hospital of Bijloke, roof of the Sick Ward (1251-1255d). Bolle *et al.* (2008) discovered the panelled barrel vault of the infirmary of the abbey of St Jacques in Liège, dated by the Laboratory of University of Liège between 1363 and 1377d. The particularity is that the framework is mixed, panelled only in the western part (c. 70 m²) to cover the sick ward: two moulded main trusses, polychrome and decorated with flowers delimiting the panelled frame; between these two trusses there were originally ten secondary trusses with raised sole pieces.

5 House St Augustin, convent chapel, Rue des Augustins in Enghien (Hainaut).

6 Le Muet (1623) and Jousse (1627) published section drawings of frames that still use the system of common rafter roof, while Briseux (1728) and the *Encyclopedia* of Diderot and D'Alembert (1751-1765) present only the system of truss and purlins.

7 A place of worship is attested in the 7th century. The southern face conserves a Romanesque door, the only remaining part of an edifice for which the width is known to be 16.30 m, probably already structured with a central nave and two side aisles. In 1501, a tower was built in the west, and a choir in the east. At that time, the choir and the central nave were covered by a panelled barrel vault with tie-beams. In the second half of the 16th century, the funerary Chapel of the lords of Boussu was built in the cemetery surrounding the church, parallel and north of the choir, and covered with a barrel vault without tie-beams. These two frameworks are the subject of this article. Two arms of the transept were built, or extended, at the beginning of the 17th century, and the builders reproduced the panelled barrel vault to cover them. Between 1716 and 1730, the nave and the aisles were vaulted in masonry while preserving the Gothic frame. This summary of the inventory of dates present in the building and the building archaeology study were done during the preparation of the restoration dossier for the roofs of the church, to be allotted, and the chapel, for which restoration was completed at the end of 2014.

8 Until the mid-16th century, the base of the rafters coincided with the end of the corbelling. After 1550, all the weight of the frame was supported by the wall, without loading the corbel. The cocking piece (*coyau**), a small rafter (*chevron**) placed on the end of the corbelling and at each roof rafter, covers the bottom of the slope and gives it a smaller inclination and a characteristic contour. This is a chronological marker (Genicot, 1972).

9 Buildings examined (see fig. 5.3): Baudour, St Géry's Church, 1490-1520 based on Delférière (1970-1971), nave width 6.40 m, alternation of principal trusses with tie-beams, principal trusses on sole pieces and secondary trusses; Boussu, St Géry's Church, 1501 based on Delférière (1970-

1971), nave width 5.25 m, alternation of principal trusses with tie-beams, principal trusses on sole pieces and secondary trusses; Boussu, funerary Chapel of the lords of Boussu, mid-16th century, nave width 5.30 m, main trusses on sole pieces, without tie-beams and secondary trusses; Chièvres, St Martin's Church, early 16th century, nave width 7.35 m, main trusses on sole pieces, without tie-beams and secondary trusses; Enghien, Chapel of the Convent of the Poor Clares, first half of the 17th century, without tie-beams; Enghien, Chapel of the House St Augustin, slightly before 1614, nave width 8.01 m, cut tie-beams; Enghien, Chapel of the Convent of the Capuchin Friars, 1615, without tie-beams; Petit-Roeulx-lez-Nivelles, St Martin's Church, second quarter of the 16th century, 6.20 m, no tie-beams, main trusses on sole pieces and secondary trusses. Building mentioned in publications: Seraing, Val Saint-Lambert, 1233-1234d (Hoffsummer, 1999); Liège, St Antoine's Church, 1247-1255d (Hoffsummer, 1999); Andenne, Sclayn, ancient hospital of the Chapter, 1290-1255d (Hoffsummer, 1999); Athis, St Ursmer's Church, 16th century (Delférière, 1972); Aulnois, St Brice's Church, 16th century (Delférière, 1972); Liège, ancient infirmary of the abbey of St Jacques, 1363-1377d (Eeckhout and Hoffsummer, 2002; archaeological study: C. Bolle for the Service Public de Wallonie-DGO4); Gent, ancient hospital of Bijloke, Sick Ward, 1251-1255d (Hoffsummer, 1999); Binche, Chapel St André, 1537 (Delférière, 1972); Blaregnies, St Géry's Church, 16th century (Delférière, 1972); Blaugies, St Martin's Church, c. 1550 (Delférière, 1972); Bougnies, St Martin's Church, c. 1600 (Delferrrière, 1972); Braine-le-Comte, St Géry's Church, 13th century (*Le Patrimoine monumental de la Belgique*, vol. 23.1: 61); Cousolre, St Martin's Church, c. 1512 (Delférière, 1972); Epinois, St Magdalene's Church, 17th century (Delférière, 1972); Givry, St Martin's Church, 16th century (Delférière, 1972); Havré, Chapel Our Lady of Bon-Vouloir, 1625-1632 (Delférière, 1972); Obrechies, St Martin's Church, 1599 (Delférière, 1972); Quévy-le-Grand, St Peter's Church, early 17th century (Delférière, 1972); Solre-sur-Sambre, St Médard's Church, early 16th century (Delférière, 1972); Tubize, St Gertrude's Church, 1549 (*Le Patrimoine monumental de la Belgique*, vol. 2: 539).

10 In the *trait de Jupiter* assemblage, the oblique angular S-cut of the two pieces in scarf joint resists very well to longitudinal compression due to the two flanges on the ends, while contact between the two pieces in the middle of the assemblage ensures resistance to traction. This may be improved by placing a supplementary wedge that, by resistance, blocks the assemblage.

11 August 2011. The north lateral wall of the nave was originally an external façade and had buttresses. The creation of a side aisle in the 17th century weakened this wall already buckling from the removal of the buttresses and the splitting of the wall in three large galleries. It took, however, three centuries for the outcome of the loads to go beyond the center of gravity of the pillars. After the collapse of the masonry, the frame remained suspended for about 10 m.

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Summary

During the restoration of several roof frames with an ogival section visible from the attics of the buildings, close and detailed observation raised some questions. Were these frameworks delimited in time and space? Was there an underlying typology and development enabled by improvements in structural mastery?

In the present state of research, this is a form of roof frame that appeared in the 13th century and disappeared in the early 17th century, replaced by another frame system: trusses and purlins (i.e., principal rafter roof). It was a widespread system in Europe, typical of Gothic construction.

For a frame to be visible in the attic, the visual impact of the tie-beams should be limited. The system of common rafter roof resolves this constraint with the complete suppression of tie-beams. The ogival form tangent to the roof slope, the low section of wood elements and their assemblages are accompanied by specific decorations.


6.1

6

Wood shingles of medieval roofs: A first approach in France

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Translation from French: Rebecca Miller

Key words

Medieval roofing / Shingles / Crafts / Wood / Xylology / Traceology

Panorama of medieval wooden roofs: State of the question and current issues in Europe

Wooden roof shingles are perishable artefacts that have only rarely survived the centuries (fig. 6.1). The discovery of these kinds of objects is rare in archaeology; publications concerning the major European excavations show the paucity of discoveries and analyses. In England, urban excavations in York and London have yielded only a few broken artefacts identified as shingles. Work in Southampton and Westminster has provided single examples and none in Exeter. In Germany and the Netherlands, the archaeological lack is even more striking, apart from Fribourg: nothing has been recovered in Amsterdam, Rotterdam, Konstanz or Lübeck. A few remains have been found in Novgorod (Russia), Gdansk (Poland) and Čáslav (Czech Republic) for Eastern Europe, but no database has been established and no major technical analyses have been conducted. For completeness, we also mention the Scandinavian churches in Norway built during the medieval period, but no original roof has been preserved.[1]

These artefacts, generally charred, broken and incomplete when they are recovered, do not lend themselves easily to detailed study. This is probably why in publications, when archaeologists have not deliberately excluded them, descriptions are generally simple and imprecise, with no roof reconstructions. Unsurprisingly, no rigorous study has been attempted on the subject.

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Fig. 6.1. Aspect of the roof section from Chevagnes, roof at Guedelon (Yonne).

Some citations of wood shingles found in Europe include the following:

- In London (GB, capital), for the 10th century: in oak, rectangular with a straight gauge (the visible part), a small reconstructed shingle 30-40 cm long with a lateral peg hole 1.7 cm in diameter; the longitudinal overlap seems to have been made on half of the shingle (Vince, 1991: 240, 277);
- In Winchester (GB, Hampshire), for the 10th-12th centuries: small incomplete oak shingles 40 cm long each with a peg hole (Keene, 1990: fig. 73; Biddle, 1990, t. 1: 322);
- Shingles found in the foundations of the Tour de Vesvre in Neuvy-Deux-Clochers (FR, department of Cher), dated to the end of the 12th century, are also of oak; quadrangular and 50-60 cm long, 14-16 cm wide, with straight drainage edges for the gauges, the overlapping parts are thinned, peg holes are lateral and 1.7 cm in diameter (Épaud, 2013: 124);
- The 21 shingles from the abbey of Landevennec (FR, department of Finistère), dated c. 1074-1080d, measure 43.5-62 cm in length with highly variable widths from 8.5 to 25 cm; in oak, part of the overlap is thinned (1-2.5 cm) and they have a lateral peg hole (Hunot and Marguerie, 1999: 70);
- In Strasbourg (FR, department of Bas-Rhin), in a context dated to the 11th-12th centuries, several thin softwood shingles shaped into a point are about 15 cm wide and 50-60 cm long, with traces of metal nailing (Rieb, 1986: 7577);
- Several groups of oak shingles from a cistern in Besançon (FR, department of Doubs), for which the felling of the trees used is dated between 1244 and 1310d; 40 cm long by 10-15 cm wide, nailed (Guilhot *et al.*, 1988: 10, 13, pl. 30);
- Dating between the 10th and 12th century, oak shingles without additional description were found in Norwich (GB, Norfolk), Oxford (GB, Oxfordshire) and Rickmansworth (GB, Hertfordshire) (Morris, 2000: 2366);
- In Novgorod (RU, Novgorod oblast), for the 11th-14th centuries: trapezoidal shingles 50-60 cm long with gauges shaped in very long points with fastening pegs (Kolchin, 1985: pl. 51; Huggins, 1992: 148);
- In Westminster (GB, city of London): 13th-century oak shingles without further details (Rackham, 1982: 208);
- In Čáslav (CZ, Central Bohemia) prior to 1300, several silver fir shingles 50 cm long and 10.5 cm wide (Frolík *et al.*, 1999: 15, 39);
- Shingles from Southampton (GB, Hampshire), dated to the end of the 13th century: oak, rectangular, measuring 40 cm long and fairy wide (18-20 cm); attached by nails (Platt and Coleman-Smith, 1975: 236);
- Two shingles from York (GB, Yorkshire), one dated to the 12th-13th centuries and the other to the 14th century: unfortunately incomplete, both with apparently pointed ends on the overlap; peg holes are 1-1.2 cm in diameter (Morris, 2000: 2366);
- In Toulouse (FR, department of the Pyrenees): remains of the wood cover of the canonry of St Sernin dated c. 1400, with no further detail (Arramond *et al.*, 1997: 56);
- In Fribourg (DE, Baden-Württemberg), for the 14th-16th centuries: pine

shingles are mentioned, again without further description (Müller, 1996: 250).

One might think from the archaeological documentation that the use of wood roof coverings was marginal during the medieval period. However, when one considers written records, it is obvious that references are numerous and recurrent throughout the medieval millennium. The use of wood even appears to have been the rule during the High Middle Ages in France. It remained common until the 12th century and was frequent after that (Mortet and Deschamps, 1995: 210). In Paris, until 1314, the metier of roofer was attached to the jurisdiction of the first carpenter of the King. At this time, they formed a specific corporation, thus indicating the importance of wood in urban roofs (Franklin, 1987: 230).

Although the number of wooden roofs decreased at the end of the Middle Ages, due to the shortage of high forests, the rise in cost for materials and decrees warning against the risk of fire, especially in urban contexts, examples remained frequent (Pesez, 1999: 106; Bernardi and Nicolas, 2003: 288). As proof, it is sufficient to consult, among others, the compilation of texts about the history of architecture annotated by Victor Mortet and Paul Deschamps in the early 20th century (Mortet and Deschamps, 1995: first edition 1911 and 1929). In this work, a significant number of buildings are indicated as having wooden roofs: abbeys, convents, churches, ecclesiastical barns, seigniorial estates and public buildings. Wooden roofs even seem to have been the standard in many regions of France, both in the mountains and on the plains, in cities and in rural areas. However, and although such references are numerous, they do not inform on the nature of the roofs or the techniques employed. This, along with the rarity of archaeological studies, necessitates caution when attempting any sort of synthesis. We thus content ourselves here with presenting some facts on the subject.

The terms used in French

During the Middle Ages, the terms used to designate wooden roofs were diverse and varied, many drawn from Latin texts, as shown in the following:

- *Ligneis tabulis*, c. 1104-1129, designated the roofs of the village and collegiate church of St Front in Périgueux ravaged by fire (FR, department of the Dordogne) (Mortet and Deschamps, 1995: 329);
- *Tectum lignis abietibus*[2] *cooperta*, c. 1066-1067, a pine roof for reconstruction work at the abbatial church of St Pierre in Oudenburg (B, West Flanders);[3]
- *Tegulis lignis tabulis*, in 1283, the roofs of the baths of Estella-Lizarra (E, Navarre) covered by shingles (Anelier, 1856: 569);
- *Scindulis*, mid-12th century: Vincent de Petit Pont uses this term for the shingles of Parisian roofs (FR, Ile de France) (Mortet and Deschamps, 1995: 719);
- *Asciculis*, between 1087 and 1114, for the cathedral of Auxerre (FR, department of Yonne): work consisted in replacing the *asciculis* roof of the apse of the Notre-Dame-le-Dehors Church (Mortet and Deschamps, 1995: 180).

In medieval French, the terms are multiple, but all derive from the same Latin root – *scindula* – which gives *shingle* in English, *Schindel* in German and *schindel* in Dutch (Du Cange, 1678: 822; Verdam, 1911: 521). *Scindula* seems to have a double Latin origin, from *scindo* – split, and *ascia* – axe (see below, 'Timber splitting' 4.2).[4]

- *Essannes*: in 1287 in Champagne, 3500 *essannes* and nails to cover a communal oven (Longnon, 1914, vol. 3: 412);
- *Aissels*, *aisselles*, *aissantes*: in the 13th century, in Saint-Denis (FR, department of Seine-Saint-Denis), frequently mentioned in the town accounts (Wiss, 1996: 191);
- *Essendes*, *essentes*: in 1315 and 1352 in Rouen (FR, department of Seine-Maritime) (Bernardi and Nicolas, 2003: 288);
- *Essendole*, *essendule*, *chandol*: terms used in the Dauphiné (FR, historical region) between the 13th and 15th centuries (Bernardi and Nicolas, 2003: 288);
- *Ensuelo quercis* (oak shingle, *ancelle* in French): in 1485 in Saint-Symphorien-d'Ozon (FR, department of Rhône) (Bernardi and Nicolas, 2003: 288);
- *Gros ancelles*: in 1457, 1471, 1474, at the castle of Orgelet (FR, department of Jura) (Gresser, 2003: 96);
- *Ancelles à clavins* (nails): in Vers-en-Montagne (FR, department of Jura) in 1522 (Delsalle, 2004: 24).

The list of these terms, spelled differently from one region to another, is extraordinary: *aissella, aissil, aisseau, aisselette, ancelle, ancette, ansulle, écente, enseille, enselle, escende, escendle, essaule, essaune, esseau, essene, essis, essole, essorne, tsandolle…*[5] Do these terms refer to different objects? Probably sometimes, but it is not possible to make a clear distinction between them. Moreover, some boards were not necessarily made for roofs but were used to make shuttering shingles, hatches, wainscoting, ceilings and furniture, for example (Bernardi and Hartmann-Virnich, 2003: 197; Gresser, 2003: 100; Mollat du Jourdin, 1996: 96-198; Douët d'Arcq, 1851: 226, 326).

Ethnographic studies are not of much utility to clarify these terms and identify for each a type of shingle and an ancient practice. Similar shingles often have different terms depending on region while, paradoxically, distinct types are referred to by the same term (Houdart, 2007: 33).

A review of the notarial and seigniorial records from the end of the Middle Ages by Philippe Bernardi and Nathalie Nicolas for the south-eastern part of France covers in part the lack of historical studies on the subject (Bernardi and Nicolas, 2003: 287-304). But the 'muteness of the texts' concerning the correspondence between the terms used, the types of objects and the techniques employed does not provide a very clear image of the metier of roofer and the use of wooden roofs during the Middle Ages. The texts are hardly more forthcoming regarding methods for overlapping and attachment. While shingles were attached to framework laths by metal nails,[6] no medieval text mentions their attachment by pegging, a practice proven by nearly all of the European archaeological discoveries (see below, 'Attachment').

In all of the regions in France, the sale of these roof boards was negotiated by the thousands but the cost, like the rare mention of the surface areas of some roofs, leads to no valid calculation that could characterise the size of the roof boards during the Middle Ages (Bernardi and Nicolas, 2003: 289; Gresser, 2003: 97). In such conditions, it is quite difficult to know what the medieval terms truly designated.

Today in French, two terms are most commonly used to designate roof shingles: *bardeaux* and *tavaillons*. The first does not appear in medieval texts. First used as a military term, it derives from the verb *barder* meaning to cover. It does not appear to have been used to refer to roof shingles before the 16th century (Picoche, 1990: 55). The second is a term from the Franche-Compté and Provençal regions deriving from the Old French *tavella*, *tabella*, which designates a small board (Greimas, 1980: 621). It was not used in its modern orthographic form prior to the Modern period apart from rare exceptions.[7] However, these two terms describe the artefacts much more precisely than the generic term 'shingle'. The term *bardeau* thus designates small to large (40-200 cm) and rather thick (more than 1 cm) roof boards, most often pegged, for which the length of the roof covering, which is never lateral, is not more than three times the width. The term *tavaillons* is used for small (30-50 cm) and thin (less than 1 cm) roof boards, systematically nailed and for which the roof covering can be done both along the length (up to four overlapping rows) and the width of the roof boards. The large *bardeaux* were always used for shallow-sloped roofs, formerly as well as today (Muller and Emmenegger, 1992: 61; Houdart, 2007: 33, 99). In contrast, the *tavaillons*, subject to very different technical constraints, can be nailed to medium- to steep-sloped roofs (greater than 50°) (Muller and Emmenegger, 1992: 71).

In the next section, the two terms will be used separately to better designate the shingles studied.

Three French datasets under study

Three recent French projects have shed some light on the subject of medieval roofs. The first comes from the castral site of Pineuilh in the department of Gironde, excavated by Frédéric Prodéo (Institut national de recherches archéologiques preventives – INRAP) in 2003. The collection includes three kinds of large oak *bardeaux* from 11th-century contexts. The most complete series, unique, allows reconstruction of both the aspect and the slope of the roof of the seigniorial tower.

The second site, excavated in 2007 by Sébastien Gaime (INRAP) in Chevagnes, near Moulin in the department of Allier, yielded several unfortunately incomplete *bardeaux* following a fire from a seigniorial building dated by dendrochronology to the mid-14th century. Nonetheless, the correlation of these charred artefacts with several series of small radially cut oak boards from the construction levels of the building provides the possibility of describing the aspect of this Bourbonnais roof.

Finally, we will see with the third example, from Saint-Denis in the department of Seine-Saint-Denis, that the wooden roofs of urban houses differ slightly from rural houses since the use of nailed *tavaillons* seems to have more common than in the countryside, at least at the end of the Middle Ages.

Pineuilh

Pineuilh is located in Gironde on the departmental border with the Dordogne. The castle mound, located near a toll, was occupied from the end of the 10th to the middle of the 12th century. Three occupation phases took place. During the first, from the end of the 10th century to 1040, the site comprised a simple circular platfrom surrounded by an annular ditch first 5 m and then 20 m wide. The first seigniorial residence, about 12 m per side, was built on posts on the palisaded platform. At the beginning of the 11th century, access was assured by a retractable walkway built on the east side of the platform. In 1040, based on dendrochronological results (Le Digol and Bernard, 2007: 311-367), the mound was built up, the seigniorial residence probably improved and a new palisade erected. During this phase, access was possible from the south, again, by a retractable walkway. The site was abandoned in the middle of the 12th century. Recuperation and evacuation of construction materials necessitated the building of a plank path on the partially filled ditch. Three types of *bardeaux* were found.

1) Type 1 *bardeaux*

Found in the earliest occupation layers (977-1040) but not able to be associated with a specific building, this type is represented by two large oak shingles with straight gauges more than 80 cm long, 21-23 cm wide and 2.5-3.7 cm thick (fig. 6.2) (Mille, 2007: 615). These artefacts, for which the overlapping part was thinned, have fairly unsophisticated characteristics. On the right and parallel edges, they were attached to a straight and shallow-sloping roof span. The overlapping was probably done for two-thirds of the length. Each was attached to the framework battens using a wooden peg 1.8 cm in diameter.

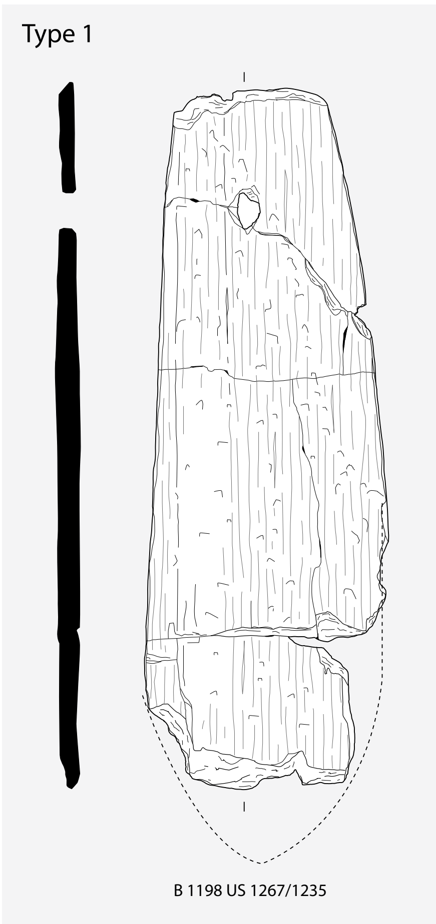
2) Type 2 *bardeaux*

Oak *bardeaux* of type 2 were recovered in a layer dated to the second half of the 11th century. With pointed gauges, these two massive shingles (60 and 80 cm long) are trapezoidal (fig. 6.3) (Prodéo, 2007: 620). The overlapping parts are also thinned (1.8-3 cm). They were pegged onto the battens with a large peg (2 cm in diameter). On the divergent edges, these artefacts – if the joints between two shingles were parallel – would cover a conical framework. Perhaps the apse of a castle church was similar to the roofs of Scandinavian churches? Some constructions of trapezoidal shingles with pointed gauges, like those in Novgorod, show however that they would also cover a flat roof framework; for these, the joints were open (Kolchin, 1985: pl. 51).

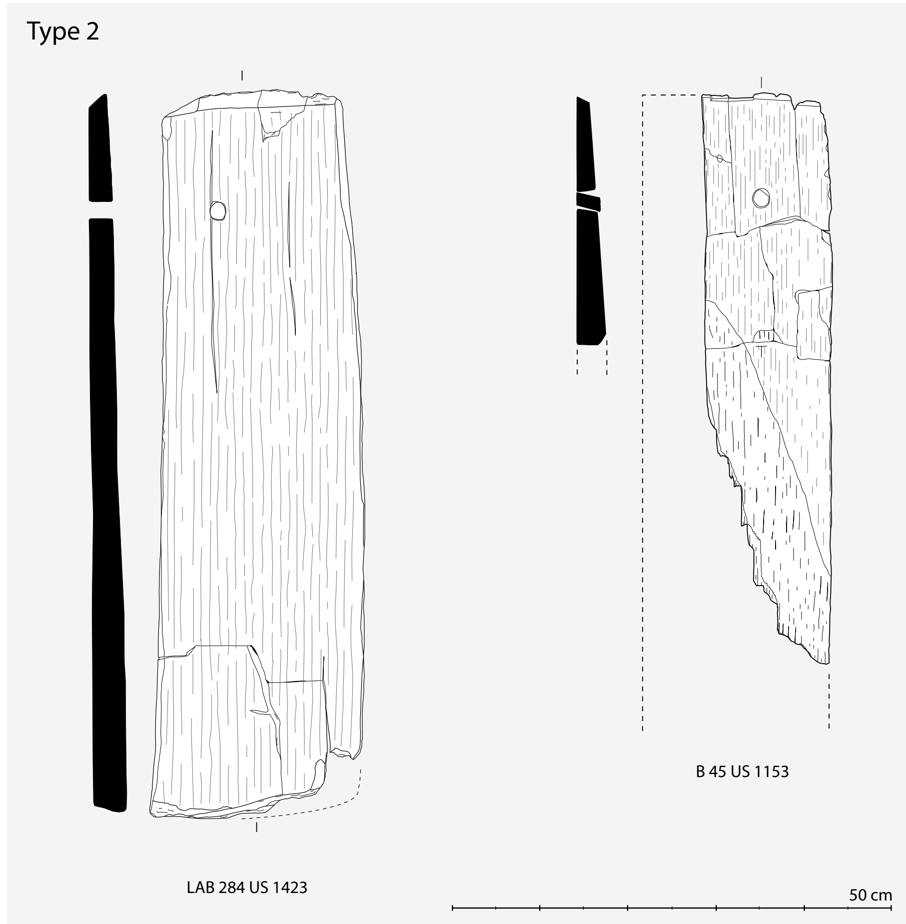
3) Type 3 *bardeaux*

Type 3 *bardeaux* were also found in a layer dated to the end of the 11th century. These were attached to the roof of the last seigniorial residence (fig. 6.4).

The 18 artefacts of this exceptional series – all cut from radial oak quarters – measure between 73.6 and 79 cm long and 17 and 27 cm wide (fig. 6.5). They all have gauges carefully rounded in half-circles and are attached to the laths with a wooden peg 1.6-1.7 cm in diameter. When these are sufficiently preserved, they show that they were made on alder (*Aulnes* sp.) or hornbeam (*Carpinus betulus*) and shaped along the grain (Prodéo, 2007: 618). The overlapping parts



6.2



6.3

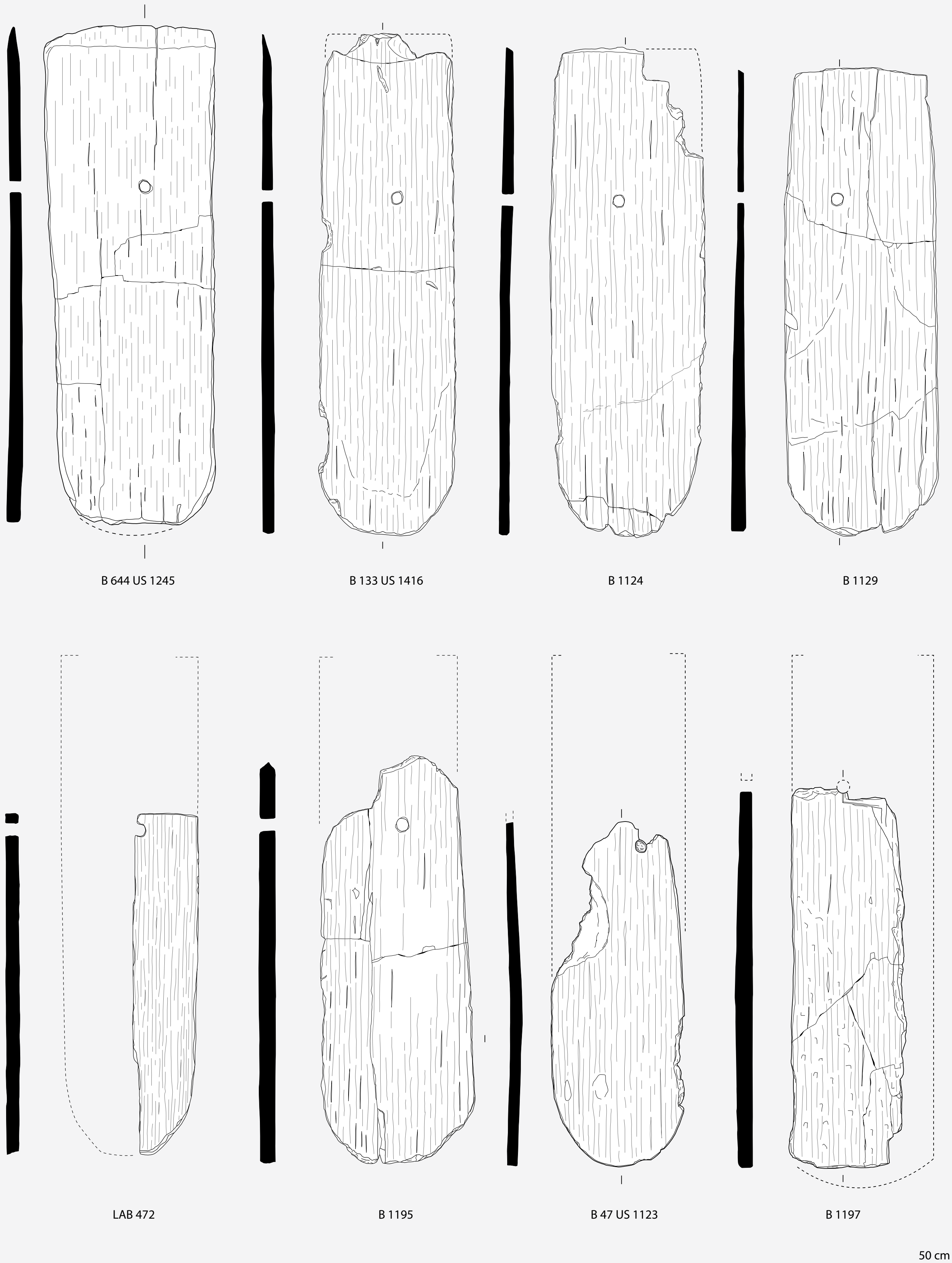
6.4

Fig. 6.2. One of the large *bardeaux* of type 1 from Pineuilh. Drawing: E. Bayen, INRAP

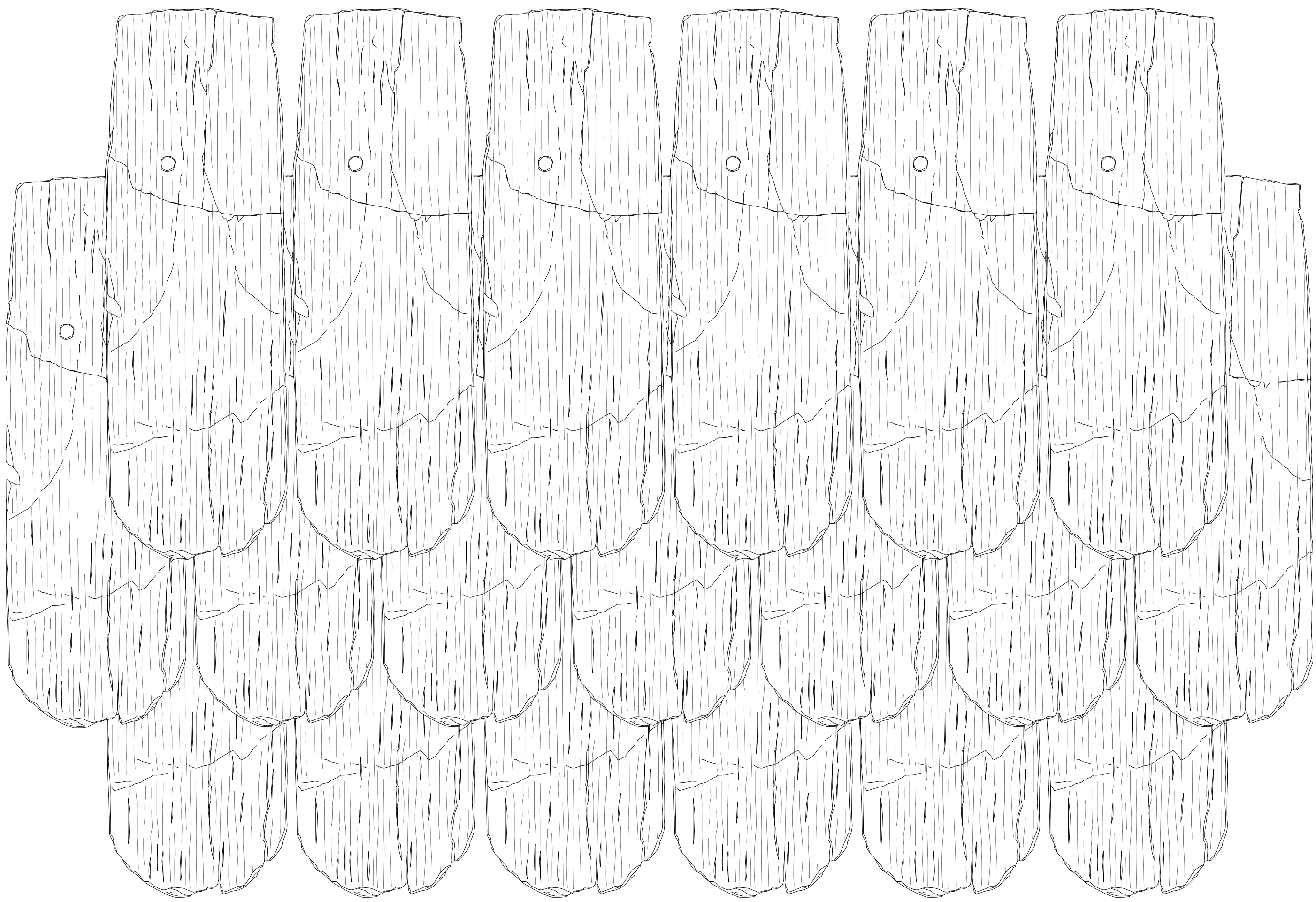
Fig. 6.3. *Bardeaux* of type 2 from Pineuilh. Drawing: E. Bayen, INRAP

Fig. 6.4. Two large *bardeaux* of type 3 from Pineuilh, *in situ*. Photo: F. Prodéo, INRAP

Type 3



B 644 US 1245
B 133 US 1416
B 1124
B 1129
LAB 472
B 1195
B 47 US 1123
B 1197
50 cm



6.6

are thinned (1.5-3 cm), while maximal thickness is located systematically along the edge of the gauge. The edges are straight and parallel.

Among these type 3 shingles, two stand out. The first is narrower than the other and is only 13 cm wide. For the second, one end of the gauge is oblique, likely corresponding to a drip edge for an extension of the roof.

Several of the shingles have very clearly preserved traces of prolonged use. The gauges exposed to the weather show a characteristic cubical deterioration while the covered parts, better protected, are well preserved. The sides facing the framework are systematically black, covered with soot and smoke residue. Study of these traces enables reconstruction of the assembly of this roof frame with regular rather than irregular joints, based on the general form of the artefacts, the drip edges and the uniformity of their dimensions (fig. 6.6). The position of the peg hole on each shingle was systematically lateral and on the upper third of the object (gauge of ⅓). The vertical overlapping was triple on this roof. Such regularity was quite likely also present for the laths on which the shingles were pegged, spaced every 25 cm.

Among the objects in this series, object no. 282 is of particular interest since it is the only *bardeau* with an oblique overlapping edge. This cut certainly corresponds to that of the shingles on the angle rafter. Given this, the

Fig. 6.5. Eight *bardeaux* of type 3 from Pineuilh. Drawing: E. Bayen, INRAP

Fig. 6.6. Reconstruction of a section of the roof of the seigniorial residence. Drawing: E. Bayen, INRAP

oblique angle of 35° allows calculation of the slope of the angle rafter as 33°. Going further, this result logically provides the slope of the roof which would be around 40°. This would create a scaled roof with four frames of 40° slope. This calculation is however not without risk, for several reasons: first because the object is unique and second because the angle rafter joints may have been open and lacking specifically shaped shingles. In addition, the roof frames may have formed different slopes. Albeit with this reservation, such a scaled roof reconstruction for the seigniorial residence at Pineuilh is, surprisingly, identical to the shallow sloped roofs represented on the Bayeux Tapestry, and those of the church of Bosham, Mont St Michel, the castle of Beaurain, the castle of Dinan and many roofs of urban buildings in London, Caen and other unidentified towns.[8]

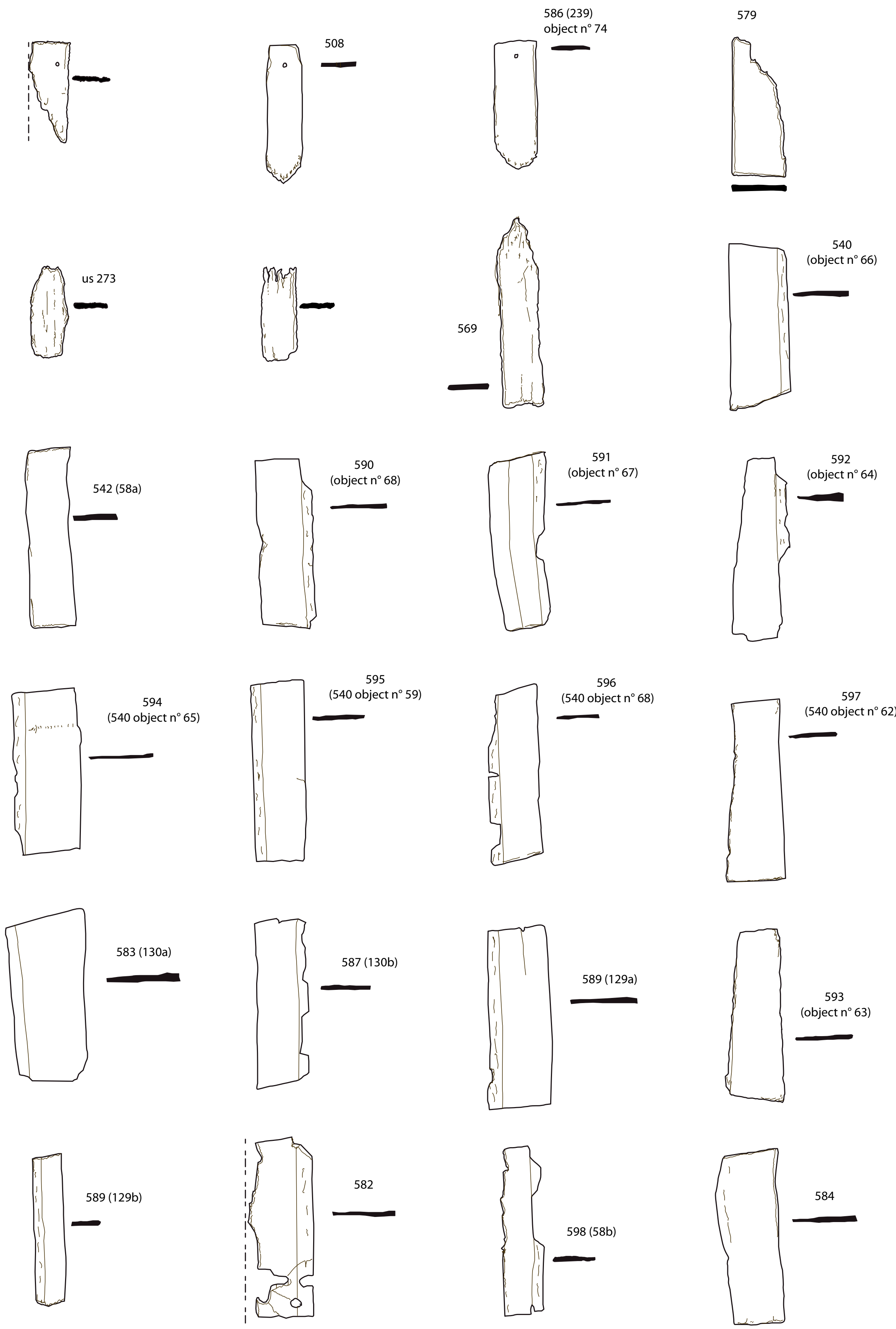
Chevagnes

The site of Chevagnes is located in the municipality of the same name, 15 km from Moulins in the department of Allier. It corresponds to the occupation of a fortified Bourbon house built in the mid-14th century during the Hundred Years' War. As at Pineuilh, the circular enclosure is surrounded by an annular ditch. The construction date of the access bridge has been established by dendrochronology to 1361 and that of the ventral building between 1361 and 1362 (Gaime *et al.*, 2011: 90).[9] In the middle of the enclosure, the coherent group of posts indicates a building of 10 × 6.60 m with a hipped roof.

Following a fire, the architectural elements of the access bridge and the buildings were discarded in the water-filled ditch and thus preserved. Twenty-eight elements have been identified, including a tie-beam, four sill plates, two posts or small studs, three upward braces or corner braces, an angle-tie and its dragon beam, a rafter, a joist, a cross-member of wall, seven shingles and a plate beam. This latter exceptional element, more than 4 m long, made it possible to reconstruct the building. The roof framing was made of rafters on purlins and the timber-framed wall was earth-filled masonry set on vertical bough without horizontal strands passers. This building is to date the oldest evidence of this type of Bourbonnais construction (fig. 6.7) (Mille, 2011: 332). Analysis of the notches for the rafters allows reconstruction of a roof with a 50-51° slope.

The seven partially charred shingles are of oak and are between 1 and 1.5 cm. When preserved, the circular hole for the peg is 1 cm in diameter. These are incomplete, but it was possible to estimate their original size from two sets of small split planks found in the installation level of the building, which correspond to semi-finished products. These are 47-50 cm long, 14-21 cm wide and 1-1.5 cm thick, the dimensions of the shingles for which they were destined would thus be quite similar in size, once the sapwood was removed. To conclude, two charred shingles still show the limit between the overlapping part and the gauge. This is situated about 25 cm from the attached edge; the overlap was thus equal to half the total length of the shingles, and the roof laths or battens were spaced at this interval. The final form of the roof of the building at Chevagnes, with gauges aligned or not, would thus be similar to the roof reconstructed for Guedelon (department of Yonne) (fig. 6.1).

Fig. 6.7. Unprocessed split planks from the site of Chevagnes. Drawing: E. Rouget, INRAP


586 (239)
object n° 74
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542 (58a)
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(540 object n° 68)
597
(540 object n° 62)
583 (130a)
587 (130b)
589 (129a)
593
(object n° 63)
589 (129b)
582
598 (58b)
584

6.7

Saint-Denis

The last two collections come from the urban excavation of Saint-Denis (department of Seine-Saint-Denis) conducted by the Archaeology Unit of Saint-Denis since 1975 and currently directed by Nicole Rodrigues and Michael Wyss, still unpublished.

1) Pegged *bardeaux*

One of the two sets of shingles dates to the 12th century and includes at least 15 shingles; it is however on the basis of the seven best preserved that the study was conducted. These measure 51-52 cm long (fig. 6.8). With straight gauges, each has a lateral peg hole. Width ranges between 9 and 13 cm and thickness between 0.9 and 1.5 cm. The overlap covers half the length of the shingle. At present, the kind of wood used for the pegs preserved is still unknown. This series would form a roof with an aspect similar to that proposed for Chevagnes (see point 3.2). The other series, dated without more precision between the 10th and 12th centuries, is composed of thinned *bardeaux* that were also pegged.

2) Nailed *tavaillons*

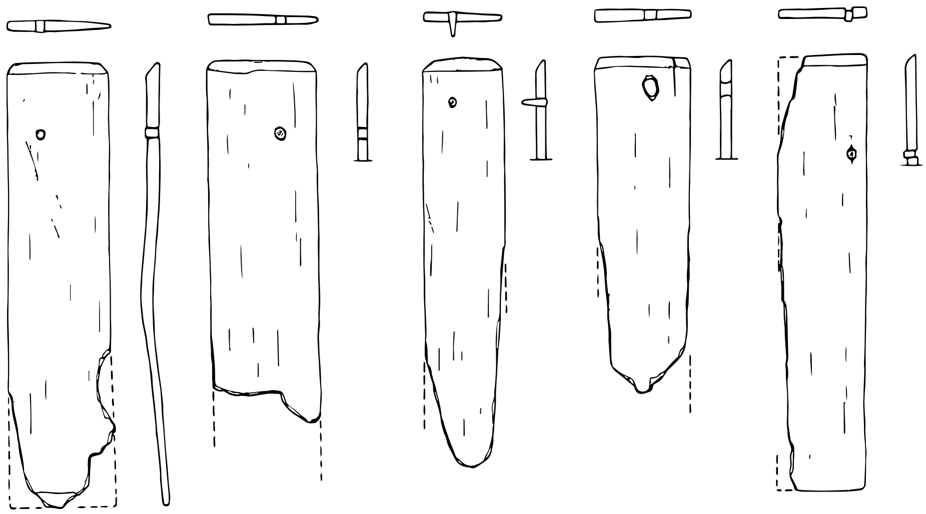
The second series from Saint-Denis presented here is of nailed *tavaillons* dated to the first half of the 14th century. These thin shingles, all from the same context, are 40 cm long. They are not more than 1 cm thick and were all obtained from radial sections of oak (fig. 6.9). All were attached by nails, as shown by traces still visible on the covered parts preserved. They overlapped longitudinally by two-thirds and half along the width. Such a roof was thus planned for one with steep slopes, likely comparable to the mountain roofs like those at Epagny in Gruyère (CH, canton of Fribourg) (Muller and Emmenegger, 1992: 52). Three other series found at Saint-Denis, dated to the 14th and 15th centuries, are also of thin nailed *tavaillons*.

In light of these examples from Saint-Denis, it would appear that in urban contexts during the middle of the medieval period, the choice of pegged bardeaux was the rule, while at the end of this period the nailed tavaillon seems to have been preferred. This change is corroborated by other known urban collections.

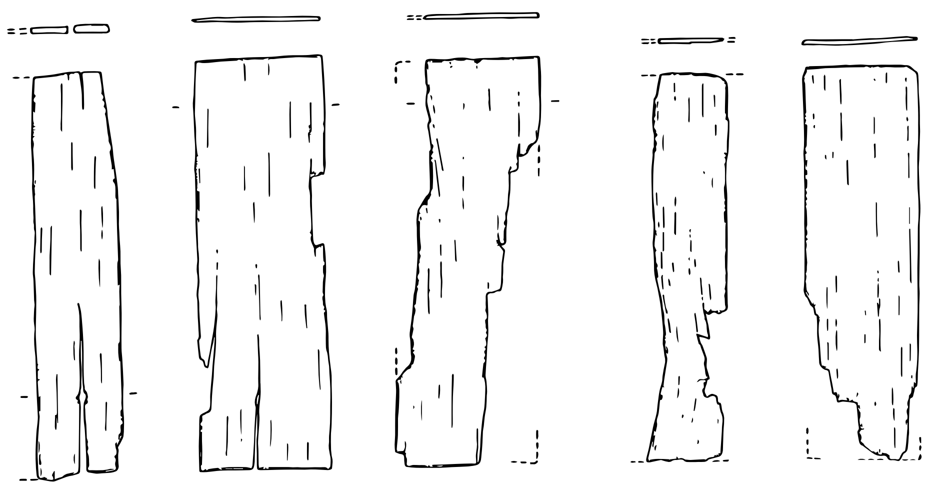
Manufacturing and assembly techniques

Wood species

In contradiction to recent publications that indicate a range of wood species used to build roofs, most of the French archaeological shingles are made of oak, although they are also made of fir in Fribourg, Strasbourg and Čáslav. The initial impression one has from texts from the Low Middle Ages is the same since all references to shingles, when they describe the species, cite oak, with a few exceptions that are almost always in mountainous contexts: larch and fir in Basse Provence and the interior Alps (Bernardi and Nicolas, 2003: 289) and, to a lesser degree, fir in the Jura (Gresser, 2003: 97).



6.8



6.9

Timber splitting

In all of the collections studied, the shingles are edged in the same way. The principle is simple: cutting is done by splitting radial sections from short calibrated oak logs without knots. The splitting tool (chisel) now used for this purpose does not appear to have been used during the Middle Ages (Mille, 2007: 707; Houdart, 2007: 46), but was rather done efficiently with a wedge (Houdart, 2007: 14) and an axe (Houdart, 2007: 22).

This was always done on green or partially dried wood since it is impossible on dry wood (Mille, 1996: 166). The planks produced by splitting and then slicing with an axe or a plane (not sawn) combined all of the qualities needed: on radial section, they do not warp, have only minor shrinkage after drying and have maximal watertightness (grain). Their duration is thus optimal: sometimes one or two centuries. Modern renovation of wooden roofs ignores these practices, resulting in premature deterioration of wooden roofs.[10]

Attachment

The holes for pegging are made by spoon-augers. They are often lateral to avoid opening under a plank joint. While most were made for wooden pegs, the use of metal nails is not excluded in some cases.

Fig. 6.8. One of the sets of large pegged *bardeaux* from Saint-Denis.

Fig. 6.9. One of the sets of nailed *tavaillons* from Saint-Denis.

The archaeological pegs preserved in position were shaped with a knife or a hatchet and cut from white woods (hornbeam, alder, etc.). They were pounded into the shingles with a hammer and extend beyond them by at least 10-15 cm. In contrast, we do not know if they went through the laths, these regularly pierced, or if the latter were simply placed above them, the peg then serving as a simple block. Some authors favour the second solution,[11] but no French ethnographic example exists to clarify this technique that appears to have been lost. Today, all of the roof shingles are nailed, both *bardeaux* and *tavaillons*.[12]

Cross-sections

The edges of the gauges and overlapping ends are made with an axe; once again, there is no evidence of sawing. It is possible that the craftsmen took care to use this technique to ensure the best impermeability for pieces rather than sawing which would make the edge irregular rather than straight (Pastoureau, 1993: 33).

Some differences in treatment are observed from one collection to another. First, the shingles from Pineuilh, La Tour de Veyre and Landevennec were thinned using an axe and a plane on the overlapping part. This was done to avoid the offset of the gauges, loss due to wind and excess weight of the roofs (fig. 6.5) and it would appear that this treatment was reserved only for the large *bardeaux* with triple overlapping. Indeed, the small shingles at Chevagnes and those at Saint-Denis, overlapping by only half, were not shaped in this way. Another characteristic seems to be unique to the shingles from Pineuilh (all three types) and Saint-Denis (both sets), and the series from Landevennec: the edges of the cover were systematically bevelled obliquely using an axe. This would have been done to facilitate the work of the roofer by orienting the shingle when the roof was laid. It should be noted that in modern roofs, these bevels are incorrectly made on the drip edges of the gauges, accelerating the aging of the roofs.

The crafts

In the Middle Ages, the most common wood species used in construction is unquestionably oak, a tree that was subject to protection and very strict regulations by the estate owners (kings, lords or abbeys). Shingle production was thus part of the long tradition of forest lodges (Devèze, 1962: 133; Bechmann, 1984: 191; Mille, 1996: 169).[13] The craftsmen responsible for wood splitting, called *scindulerius* (Poisson, 2003: 443), were specialists contracting their skills to merchants who benefited from the adjudication of sales and transport of wood products to urban or rural work sites. The example of Chevagnes has shown that the products made by these splitters were actually semi-finished products (see above). Like the sites using large quantities of shingles, such production could take on a semi-industrial aspect. This is moreover perceptible in some adjudications, such as the reference in 1314 of the arrival of a hundred thousand *essendes* at the toll gate of Paris, for which the merchant paid four deniers per thousand for their passage (Fagniez, 1900: 32), or that for the production in the Forest of Dean and the transport of 60000 shingles for Gloucester Castle, tendered at £23 17 s 7d in 1252 (UK, Gloucestershire) (Morris, 2000:

2367). Next, at the work sites, the joiners-roofers or the roofers ensured the final shaping and placement of the shingles on the roofs. References to these crafts are rare but some sources provide evidence, for example for Paris in the 13th and 14th centuries and Prague at the end of the Middle Ages (Husa, 1967: pl. 97; Mille, 2009: 60).

Such organisation that connects wood splitters to forests and roofers to work sites is typical of the medieval system and the structuring of the crafts, in particular for large sites. There is, however, little doubt that a degree of versatility linked to shingle production also existed, for example in the context of small rural estates.

Conclusion

This review of medieval wooden roofs underlines the paucity of studies on this subject, as much in France as in Europe generally. A comprehensive study of synthesis remains to be done to move beyond the examples and discussion presented here.

We see, however, from historical and archaeological records, and this despite the rarity and wide geographic and chronological range of the collections, that oak was used nearly exclusively to make roofs, apart from mountainous regions. Ultimately the choice of wood species is conditioned by its availability as well as by size and the mechanical constraints proper to each. Yet oak is known for its excellent mechanical properties and resistance to humidity, as Jacques-Joseph Baudrillard states, it provides all of the advantages (Baudrillard, 1821: 292). It is the best timber, and we have seen that splitting was the *sine qua non* condition for its watertightness. Moreover its resistance to weather makes it a nearly essential species for roofs destined to be covered in wood.

We also note that in the middle of the medieval period (10th-12th centuries), roofers preferentially used pegged shingles. All of the examples except for Strasbourg support this observation: London, Winchester, York, Saint-Denis, Pineuilh, La Tour de Veyre, Landevennec, etc. By the 13th century, or perhaps the mid-12th century, the use of iron nails replaced wooden pegs, while York, Novgorod and Chevagnes appear to have persisted in the use of such pegs for a certain time. This change in the technique of attaching roofing probably parallels the change in roof slopes for religious or secular buildings that increased with the advent of the Gothic style. The wooden peg would thus appear to have no longer been sufficiently effective to keep shingles on steeply sloped roofs. The use of large numbers of nails would also have been possible due to improvement in iron smelting kilns during this period (Parias, 1962: 131, 172).

It is useful, however, to increase the number of studies and publications on this subject for a real consideration of medieval roofs to be made. I invite archaeologist, xylologist and dendrologist colleagues, French and European, to work in interdisciplinarity to extract additional information from the collections, among others through use-wear analysis. We have seen that it is often possible to determine the original size and the characteristics of the shingles and, in some cases, the form and slope of the roofs

Notes

1 Restoration of the wood cover is done every 50 to 200 years depending on exposure (Muller and Emmenegger, 1992: 51).

2 Plural dative form of *Abies*.

3 Mortet and Deschamps (1995: 257) give rare and valuable description of wood.

4 After Houdart (2007: 26), it is from Greek *skiso*, split.

5 And this is not exhaustive (Delsalle, 2004; Greimas, 1980: 263-264; Bernardi and Nicolas, 2003; Houdart, 2007: 34).

6 '*Scindulas ejus ferreis clavis affixit*' (Du Cange, 1678: 822).

7 *Tavaillionus* in the castellany account of Savoie Dauphiné (15th century) (Poisson, 2003: 444).

8 See the Tapestry in the Musée de Bayeux (Herrmann, 1989: 70, 72).

9 Christophe Perrault, CEDRE laboratory, Besançon, has confirmed this dating.

10 Examination of modern shingles shows wood splitting in all directions.

11 For example, Frédéric Épaud (Laboratoire Archéologie et Territoire, Tours, UMR 6173, Université François Rabelais).

12 Apart from the pegging still practiced for the roofs of Scandinavian churches.

13 Called *loges* or *hostises* in French: temporary forest lodges (Mille, 1996: 167).

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Summary

Wood shingles are perishable artefacts that have only rarely survived the centuries. One would think that their use was marginal in the Middle Ages, yet based on texts – until the 13th century at least – wooden roofs were dominant in many regions of France, in both cities and rural areas, and on both ecclesiastical and seigniorial estates.

Discoveries of wood shingles are extremely rare in archaeology, at least based on the few described in publications. Three French collections, however, provide some information. The first is from the castral site of Pineuilh, occupied at the end of the 10th century to the early 12th century (department of Gironde). It contains three types of large pegged oak shingles including an exceptional set that enables reconstruction of the roof of the seigniorial residence. The second site, excavated in 2007 at Chevagnes near Moulins (department of Allier), yielded the burnt pegged shingles from a fortified house dated by dendrochronology to 1361-1362. The linking of these charred artefacts with several lots of boards from the construction levels of the building made it possible to determine the aspect of this Bourbonnais roof. Finally, the presentation of two collections from Saint-Denis (department of Seine-Saint-Denis), rescue excavations by the Archaeology Unit of Saint-Denis, additionally allows us to address the types of wooden roofs of urban house in the 12th-14th centuries, where small nailed shingles seem here to have been preferred over large pegged shingles.

Technical analyses of these collections have also made it possible to better determine the compartmentalised organisation of this profession, in which some production crafts are attached to lodges in forests, while other itinerants followed work sites in response to construction activity.

7.1

7

Wooden witnesses: Romanesque joinery and other wooden elements or their negatives divulging historical secrets of the St Martin's Church, Zaventem (Belgium)

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Key words
Romanesque joinery / Material-technical research / Wall painting / Stucco work / Lime-mortar / Vault construction

Introduction

St Martin's Church in Zaventem at first sight looks like a common Gothic-style church similar to many others in Brabant. It has a basilical ground plan with a transept only slightly wider than the three-bay western part consisting of a nave and two side aisles. The interior is characterised by plastered brick cross-ribbed vaults for all ceilings. The church obtained its present Gothic appearance rather late as the major architectural changes of its exterior and interior were established only between the late 16th and 18th centuries.

The structure studied in this article is invisible from the church interior. A 17th-century stuccoed barrel vaulted attic is hidden above the current cross-ribbed vaults of the nave (fig. 7.2) and can only be reached by a narrow stair tower situated north of the main tower (fig. 7.3).

This stuccoed vault rests on the old Romanesque walls of the church (fig. 7.3). The vault transversally reflects six bays, divided by transverse ribs, alternatively ending either on three tie-beams situated at the level of the vault's

7.2

Fig. 7.1. Romanesque window joinery. North wall, bay 6. Photo: K. Keutgens, B. Delmotte and P. Duerinck

Fig. 7.2. The 17th-century stuccoed barrel vaulted attic above the current nave of the church. View from the west. Photo: K. Keutgens, B. Delmotte and P. Duerinck

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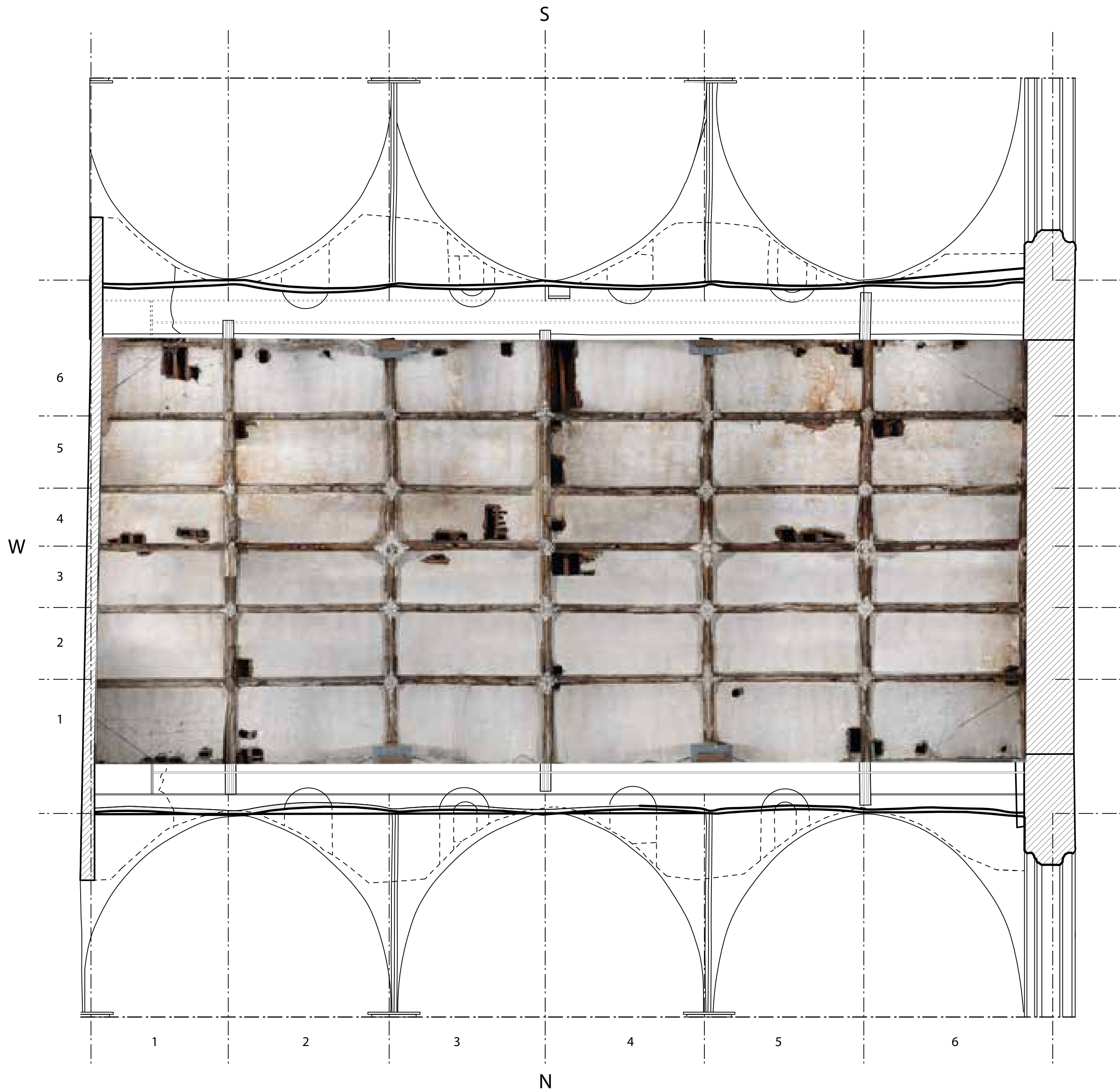
7.3

Fig. 7.3. Situation plans. From left to right: View from the west; Longitudinal cross section, view from the south; View from the east; Attic; View from north transept on north wall (bays 5 and 6). Drawings: K. Keutgens and B. Delmotte

springing and connected with the trusses of the roof construction, or running until a level lower than the tie-beams where they were sawn at different lengths when approaching the upper sides of the brick vaults of the nave, upstairs the floor of the attic. Five longitudinal beams divide every bay in six parallel sections or fields. The crossings of transverse ribs and longitudinal beams are decorated with stuccoed ornaments, some of which are no longer present (fig. 7.4).

In 2012, a material-technical study was carried out prior to the restoration of the roofs and attics of the church.[1] The main goals were to provide an evaluation of the condition of the stuccoed vault and adjacent walls and to formulate conservation recommendations. The material-technical study mainly consisted of conducting stratigraphic tests on all architectural elements to obtain more information on the relative chronology of the building and painting phases. In addition, some specific architectural features were studied. To contextualise the on-site findings, the material-technical investigations were paralleled by a restricted historical study. A detailed description of the material-technical study and all stratigraphic test zones can be found in Keutgens and Delmotte (2013a). A summary of the results and their relation to the building history of the church is also available (Keutgens and Delmotte, 2013b).

This article focuses on findings of the preliminary study that are specifically related to the wooden elements (fig. 7.1). It refers only to the general results of the material-technical study when necessary. As will be pointed out below, the building history of St Martin's Church still shows some major gaps. This article will try to at least partially fill some of them by relating the results of the study of the wooden elements to a few key moments recorded in the archive documents. Finally, it will describe in detail the particularly well-preserved Romanesque window-joinery.



7.4

A brief history of previous research

Canon Raymond Lemaire (1905) was the first to study and describe the Romanesque building phase of the church. Based on his findings he provided a ground plan and longitudinal cross-section of this building phase. Jan Lodewijk De Ceuster (1929) inventoried the church archives and described the history of the church in more detail. Since these two studies, as far as we know, little additional data concerning the building history of the church, or the vault in particular, have been published. Generally, these two main texts are incorporated or referenced in later publications (e.g., Lemaire, 1952; Doperé, 2005).

Fig. 7.4. The dismantled stuccoed vault. Drawing and photo: K. Keutgens, B. Delmotte and P. Duerinck

Current historical research has not yielded new information.[2] The most important dates, mainly based on De Ceuster's article, are summarised in Table 7.1. This chronological table shows a relatively large gap between the 'approximate' dating of the Romanesque church and the first adaptation to the Gothic style (in the choir).

Century	Year(s)	Structure
12th-13th c.		Romanesque church
16th c.	1567	Gothic cross vaults in choir
17th c.	1599-1605	first raising of tower
17th c.	1607-1608	new wooden ceiling in middle aisle (by Jan Gots)
	1607	*vunctkoor* near entrance
	1607-1610	demolition of old and reconstruction of new side aisles
	1608-1646	plastered ceilings in side aisles (?) and transepts. Interior lime-washed
	1609	white glasses put in east bays, one coloured glass put elsewhere in middle aisle
	1648	stone cross vaults in north transept
	1687	stuccoed ceiling in middle aisle
18th c.	1749	stone cross vaults in south transept
	1772-1773	new roof on side and middle aisles
	1785	cross vaults in middle aisle (by Le Cat, Brussels)
19th c.	1864	new west bay

Tab. 7.1

Table 7.1. Dates obtained from archive documents.

Early wooden witnesses

Wooden witnesses of the Romanesque building phase (12th-13th centuries?)

Particularly well-preserved (non-wooden) key components of the Romanesque building phase, also described by Lemaire (1905), are the original cornice and the dripstone moulding of the formerly exterior north and south walls. These walls, still showing their original Romanesque lime plastering with scratched joints (Keutgens and Delmotte, 2013a: 64-67), are now protected under the roofs of the current north and south aisles. Remnants of terra cotta pantiles are still present at some spots, beneath the dripstone moulding (Lemaire, 1905: 132). The repetitive scheme of cubic holes directly under the cornice was interpreted by Lemaire as the fixation points for the beams of a flat Romanesque wooden ceiling (Lemaire, 1905: 132). A similar row of holes can be observed under the dripstone moulding (fig. 7.5). The bottoms of these holes show an inclination of approximately 45°, indicating that the former rafters of the Romanesque roofs of the side aisles were inserted in these holes.[3] This was achieved by means of lime mortar (fig. 7.1). The same inclination of the old roof can also be observed at the eastern wall of the northern aisle of the church.

The eastern or tower wall of the attic above the stuccoed vault shows the imprints of the former saddle roof of the middle aisle of the Romanesque church, again with an inclination of approximately 45° (fig. 7.6). The constructive elements of the roof, probably in wood, were fixed into a slit in the stone wall, once more by means of lime mortar.

7.5

7.6

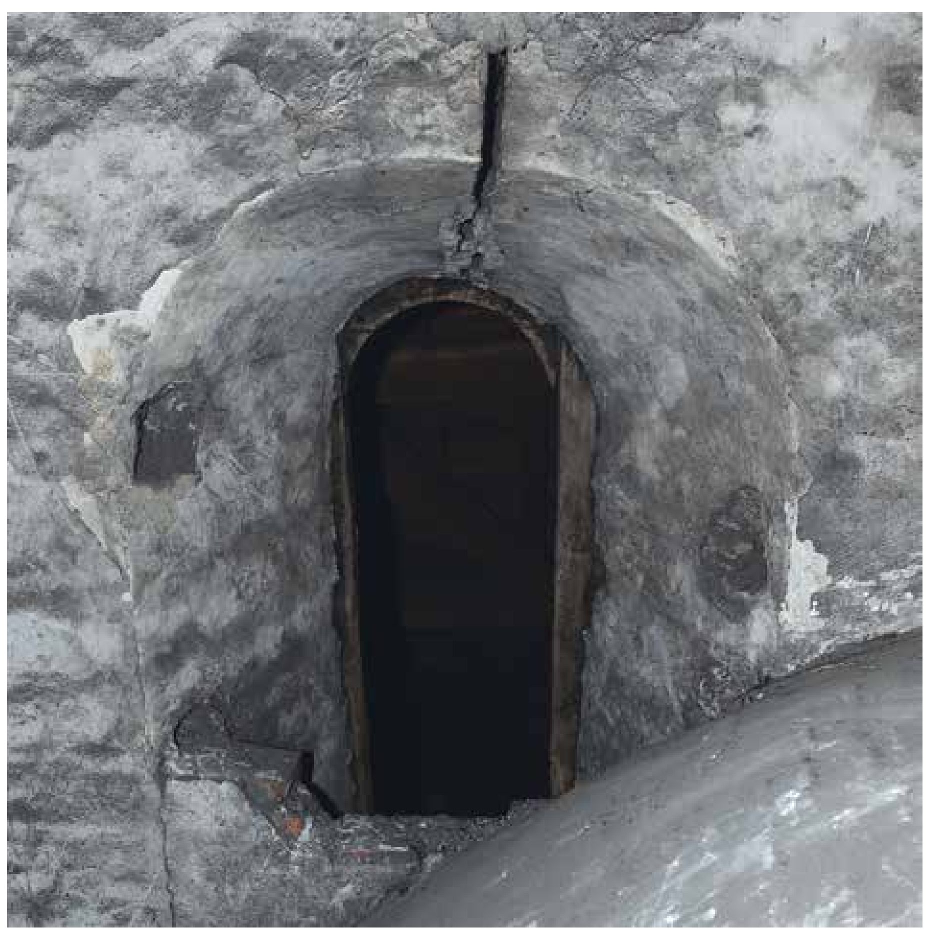
Fig. 7.5. North transept, bays 5 and 6. Photo: K. Keutgens, B. Delmotte and P. Duerinck

Fig. 7.6. East or tower wall: imprints of saddle roof of Romanesque church. Photo: K. Keutgens and B. Delmotte

Romanesque window joinery

The Romanesque walls had 12 top lights, six north and six south, corresponding to the six-bay nave of the church at that time.[4] Given that they were hidden in the attic and protected by the roofs of the side aisles, ten of the top-lights remained relatively intact to the present-day. Eight of these still contain important remnants of their original Romanesque joinery. Figures 7.7 and 7.8 show an example of a window viewed from the interior and exterior sides of the Romanesque church. Some of these window openings were partly or completely filled during later building phases: the two most eastern windows (north and south) were partially filled with stone in an earlier building phase, while all windows were walled with brick masonry during the 17th century.

The remains of the window frames in the walls of the nave of the former Romanesque church show typical features of early joinery (Lemaire, 1905: 131-132; Leurs, 1922: 198; Lemaire, 1952: 164). They are manufactured very simply with two stiles joined with four rails. These are half-lap joints or T-halving joints, each secured with one tapered dowel. As such, they can be considered archetypes of window joinery (fig. 7.9). There are no jamb-rails as in modern window frames, as the function of repelling water was performed by the stone-masoned reveals. The rebates, to hold glass panels, were made on the outside of the frame. This retains the remains of hand-forged nails, which, as assumed, served to hold and position leaded glass panes.[5]



7.7

Fig. 7.7. Romanesque window, interior view. North wall, bay 3. Photo: K. Keutgens, B. Delmotte and P. Duerinck

7.8

7.9

Fig. 7.8. Romanesque window, exterior view. North wall, bay 3. Photo: K. Keutgens, B. Delmotte and P. Duerinck

Fig. 7.9. 3D digital drawing and exploded view of window joinery. Drawing: C. Indekeu

7.10

Fig. 7.10. Groove (top rail) in north wall (bay 1) in which window joinery was fixed with lime mortar. Photo: K. Keutgens and B. Delmotte

The manner that the frame was embedded in the up-going masonry is typical of the construction of wooden window frames during the Romanesque period. The Romanesque window joinery was consolidated with lime mortar into the grooves (fig. 7.10).[6] Such negative witnesses show interesting details concerning the original joinery itself. In order to enhance solidity against the pressure of the wind, the top rail was constructed to extend further from the frame than the reveals and fitted deeper into the wall. This is clearly shown in the lateral nudes in the middle of the thickness of the wall. Since parts of the walls (in bay one) were demolished during later alterations, it can be observed where and how far this top rail extended from the frames into the walls. This feature also occurs in other Romanesque window joinery in the Netherlands and Belgium (van Der Wal, 1968). One detail that has not yet been explained is the presence of peg holes in the top rails. It can be assumed that they held small half round panels to hold the glass panes.

A sample of the wood from the Romanesque joinery was boiled and cut on a sledge microtome and then analysed by optical microscopy using transmitted light. The wood was identified as sweet chestnut (*Castanea* sp. *Fagaceae*) based on its typical characteristics: porous rings, coarse-grained dicotyledonous wood with only uniseriate rays of one size, length of large rays up to 500 µm, homocellular, procumbent.

Study of the growth rings indicated that the wood was cut from fast-growing trees and was probably produced by coppice-exploitation of forests, occurring in the Low Countries from the early Middle Ages to the 18th century (Haneca *et al.*, 2005: 289). Other wooden elements of the attic, for example the tie-beams, appear to have been cut from the same kind of trees.

Wooden (and other) witnesses of later building phases (14th-16th centuries)

On the (formerly exterior) north wall, the negative traces of the inclination of a former saddle roof can be observed (Lemaire, 1905: 133) (fig. 7.5). This was the roof of a post-Romanesque north transept. The term 'post-Romanesque' is used as it was impossible to date the phase more accurately. However, the roof is assumed to be older than the Gothic stone vault in the choir, which is known to have been executed in 1567. While building the transept, the lower parts of the two windows were partially filled with stone. This post-Romanesque north transept had a plastered surbased wooden barrel vault. Remnants of the plaster layer, indicating the form of the vault, are still visible on the north wall.

On the south wall, next to the third bay, the negatives of the incline of a roof built against the wall of the middle aisle can apparently be seen. Hitherto, it could not be determined which building component was covered by the roof. This roof may be related to the *vunctkoor* (or baptising chapel) mentioned in archive documents (De Ceuster, 1929: 26) and wich was perhaps built against the south facade of the church.

During the preliminary study, while trying to uncover parts of the east wall to conduct stratigraphic tests, a wall painting was discovered (Keutgens and

7.11

Delmotte, 2013a: 30-35, 42-43). The painting was very difficult to study due to its extreme degradation and highly vulnerable condition and consequently has not yet been dated. However, it was found to cover the east wall up to a level higher than the vault's springing. Therefore, from a certain time onwards, as yet undetermined, the ceiling of the middle aisle of the church would no longer have been able to be flat.

Moreover, at a later and undated point, the roof above the middle aisle was raised and thus renewed. This renovation was possibly carried out contemporaneously with the first rising of the tower in the early 17th century. On the north side of this 'new' roof, remnants of the wooden boarding are still partly preserved, indicating that the post-Romanesque north transept's roof and the 'new' roof above the middle aisle must have been present simultaneously until a certain time (fig. 7.11).

The 17th century

Wooden versus stuccoed vault

The support of the stuccoed vault is composed of purlins and vaulting spars, transverse ribs and split laths. Conforming to the traditional technique of constructing supports for stuccoed vaults or ceilings, the laths are nailed onto the vaulting spars, leaving a small gap between them. The first action when stuccoing a ceiling is to plaster the first (or rendering) coat of lime mortar in a single movement through the laths to obtain good mechanical adherence with the wooden support, to which lime mortar does not chemically adhere. This action causes the formation of plaster keys. A setting or finishing coat is then put on over the render coat. For this vault, plastered in only two coats, the rendering and floating coats are the same.

Fig. 7.11. Post-Romanesque roof (second roof) boarding on middle aisle, view from north transept. Photo: K. Keutgens and B. Delmotte

7.12

The lime rendering and the total set of subsequent lime wash layers were identically applied on all wooden elements (transverse ribs, longitudinal beams, wall plates, etc.) and on the vault fields or *cassettes*. The crossings of the longitudinal beams and the transverse ribs show octagonal wooden plates, sculpted from the ribs, which were carved to obtain the same mechanical adherence with the lime mortar. Similar notches were cut into the wall plates, beams and ribs.

To connect the laths to the transverse ribs, the former were cut conically to fit into a slit incised into the latter (fig. 7.12). The support of oak laths was clearly done simultaneously with and intended for the stucco work. On the other hand, the transverse ribs are well-connected with the truss posts of the roof construction. Consequently, roof and vault constructions were very likely made at the same time. The examination of the wooden elements would therefore indicate that the vault and roof constructions were done as early as the beginning of the 17th century ('new' roof). On the one hand, this agrees with historical data showing that Jan Gots built a wooden ceiling (*zoldering*) in 1608 (De Ceuster, 1929: 27). However, another archive document states in contrast that the execution of the stucco work was not paid out before 1687 (De Ceuster, 1929: 29). This contradiction troubled the authors during the entire preliminary study and more particularly while evaluating the results.

Moreover, the stratigraphic study revealed that the layering of lime rendering and paint layers was identical on both the stuccoed vault and brick-masonry in the windows, indicating that the windows were masoned in function of the stucco work and consequently not at the beginning of the 17th century.

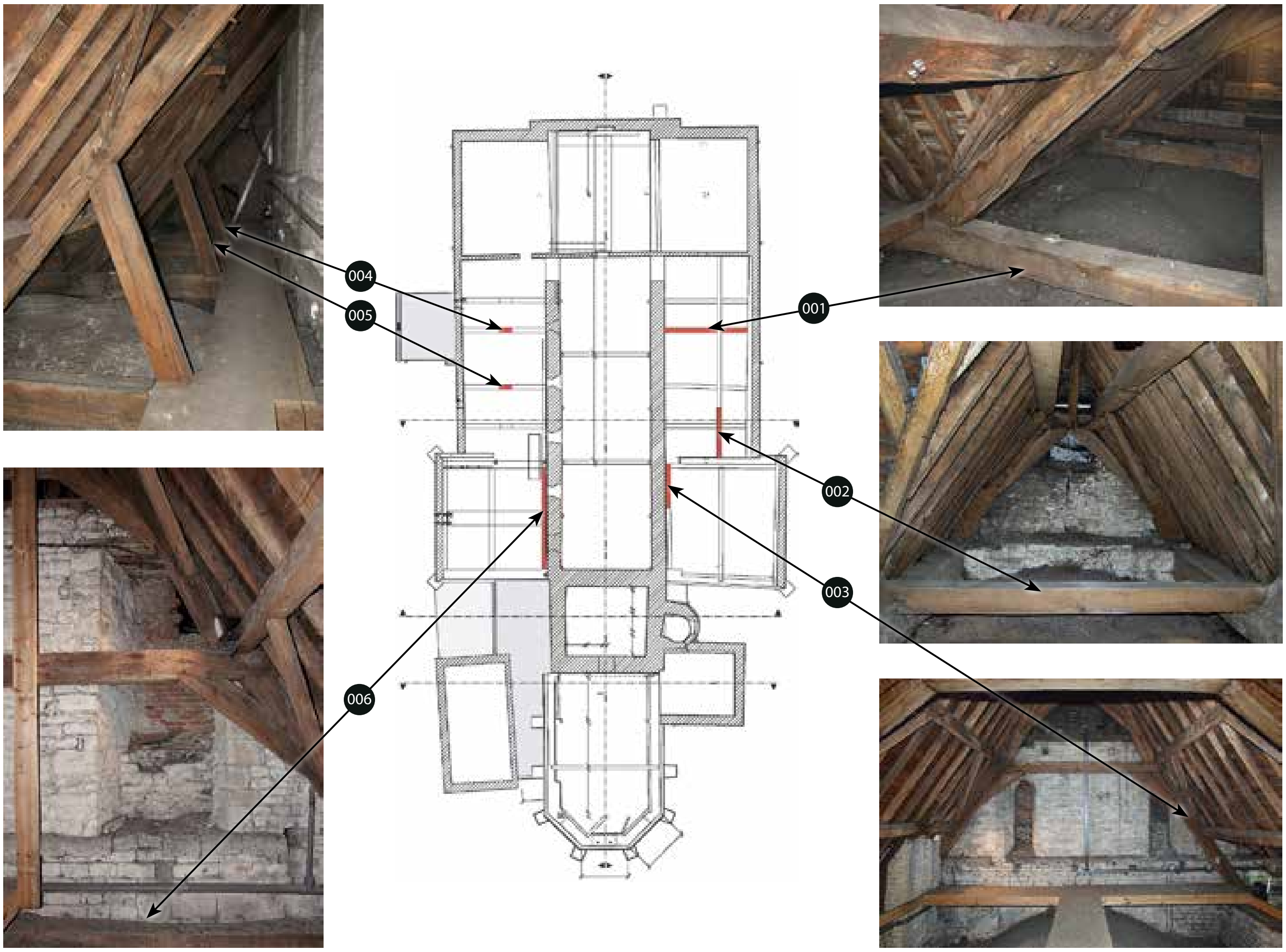
Dendrochronology

For the wooden elements, dendrochronological analysis was conducted to test the findings based on the stratigraphic studies and the on-site study of the different architectural building phases.[7] Unfortunately none of the particularly interesting constructive elements (tie-beams, transverse ribs, longitudinal beams, truss posts, wall plates, laths, etc.) or the window joinery could be dated due to the insufficient number of growth rings (van Daalen, 2012: 1). As an alternative, some beams from the side aisle's roof construction were sampled. In a single case enough rings and the sapwood were present, providing a date of 1643 and a date interval of 1643-1648 (van Daalen, 2012: 5). This was a roof plate of the roof construction of the north aisle (fig. 7.13, locus 002). The date obtained from this study corresponds well to historical information concerning the execution of the stone cross vaults in the north transept. From both findings it can be concluded that the new roof of the north aisle was finished in the middle of the 17th century.

Hypothesis

Taking into account the results of the dendrochronological analysis, we propose that the wooden vault construction, or at least particular parts of it, was done in the beginning of the 17th century and therefore existed independently of and more than half a century earlier than the stucco work. Consequently, and

Fig. 7.12. Conically cut laths fitting into a slit sliced into the transverse ribs. Photo: K. Keutgens and B. Delmotte



7.13

in accordance with the results of the stratigraphic study, the windows were not masoned as long as the roof of the north aisle was not finished. This hypothesis would agree with the historical dates. Moreover, there are additional arguments to support this hypothesis. Remnants of polychromy on the ribs and tie-beams have been found under the set of lime mortars and lime wash layers that is identically present on the vault panels, wooden elements and masoned windows. This would indicate that the tie-beams and ribs are probably older than the stucco work itself. There are several examples of similar Gothic or late-Gothic timbered barrel vaulted or pointed arched ceilings.[8] As mentioned above, the split laths were clearly installed for the stucco work and inextricably associated with it. We therefore propose that in the beginning of the 17th century an entirely wooden barrel vault was present, containing a vault wainscoting fixed into the slices of the same ribs.

There are some minor arguments against this hypothesis. First, on the places where the ribs were sawn, the layering packet is more limited than on other parts of the walls, which would indicate that the ribs were already present before the beginning of the 17th century. Layers were probably removed while sawing the ribs. Second, the octagonal vault plates were clearly foreseen and

Fig. 7.13. Overview of loci where dendrochronological analysis was conducted. Drawing and photos: K. Keutgens, B. Delmotte and S. van Daalen

prepared for the stucco ornamentation. The only counter-argument to the latter is that on the octagonal plates, wooden ornaments instead of stuccoed ones were attached during the period when a complete wooden vault was visible.

Conclusions and future prospects

St Martin's Church in Zaventem is more than just a common Gothic-style church, probably containing more than enough keys to fill the gaps in its architectural building history. This article has highlighted only some of these.

The church possesses one of the few examples of Romanesque window joinery that, due to considerably good preservation conditions, allows on-site study of both the joinery and its insertion into the Romanesque stone masonry. This study has provided valuable new information about Romanesque window joinery in our regions. For the 17^{th}-century building phase, we have proposed a hypothesis to resolve seemingly contradictory findings resulting from the material-technical investigations of the wooden elements, the stratigraphic studies and the historical documentation. Although we have shown that the hypothesis agrees with most of the results of the preliminary study, future research will be necessary to confirm or refute it. The current study has, on the contrary, not been able to reveal additional information on the original Romanesque ceiling.

Tasks remain for future research: (1) the study of the east wall that will probably reveal more information on the Romanesque and post-Romanesque ceilings or vaults; (2) ^{14}C-analysis of the Romanesque joinery to date the Romanesque building phase; (3) dendrochronology of some of the wooden elements of the roof construction of the middle aisle to obtain further dates; (4) comparative mortar analysis of lime mortars used for fixation of architectural elements to relatively date or confirm Romanesque and post-Romanesque building phases; (5) updating of De Ceuster's historical study to confirm or refute some of his dates.

Acknowledgements

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Notes

1 Preliminary study commissioned by Church Fabric St Martin, Zaventem; co-ordinated by TV Ebtca multiprofessionele architecten vennootschap en Sofie Beyen Architecten bvba, Kessel-Lo; funded by the Flemish Government, Agentschap Onroerend Erfgoed; carried out by B.J. Delmotte bvba (Bernard Delmotte and Karin Keutgens) in cooperation with Charles Indekeu (window joinery).

2 See Keutgens and Delmotte (2013a: 129-130) for the archives that were consulted. During the historical study the bulk of the archival material proved to be still conserved in the Church Archives themselves. As searching the entire Church Archives was beyond the scope of the material-technical study, the inquiry was restricted to checking particular documents.

3 The roof slope was more precisely dated by Hoffsummer from the end of the 12th or early 13th century (Hoffsummer, 1995: 123; Hoffsummer, 2002: 151, 264) (Philippe Sosnowska, ULB and Paulo Charruadas, ULB-ULg, pers. comm., 11 August 2015).

4 See ground plan and longitudinal edge of the Romanesque church in Lemaire (1905: 132-133).

5 See also van der Wal, 1968: 2, 5, 6.

6 See also van der Wal, 1968: 2; Lemaire, 1952: 70. For additional photographic documentation see Keutgens and Delmotte, 2013a: 96-97.

7 Dendrochronological analysis was carried out by Sjoerd van Daalen, Deventer, The Netherlands (van Daalen, 2012).

8 Some examples in Belgium are as follows: St.-Laurenskapel, Zoutleeuw (Flemish Brabant), XVIB (Agentschap Onroerend Erfgoed, 2015a); St.-Laurentiuskerk, Hove (Antwerp), XVII (Agentschap Onroerend Erfgoed, 2015b); Kapel van Onze-Lieve-Vrouw ten Steen (south-transept), Tienen (Flemish Brabant), late-Gothic (no date) (Agentschap Onroerend Erfgoed, 2015c); St.-Pieterskerk (choir), Langdorp (Flemish Brabant), XIII-XIV (?) (Wouters, 2010: 90-93; date: Wouters A., pers. comm. 11 October 2015); St.-Janskerk, Mechelen (Antwerp), XIV/XVB (?) (Nuytten, 2013; date: Nuytten, 2013: 219); also see Nuytten (2013: 215) for more Brabant examples. For other examples in Belgium and the Netherlands, see Janse (1989:147-228, 265-274). For more Western European examples, see Erler (2013: 17-28, 41-46).

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Summary

At first glance, St Martin's Church in Zaventem would appear to be a common Gothic-style church. Inside, however, the attic above the current cross vaults of the nave hides a 17th-century stuccoed barrel vault supported by the old Romanesque walls of the church. Hitherto, the architectural building history of the church shows gaps between the first Romanesque building phase and the adaptations to the Gothic style, which appeared rather late as they were established only between the late 16th and 18th centuries.

In 2012, a preliminary material-technical study of the stuccoed vault and the adjacent walls was carried out. This paper highlights the results of this study that are directly or indirectly related to the wooden architectural features or elements. First, it provides a detailed description of the Romanesque windows and their joinery still preserved, adding information to what has been previously published for the Romanesque phase of the church. Second, it enumerates other findings related to the post-Romanesque building phases that are not yet understood and have not yet been studied in depth. Third, it suggests how the combined findings of both the material-technical investigations and the archive documents contribute to a better understanding of the major architectural changes of the 17th century.

8.1

8

Wooden nailed doors in western France: An Armorican model inherited from the Middle Ages?

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Key words

Joinery / Wooden nails / Doors / Middle Ages / Brittany / Dendrochronology / Experimental archaeology

Introduction

More than 240 tree-ring studies have been conducted in north-western France, both in archaeological sites and historic buildings, under the guidance of the *ArchéoSciences* and *Dendrotech* laboratories (Rennes). During sampling campaigns, many building components are considered, including old windows, panelling and doors,which have been a research priority in the dendroarchaeological approach applied in these laboratories. Further, for the last ten years the authors have worked on identifying an original model for the construction of wooden nailed doors and shutters to a lesser extent (fig. 8.1). This is an important building component of small rural heritage, which tends to be lost for many reasons, including a deep-seated misunderstanding of ancient woodwork and more generally of wood as a material. Unfortunately, this research has

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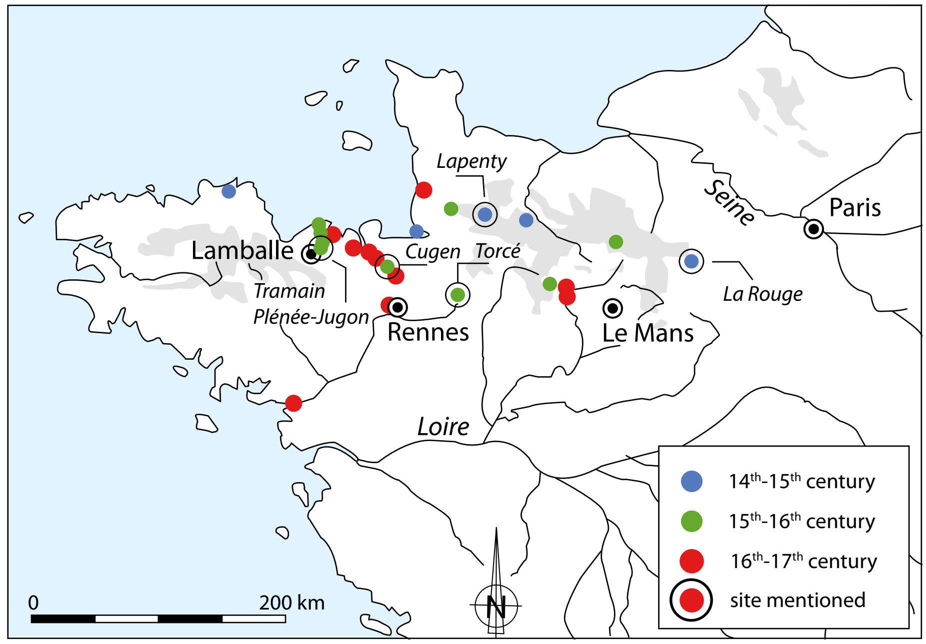
Fig. 8.1. Wooden nailed door of the 17th century (Plenee Jugon, 'La Cour' – Brittany). The decoration of the panels clearly follows from the medieval register. © V. Bernard, CNRS



8.2

Fig. 8.2. Map of western France showing the location of the main sites with preserved wooden nailed doors. © V. Bernard, CNRS

had to be conducted on the sidelines as a supplement to programmed research. Thus it has sometimes been seen as a hobby and cannot be considered as systematic. Therefore the highest concentration zone studied in Brittany is located between Rennes and Lamballe, that is, close to the homes of two of the authors (Bethencourt and Bernard). However, examples of such joineries are rare east of Le Mans: this type of joinery seems indeed to pursue its full development in Brittany, and more widely in the Armorican Massif (fig. 8.2).

The terminology 'wooden nailed doors' refers to the fact that in some early examples no metal was used and that all the mechanical stresses weighing on the vertical slats were resolved only by wooden pegs that acted as nails and bracing. Due to strong squared heads and small forced wooden wedges, planks and transoms were secured exactly as iron nails would have done (fig. 8.3). This model requires great skill in the different stages of using wooden nails. Indeed, although often misunderstood or misinterpreted, and considered simple, even rudimentary, this is deceptive as it is quite difficult to create such joineries; they are often poorly achieved by later generations of woodworkers. This loss of traditional skill resulted in a lack of interest for this door model, deemed too rough or poorly executed, in favour of other models that were more elegant, lighter, more wood-efficient and smartly designed.

However, the type of pegged door presented here reveals a masterful example of the traditional joiner's art. It is hoped that this paper will help to support the preservation and revival of a door model more than a millennium old.

Description and reconstitution

Most of the doors observed have a very simple look: vertical boards are reinforced by two to four transoms, held firmly in place by wooden nails or pegs. The width of the boards may vary depending on the width of the doorway.

8.3

When planks are made of oak, elm or sometimes walnut, wooden nails are also made of the same woods. Very efficient, this heavy model swings open very easily. The planed and sometimes moulded side of the door corresponds to the outer side, i.e., the visible side, while the rough face with pit saw marks and the crosspieces are on the interior. The crosspiece is generally 3-4 cm (2 inches) thick and around 10-12 cm (6 inches) wide.

Because older door models contain virtually no metal, it is crucial that the section of the nail close to its head is squared to fit into the square opening of the hole on the outer side to prevent planks from sliding and the door from warping. Long hinges would progressively reinforce this function later. This technical aspect is certainly the most important in understanding how 'simple' wooden pegs ensure that a door of 30 kg or more maintains its original rectangular shape.

Thin lines are incised with a blade (a knife?) on the outer face of the door at the level of crosspieces prior to boring the peg holes (fig. 8.4). The distribution of nails across the door width can vary in number and arrangement. Given that these nails are fully involved in the decoration of the door and that their chamfered heads copy large forged nails found on the heavy doors of medieval cities or cathedrals, one must consider their number as an ornamental element, a demonstration of the know-how and skill of the craftsman and a display of the status of the owner, much more than simply a technical feature. However, the spacing between the nails on the outside door boards is determined by the

Fig. 8.3. Wooden nails with small wedges and traces of red paint. © V. Bernard, CNRS

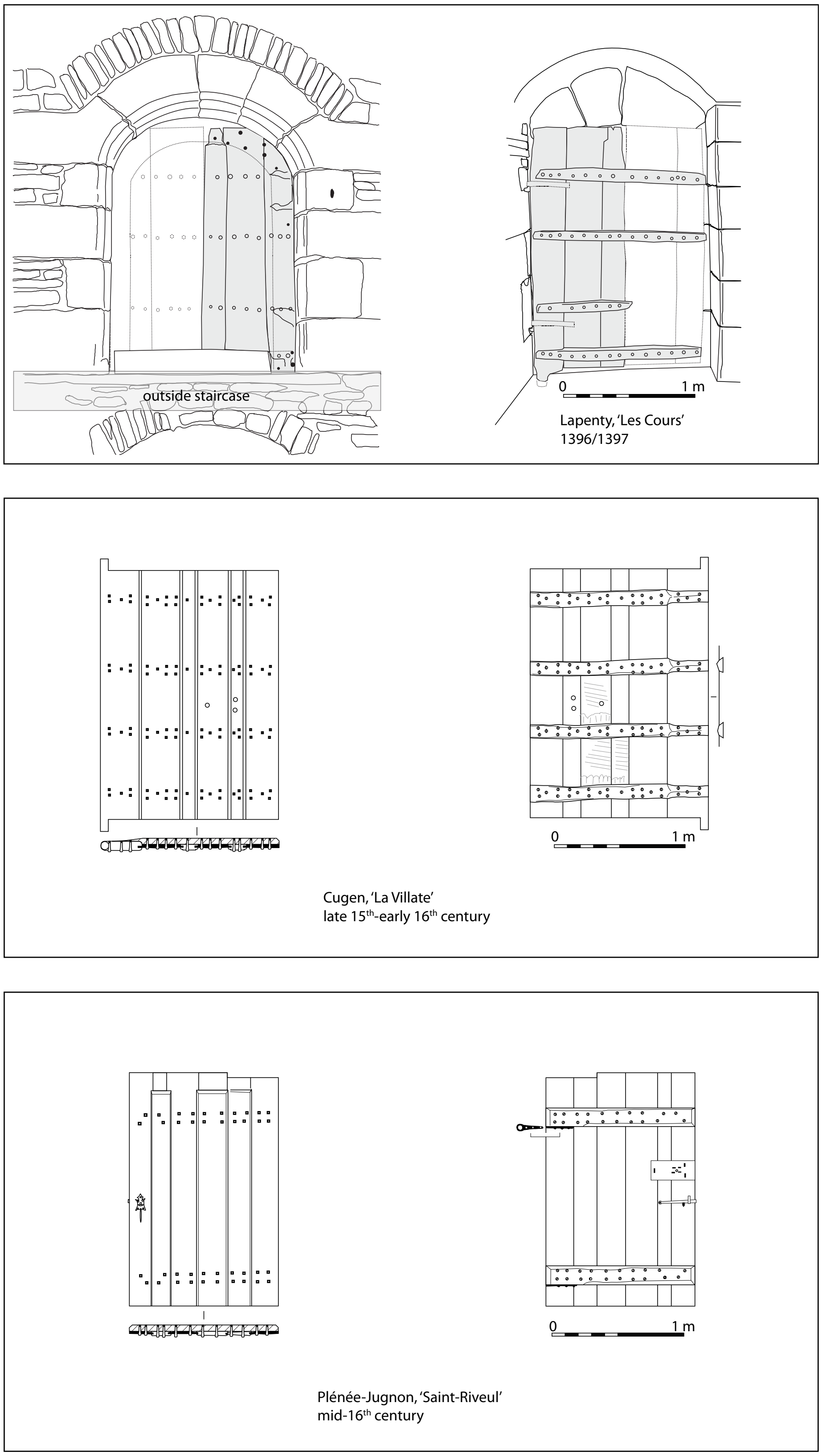
8.4

length of the cross brace, and above all by the width of the board. Thus, the nail organisation on the external face of the door frequently makes one or two horizontal lines (fig. 8.5). Staggered triangles are probably the most common pattern as this adapts perfectly to the width of the boards without showing discontinuity, since a narrow board will be attached with one nail and a large one with up to three nails.

Experimental archaeology demonstrates that pegs were made with a drawknife from freshly cut oak, wedged in a shaving horse on which different markings allowed control of length and thickness during the whole operation, which took about three minutes (fig. 8.6). Other marks are possible: an inch corresponds to the basic measure of the nail head width which could be controlled at different stages of the work by means of the joiner's thumb.

In order for the door to fit securely, the cross braces must be held firmly against the door while the holes are drilled and the nails driven. As the wooden nails are gently hammered to attach horizontal and vertical elements, the craftsman must ensure that the squared part of the nail properly penetrates the squared compartment created at the opening of the hole on the outer side of the door. Here, the use of fresh wood has certain advantages: easy shaping of the pegs, a lower risk of breaking when driving nails and a simplified insertion of the locking wedge. Moreover, observation of traces on old woods reveals that to insert the wedge, pegs were split in place and not before. Likewise, sometimes decorated heads often remain intact with no traces. Thus they were also carved and driven in once recut to their final size. The section view of experimentally reproduced joinery shows that the fresh wood nail fits the entire space of the hole and its irregularities. When all the nails have been seated, the ends of the nails are sawed off and the surface cleaned with a chisel.

Fig. 8.4. Restored door showing thin lines before the drilling of peg holes. © V. Bernard, CNRS



8.5

Fig. 8.5. Survey of three wooden nailed doors.
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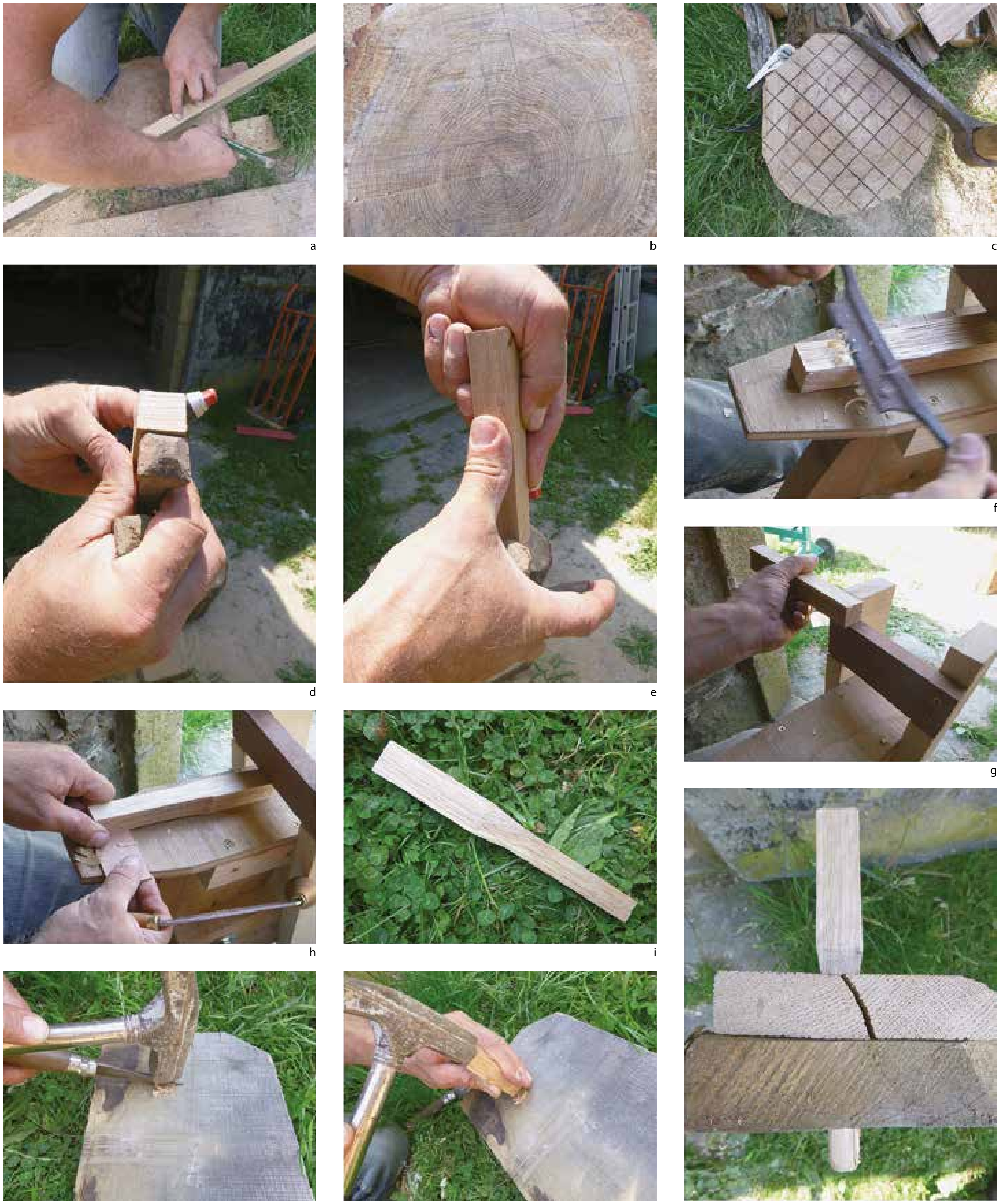


8.6

m n o p q r s t u

8.6

Fig. 8.6. Operational sequence for the production of a wooden nail: a) drawing of pegs on a fresh oak section; b) detail of the drawing; c) splitting knife in action for the production of pegs; d-e) marking of reference points using an old nail and thumb measuring; f-h) a shaving horse in different manufacturing steps of the nail; i-j) the nail in place; k-l) preparation and installation of the locking wedge; m-o) archaeological examples showing the square location for the nail head; p) chisel cleaning of the nail end; q-r) traces of splitting of the nail end before insertion of the locking wedge (q) on experimental and (r) archaeological artefacts; s-t) finishing the nail head; u) sectional view of the nail and its small wedge. © B. Bethencourt, Utensia; V. Bernard, CNRS

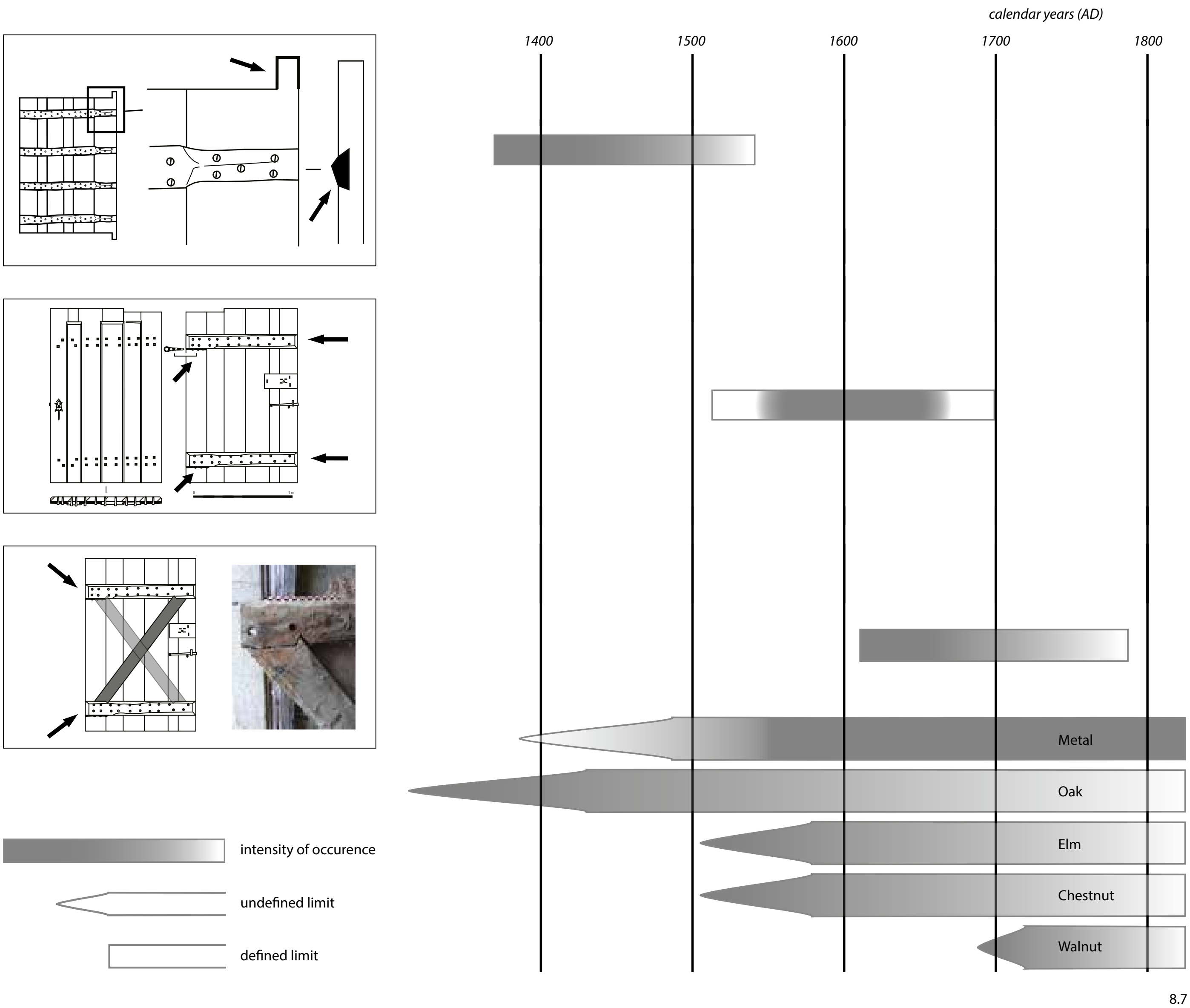
Typo-chronological evolution (fig. 8.7)

Most of the doors and shutters discussed here were dated by dendrochronology, often in combination with a tree-ring analysis of the timber frame and an archaeological study of the building. In most cases, these door and window frames date to the earliest building phases. These fragile components must be taken into account to be preserved and restored during renovation projects.

Among dated doors that fall between the late 14th and 18th centuries, the oldest remains each have a pivot at the top and bottom, cut within the mass of the first and main carrying plank. These pivots, in turn, are set into sockets in the door lintel and the sill plate. These elements seem to have been characteristic of the 14th and 15th centuries. At this time, in Brittany as in England, some doors have no visible hinge, for example those from the Mount Grace Priory, Yorkshire County (Diehl and Donnelly, 2012). Yet, since the beginning, some door models combine a pivot at the base and metal hinges. The example of the Hall of Justice at Lapenty in southern Normandy shows that hinges were installed with the masonry; they were not a restoration (fig. 8.5). The dating of this door is consistent with the framework dated from 1396-1397d (Dendrotech, 2012). Although almost no metal was used in the early period, in the second half of the 15th century, the doors were rapidly equipped with ironmongery: hinges fastened with metal nails, locks and latches.

From the late 14th to the early 16th century, transoms were assembled by dovetail to the axial strut in order to strengthen the door. During the same period in England, transoms penetrated into the carrying timber with tenons and mortises (for 15th-century examples, see Diehl and Donnelly, 2012).

During the 16th century, this type of assembly was abandoned in favour of simple transoms without oblique reinforcement, which requires a perfect fit of nail heads in the plank. On the opposite side of the door, a small wedge is inserted to firmly hold the transom against the boards. This wedge is always driven at right angles to the transom in a manner not forcing the fibres to prevent wood splintering. In the following century, this type was replaced by simple holes into the thickness of transoms, which allows the articulation of the door with metal or leather reinforcements. It should be noted that at the end of the 16th century, the addition of diagonal reinforcements equipped with stops seem to reflect a loss of skills and confidence in these assemblies. At a time when the distinction between carpenters and joiners was well-established, these assemblies, called 'carpenter's assemblies', suggest that this work emphasizes strength over fineness (Icher, 2003: 114; Roger, 1995). In the same vein, it appears that 14th- and 15th-century doors contain fewer nails than, in particular, during the 17th century. This idea would also be consistent with a loss of knowledge, revealing a poor understanding of the technical principles implemented in previous centuries and thus a fear of a work failing under its own weight. This observation could also be extended to the context of the time, when too many timbers that were also too big were incorporated, as recent dendroarchaeological research in north-western France suggests (Bernard *et al.*, 2014; Épaud and Bernard, 2008; Hunot, 2004). Yet it is at this stage that decorated panels were strangely reminiscent of 15th- and 16th-century linen-folded patterns (fig. 8.8; Le Roux, 1984).



Oak remains the most widely used wood throughout the chronological sequence for architecture in western France. Similarly, elm and chestnut appear at the beginning of the 16th century, as they do in the Breton frameworks. In later periods, approximately the late 17th or early 18th century, walnut made a rare appearance for very refined doors. This was the latest expression of a type of door now reserved only for farm outbuildings. Currently, we do not have dated elements more recent than the 18th century, and it seems quite certain that the 19th century sounded the death knell of a door model that lasted for at least six centuries.

Fig. 8.7. Typo-chronological evolution of wooden nailed doors. © V. Bernard, CNRS

8.8

Discussion: What status for such joinery?

Simple in its design, this model of joinery takes sometimes misleading appearances which have given it a reputation as being a rural or 'rustic' production. It is true that the simplest models are today limited to farm outbuildings or attics, but this mainly involves poorly designed doors of the late period (17th-18th centuries). That is likely due, at least in part, to the fact that in western France, the development of hedgerows with typical '*bocage* landscape' since the 15th century led to the output of trimmed trees. By the mid-16th-early 17th century then, materials selected for carpentry and joinery were of poor quality: the wood knotty with cankers and wood fibre deformations due to repeated pollarding (Bernard *et al.*, 2007). A loss of skill associated with wood that was harder to work seems to mark the end of an original wooden door style during the 18th century. At any rate, whether those doors were originally ill-conceived or poorly preserved, their current appearance plays against them.

Fig. 8.8. The 17th-century front door of the church of Saint-Juvat, Brittany. © B. Bethencourt, Utensia

Should we consider that such joinery was reserved for modest buildings in a rural environment? Or were they intended to equip service rooms in more prestigious buildings? We will attempt to answer these questions using examples dated by dendrochronology.

At Torcé (near Rennes, Brittany), in a small manor dated to 1520d, wooden nailed doors and shutters were hidden, with their raw appearance, with the more sophisticated elements exposed: in this way, the lower levels of the building were closed with linen-folded shutters and doors while the attic was equipped more soberly with simple wooden nailed shutters (Dendrotech, 2013). This sobriety even went as far as to saw nail heads flush to the boards to present a surface devoid of any setting (fig. 8.9). In the early 16th century, Breton manors lost their lower rooms and new parts were created in upper levels to accommodate

8.9a

8.9b

Fig. 8.9. Manor at Torcé, Brittany: a) linen-folded wooden nailed shutter; b) sober wooden nailed shutter © A. Marais, Dendrotech

8.10

Fig. 8.10. La Gauberdière entrance door at La Rouge (1465). © V. Bernard, CNRS

enlarged families or domestic staff (Merion-Jones, 2013; Nassiet, 1993). Given the homogeneity of the dendrodates showing a single phase at 1520, it seems that the top of the house was destined for the staff from the original conception and building of the manor. Yet such hierarchical organisation of joinery seems to be an isolated case here. Generally, when this kind of joinery exists, it is featured from the front door, reinforcing the defensive character of the building and the owner's authority.

The Manor of La Gauberdière at La Rouge (Normandy, 1465d) preserves a unique example of a red painted door in its main entrance that presents an original decoration consisting in the assembly of heavy curved boards (fig. 8.10). Here and elsewhere, wooden nails take part in the decoration of the door through the patterns they materialise. Traces of red ochre paint are fairly common, although not always well-preserved. Indeed, they are unfortunately limited to a few protected areas, generally in the hollow mouldings. No other colour has been as yet visible to the naked eye on this type of door. It is true that red ochre is conventionally used for this kind of joinery in Brittany and western France (Simon, 2008), although a wider range of colour exists in urban housing and castles in this region (Leloup, 2002).

Likewise, at Lapenty (Normandy, 1396/1397d), the Hall of Justice had a front door at the top of a set of steps with mouldings fitting closely to the masonry arch (fig. 8.5). This now lost moulding is underlined by the peg holes that kept it in place. Applied elements on external doors are rare, since wood constantly expands and contracts with humidity. However, this detail would heighten the formality of the place. Its access at the top of the steps was immediately visible to all visitors. The opening of the door to an upper room with a huge fireplace and an imposing framework certainly contributed to impressing litigants in pure medieval tradition.

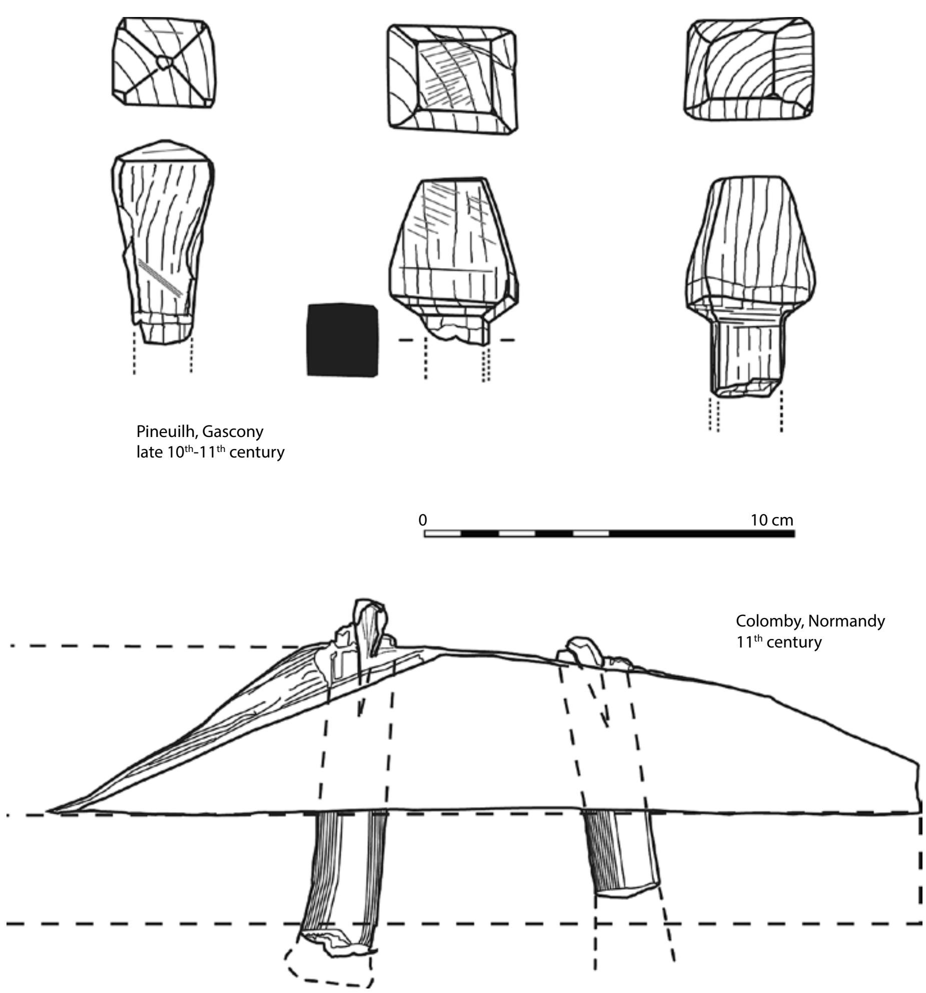
In the late 15[th]-early 16[th] century, the manor of Bois Julienne at Tramain (Brittany), a wide and heavy wooden nailed door (1.70 × 1.10 m) provided access to the cellar and its cider reserve. The same model was used for the staircase of the seigniorial room and for the guest room.

From these examples, we can reasonably abandon the idea of 'second-class' joinery relegated to dark and poor places, as variations on the same theme are common. Along with classical models of joinery decorated with linen fold motifs widespread throughout Europe, wooden nailed doors are striking for their austere design and massiveness. The use of heavy timber sections, the soberness of decors and the near absence of metal are typical characteristics rooted in a medieval tradition. In Brittany during the 17[th] century, the introduction of linen fold motifs on wooden nailed doors and chests would act as a reminder of the Middle Ages (fig. 8.1; Le Roux, 1984). But, even more importantly, it is increasingly clear that the fundamental principle of thrifty use of metal – or even the exclusive use of wood – was deeply anchored in practices of the early Middle Ages. Indeed, recent discoveries of water mills at the turn of the 1[st] millennium AD show that even technical parts theoretically requiring iron were made of wood. Interestingly, some of these sites also contained pegs with heads looking nearly identical to the wooden nails discussed here, and four centuries older (Bernard *et al.*, 2016; Mille, 2007). All of these wooden nail examples with square or frustopyramidal heads prior to the 12th century were meant to join thin pieces of wood (e.g., planks) and quadrangular assembly members (hinges, crosses), which is very different from a carpentry work. Their function was also to hold in place elements likely to be mobile: chest covers, door leaves, sluice gates, etc. It was therefore essential that they had two locking ends: a head and a clamping wedge. Finally, as visible and ostentatious elements, they had to be aesthetic, decorative and deterrent (to prevent shouldering a door open!), especially on portal and residential gates. The frustopyramidal shape was the simplest but also the most efficient compromise between the material used, the speed of installation and aesthetics.

With such early medieval examples, which in fact belong to joineries and not to structural elements, it is difficult to call into question the seniority of such manufacturing principles (fig. 8.11). In this context, there can be no doubt that western France should be regarded as an archaeological repository for wooden nailed doors, a model probably more widely known in the past.

Acknowledgements

The authors would like to thank all of the owners for having opened their doors for this study.



8.11

Fig. 8.11. Archaeological examples of 11th-century wooden nails. © P. Mille, INRAP; V. Bernard, CNRS

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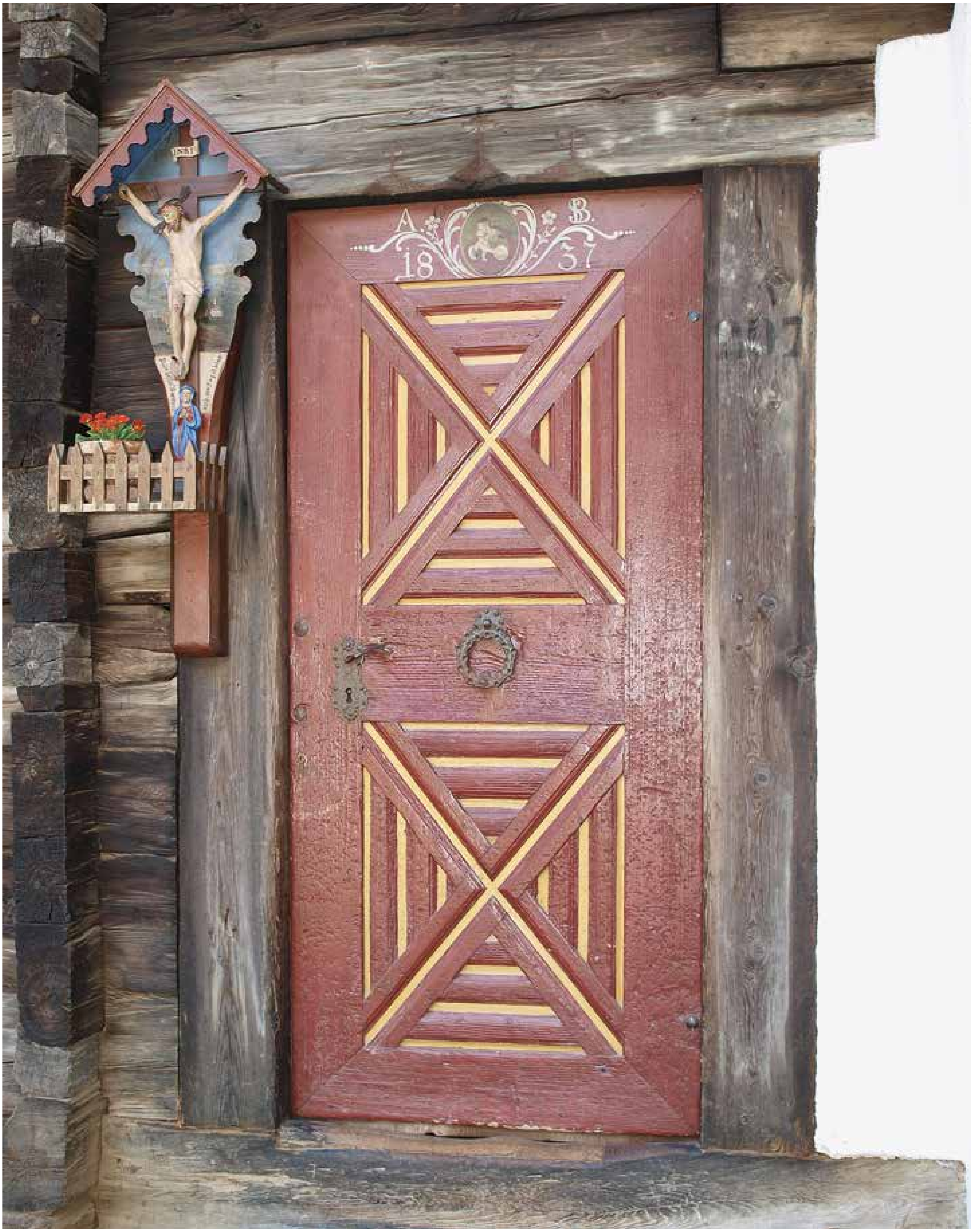
Summary

In Brittany, and more widely in western France, an original joinery model has survived both the ravages of time and unscrupulous renovations of old buildings. This most often concerns doors, more rarely shutters, termed 'wooden nailed door'. This terminology is used judiciously since the frustoconical pegs with a square head work in traction due to the insertion of a wedge from the distal end.

At first view of simplistic execution, these joineries actually require mastery of mechanical stresses by the craftsman. Indeed, before the 17th century vertical slats assembled with a tongue-and-groove system were generally maintained only by two transoms with no diagonal elements. Dozens of archaeological observations and recordings highlight the importance of nails when no bracing system is present, to the extent that nails fulfil this function.

Both archaeological observations and experimental archaeology allow us to establish a complete production sequence for this kind of joinery.

Dendrochronological dating shows great continuity of this joinery model, from the 14th to the 18th century. For recent times, its adoption and persistence in farms have given it a rural or 'rustic' character. However, its widespread use in aristocratic housing and religious architecture proves that such joineries were used in farm outbuildings as well as in prestigious buildings. For the latter, the joinery was sometimes adorned with simple and elegant decorations. The presence of similar wooden nails in sites as early as c. AD 1000 broadens the spatio-temporal range of this type of joinery, for which Brittany can be seen as a region for its preservation.



9.1

9

Analyses of wooden front doors in rural buildings from Austria

Sebastian Nemestothy[1], **Andrea Klein**[2], **Michael Grabner**[3]

Key words

Dendrochronology / Wood species / Wood utilisation / Building history / Doors / Rural construction / Austria

Introduction

The door, as the opening of a building, is a place of physical and spiritual danger (Sentance, 2003); style and ornamental decor are very important and have been described and interpreted in many publications (e.g., Brausewetter, 1895; Wickop, 1949; Milan, 2000; Figiel, 2001; Langenbeck and Schrader, 2002; Pech *et al.*, 2007; Bronstein, 2008). However the literature has mainly described the doors of city buildings, castles and churches (e.g., Thielen and Mey, 1961; Semff, 1979; Neumeister, 1996; Krautheim, 2011; Adam and Herzog, 2002), whereas rural buildings from the 15th to the 20th century that have been investigated include door elements which were often extravagantly constructed and richly decorated (fig. 9.1).

A fundamental function of doors is to provide insulation and protection against the weather and unwelcome guests (Pech *et al.*, 2007; Arnold, 2012). Here as well, technical details for the crafts employed have only been discussed for urban doors (e.g., Schneck, 1933; Meyer, 1939; Haberer, 1959; Pracht, 1978).

Consequently, there is very little information available concerning rural doors in Austria. The main objective of the present study was to fill in this gap by studying a sample of rural doors conserved at the Austrian Open Air Museum Stübing, near Graz in Styria. This paper is part of ongoing research addressing the historical use of wood in Austria conducted by the Institute of Wood Technology and Renewable Materials at the University of Natural Resources and Life Sciences in Vienna.

Our study focuses on the identification of the wood species used to make door leaves, frames, locks, etc., the size and types of doors (simple plank doors,

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Fig. 9.1 Example of a nicely decorated door in a rural farmhouse from the Austrian Open Air Museum Stübing.

double-layer doors, frame doors, etc.), description of the wooden elements to obtain information on the parts of the tree trunk that were used and an idea of the woodworking techniques employed, and using dendrochronology to date the rural doors in this data set.

Material and methods

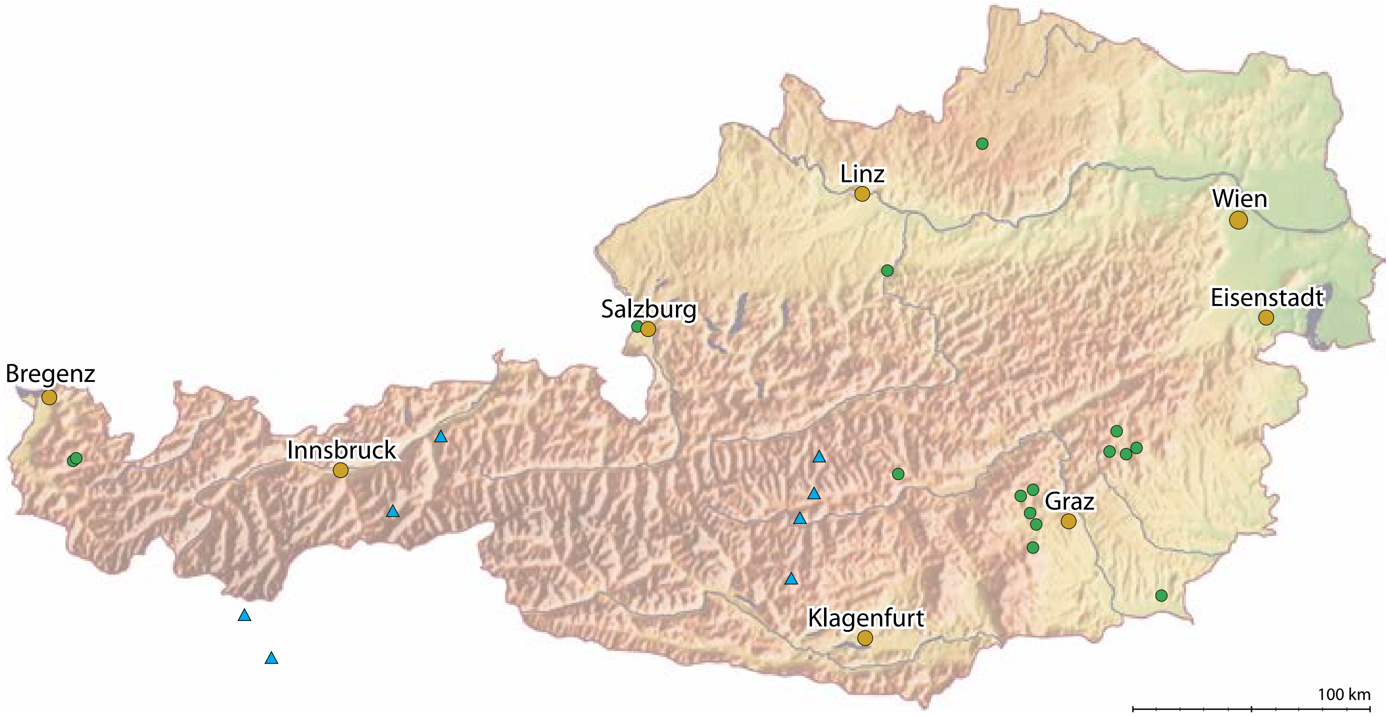
In 2012-2013, 51 doors from 30 buildings, which had been transported to the Austrian Open Air Museum Stübing, were analysed. The museum depicts the Austrian cultural landscape in alignment with the general purpose, scientific methods and goals for open air museums declared by the Association of European Open Air Museums. During the initial building phase of the museum, a search for distinctive structures from the different provinces of Austria was done. Selected buildings were carefully documented and dismantled at their original site and then transferred to the museum where they were rebuilt according to their previous state. However, dependent on their condition, single timbers or elements such as roofing may have been restored or replaced during the reconstruction. At its opening in 1970 the Austrian Open Air Museum included 32 buildings, in which over 90 objects are now presented and conserved (Pöttler, 2005). All buildings included in this study were from rural areas and used as farmhouses, granaries and stables. The associated doors include front doors (33), interior doors (14) and stable doors (4). They come from seven provinces in Austria – Styria, Carinthia, Lower Austria, Upper Austria, Tyrol, Salzburg, Vorarlberg – and South Tyrol in Italy. The map in Figure 9.2 shows their original locations, in alpine and bordering (non-alpine) sites.

Types and dimensions of doors

The study includes a description of the construction types of doors (plank doors, double-layer doors or doors with a frame) and their hinges (metal hinges or wooden pivots). Thickness, height and width of the door leaves were systematically measured. In order to understand the influence of the geographic origin and age of a door on its size and type, the area was divided into the alpine and bordering (non-alpine) regions. The mountain climate of the alpine regions is marked by high continentality, short summer periods and high annual rainfall or snowfall. The bordering (non-alpine) region has more moderate climate conditions, with warmer and drier regions and a sub-alpine climate south of the inner Alps, in contrast to higher precipitation in the oceanically influenced climate of the regions north of the inner Alps (Kilian *et al.*, 1994). These descriptions were then studied in light of the dendrochronological dates to identify possible changes in door type and size through time.

Wood species identification

Wood species were determined on the basis of anatomical features using a reflecting light and a transmission light microscope (Wagenführ, 1989). Some species are detectable simply with a magnifying glass to enlarge the wood structure; for others a microscope was needed. The wood species of the boards,



9.2

which were sanded for tree-ring measurements (see below), were identified directly on the piece with a magnifying glass (and also photographed to measure ring widths. For door frames, latches, handles and locks, very thin pieces for all anatomical directions (less than 1 mm thick) were sampled using a razor blade, to be analysed with a transmitting light microscope.

Dendrochronological dating

All door planks were measured *in situ*, without dismantling. To make the boundaries of the rings perfectly visible, their cross-sections were sanded. However, to limit such abrasive and destructive preparation, the boards were firstly strictly selected to keep the best preserved boards intact. Measuring tree rings on the flat surface of these softwood planks would have been entirely non-destructive but this method does not allow precise measurement of the ring widths for the innermost part, which can be distorted if the log was not perfectly sawn through the pith.

For sanding, a small precision bore grinder with a spindle collar 20 mm in diameter was used. The sanding paper (grain size 120, 240 and 600) was glued to the collar. After sanding, the sample was photographed using a scaled frame to make calibration possible for tree-ring measurements (fig. 9.3). This reference frame also helped to maintain a constant distance between the object and the lens. In some cases the sampled board was too big for the frame; for these, several photos were taken which were later overlapped digitally. The photos were made with an Olympus E-420 digital camera using a lens with a focus length of 25 mm, causing the least possible distortion. The distance of approximately 120-150 mm between the object and the camera was determined by the lens and the size of the reference frame.

Fig. 9.2. Map of Austria showing the former locations of the doors analysed. Triangles: buildings/doors in an alpine environment; circles: buildings in bordering (non-alpine) regions. Background: http://www.ginkgomaps.com

9.3

Fig. 9.3. Reference frame for calibration of photos used for digital recording for dendrochronology.

The ring widths were then measured on the photo directly on the computer screen using the measuring software WinDENDRO 2009 (Regent Instruments Canada Inc.). Tree-ring series were dated using t-values and *Gleichläufigkeit* compared by TSAP (www.rinntech.com) and by visual checking of the plots (Baillie, 1995; Stokes and Smiley, 1996). All boards from the same object were first cross-dated against each other. The average curve of the object and the single curves were then cross-dated against Austrian chronologies.[1]

As many different boards as possible were sanded for each object in order to increase the reliability of dating the door.

Results and discussion

Dendrochronological dating

From the corpus of 51 doors, 33 were successfully dated. The dates range from 1442 for a door in the 'Hanslerhof' farmhouse to 1909 for an alpine hut from Vorarlberg. An overview of all dated doors, together with their type (see description below) and the date of the building construction to which they belong are presented in Table 9.1.

In most cases, it was not possible to detect a waney edge (bark ring, *Waldkante*). The dendrochronological result thus corresponds to the year of the outermost tree ring but not the date of felling, which took place later. The difference between the felling date and the obtained dendro-date is due to the processing of the boards, during which wood material was lost by planing the edges of the boards. However, the last tree rings measured are generally very narrow, which would indicate that only little wood was removed, as narrow rings are typical of the slowdown of the growth of the tree at the end of its life. Indeed, in a study on furniture and coopered vessels, Klein *et al.* (2014) showed that

Building	Wood species	Type of		Date of	
		hinge	door	building	door
mill	Norway spruce	metal	plank door	1782	1783
	Norway spruce	metal	plank door		1783
blacksmith's workshop	Norway spruce	metal	plank door	1682*	1628
farm house 'Sallegger'	Norway spruce	metal	plank door	1775*	1561
	Norway spruce	metal	plank door		1561
barn 'Naintsch'	Norway spruce	metal	plank door	1680*	1688
school house	Norway spruce	metal	plank door	1857*	1839
farm house 'Säuerling'	Europ. larch	metal	plank door	1591*	1518
	Europ. larch	metal	plank door		1514
	Norway spruce	metal	plank door		1703
granary 'St. Nikolai'	Norway spruce	metal	plank door	1698*	1604
farm 'Paule' ground floor	Norway spruce	wood	plank door	1690*	1836
	Norway spruce	wood	plank door		1858
farm 'Paule' granary	Norway spruce	wood	plank door	1528*	1510
	Norway spruce	wood	plank door		1510
farm 'Paule' first floor	Norway spruce	wood	plank door	1548*	1527
	Europ. larch	wood	plank door		1564
granary from Carinthia	not accessible	not acc.	not acc.	1713*	1651
	not accessible	not acc.	not acc.		1651
farm from Upper Austria	Europ. larch	metal	double layer	1777	1607
	Europ. larch	metal	double layer		1607
	Europ. larch	metal	plank door		1752
farm from Lower Austria	Norway spruce	metal	double layer	1827*	1826
mill 'Schnals'	stone pine	metal	double layer	1830*	1834*
farm house 'Hanslerhof'	Norway spruce	metal	plank door	1482*	1442
	Norway spruce	metal	plank door		1459
	silver fir	metal	plank door		1847
	Europ. larch	metal	plank door		1463
	Norway spruce	metal	plank door		1625
fodder stable	Norway spruce	metal	plank door	1830*	1824
farm house from Salzburg	poplar	metal	plank door	1854	1813
	Norway spruce	metal	framed door		1813
alp hut (dairy)	silver fir	metal	plank door	1927*	1909

Tab. 9.1

only a few (on average 14) growth rings were missing below the waney edge. One reason would be that the outermost wood with narrow tree rings has a high density for softwood which is of high quality for joinery (Wimmer, 1995); craftsmen would have thus tried to keep it as much as possible (Klein *et al.*, 2014). This might also be the case for doors; however, such evidence could not be acquired in this study because of the low occurrence of waney edges. It is also probably for this reason that boards are not always sawn parallel but rather with a conical shape which follows the natural taper of the tree.

The dendrochronological dates of the outermost rings from the 33 dated doors vary between 1442 and 1909. Adding to this the time of seasoning, which

Table 9.1. Overview of all dated doors (objects dated with waney edge are marked with a *).

occurred between felling and use, four possible scenarios were observed when comparing the age of the doors with that of the buildings.

1) Contemporaneous construction of building and door

The front door of the residential building 'Dreikanthof' was dated with the outermost ring at 1826 (Klein and Grabner, 2014) and the building itself was dated (with waney edge) to 1827. Only a single year separates both dendro-results, which strongly supports the conclusion that construction of the building and its door were contemporaneous.

Another case is given by the 'Schnals' mill which was dated (with waney edge) to 1830 and its door, which also has a waney edge, to 1834. Here, the trees used for the door were felled a few years later than those for the building and further, that the doors must have been added a few years after completion of the mill. Another explanation for this difference could be a possible storage time for the timber used for the building or a long construction period until the completion of the mill.

Finally, wall beams and the wood elements from the doors of the 'Mühle/Stampfe' were dated respectively to 1782 and 1783, but without waney edge. Here again, it seems highly probable that the construction of the building and of the doors took place at approximately the same time.

2) The outermost ring of the door is slightly older than the building

When the outermost ring of the door is slightly older than the building, this could indicate that several tree rings were lost during wood processing. It must be noted that for slow growing trees, i.e., with narrow tree rings, wood loss of only a few centimetres can lead up to 100 years of missing rings (Klein *et al.*, 2014). This could explain the results obtained for two doors of the 'Säuerling' dated to 1514 and 1518, while the building was dated to 1591.

This scenario could, however, also be explained by a long seasoning and storage time, the re-use of older planks or a combination of all these factors.

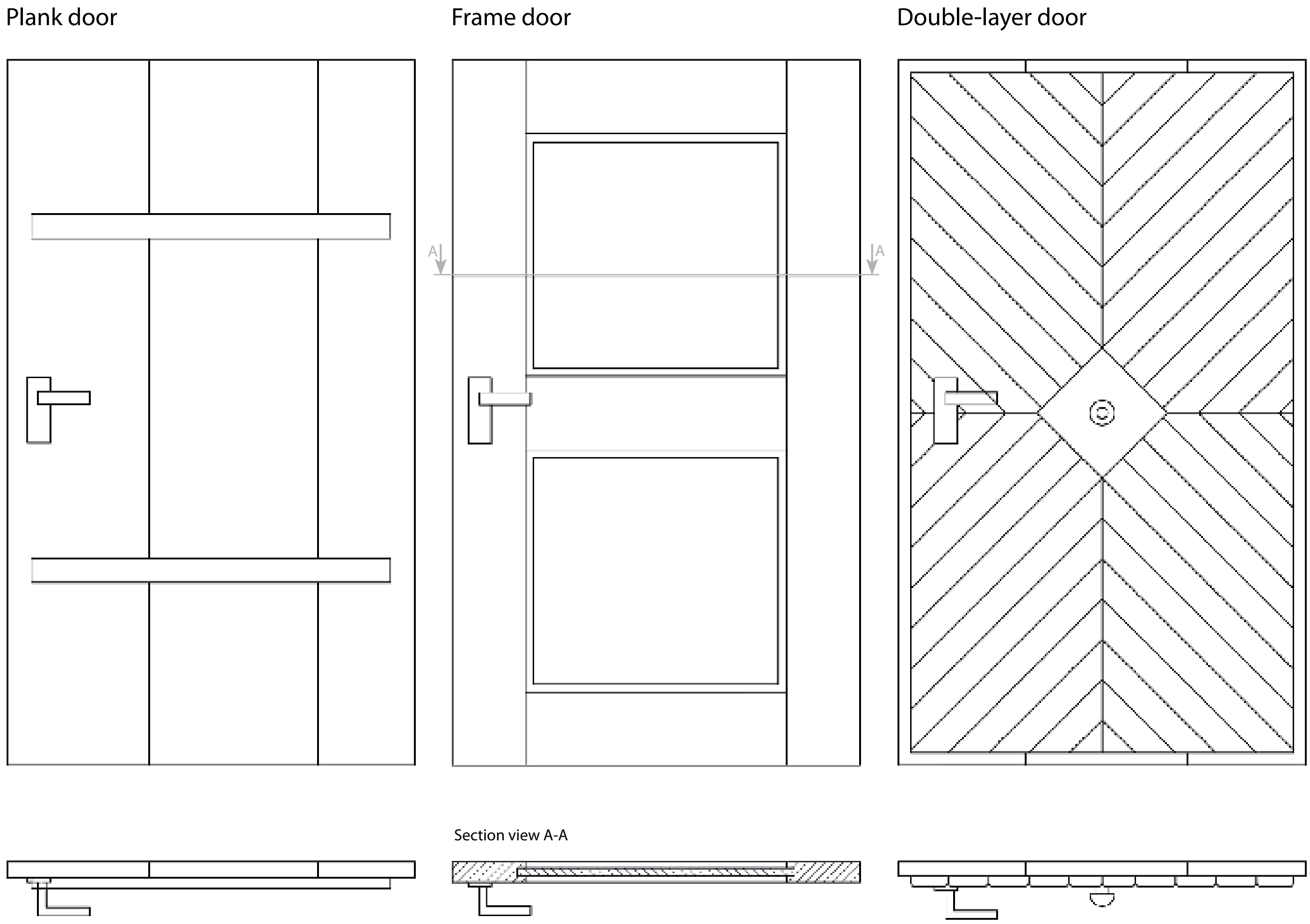
3) The door is much older than the building

If the outermost ring of the door is much older than the building, then the re-use of old wood or an old door from a former building can be postulated. This is, for example, what was proposed for two doors from the 'Sallegger' farm house which were both dated to 1561, while the building was constructed in 1775. However, it was not possible here to conclude if this was a re-use of the doors or of the single boards.

4) The door is more recent than the building

The final possibility is when the outermost ring of the door provides a date much younger than the building. This would indicate that the door was replaced (or installed later). For instance, another door of the aforementioned 'Säuerling' was dated to 1703, while the building was constructed in 1591.

It should be noted that not all cases fit into these four categories; others are less clear. One example, among others, is given by the doors of the 'Stadl Naintsch'



which were dated eight years later, for the outermost ring without waney edge, than the building. This may be due to a longer seasoning time or to storage of the planks, as well as to a later installation of the doors, possibly because the building may have needed an unusually long time for seasoning.

Types and size

All of the doors studied were single-leafed and can be classified in three different types: plank doors, double-layer doors and doors with a frame. An overview of these door types is given in the schematic in Figure 9.4. It can be seen that 78% of the doors were constructed as plank doors (fig. 9.5). For this type, boards were fixed together by dovetail battens. For 16% of the doors, a second layer of boards was mounted (double-layer door) (fig. 9.6). Only 6% had frames (fig. 9.7).

Based on the present data, not surprisingly the oldest type of door dated in Stübing is a plank door (dated to 1442), which represents the less technically elaborate type. However, it is also the most recent with an example dating to 1909. Double-layer doors can be found at the earliest from the early 17th century (1607 for the oldest example in Stübing), whereas the oldest example of the

Fig. 9.4. Door types found during the investigation of rural buildings.

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third type, a door with a frame, is not older than the early 19th century (1813). The most common construction type is the plank door, both in numbers and chronologically. Geographic distribution, however, does not seem to have any statistically significant influence on the type of door used in buildings.

The thickness of the doors varies between 1.6 and 7.3 cm (mean 4.15 cm), width between 75.7 and 122.5 cm (mean 100 cm) and height from 132.2 to 222.5 cm (mean 173.2 cm). Comparisons of the dimensions in function of both provenance categories (27 alpine and 24 non-alpine) show a slight trend of wider and higher doors for the lowlands, the mean width and height of the alpine doors being 96.4 × 168.7 cm and 103.0 × 179.7 cm for non-alpine doors. This may be explained by the harsher climatic conditions in the alpine regions where buildings had smaller openings for better insulation. Moreover, if no clear change with time could be detected in the size of the doors, it would appear that there is a trend towards bigger doors in residential and workshop/farming buildings. Blacksmith, dairy and stable doors have an average size of 100.4 × 175.8 cm, while the doors of the granaries were the smallest with a mean size of 97.7 × 156.6 cm. This seems natural as livestock had to be moved in and out through the doors of farming buildings, therefore they would need to have been wider than those used only by people; however, there is no statistical significance given the present sample size.

For residential buildings, all doors except one opened inwards, while stable doors all opened outwards and 70% of all doors had hinges on the left side (seen from the direction in which the door opens). 80% of the doors had metal hinges (fig. 9.8), while 20% had a wooden pivot (fig. 9.9). Interestingly, the wooden pivot was not the oldest type of hinge in Stübing: these were found on doors dated 1510, 1836 and 1858 whereas metal hinges occurred on doors throughout the time range studied (1442 to 1909).[2] It has also been observed that metal hinges occurred in both alpine and non-alpine regions; our dataset doors with a wooden pivot are all from alpine locations in.

Fig. 9.5. Example of a plank door from the Austrian Open Air Museum Stübing.

Fig. 9.6. Example of a double-layer door from the Austrian Open Air Museum Stübing.

Fig. 9.7. Example of a frame door from the Austrian Open Air Museum Stübing.

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Apart from these considerations, this corpus of 33 dated doors is certainly too small to construct a more precise typology of rural doors in Austria. Moreover, many other factors could affect their classification, for example the wealth of the former owners of the building.

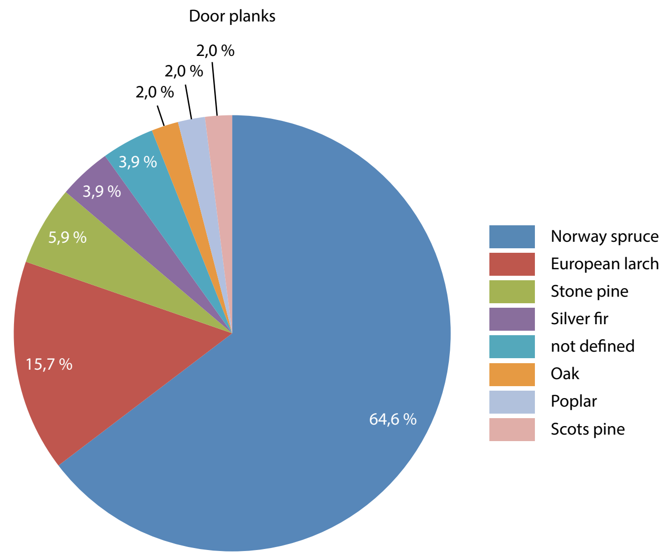
Wood species

From the 51 sampled doors, 92% were made of softwood (the remaining 8% includes 2% oak, 2% poplar and 3.9% undetermined). The most common building material was Norway spruce, used for 64.7% of the door leaves, followed by European larch (15.7%), stone pine (5.9%) and silver fir (3.9%) (table 9.2). As for the buildings themselves (table 9.3), Norway spruce is the most important building material for doors, and a very similar pattern of the use of all these species can be observed when examining furniture in rural farmhouses in Austria (table 9.4). This highlights the major importance of softwood, particularly Norway spruce, in Austria. Softwood has been mentioned as the preferred construction timber because of its light weight and length as well as straightness of the tree trunk (Klöckner, 1982). Another reason for the common use of softwood and especially Norway spruce could be its widespread distribution in the Austrian forest area in the given time period (Wessely, 1853). In terms of provenance no major difference of the wood species used between alpine and non-alpine regions is observed (table 9.5).

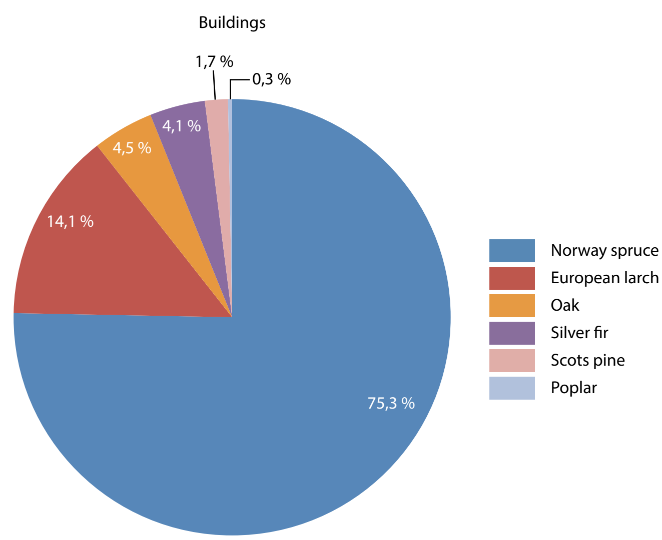
From the 12 sampled door frames, the majority were also made of softwood but interestingly include a higher content of larch than the doors themselves (50% European larch for the frames versus 15.7% for the doors) which could be attributed to the higher natural durability of this species. As door frames are directly attached to the buildings, durability could be of greater importance than for door leaves, which could be more easily replaced, but the sample studied is not sufficiently consistent to make a general argument for rural buildings in Austria.

Fig. 9.8. Example of a metal hinge from the Austrian Open Air Museum Stübing.

Fig. 9.9. Wooden pivot acting as a hinge from the Austrian Open Air Museum Stübing.



Tab. 9.2



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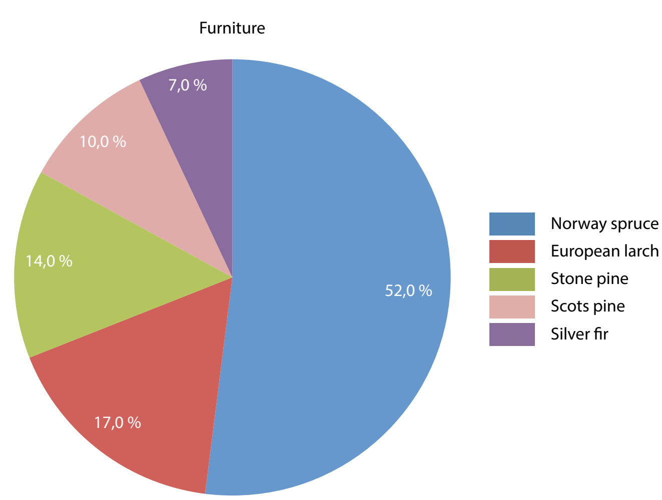
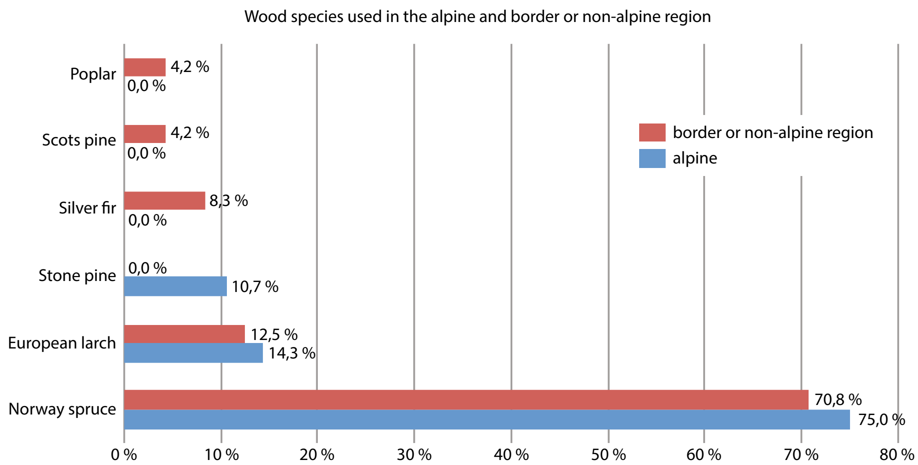


Tab. 9.4

Table 9.2. Wood species used for door planks.

Table 9.3. Wood species used for buildings (after Klein and Grabner, 2014).

Table 9.4. Wood species used for furniture (after Klein *et al.*, 2014).



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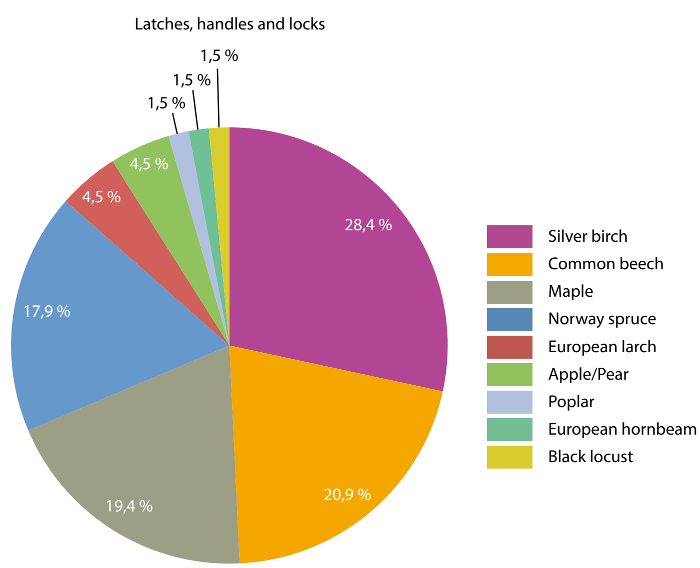

Tab. 9.6

Table 9.5. Wood species used in the alpine and bordering (non-alpine) regions.

Table 9.6. Wood species used for latches, handles and locks.

Overall, 68 samples from door latches, handles and locks were identified; results show nine different wood species, 8% of which are softwood and 92% hardwood (table 9.6). This dominance of hardwood derives from a different requirement with respect to technical properties, which, for these small components, consist of resistance against abrasion, high strength and low swelling and shrinking (Klein, 2015).

Conclusion

This study of a dataset of 51 doors has provided technological information for the construction of rural doors in Austria. In this corpus, 33 doors could be dated dendrochronologically between 1442 and 1909. Three different construction types were observed, from the simple plank door which is the most common, followed by double-layer doors, to the most crafted but also the rarest frame doors. The oldest type found throughout this time range was the plank door; double-layer doors appeared in this dataset in the early 17^{th} century, while frame doors did not appear before the early 19^{th} century. Most of these doors were attached to the door frame by metal hinges (80%), the remaining 20% with a simpler wooden pivot. Norway spruce largely dominated the wood species used for rural doors (65%), followed by European larch, stone pine, and silver fir; hardwood was found in only 8% of the samples. When looking at the geographic provenance of the doors, no major difference appeared in wood species between alpine and bordering (non-alpine) regions. In contrast, slight differences in dimensions were noted between regions, those from the bordering region being slightly bigger.

Ultimately, while a more comprehensive view of rural doors – their typology, geographic distribution, wood working techniques, etc. – would require a larger number of samples in the data set, perhaps with a more detailed technological analysis, the results presented in this paper contribute to our understanding of the utilisation of wood over several centuries in Austria.

Acknowledgements

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Note

1 Oral presentation, Grabner M., Wächter E., Karanitsch-Ackerl S. and Bolka M., *New regional chronologies for Eastern Austria – basis for dendroclimatology and dendroprovenancing* (EuroDendro 2014, Lugo, Spain, 8-11 September 2014).

2 See the contribution no. 8 in this volume (Bernard *et al.*) for other examples of old doors with metal hinges, in Brittany.

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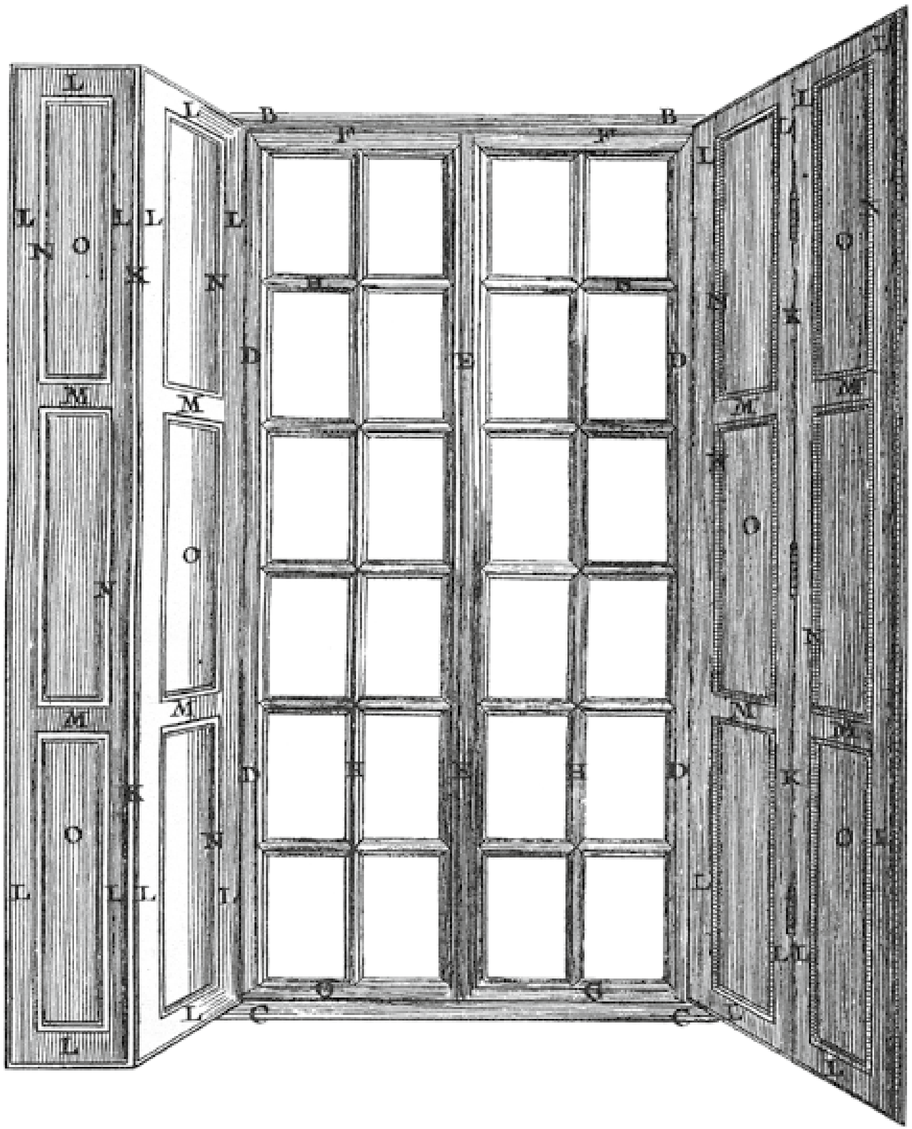
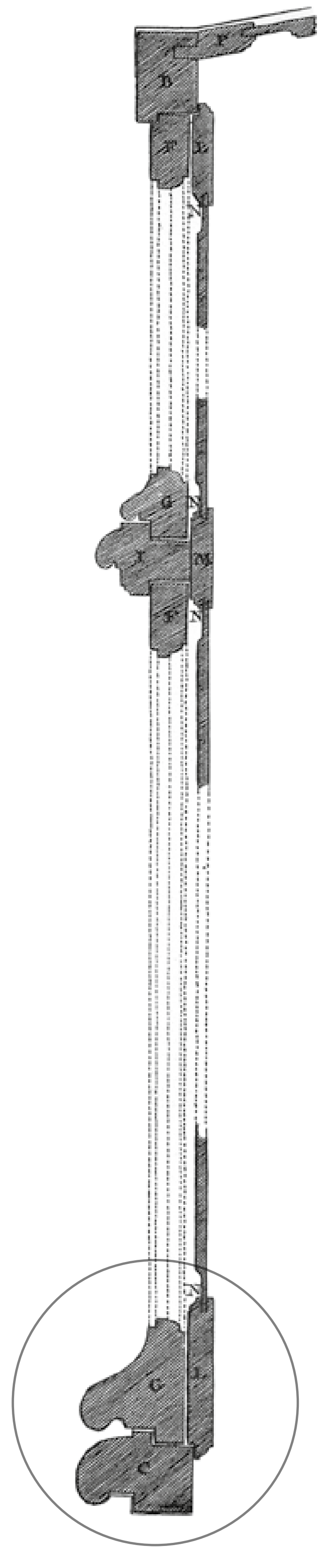
Summary

Front doors are both welcoming and deterring, acting as an entrance into the building as well as a barrier. The literature has mainly described the doors of city buildings, castles and churches whereas there is very little information available concerning rural doors in Austria, which were, however, often extravagantly constructed and richly decorated.

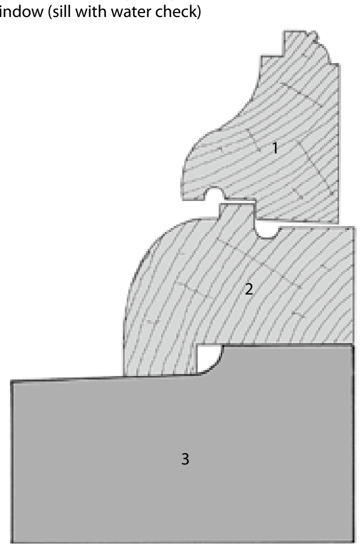
From 2012 to 2013, a total of 51 doors now conserved at the Austrian Open Air Museum Stübing originally from farmhouses, granaries and stables from seven provinces in Austria and South Tyrol in Italy were analysed. Thirty-three of these were entrance doors, 14 interior doors and four were stable doors. Overall, 33 door leaves were successfully dated by dendrochronology to between 1442 and 1909.

This paper presents an overview of their technical characteristics, wood species exploited and woodworking techniques, with dendrochronological dating to contextualise the information acquired. It thus provides the first detailed technical analysis of rural doors in Austria.

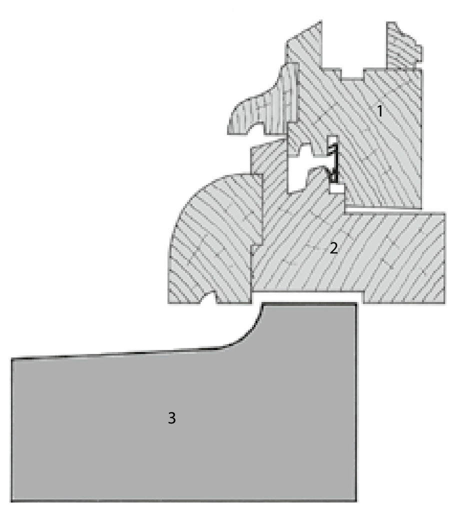




1- glazed casement leaf (bottom rail with weather board)
2- fixed casement (projecting sill)
3- window (sill with water check)



Second half of the 18th century



Early 21st century

10.1

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The watertight integrity of window sills in western France: A simple system with a complex development history

Arnaud Tiercelin[1]

Translation from French: Rebecca Miller – Hendrick Louw – Pascale Fraiture

Key words

Window frame / Casement window / Sill / Weather board / Watertightness / Western France

* An asterisk in the text refers to the glossary at the end of the article.

Introduction

The impermeability to water of window sills is still (*appuis de fenêtre**) today a key objective in their design. While they have been increasingly improved by sophisticated attempts to track even the most minor leaks, the basis is identical to the system adopted in the mid-18th century which includes three elements: stone sill with water check (*appuis à rejingot**), a projecting sill (*pièce d'appui saillante**) and weather boards (*jets d'eau**) (fig. 10.1). It would be difficult to make a system simpler and more effective than this rational system that has been used ever since. Yet as elementary as it appears, it took several centuries for it to fully develop. Some of these elements may have been used in isolation. Other systems were also used. As far back as we can go, that is, to the end of the 14th century, we see that no specific design was imposed although some contributed real advances. So, even at the beginning of the 18th century, some casements still did not have weather boards. To understand such a long development period and attempt to reconstruct the stages that allowed the trio of elements to be definitively adopted, we examine remains found in western France, complemented by written sources when these are lacking.[1] In the study

Fig. 10.1 Elevation and vertical section of a casement window with shutters (Diderot and d'Alembert, 1751-1765, *Recueil de planches sur les sciences, les arts libéraux et les arts méchaniques, avec leur explication* – Building joinery, extracts from plate V); sections for two window sills from the 18th and 21st centuries with their elements.

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of window sills, the elements most exposed to weather conditions are of the most interest, but these are thus the most degraded. The subject is limited here to watertightness, but obviously airtightness is closely related and we will thus see some inseparable stages. The development described here is based on 12 sections that schematize and simplify the works drawn to facilitate their comprehension (fig. 10.2). Each of these sections therefore represents rather a synthesis of the procedures employed than an actual model.

Panel windows hinged to the frame

Fifteenth-century casement windows (*croisées**) present two methods of closure, one which is lap-jointed and the other formed with a peripheral rebate (*feuillure**), but neither of these two systems is capable of ensuring water impermeability.

On the casement at the manor of Cours in Lapenty (department of Manche) at the end of the 14th century (reconstructed from the remains of its condition in the last quarter of the 15th century), the casements close directly on the tracery and stone sill (fig. 10.2a and 10.3).[2] Water running down the casement could therefore only flow to the light wall under the window, to the sill. In contrast, the sealed glass panes of the top compartments are quite watertight. This type of jointing is rare in western France where one more frequently sees rebates.

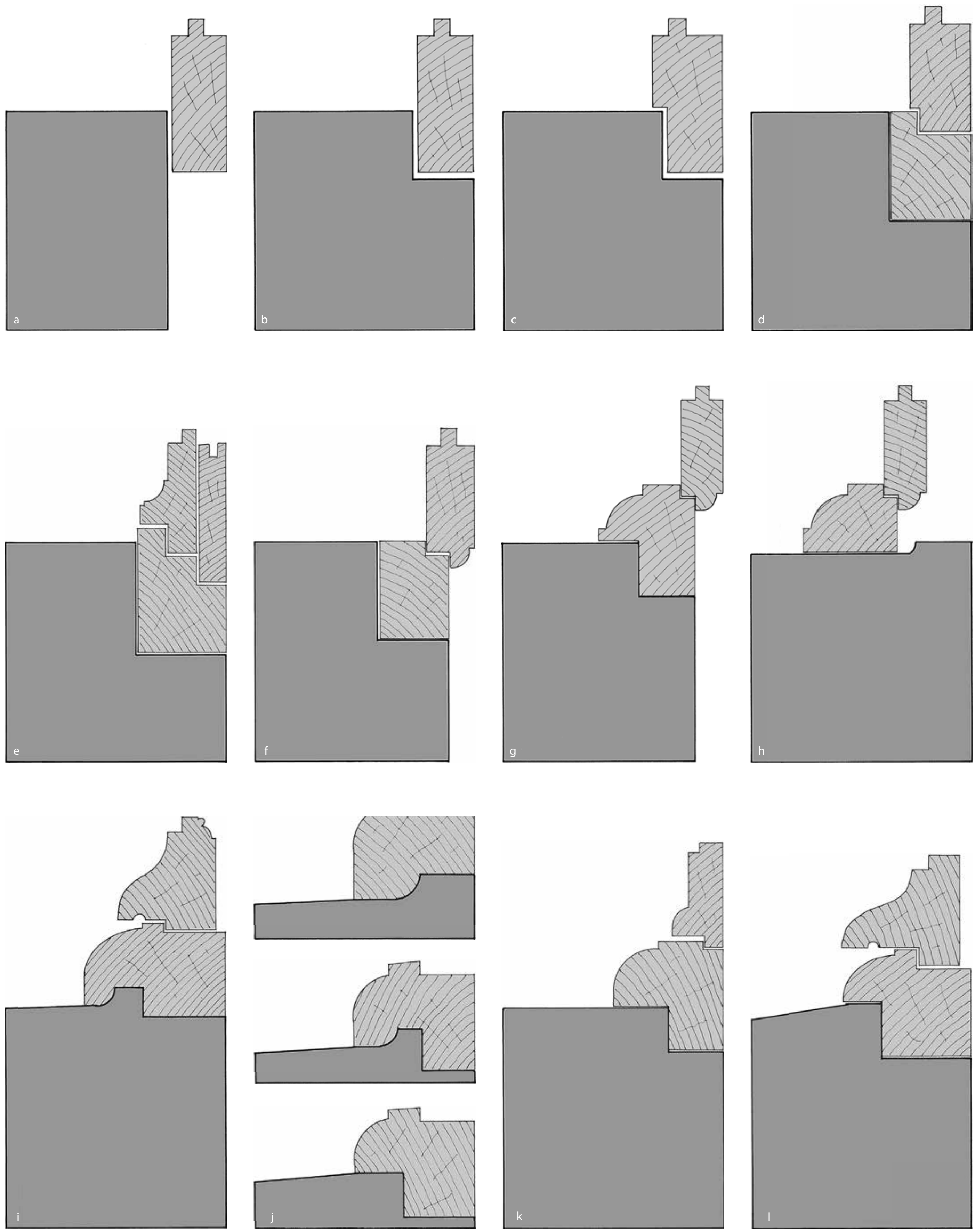
On the half-casement of the first quarter of the 16th century at the house of Fontaine-Bresson in Vernantes (department of Maine-et-Loire), the casements shut within a rebated stone frame (fig. 10.2b and 10.4).[3] Some windows where hinges or latches offer a reduced thickness for the casement windows suggest that they may have been slightly recessed (fig. 10.2c). For all that, water impermeability was hardly improved.

Should one conclude that medieval people were less concerned about water leaking into their homes? Probably not: even if examples are quite rare and their authenticity can be discussed, some windows show that they tried to direct water flow to the edge of the sill by channeling it.

At the manor of Bot-er-Barz in Cléguérec (department of Morbihan) and the house of Grand-Poillé in Contest (department of Mayenne) (fig. 10.5), water channels (*fils d'eau**) were carved in the stone. The system was perhaps linked to external mouldings, the projection of which already served to direct water flow. Frames of this type, dated to the first quarter of the 16th century, were documented by the Research Center for Historical Monuments (Ministry of Culture and Communication – France) at the Hôtel of Alluye in Blois (department of Loir-et-Cher) and in the southern wing of the castle of Laval (department of Mayenne). An increase in the number of these profiles would have quite likely allowed better impermeability, but the impossibility of making fine adjustments with the masonry limited their role.

Of more interest is the example of the manor of Kermeno in Moréac (department of Morbihan), datable to the mid-15th century, that we studied in 1996 before its destruction (fig. 10.6).[4] Like the manor of Cours in Lapenty, the glazing in the upper compartment was sealed. Impermeability was thus complete.

Fig. 10.2. Schematic development of window sills.



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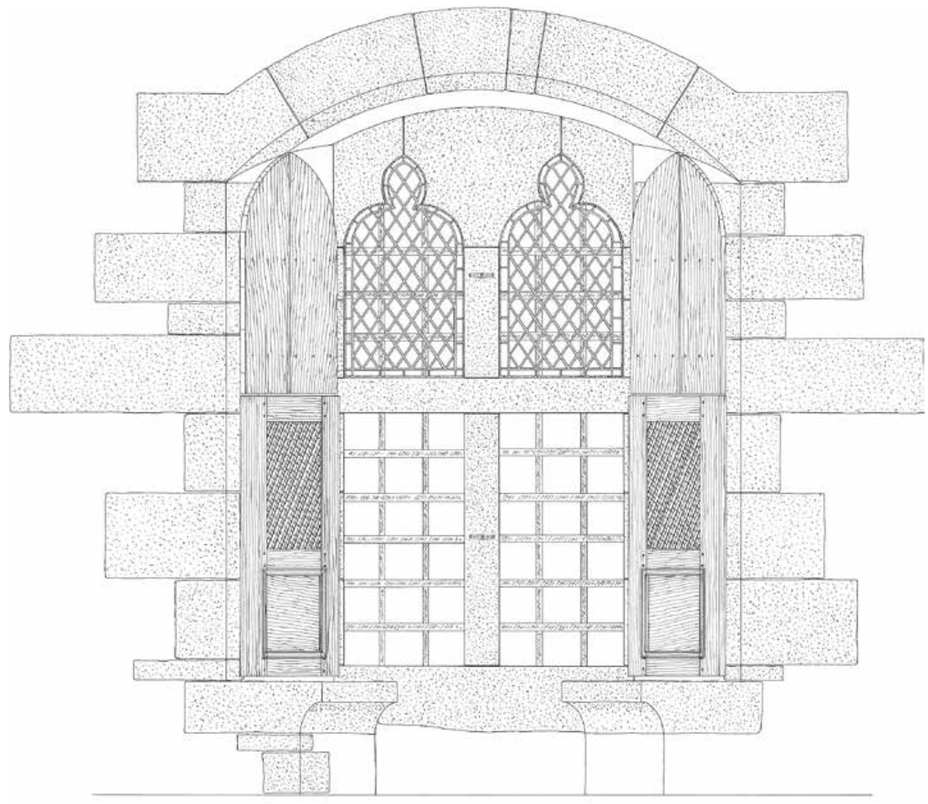

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Fig. 10.3. Manor of Cours in Lapenty (department of Manche): the stone window dates to the end of the 14th century; at this time, it was probably closed by simple wooden shutters that were removed on the lower part in the last quarter of the 15th century to add latticed wings (*vantaux à treillis**).

Regarding the sill, the shutter (*volet**) with staggered vertical slats on the outside does not at all ensure impermeability. Water running down the cladding (*parement**) could only abundantly flood the wall under of the window. The problem was thus resolved by adding a long channel behind the sill that collected the run-off and discharged it to the exterior by a small rainwater spout (fig. 10.7). This simple and effective technique was also used on a skylight at the manor of Tréhardet in Bignan (Morbihan), located a few kilometres from the first. Eugène Viollet-le-Duc also noted it on a window of the Narbonnaise Gate in Carcassonne (deparment of Aude), dated to the end of the 13th century.[5]

Casement windows

It was not until the second quarter of the 16th century and the refinement of the fixed casing (*bâti dormant**) that a system initiating real watertightness was introduced. Sealed in a peripheral rebate the outer wooden window frame (*châssis de fenêtres**) allows more effective room for operation and reduces infiltrations (fig. 10.2d). Initially, the leaves or wings (*vantaux**) were set flush with the surface of the fixed frame. It was then a simple further adjustment for traditional leaves to be inset completely within the fixed outer frames (fig. 10.8).

Performance being still limited, systems increasing the number of rebates were introduced, as can be seen at the castle of Bois Orcan in Noyal-sur-Vilaine (department of Ille-et-Vilaine) (fig. 10.9).[6] This example however deserves further attention. The wooden mullions (*meneaux**) are decorated with colonettes

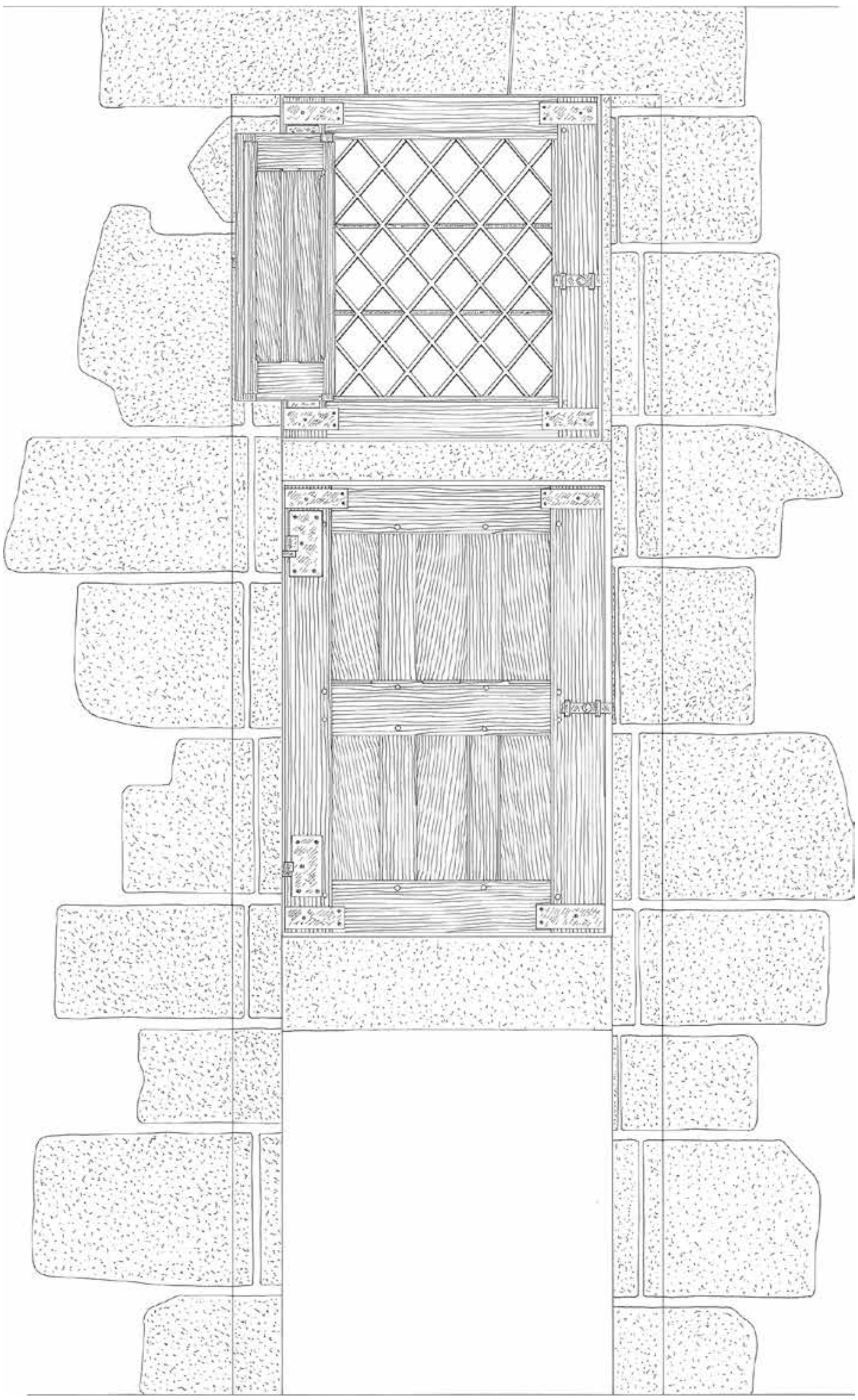

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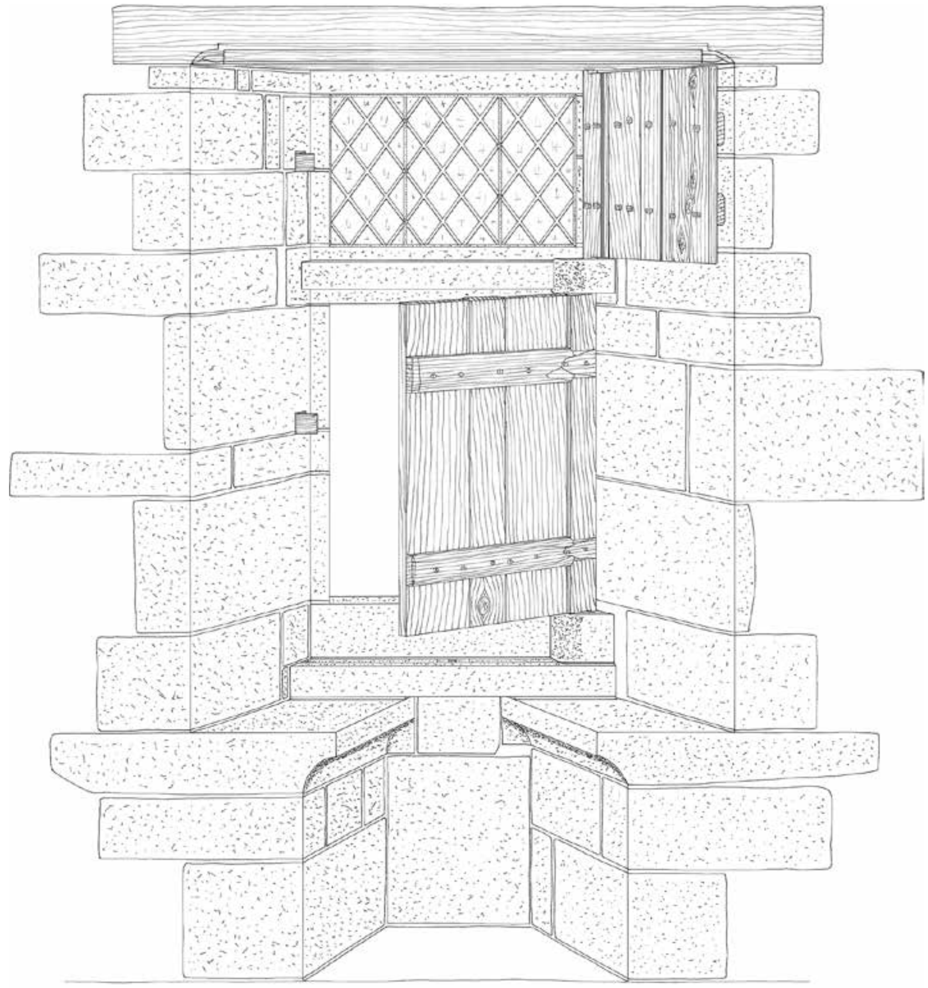
Fig. 10.4. House of Fontaine-Bresson in Vernantes (department of Maine-et-Loire).

Fig. 10.5. House of Grand-Poillé in Contest (department of Mayenne): detail of the stone window sill with channels draining water from the joinery.



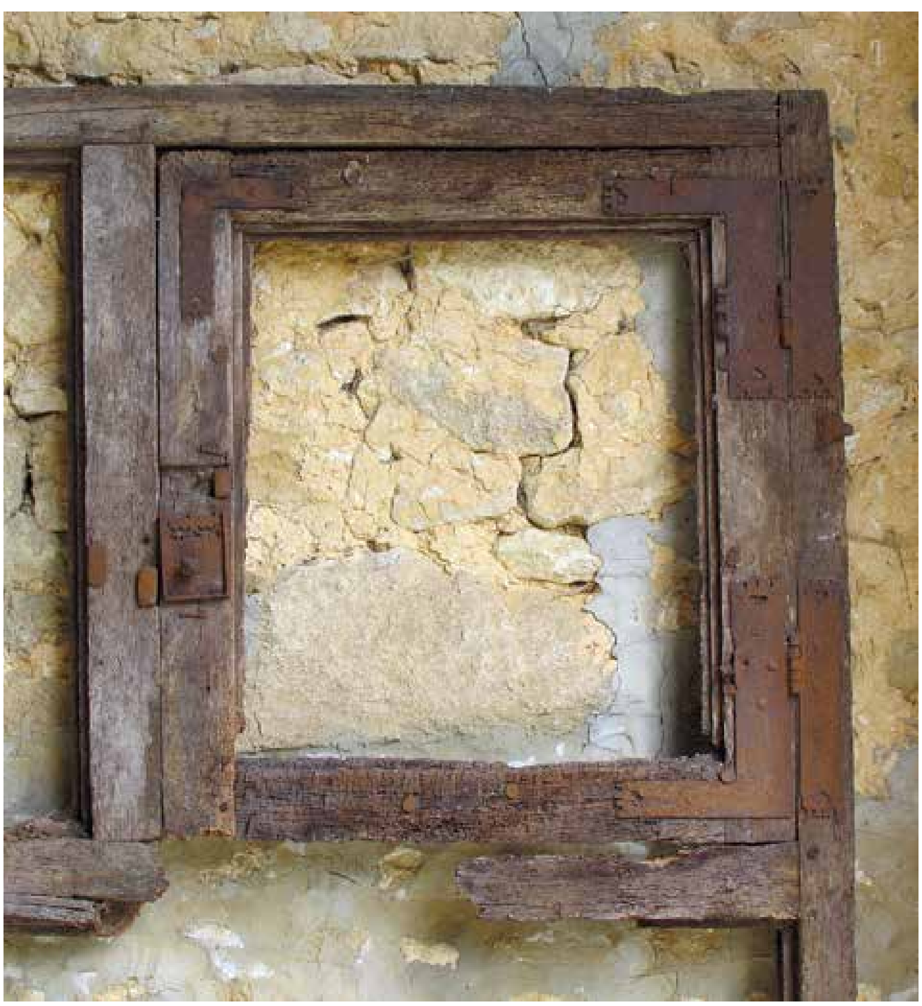
10.6

and crocketed pinnacles which are discontinued at the junctions with the floated transom (*traverse flottée**), thus allowing the latter a continuous smooth protruding surface. The procedure is frequently used in furniture, but was the joiner aware of the technical role that the transom played? Could this have been one of the first examples of a real weather board?

During the entire first half of the 16th century, glazed wines (*vantaux vitrés**) and even shutters, were generally fitted within fixed frames. Once again, certain projecting sections, like those adopted at the manor of La Lubinière in Préaux-du-Perche (department of the Orne) which run on the four sides of the glazed leaves, are suggestive of later weather boards (fig. 10.2e). This technique created large fixed window frames to accept the casements. In addition, the degree of impermeability obtained depended on the precision of the adjustments, but without going so far as to risk blocking the opening of the wings. To reduce the width of the elements, use the framed shutters and facilitate construction and adjustment, joiners gradually adopted overlapping on the windows with fixed casements (fig. 10.2f). This technique involves stacking the elements over and within each other, using peripheral rebates.[7] First applied to shutters and then to glazed leaves, it had little effect on overall watertightness, but was more effective for air flow. This same procedure again became popular

Fig. 10.6. Manor of Kermeno in Moréac (department of Morbihan).

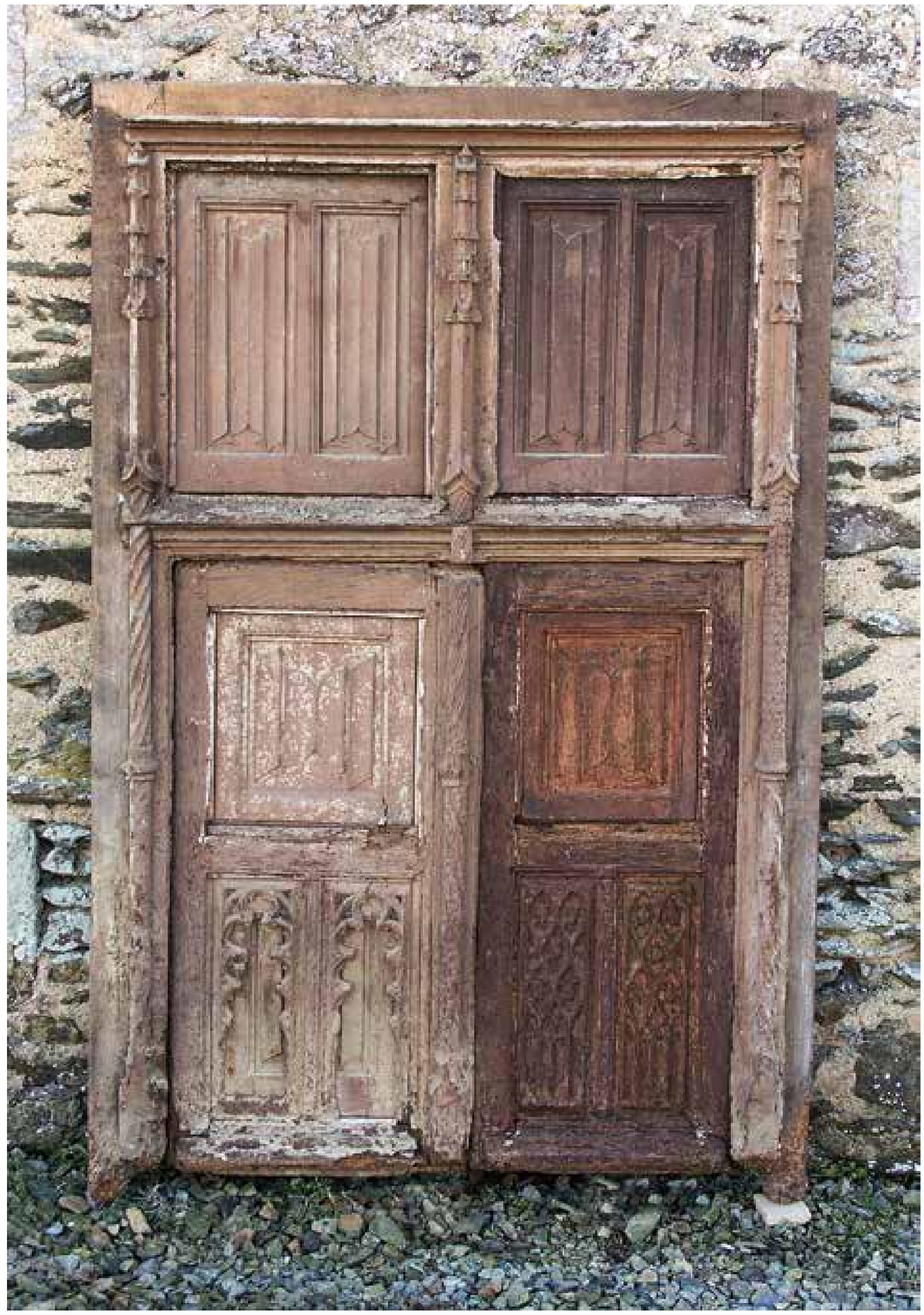
10.7



10.8

Fig. 10.7. Manor of Kermeno in Moréac (department of Morbihan): detail of the window sill with an interior channel evacuated by a rainwater spout.

Fig. 10.8. Manor of Couesme in Ancinnes (department of Sarthe): remains of the upper right compartment of the casement (fixed casement and glazed wing – the shutter is not preserved).



10.9

in the 1970s, well after its abandonment in the 18th century, to make reinforced watertight windows.

In the second half of the 16th century, casements lost the major ornaments that sometimes decorated the external surfaces. The pinnacles ending on the protruding elements disappeared; ornamental design was simplified; overlapping became common. In fact, this was the onset of a somewhat stagnant period from a technical viewpoint and overlapping seems to have become the only response although it alone did not solve all problems. Even simply putting a slight slope on the surface of the stone sill was not obvious and many windows did not have this feature.[8]

Fig. 10.9. Castle of Bois Orcan in Noyal-sur-Vilaine (department of Ille-et-Vilaine).

Window sills

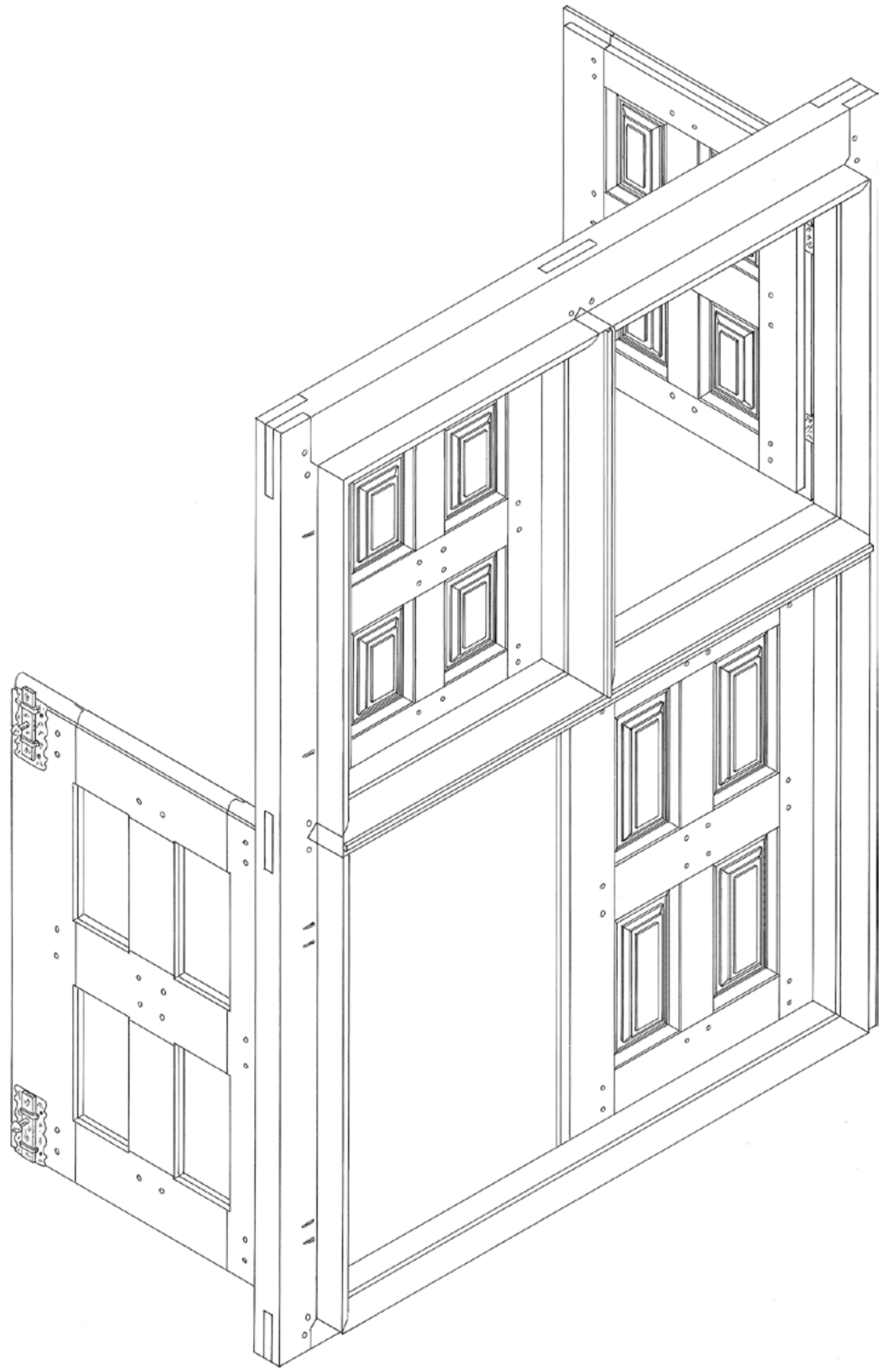
In the 17th century, casement windows fortunately saw improvements in the treatment of the bottom rail (*traverse inférieure**): a moulded profile suitable for discharging water from the joinery and avoiding infiltration along the wall under the window was adopted (fig. 10.2g). However, since this element was exposed, examples that could evidence its use are rare. Nonetheless we can sometimes obtain a better idea of this element when the window frames are recorded in their openings since adding a moulded sill raises the ensemble of the sashes (*ouvrants**) by a few centimetres. This exercise in reconstruction tends to demonstrate that its use in the 17th century in western France remained limited despites its advantages.

In the absence of very old preserved remains, a contract awarded by Sully, minister to King Henry IV, clearly reflects its presence since 1608 for the creation of casements at Gobelins in Paris. It was planned that for 'ach (of the) fixed casement windows, as much for rooms as for attics, there will be a quarter round for the lower bottom rail to cover the sill of the window' (de Mallevoüe, 1911: 167).[9] This example allows identification of a sill that we term 'autonomous' since its operation and profile distinct from other elements of the casement are clearly established.

But the 17th century also sees the appearance of some casements with a sill that we can qualify as 'natural'. The manor of la Vallerie in Sens-de-Bretagne (department of Ille-et-Vilaine), dated 1649, provides a good example of this (fig. 10.10).[10] The cross is formed of a mullion and transom, traditionally moulded from a torus (*tore**) that is turned around the edge of the fixed frame as a quarter round. The ensemble is thus moulded with a profile that covers the reveals (*tableaux**), the lintel (*linteau**) and the sill by the intermediary of a peripheral rebate. As a result, the lower moulded rail of the casement, forming a 'natural' sill, increases the watertightness of the window. By making this particular type of casement, was the goal of the joiners to improve its performance or were they simply following the current style? It is impossible to resolve this question, given that surviving remains of this technique are rare and for the series of casements from Brittany we have inventoried, it is observed in only a few examples from the second half of the 17th century.[11] Parisian joiners also likely used this type of casement from the start of the 17th century. Once again, a contract awarded by Sully in 1608 seems to indicate the use of a peripheral moulding used as a natural sill. It states that 'the fixed frame of each window will be furnished with two stiles (*battants**) of [...] three inches thick, a mullion in the middle, [...] four inches thick, five transoms [...] of the same width and thickness; these mullions and transoms finished as band molding [?], an ogee moulding (*talon**) with raised squares all around the window frame on the outside'(de Mallevoüe, 1911: 122).[12]

The earliest autonomous window sills found date to 1660. These were made for the casements at the castle of Vaux-le-Vicomte in Maincy (department of Seine-et-Marne) and have a quarter round profile attached in different ways to the mullions (fig. 10.11).[13]

We know of no other evidence of such early use and written sources are rarely explicit regarding them. Two plans, respectively from 1670 for a hotel



10.10

Fig. 10.10. Manor of la Vallerie in Sens-de-Bretagne (department of Ille-et-Vilaine).

in Versailles (*Fenêtre de Paris*, 1997: 24) and 1692 for the Hôtel des Invalides in Paris (*Fenêtre de Paris*, 1997: 20),[14] however, show the presence of this element. In 1691, Pierre Bullet, in *L'architecture pratique*, the first work to go into detail on the fabrication of casements, does not specifically mention their existence, but this is implied by the thickness of the peripheral elements that corresponds to a return to the moulded profile of the mullion to form a 'natural' window sill as discussed above. Such a lack of mention, although he later underlines

10.11

the benefits of weather boards, suggests that the technique had already been adopted and did not merit particular commentary.[15]

If moulded wooden window sills provided an undeniable advantage by discharging water better than a simple fixed bottom rail, for a long time they remained recessed within the stone sill and were incapable of ensuring complete watertightness. However, at the end of the 17th century, some casement windows adopted a new system to refine the wooden sill (fig. 10.2h). At the ancient Hôtel-Dieu of Bayeux, this was judiciously placed in front of a stone rise that prevented water infiltration along the wall under the window (fig. 10.12).[16] Of course, the procedure still did not prevent deterioration of the piece that stagnated in the water, especially since the slope of the sill was almost flat, but it is not far off from the ideal procedure. It should be noted, however, that this astonishing concept was not applied to all of the casements in the building; the dormer windows were excluded. The casement of the ancient presbytery of Laize-la-Ville (department of Calvados),[17] about 40 km from Bayeux and precisely dated to 1701, shows the same concept that we find a few decades later at the castle of Versainville (department of Calvados), built in the 1720s, and in the east wing of the convent buildings of the abbey of Juaye-Mondaye (department of Calvados), built between 1731 and 1738. Despite its advantages, this system does not appear to have been widespread.

In the absence of available evidence, it is Jacques-François Blondel who will serve as guide to address the ideal window sill, similar to that of today (fig. 10.2i). In his 1738 work, *De la distribution des maisons de plaisance et de la décoration des édifices en général*, he published a vertical section view of a casement in which this sill is raised (Blondel, 1738, vol. 2: pl. 97). The stone sill clearly has a water check, that is, a piece on which the timber window sill can be fixed and which serves as a water barrier. This is a mixed system that combined the older rebated frame structure and a water check.

A few decades later, in 1769, André-Jacob Roubo, in *L'art du menuisier*, developed three installation methods for window sills to describe their advantages and disadvantages, the first of which would become the standard (fig. 10.2j).[18]

Fig. 10.11. Castle of Vaux-le-Vicomte in Maincy (department of Seine-et-Marne): three methods to attach the mullion to its sill.

10.12

Fig. 10.12. Ancient Hôtel-Dieu of Bayeux (department of Calvados): detail of the stone sill and wooden sill after removal of the window board that masked the internal structure.

After having acquired their ideal profile, window sills hardly changed apart from the adoption of a recess at the back of the rebate that trapped water and evacuated it through holes or condensation tubes in the moulded part. In the 1770s, Jacques-François Blondel pointed out that 'for some time it has been advised, to prevent water penetration even with a drip groove (*larmier**), to add a small channel on the window sill along its length, oriented on a slope to the middle of the casement, and in the base of which a small hole is perforated through the sill, to drain the water that would bypass the drip groove; an expedient that works very well and should be imitated' (Blondel, 1771-1777, vol. 6: 373).[19]

Weather boards

If the window sill provided a significant improvement by reducing or eliminating water infiltration from the stone sill, it remained ineffective against water from running down the glazed wings. This was not remedied until the adoption of the weather board, that is, a moulded profile forming a projection on the lower horizontal rail of the wing to discharge water from the rebate of the frame. The term weather board (Duhamel Du Monceau, 1767: 131) appeared in the 18th century, also called a *rejetteau** (Diderot and d'Alembert, 1751-1765, vol. 14: 44), or *reverseau** (Bullet, 1691: 264) at the end of the preceding century. Based on the inventoried remains, its use appears to have been late. None of the casements studied from the 17th century used this element. For some, it is present, but it can be easily shown that it was added later.

The first example dates to the end of the 17th century and comes from the ancient abbey of Saint-Pierre-sur-Dives (department of Calvados) (fig. 10.2k and 10.13).[20] It has a quarter round form, but its operation seems to have still been poorly understood as its depth and lack of true drip grooves does not permit it to drain water onto the profiled part of the stone sill.

At a house in Bécherel (department of Ille-et-Vilaine) (fig. 10.14), probably slightly more recent, the form is the same but more pronounced, and thus more effective.[21]

At the castle of the Perrière in Angers (department of Maine-et-Loire) (fig. 10.2l), in the early 18th century, weather boards had a taller ogee profile that became the norm. This moulding threw water further away from the frame by changing its shape without increasing the weight of the drain element, unlike the quarter round form for which increase in size would rapidly become problematic.[22] This taller profile is seen on a casement project dated to 1692 for the Hôtel des Invalides in Paris (*Fenêtre de Paris*, 1997: 20). It is also this profile that was adopted in the early 18th century at the bishopric of Tréguier (department of Côtes-d'Armor) (fig. 10.15).[23] The use of weather boards, however, appears to have caused a problem since they were not systematically used on all of the casements. Even if it is still uncommon to see the upper glazed wings without weather boards during the first quarter of the 18th century, their advantages allowed them to subsequently become rapidly widespread.[24]

According to written sources, their use at the end of the 17th century is confirmed by Pierre Bullet in *L'architecture pratique*. He states that 'to prevent water from running straight off the sill and the mullion of the window, the lower rail of the glazed wing is made fairly thick so as to create weather boards. This piece is made with a quarter round form above and below a "hanging beak" mould (*mouchette pendante**) to eject the water away from the sill, so that it enters nowhere in the apartments' (Bullet, 1691: 264).[25] It is also mentioned in the 1710 edition of d'Aviler's *Cours d'architecture* although it was absent from the two preceding editions in 1691 and 1696 (d'Aviler, 1710: 145).[26]

10.13

Fig. 10.13. Ancient abbey of Saint-Pierre-sur-Dives (department of Calvados): detail of the window sill and weather boards in quarter round form.

10.14

However, as for the window sills, a contract awarded by Sully in 1608 for the fabrication of 40 windows for the Grande Galerie of the Louvre shows the use of weather boards much earlier. It states that 'there will be eight glass frames with rebates and a covering of a wooden quarter round feature, which will be four inches wide and two inches thick, and each with a quarter round below that will serve to cover said fixed frame to prevent rain from entering' (de Malevoüe, 1911: 122).[27]

This comment, made a century before the common use of weather boards, is surprising, to say the least. Although their role was perfectly understood here,

Fig. 10.14. House in Bécherel (department of Ille-et-Vilaine).

10.15

Fig. 10.15. Ancient bishopric of Tréguier (department of Côtes d'Armor).

why were they not further refined? The castel of the Mesnil-Voisin in Bouray-sur-Juine (department of the Essonne),[28] dated to 1639, like that of Vaux-le-Vicomte in Maincy (department of Seine-et-Marne), dated to 1660, did not include them. The rare remains of wooden windows preserved today in the Île-de-France and the deterioration of their most exposed elements will probably not allow this question to be answered, but written sources that remain to be more fully exploited may perhaps in the future provide us with a measure of understanding.

On the origins of window sills and weather boards

Concerning the origin of these elements, some authors, although they give no examples, state that they were originally attached to frames by nails or pegs.[29] Assemblages with nails are rare, but do exist. Thus, the mullion and transom of a dormer at the Hôtel de Limur in Vannes (department of Morbihan) was formed of two superimposed pieces of timber to obtain the desired thickness.[30] Following the reasoning of these authors, we can add that the use of the more modest features built up in this way since Charles-Antoine Jombert felt the need in the 18th century to condemn this practice. He stated, in effect, that 'all rebates, tongues, weather boards, mouldings and any other projections, and even ornaments of Architecture and Sculpture, if any, must be worked in the thickness of the wood, without being joined, glued or pegged onto the structure' (Jombert, 1764: 330).[31] However, concerning the sill, we have found no examples of this type. Moreover, if we consider that this was not something other than the continuity of the periphery of some casement windows with four compartments decorated with torus moulding, the question can be raised why joiners changed their mode of fabrication to make sills in several elements. In accepting that we could one day find this type of concept applied and that it can be demonstrated that this was not a later modification, sills attached in this way would certainly be interpreted as anecdotal examples, resulting from lack of know-how or to economy rather than a real stage in the adoption of window sills. Similarly, nailed weather boards recorded so far are easily demonstrable as being later additions (the non-systematic use for a set of casements, different profiles, the use of industrial nails, the wear of the crossbar prior to the addition of the weather board, etc.). It should be clearly noted that the only technical difficulty posed by weather boards in a casement window is how to make them flush with the stiles in order to align their moulded profile (overlapping – *flottage**). The overlapping of projecting mouldings was completely mastered by joiners who had long used the technique on doors and sometimes on richly decorated window frames (fig. 10.9). Thus, once again, the reasons that would have encouraged joiners to make nailed or pegged assemblages as they had not previously done remains to be clarified. Although extremely modest and easier to add, the weather boards at the abbey of Saint-Pierre-sur-Dives (fig. 10.13) were made from solid pieces of timber. As seen above, the examples from the end of the 17th and early 18th centuries do not systematically adopt window sills or weather boards and their use does not appear to have always been well understood or assimilated. However, in each of the cases where these elements are used, they were made on traditionally assembled solid pieces. If there did exist a period during which these two elements of watertightness were gradually introduced, it would appear unlikely that this included a significant and transitory phase of composite elements, assembled with nails or pegs.

A winning trio

Apart from a few marginal systems, it is not until the refinement of casement windows in the first quarter of the 16th century that we can truly examine techniques that would begin to improve watertightness. But it is difficult today to measure the importance of this concept in the structure of window frames. In the 16th century, the role of moulded profiles used on the edges of the wings or only on the lower part, as at the castle of Bois Orcan, does not appear to have truly been understood as limiting water infiltration; in all cases, their use was limited. At the start of the 17th century, the contracts awarded by Sully for royal buildings clearly demonstrate the presence of window sills and weather boards whose function was perfectly understood. Yet, if sills can be accounted for fairly rapidly by the remains preserved, at least in the Île-de-France, weather boards cannot be found prior to the last quarter of the century and their development remained slow, particularly for mullion-and-transom frames (*chassis d'imposte**). It is not until the mid-18th century that all of the modern elements contributing to the watertightness of casement windows closing on the sill were brought together: taller ogival weather board, quarter round sill, assembly of the fixed casement window mounted on a stone water check with a recess for water evacuation. Subsequent centuries would invent nothing better and if, after the 1970s, the profiles of these elements changed drastically, the principles established two and a half centuries before still remain pertinent.

Glossary of technical terms (*French* – English)

Rebecca Miller – Hendrik Louw – Pascale Fraiture

***Appui à rejingot* – stone sill with water check, with drip cap or with drip sill** (see 'water check', 'window sill' and 'drip cap')

***Appui de fenêtre* – window sill:** Horizontal member at the base of a window.

***Appui saillant* (or *pièce d'appui saillant*) – projecting sill:** Window sill that extends outwards from the face of an exterior wall or frame.

***Battant* – stile or stanchion bar:** Vertical sidepiece of a sash that is joined to rails to form a frame holding panes of glass (see 'muntin bars').

***Châssis de fenêtre* – window frame:** Outer trim or finished frame around the top, and both jambs of a door or window opening, usually a piece of timber with various profiles used to cover the junctions between surfaces or for decoration.

***Ouvrant* – sash:** Movable inner window frame: inner window frame with vertical stiles on the sides and horizontal rails at the top and bottom that encloses the wooden grid holding glass panes. This opens as a unit attached with hinges to the outer frame.

***Bâti dormant* – fixed casement or casing:** The outer frame, fixed, into which the casements are set, formed by the jambs on the vertical sides, the sill at the bottom and the head piece at the top.

***Croisée* – casement window or cross window:** Window with a cross formed by the vertical mullion and horizontal transom dividing it into four separate lights which are fitted with either fixed glazing or opening casements; or general term for casement windows (with and without mullions and transoms).

***Croisée à bâti dormant* – window with fixed casements:** A casement is a window divided by a mullion and one or more muntin bars. A window with a fixed casements is a casement within which a wooden frame is set (this frame follows the form of the casement). The paned leaves or wings (*vantaux vitrés**) are installed within this frame. A *croisée à bâti dormant* differs from a simple *croisée* by the addition of this interior frame.

***Croisillons de petits-bois* – vertical and horizontal muntin bars:** Rebated and moulded bars of wood forming a grid in a casement or sash, separating and holding rectangular panes of glass with putty. Muntin bars are also called 'glazing bars', or 'sash bars'.

***Ébrasement* – splay:** Jambs of window opening cut at oblique angle to the external face of wall in order to facilitate better illumination and views to the interior.

***Feuillure, bâti dormant en feuillure* – rebate** (also known as **rabbet,** US)**, rebated window frames:** Recess, or frames using rebate joints. Rebate (or rabbet) joint: a recess or groove formed along the edges of a piece of wood framed with mortise and tenon joints.

***Fil d'eau, canal* – water channel:** Vertical groove carved into the stone or incorporated into the frame.

***Flottage* – overlapping:** Assemblage in which one part covers another and forms a different side.

***Imposte* – transom:** A transverse horizontal structural beam or bar, or a crosspiece dividing a door or window opening vertically into two or more lights.

Jet d'eau, rejet d'eau (17th century: ***rejetteau, reverseau***) **– weather board or bar:** A projecting moulded wooden horizontal piece at the base of a window or frame to discharge water away from the frame.

***Larmier* – drip groove or drip-stone:** Any horizontal member or stringcourse similar in profile to a corona and projecting from the wall to discharge rainwater. A roll moulding or drip (US).

***Linteau* – lintel or head piece:** Horizontal member spanning between two vertical supports above the windows (part of the outer casing of the window opening); horizontal piece at the top of the outer casing forming the frame into which the windows are set.

***Meneau* – mullion, muntin or monial:** Vertical piece of wood, stone, metal, etc., that separates window into two or more lights.

***Montant* – jamb:** Vertical member of the fixed frame on either side of the window. Together with a horizontal piece at the top (head piece) and the sill at the bottom, forming the frame into which the casements are set by hinges (see 'external casing').

***Mouchette pendante* – rain water check:** Small, beak-like fillet left on the edge of a larmier, or drip-stone which forms a drip ('hanging beak' mould) (see 'drip groove').

***Parement* – cladding:** exterior facing or siding.

***Rejingot* – water check, drip sill, drip cap or drip mould:** Horizontal moulded feature that projects beyond the frame of the window, usually with a throat or drip channel formed underneath. It serves to discharge water away from the wall surface directly underneath the sill; horizontal piece projecting above the window or sill to protect the area below from rainwater; if above the window, it is attached to the two jambs below the head piece. ***Rejingot à talon* – ogee-moulded water check:** ogee-moulded rather than quarter round.

***Tableau* – reveal:** The vertical side of an opening in a wall, especially the area between the frame and the wall face; can be of brick or stone masonry with the window set back (not flush with the outside of the wall).

Tore **– torus:** Convex, semi-circular moulding, larger than an astragal, which may be enriched with leaves or plaiting.

Traverse **– transom:** Horizontal crosspiece of cross window; rail at the top and bottom of a window casement forming a frame holding the panes of glass with the sash bars or muntins. ***Traverse flottée*** **– floated transom** (see also **flottage**). ***Traverse inférieure*** **– bottom rail**.

Vantaux **– wings or leaves**

Vantaux à treillis **– latticed wings or windows:** Casement with a lattice formed by close-knit diagonal or vertical grid 'woven' with thin wooden strips without any glazing.

Vantaux vitrés **– glazed wings or leaves, or paned windows:** Casements fitted with either a leaded lattice window pane or a wooden-barred grid with squared glass panes.

Volet **– shutter:** Solid wooden doors shutting in front or behind the glazing of the window.

Notes

1 This research began 20 years ago. Its main objective is to inventory the earliest window frames, thus the most fragile, to document them and make them known to the public. The entirely volunteer framework of this work has caused us to limit ourselves to frames prior to the 18th century and to western France. Our studies are available on our web site: www.chassis-fenetres.info. This article sometimes refers to these studies in the form of a number (example: Study no. 35005) that will allow all interested readers to obtain more detailed information.

2 Study no. 50004.

3 Study no. 49003.

4 Study no. 56005.

5 Viollet-le-Duc, 1854-1868, vol. 5, 'fenêtre': 414.

6 Study no. 35005.

7 For more information on the origins of these techniques, on our web site please consult thematic page no. 6: *le ferrage des premiers bâtis à recouvrement.*

8 Louis Savot, however, recommended that 'the top of said sill should not be level, but slope slightly to the outside'. Author's translation of : '*le dessus dudit appuy ne soit point à niveau, ains qu'il descende un peu en pente du costé du dehors*' (Savot, 1624: 128).

9 Contract of 9 August 1608. Author's translation in the text of: '*chacun (des) chassis dormants tant des salles, chambres, que galetas, y aura ung quart de rond à la traverse d'en bas pour recouvrir l'apuy de la croisée*'.

10 Study no. 35008.

11 Ancient convent of the Dominicaines in Dinan (department of Côtes-d'Armor), house on Rue de la Corne de Cerf in Saint-Malo (department of Ille-et-Vilaine), Saint-Magloire in Léhon (department of Côtes-d'Armor) and house on Rue de la Filanderie in Bécherel (department of Ille-et-Vilaine: Study no. 35007).

12 Contract of 24 May 1608 for 40 windows in the Grande Galerie of the Louvre. Author's translation in the text of: '*se fera le chassis dormant de chacune croisée garny de deux battants de [...] trois poulces d'espoisseur, un montant au milieu, [...] de quatre poulces d'espoisseur, cinq traverses [...] lesd. montans et traverses ravallez d'une plate bande, ung tallon et ung carré régnant au pourtour dud. chassis dormant par dehors*'.

13 Study no. 77001.

14 Drawings of these casements were also done by the Centre de Recherches sur les Monuments Historiques.

15 'For large casements 5 feet high (1624 mm) the frames should be 3 inches (81 mm) by 4 or 5 inches (108 or 135 mm), the mullions of the same thickness'. Author's translation of: '*Aux grandes croisées de 5 pieds (1 624 mm) les chassis dormans doivent avoir 3 pouces (81 mm) sur 4 ou 5 pouces (108 ou 135 mm), les meneaux de mesme grosseur*' (Bullet, 1691: 264).

16 Study no. 14001.

17 Study no. 14008.

18 'Window sills should be 3-4 inches thick, depending on how the window rebates were made, these were made in three ways. The first and best, is to allow the stone to project 8-9 lines in the width of the window rebate and to make a rebate on the sill of the same width and height as that which the stone projection exceeds. The second is to create a rebate in the stone sill with the same width as the window and 1 inch or so in depth; this method, although more complicated than the first, is not better. On the contrary it serves only to weaken the sill and as a result exposes it sooner to deterioration. Finally, the third is to create the rebate on the stone sill like the second, but without a weather board: this is even less effective; because it weakens the sill and also causes water flow inside the apartments.' Author's translation of: '*Les pièces d'appui doivent avoir depuis trois jusqu'à quatre pouces d'épaisseur, selon les différentes manières dont sont faites les feuillures de la baye, ces feuillures se font de trois manières. La première et la plus parfaite, est de laisser saillir la pierre de l'épaisseur de huit à neuf lignes dans la largeur de la feuillure de la baye, et de faire une feuillure sur la pièce d'appui de la même largeur et hauteur de ce que la pierre excède. La seconde manière est de faire une feuillure à l'appui de pierre qui règne pour la largeur avec celle de la baye sur un pouce ou environ de profondeur, sur l'arrête de laquelle on réserve un listet ou reverdeau, lequel entre dans la pièce d'appui ; cette seconde manière, quoique plus compliquée que la première, n'est pas meilleure. Au contraire elle ne sert qu'à affaiblir la pièce d'appui, et par conséquent l'expose à se pourrir plutôt. La troisième enfin, est de faire à l'appui de pierre une feuillure comme à la précédente, mais à laquelle on supprime le reverdeau : cette dernière manière est plus vicieuse ; car non seulement elle affaiblit la pièce d'appui, mais aussi elle favorise l'écoulement des eaux dans l'intérieur des appartements*' (Roubo, 1769: 92).

19 Author's translation in the text of: '*depuis quelque tems, pour empêcher absolument les eaux de filtrer, comme il arrivait quelquefois malgré le larmier, on s'est avisé d'ajouter encore un petit canal sur la piece d'appui dans toute sa longueur, que l'on dispose en pente vers le milieu de la croisée, et dans le fond duquel on perce un petit trou à travers la pièce d'appui, pour rejetter en dehors les eaux qui franchiraient le larmier ; expédient qui réussit très-bien et qui mérite d'être imité*'. 'The window sill is at least three and a half inches, and ends outside in a quarter round; a rebate is made below to accept the projection of the stone sill with a weather board'. Author's translation of: '*La pièce d'appui a au moins 3 pouces et demi, sur 3 pouces, et est terminée en dehors en quart de rond ; on y fait une feuillure par-dessous pour recevoir la saillie de l'appui de pierre, disposé en revers d'eau*' (Blondel, 1771-1777, vol. 6: 373).

20 Study no.14002.

21 Study no.35007.

22 As André-Jacob Roubo indicated, weather boards should not, however, be too hollow: 'weather boards should be from 3 inches (81 mm) to 4 inches (108 mm) high and one inch (27 mm) or even one and a half inches (41 mm) thicker than the frame, so that this projection being hollow and curved, facilitates water flow; one should avoid that it is too curved, because this technique is vicious in that it retains the water longer, which stagnates

more quickly'. Author's translation of: '*les jets-d'eau doivent avoir depuis trois (81 mm) jusqu'à quatre pouces (108 mm) de hauteur, et avoir un pouce (27 mm) et même un pouce et demi (41 mm) de plus épais que le chassis, afin que cette saillie étant creusée en doucine, facilite l'écoulement des eaux ; on doit éviter de les faire trop creux, parce que cette manière est vicieuse en ce qu'elle oblige les eaux à y séjourner plus long-temps, ce qui les fait pourrir plus vîte*' (Roubo, 1769: 97).

23 Study no.22002.

24 At the ancient abbey of Saint-Georges-sur-Loire (department of Maine-et-Loire), the casements of the house dated to 1699 have ogee-moulded weather boards only on the lower glazed wings (Study no. 49008).

25 Author's translation in the text of: '*pour empescher que l'eau ne passe au droit de l'appuy et du meneau de la croisée, l'on fait la traverse d'enbas du chassis à verre assez épaisse pour y faire des reverseaux. Cette pièce est faite par dessus en quart de rond, et par dessous une mouchette pendante pour rejetter l'eau assez loin sur l'appuy, afin qu'elle n'entre point dans les appartemens*'.

26 A note added to this edition reminds that 'to also prevent water from entering the apartments, we add weather boards to the glazed wings to drain it outside'. Author's translation of: '*pour empêcher aussi que l'eau n'entre dans les apartemens, on pratique aux châssis à ver des rejets qui l'égoutent en dehors*' (d'Aviler, 1710: 145-2).

27 Contract of 24 May 1608. Author's translation in the text of: '*se feront huict chassis à verre portant feuilleure et recouvrement d'un quart de rond boys, desquels aura quatre poulces de large et deux poulces d'époisse, et auront chacun un quart de rond par bas qui servira de recouvrement sur led. chassis dormant pour empescher la pluye d'entrer*'.

28 Study no. 91001.

29 Window sills: 'In the 17th century, this window sill was fixed on the bottom rail, slightly above the stone sill, between two vertical reveals, by forged nails embedded obliquely in the stone work'. Author's translation of: '*Au XVIIe siècle, cette pièce d'appui était maintenue sur la traverse basse, légèrement au-dessus de l'appui maçonnerie, entre les deux tableaux, par des clous forgés enfoncés de biais*' (Roger, 1984: 71). Weather boards: 'The first weather boards were added and pegged, then little by little the craftsmen included them in the bottom rails that were then floated'. Author's translation of: '*Les premiers jets d'eau sont rapportés et chevillés, puis peu à peu les artisans les intègrent aux traverses basses qui sont alors flottées*' (Compagnons menuisiers du devoir, 1989: technical synthesis, 17th-century table); 'The weather board appears at the end of the 17th century in the form of a nailed quarter round'. Author's translation of: '*Le jet d'eau apparaît à la fin du 17e siècle et se présente sous la forme d'un quart de boudin cloué*' (Roger, 2001).

30 Study no.56001.

31 Author's translation in the text of: '*toutes les feuillures, languettes, reverseaux, moulures, et autres saillies quelconques, et même les ornemens d'Architecture et de Sculpture, si aucuns y a, doivent être pris et élegis dans l'épaisseur des bois, sans être rapportés après coup, collés ni chevillés par-dessus*'.

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Summary

Window frames, today products of high technology, are not without relationship to their 18th-century precedents. The water impermeability of their sills still involves the same elements: a stone sill with water check, a projecting sill and weather boards. Yet despite the simplicity of the system, it took several centuries to fully develop. In order to understand such a long preparatory period and attempt to reconstruct the stages that would allow such a system to be definitively adopted, we begin with physical remains found in western France, complemented by written sources when such elements are lacking.

We thus see that from the 15th century, some windows had resolved the problems of watertightness. These examples, however, would not persist. It would not be until the first half of the 16th century and the appearance of fixed casements, which would later lead to the window sill, that one would see the development of a new procedure that would limit water infiltration.

The 16th century also saw the appearance of strong mouldings on the outside of glazed casements that, in addition to their decorative function, played a role in the impermeability of the windows. Although remains from the first half of the 17th century do not show the presence of window sills or weather boards, written sources indicate their presence at two Parisian sites. Even if window sills are more common in the second half of the century and weather boards still rare, watertightness remained mediocre. Sills were always mounted in masonry rebates and could not be entirely sealed while weather boards were sometimes ineffective.

The installation of rebated fixed casings was reconsidered only at the end of the 17th century when rare examples show sills placed above stone sills. A few decades later this led to the adoption of the sill with water check. Weather boards did not become common until the first quarter of the 18th century. Ultimately, the convergence of these three elements – stone sill with water check, projecting sill and weather boards – took place in the mid-18th century and allowed the adoption of a system that is still effective today.

11.1

11

Window frame inventory number 3079 in the collections of the Royal Museums of Art and History, Brussels (Belgium): Results of archaeological, historical and dendrochronological studies

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Translation from French: Rebecca Miller

Key words

Window frame / 16th century / Unexplored museum collections / Archaeology / Dendrochronology

Introduction

Like other museums of decorative arts, the Royal Museums of Art and History, Brussels (RMAH) conserve a significant collection of window elements acquired after building demolitions (fig. 11.1 and 11.2). This kind of collection, with specific conservation issues given the large size of these composite objects, is often poorly known and rarely studied. However, using detailed technological and stylistic descriptions and dating by objective methods, such collections can be used to create a major comparative database. This could be particularly helpful for archaeologists and architects responsible for the study and/or restoration of monuments to better identify them and, as a result, preserve them. It is within this perspective that one of the most richly decorated window frames of the RMAH collection, inventory number 3079, has been studied.

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Fig. 11.1. Window frame inv. 3079 (Brussels, RMAH): interior side. Photo: R. Pessemier, RMAH, 2015

11.2

Up to now, the typology of wood components of windows has been primarily based on stylistic and/or relative dating. For the earliest periods, due to the lack of preserved evidence, the diagnostic markers for the typology of casements are based on iconography. For example, in a 1987 article on a window frame conserved at the Musée de Louvain-la-Neuve (inv. V.H. 474), Luc-Francis Genicot introduced his subject by the set of 15th-century paintings from the Low Countries (Genicot, 1987). Apart from the iconography, to date a museum object, or an *in situ* piece, one generally had to resort to the examination of the decoration and the stylistic or archival dating of the buildings in which they were found. These indirect dating methods are thus insufficient for the more common, less decorated window frames, those with regional particularities or for which the provenance is unknown.

The study of the selected frame presented here includes an archaeological description and visual recording, documentary research on its provenance in the collections and dendrochronological dating compared to the stylistic date.

Fig. 11.2. Window frame inv. 3079: external side. Photo: R. Pessemier, RMAH, 2015

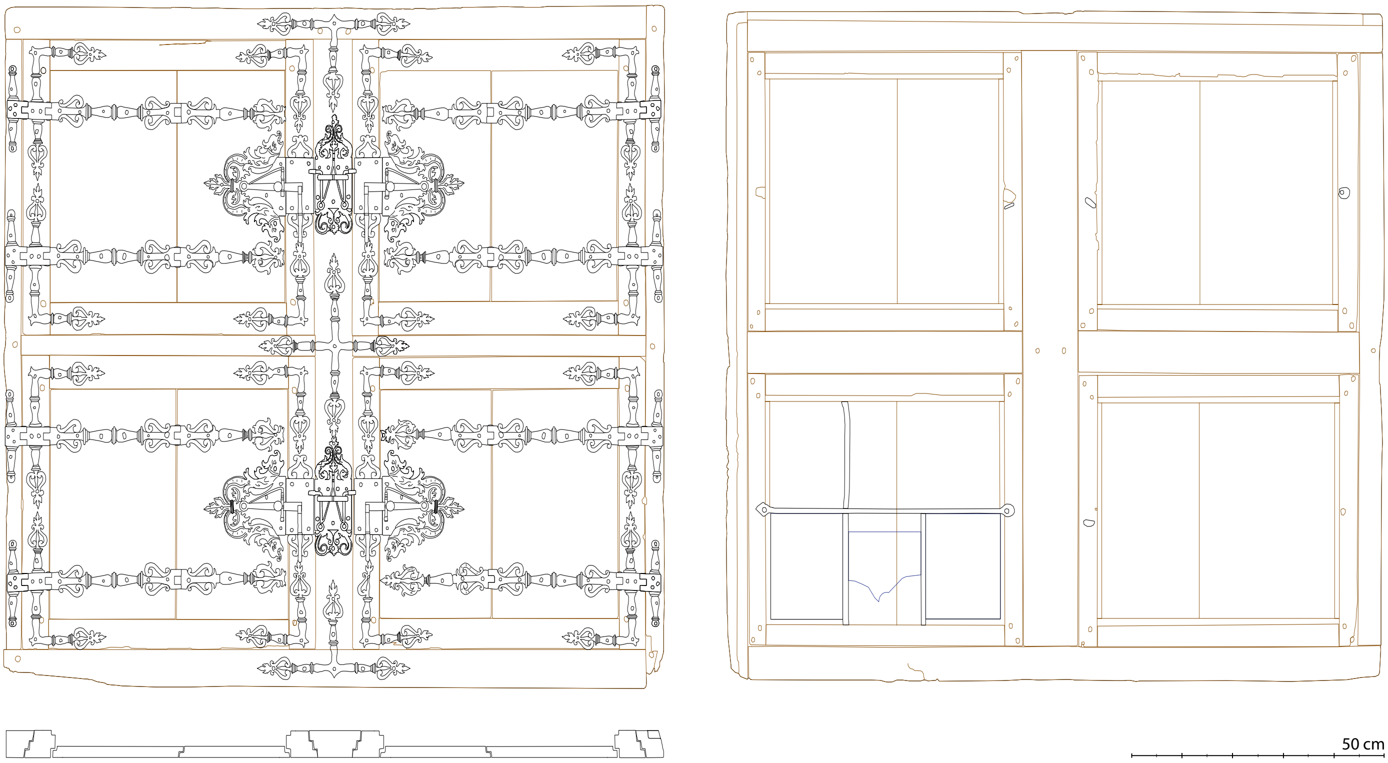
Fig. 11.3. Archaeological drawings from rectified photographs of window frame inv. 3079. Left: interior side; right: exterior side. Drawings: P. Gautier, RMAH, 2015

Fig. 11.4. Window frame inv. 3079: interior side, partially opened. Photo: R. Pessemier, RMAH, 2015

Fig. 11.5. 3D reconstruction of window frame inv. 3079: view from the interior showing the different ways it could be opened. Drawings: P. Gautier and L. Hardenne, RMAH, 2015

Technological description of the window frame, inv. 3079

The focus of the study is a window frame (113 × 132 × 4.5 cm) made entirely of oak (*Quercus robur* L. or *Q. petraea* Liebl.), divided into four nearly rectangular compartments (49 × 59 cm) (fig. 11.3). Each of the compartments contains a paned window opening to the interior of the house accompanied by folding split interior shutters made of two boards (fig. 11.4 and 11.5). On the interior



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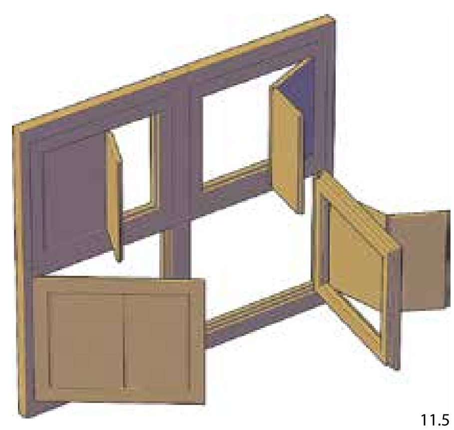
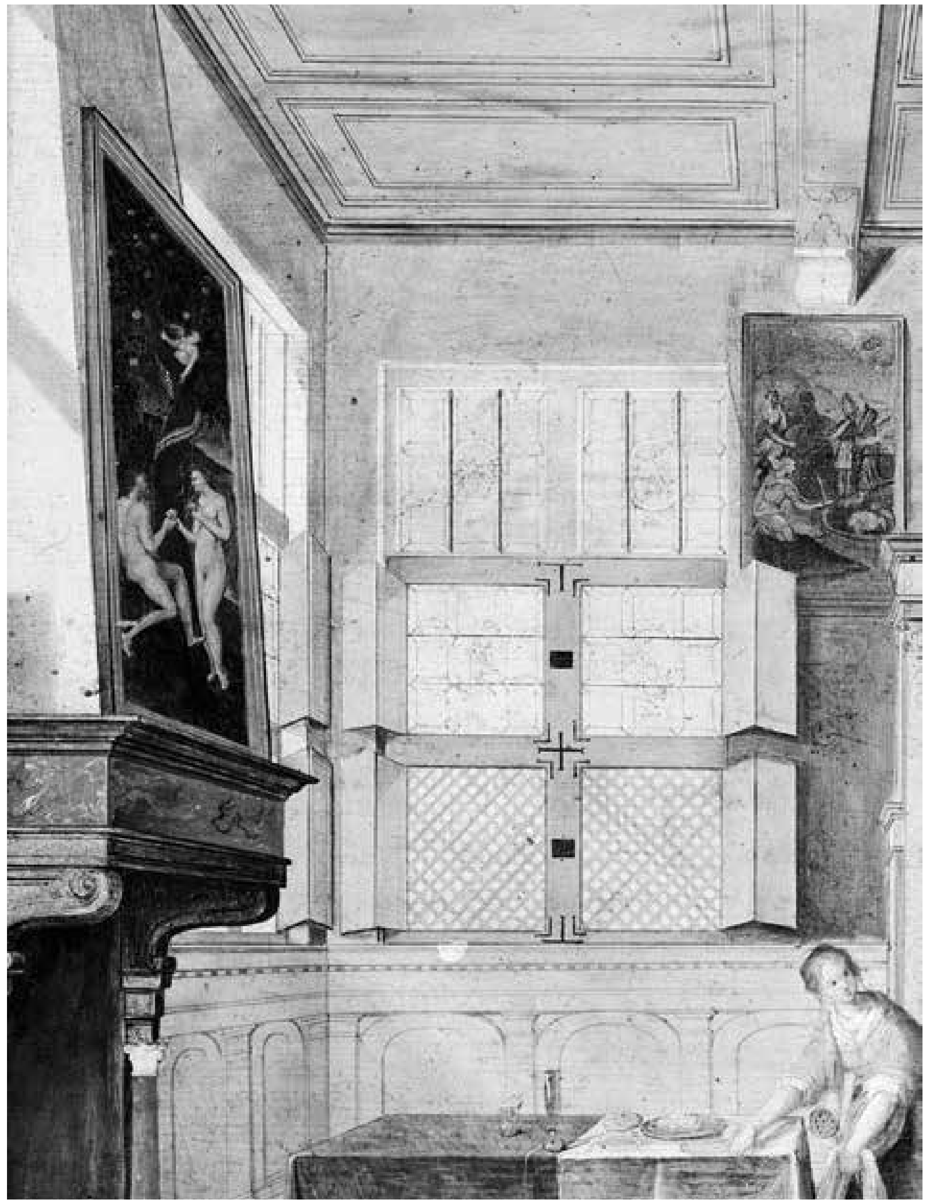


11.5

facing, all of the frames being exposed, the rotation of the paned windows and the shutters is ensured by richly decorated branched strap hinges (fig. 11.1). In its original position, this work covered the two lower openings of a stone casement window. The wooden window frame was attached in a vertical strip of the reveal, against the mullion and transom made of dressed stone.

An identical arrangement is visible in a painting by Abel Grimmer and Frans Francken II, *Jesus in the House of Martha and Mary*, conserved at the Royal Museums of Fine Arts of Belgium and dated 1614 (fig. 11.6). This allows



11.6

Fig. 11.6. Abel Grimmer and Frans Francken II, *Jesus in the House of Martha and Mary*, Antwerp, 1614, oil on oak, 54 × 73 cm (Brussels, Royal Museums of Fine Arts of Belgium, inv. 312): detail of the window. © KIK-IRPA, Brussels (B160931)

consideration of the entire arrangement in its original context. From the interior – and without leaning outside – a person could completely or partially open the shutters or each of the paned windows separately. In the painting, the two lower compartments are covered with wooden lattices, probably movable panels protecting the room from intrusion or inquisitive eyes (Genicot, 1987: 239-240). The upper compartments of the casement, above the stone crosspiece, are equipped with fixed panes. In general, these unmovable panels are aligned with the plane of the façade and are not covered by the shutters.

The joinery

The wooden casing is made of a frame assembled with corner bridle joints, divided into compartments by a central vertical mullion and a horizontal transom (fig. 11.1 to 11.3). These two wooden elements are assembled with a through mortise and tenon joint, in the middle of the frame. The assemblies are reinforced by one or two wooden pegs. The edges of the casement have a double rebate allowing complete housing of the paned windows (fig. 11.4 and 11.5). This 'double strike' of the leaves guarantees improved watertightness of the joinery in such a rainy region.

The wooden elements of the paned windows are also assembled with corner bridle joints, reinforced by wooden pegs (fig. 11.3, right). These have a double rebate on the external edges for housing in the casement. The shutters and lead cames fit into two rebates on the internal edges of the windows (fig. 11.4).

Each compartment is covered by a folding split interior shutter, formed of two boards of unequal width allowing their lowering (plank on plank) into the window frame (fig. 11.4 and 11.5). These oak planks are assembled by cross-lap joints that ensure better prevention of light penetration and visibility and block the planks once they are aligned (fig. 11.7). A rebate was cut around each shutter to house it in the paned wing (fig. 11.8). The planks positioned next to the central mullion of the casement are 21-22.5 cm wide; those next to the lateral jambs are slightly wider since they reach 26 cm. Dendroarchaeological examination of these wooden elements shows that the planks were quarter-cut. Their flat faces were perfectly smoothed and planed, eliminating all traces of the cutting mode, which may have been by splitting or sawing. The trees from which these planks were made had a slow growth rhythm; the wood grain is rectilinear and regular (fig. 11.7 and 11.8). The wood elements forming the frame also have similar characteristics, all of which indicate a high-quality wood for use in joinery.

11.7

11.8

Fig. 11.7. Detail of the upper edge of an interior shutter showing the cross-lap joint assembly between the two boards (after cleaning for dendrochronological measurement). The wood comes from a very slow growing tree (narrow rings). Photo: P. Fraiture

Fig. 11.8. Detail of the rebate on the exterior side of a shutter. The wood presents a straight grain. Photo: P. Fraiture

11.9

11.10

The frame shows traces of grey-green paint on the outside face (fig. 11.9). These are found on all of the joinery except for the wooden mullion corresponding to the central stone mullion of the window, against which the frame was set. The window frame was thus painted after being installed in the frame of the casement. It should be pointed out that the insertion of the frame into the masonry required some modification of the joinery to ensure correct positioning: one of the angles of the casement was shaved to fit into the rebate of the window.

The locking mechanism

Since all of the wooden elements were aligned, the rotation of the paned wings and shutters was done using branched hinges. This locking mechanism, when applied, has the form of a series of small wrought (hammered) iron colonettes with a base and capital, decorated with scrolls and leaves. All of the wrought iron metalwork was nailed to the joinery with small forged nails with round heads (fig. 11.10).

The paned windows close in pairs via a plate on the central mullion, with an M-shaped double leaf spring in the middle that is pinched to use. These pieces are richly decorated with scrolls and small heads of sea monsters. A handle on the end of the wings, the length of the central mullion of the casement, allows them to be opened. It also serves as a catch for the shutter latches. Each of the split shutters close using a spring catch operated by a button on each shutter. The catches are decorated with a pair of dolphins and leaves.

The casement is reinforced by cross- or T-shaped brackets connecting the central mullion with the horizontal glazing bars and the frame. Angle brackets also reinforced the frame of the paned windows. Scrolls and leaves also decorate these elements.

Fig. 11.9. Detail of the exterior side of the frame, lead cames and traces of greyish paint. Photo: P. Gautier

Fig. 11.10. Detail of one of the plates attaching the M-shaped double leaf spring of the paned wings and one of the spring catches of window frame inv. 3079. Photo: P. Gautier

11.11

Fig. 11.11. Window frame dated c. 1550 (London, Victoria & Albert Museum, inv. 2452-1856): this has nearly the same dimensions as inv. 3079 at the RMAH; their construction modes appear to be identical and there is great similarity in the décor of the wrought iron hinges and scrolls. Photo: V&A Images

The lead cames

One of the compartments of the frame has partially preserved the lead cames (fig. 11.9). This is part of the rebate created in each wing, on the side facing outwards. It is attached with small drops soldered to the lead cames and fixed on a saddle-bar nailed horizontally in the middle of each compartment. Small forged nails hold the edges of the glazed pane against the joinery.

The lead cames, now with many gaps, would have originally contained six flat rectangular glass panes. This leadlight pattern is known throughout the 16th century, replacing lozenge-shaped panes (Houbrechts, 2008: 160). It is probable that the lead cames preserved on the window frame are that of the original window.

The window frame in the RMAH collection

The main archival source for this frame is the accession book of the Royal Museums of Art and History, and more specifically that for the Section of Industrial Arts, one of the four sections which formed the Decorative and Industrial Arts Museum (the predecessor of the RMAH) at the end of the 19th century (fig. 11.11).[1]

The Decorative and Industrial Arts Museum was created in 1889, following the model of the South Kensington Museum (now the Victoria and Albert Museum) in London (Montens, 2007a). It was established at the Palais du

Cinquantenaire, in Brussels, which had been built in 1880 to celebrate the 50th anniversary of the Kingdom of Belgium. Its section of 'Old Art Industries' took over the collections of the Museum of Arms, Armor and Antiquities installed since 1846 at the Porte de Hal museum, except for the arms and the ethnographic objects which remained at the Porte de Hal.

The aim of this new museum in 1889 was to provide models to craftsmen and develop the 'good taste' of the common public. This policy was clearly expressed in a note by the Minister of Internal Affairs to the director of the museum: 'The government expects that the museum will be a place of learning for our industries of art, and that it will collect the best models rather than pure curiosities'.[2] Moreover, priority was given to national heritage (Montens, 2007b), as a major concern of the politicians at the end of the 19th century was to conserve 'the national wealth in what is the most attractive and most educational of the products of art'.[3] It is in this context that the collections of Belgian decorative arts grew considerably in the Decorative and Industrial Arts Museum, with a quantity of metalwork, furniture, ceramics and glass.

Date of acquisition

The acquisition of the frame in April 1892 therefore corresponds perfectly with the aim of the new museum. It also reflects a period of important urban works that led to the introduction, in the art market, of architectural elements such as ceramic panels, stained glass windows, doors, fireplaces, etc.

Description (accession book)

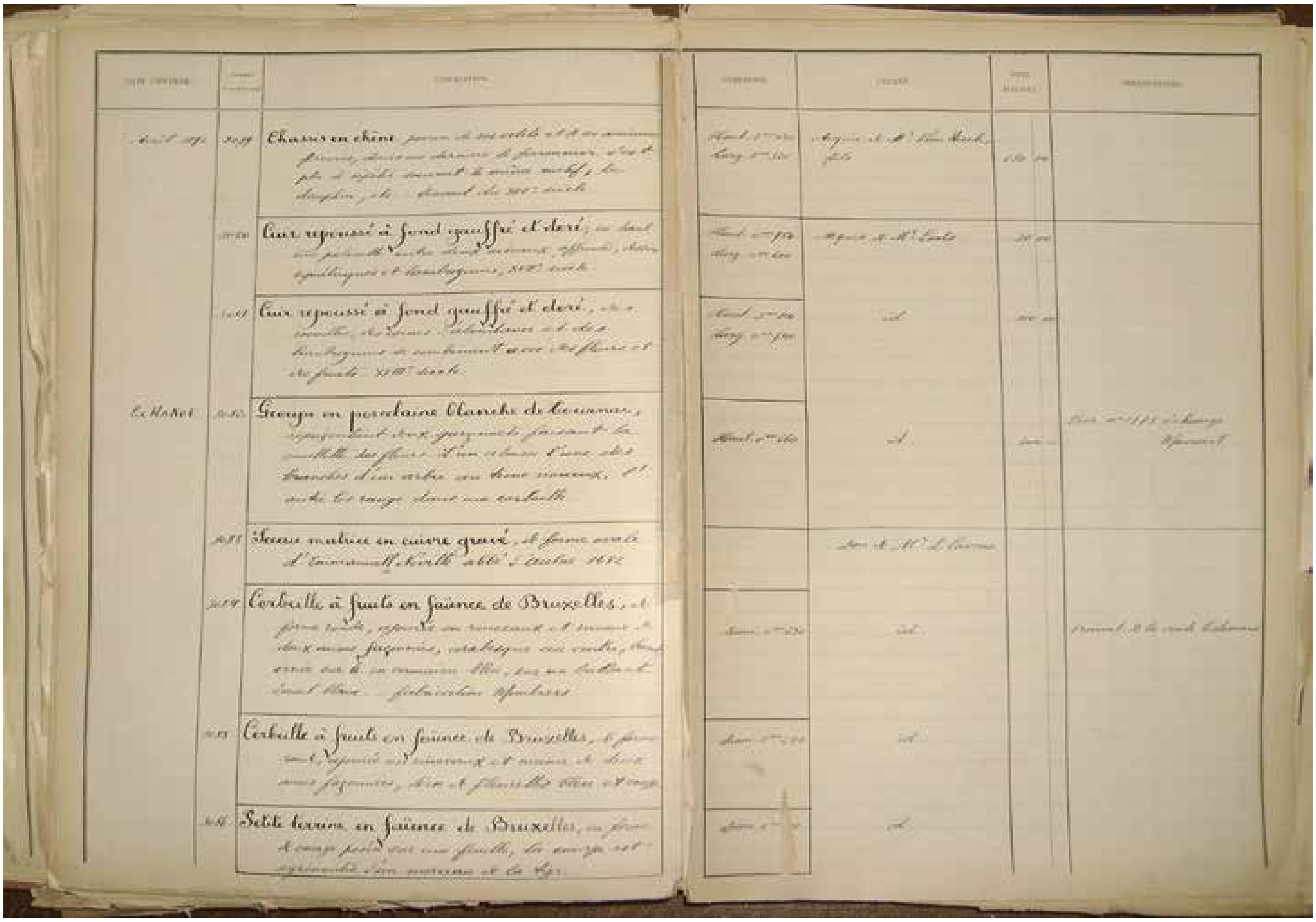
This frame was described in the accession book as an 'oak window frame with shutters and original ironwork, in the latter the ironworker repeated the same motif, the dolphin, etc. Work of the 16th century.'[4] To our knowledge, this is one of the few objects which entered the collections as a 'frame' (fig. 11.12). The only two other examples found in the museum accession books were purchased in 1873 from the civil hospital of Lierre (inv. I.A.2017). These each contain eight roundels of stained glass dated to the 17th century and depict the story of Joseph. The museum storage areas, however, contain many other frames which still need to be listed, identified and dated.

It should be noted that in the description of frame inv. 3079, the emphasis is placed on the ironwork. This corroborates the idea that the piece entered the museum primarily as a model of ironwork, with many other iron pieces which came into the collections at this time.

Acquisition mode

The museum accession book gives the name of the art dealer, Van Herck Son, who sold the frame to the museum for 230 Belgian francs. This man can be identified as the antiquarian Eugène van Herck (1854-1941), son of Jan Frans van Herck (1824-1903) who established an art trade in Antwerp around 1870.[5]

Research conducted in the archives of the RMAH failed to yield further information about the circumstances of this acquisition, firstly because the museum acquisitions records exist only from 1900 onwards, and secondly because there is no mention of Van Herck in the correspondence of the director



11.12

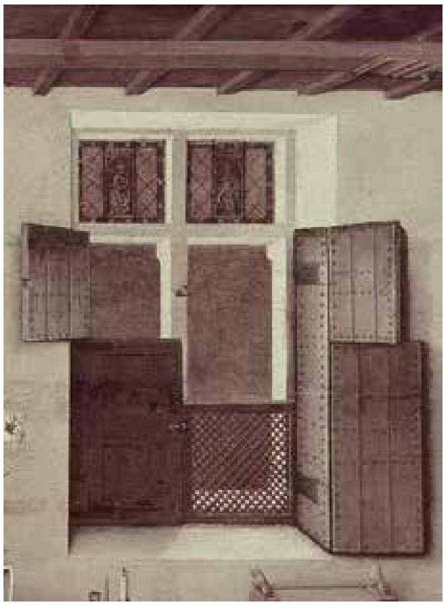
of the museum. Similarly, the records of the auction room of Eugène and Charles van Herck, conserved in the State Archives in Antwerp, provided no further information for this period.[6] Regardless, study of the acquisitions records seems to indicate that it was the first purchase of the museum from Eugène van Herck, who had not been not one of the regular art providers for the museum. In succeeding decades, however, this acquisition would be followed by others.[7]

Regrettably, essential information is lacking in the records: identification of the building from which the frame came. Given that it was purchased from an antique dealer in Antwerp, it would be tempting to identify this city as the place of its manufacture, but no objective arguments exist to support this hypothesis.

Typological and stylistic dating

The history of closing window openings in what is present-day Belgium is known in particular by the work of Luc-Francis Genicot (1987) based on the iconography of the Flemish Primitives, Geert Everaert for the 17th century (Baillieul *et al.*, 1993) and David Houbrechts (2008) for urban timber-framed

Fig. 11.12. Accession book, April 1892: page including the frame inv. 3079, among other objects. © RMAH, 2015



11.13

buildings in the middle Meuse Basin. Based on these studies, the window frame studied here may be dated to the 16th century.

In the last century, iconography has revealed that urban houses of a certain status were typically fitted with stone casement windows. The ways in which they were closed resulted from a compromise between insulation and luminosity or, as Houbrechts notes (2008: 155), a choice between 'being warm or seeing clearly'[8]. Above the horizontal stone crosspiece of the casement, the two more or less square wings of the transom are filled in alignment with the exterior wall by flat glass panes with simple lead glazing. Below the crosspiece, the window generally lacks panes (Genicot, 1987: 238).[9] The lower wings sometimes have lattices. Blocking of the lower parts of the casement opening was done only by split shutters that could be opened both vertically or horizontally. The shutters, with unequal widths, pivoted on metallic hinges set directly into the masonry and lowered into the frame (Fig. 11.13).

During the first half of the 16th century, a major innovation marks the history of the window: the installation of a casing between the wings and the masonry.[10] It is thus at the same time that in our cities, complete glazing of the openings began to be imposed (Genicot, 1987: 238). The frame conserved at the RMAH, with both casing and paned wings, belongs to this category.

Forerunner in the dendrochronological study of finishing work, Houbrechts identified a frame of this type at the Curtius Museum in Liège (inv. I/117, fig. 11.14)[11] and dated it after 1501d.[12]

With respect to the style of the ironwork of frame inv. 3079, the composition extends the Gothic tradition by the abundance and animation of the décors (Genicot, 1987: 250). The motifs, in contrast, are of Renaissance style, both in the series of colonettes, capitals and scrolls and in the bestiary of sea monsters (fig. 11.10).

Dendrochronological study

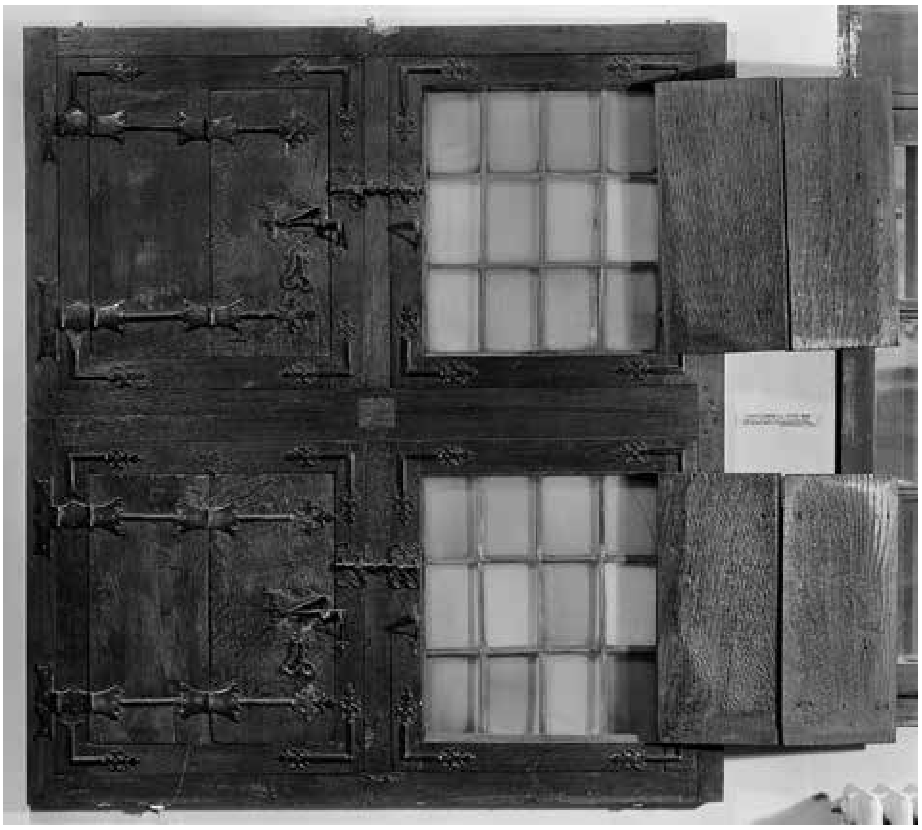
Sampling

Given the aesthetic and heritage value of this window frame, only a non-invasive dendrochronological analysis was permitted, with no destructive samples collected. For the oak, the growth rings had to be measured on the transversal plane of the wood. In addition, a dendrochronological data is considered scientifically reliable only if the wood contains at least 70-80 rings for oak (e.g., Hillam *et al.*, 1987).

On this frame, the elements forming the casement have too few rings for such a study. However, the planks of the shutters, which were quarter-cut, meet the necessary conditions on their horizontal edges. The growth rings were recorded by calibrated macrophotography after superficial cleaning of the wood using flexible blades and a medium-stiff brush (fig. 11.7).[13]

The eight planks of the shutters show an extremely slow growth rhythm for the wood (average ring between 0.77 and 0.84 mm on each plank)[14]. As a result, each series measured has a large number of rings, between 187 and 265. The pith and sapwood were not present on any of the planks; the ring series

Fig. 11.13. Robert Campin, *The Annunciation*, c. 1415-1425?, oil on oak, 61 × 63.7 cm (Brussels, Royal Museums of Fine Arts, inv. 3937): detail of the right window. © KIK-IRPA, Brussels (B240201)



11.14

sampled are thus truncated at the start and end of the growth rings formed during the life of the tree(s).

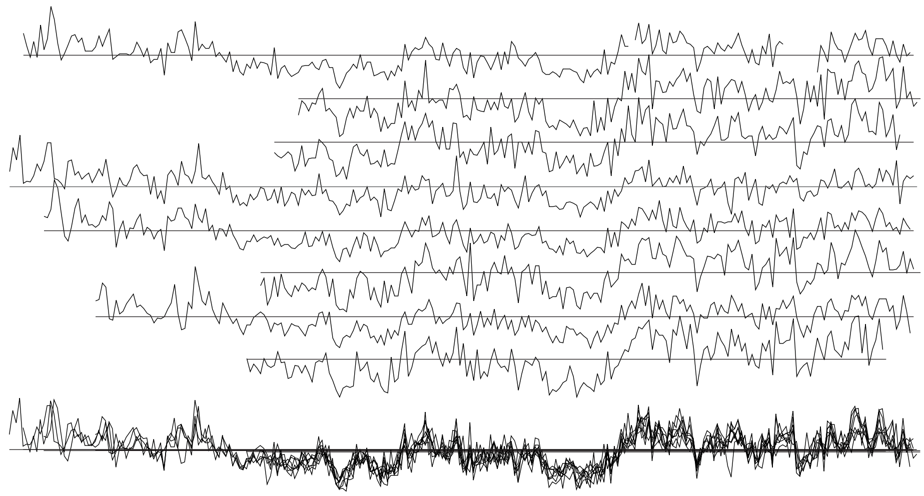
Planks obtained from the same tree

The quality of the synchronisations obtained between the ring series measured shows that the planks used for the shutters of the four compartments all come from the same tree (fig. 11.15). It is therefore unsurprising that the growth rhythm is so similar for all of them. As a result, the dendrochronological graph clearly demonstrates the differences in widths between the narrower planks, those placed against the central mullion when the shutters are closed, and those assembled with lateral jambs, larger than a few centimetres. The tree-ring series for the first group are clearly shorter than those for the second and it should be noted that the wood removed when the narrowest planks were cut to size is systematically that close to the centre of the tree, that is, the oldest rings. This observation, along with the fact that the last rings measured on the eight elements are chronologically very close, would tend to indicate that very little wood was removed on the bark edge, including all of the sapwood but likely very little of the heartwood.

Dating and provenance of the wood

The series from the eight planks were grouped in a dendrochronological mean representative of the single oak tree studied, which, compared with reference databases, is dated with a final ring in 1527. This position is determined by

Fig. 11.14. Window frame dated by dendrochronology after 1501d (Liège, Curtius Museum, inv. I/117). © KIK-IRPA, Brussels (B178591)



11.15

Fig. 11.15. Drawing of the ring series measured on the eight boards that composed the shutters of inv. 3079, in relative position, and superimposition of these eight sequences (bottom) showing their very close resemblance (drawings in raw values). Drawing: P. Fraiture

chronologies originating around the Baltic Sea and indicates that the oak used for the shutters came from this broad geographic zone.

It should be clarified that the provenance of imported Baltic oak is imprecise as different zones in this region were exploited over time, from northern Poland probably to modern Russia.[15] Many historical sources attest to considerable exportation of north-eastern oaks to the Low Countries starting in the 14th century via the Baltic ports.[16] Dendrochronology contributes to the knowledge of this trade since most of the supports used, among others, by Flemish painters from the 14th to the mid-17th century are of this type of wood.[17] Available in large quantity, Baltic oak had mechanical properties particularly suitable to making long high-quality planks.[18] More specific studies of finishing structures, especially in Flanders, demonstrate that use of such planks went far beyond the context of art objects, since wainscoting, cladding and ceilings appear to have been systematically composed of 'Baltic' oak (Fraiture, 2015). The frame inv. 3079 is thus a new example of the use of this material.

Without sapwood preserved, the date obtained represents a *terminus post quem* for the felling of the tree, that is, the date after which the oak was cut and not the exact year of its felling. A study conducted on 668 oaks in Baltic countries (Estonia, Latvia and Lithuania) and in Finland shows that the sapwood in these regions contains between 6 and 19 rings (Sohar *et al.*, 2012). A minimum of 6 rings, equivalent to six years, can thus be added to the date of the last ring measured to determine the earliest year after which the tree was felled: 1533 (1527 + 6).

For the lapse of time between felling of a tree and use of the wood, while it has been demonstrated in carpentry that the wood was often used rapidly[19], this generalisation cannot be applied to joinery made of Baltic oak. Indeed, on the one hand, historical, archaeological and dendrochronological research suggests that, for the period from the 15th to 17th century, the interval may only be a few months (Haneca *et al.*, 2005: 287; Wazny and Eckstein, 1987; Fraiture, 2007). On the other hand, some dendrochronological studies indicate a larger interval between the dendrochronological result and the known or estimated date of use (Fraiture, 2007). The parameters involved are numerous (transport, warehousing, storage, etc.), added to the drying period which should not require more than one season. In these conditions, the date of 1533 is proposed as a *terminus post quem* for the production of the window frame.

Conclusion – perspectives

The façade of a building, between the private and public spheres, was a key showplace during the Middle Ages, as Yves Esquieu states (Esquieu, 2006: 229). Yet, beyond the materials used, the openings above all play a role of representation, windows more so than doors, and the dressing of windows participates in this dramatisation. Open during festivals and processions, they allow their wealth to be exhibited to passers-by. During private receptions, they reveal the richness of the décor and fineness of the production to the guests. The window frame thus plays a role as a frame for a 'living tableau' of bourgeois representation, in which the shutter forms the decoration.

The technological and stylistic analysis of window frame inv. 3079 has enabled it to be chronologically situated to the first half of the 16th century. Dendrochronology further refines this date by demonstrating that it could not have been made before the middle third of the century (after 1533d). The tree-ring dating of the shutters further indicates that these were made of planks from a single tree, and that it came from the Baltic Sea region. These imports arrived in the form of split quarters (*waynscots, wagenschots*), cut into planks once at their destination. This provenance and the generally associated characteristics of the wood attest that this was a very high-quality material for joinery, as shown by most of the supports for Flemish paintings and the meticulous joinery of the Low Countries during this period.

The present study adds a new marker for the absolute chronology of windows in this region, including several others that have already been identified. The ongoing development of less invasive analytic methods allows the number of such investigations to increase, or even become standard for museum pieces and windows still *in situ*.

Of course, the establishment of a typo-chronology in window frames requires other tools in addition to 'direct' dating methods. As in other regions, western France for example, the systematisation of specific archaeological documentation of the window openings and their system of blocking preserved *in situ* has created a corpus of ancient windows that, studied in the perspective of change in forms and techniques used, will result in the development of a typology. This would then serve as the basis for the study and description of specimens in museum collections, out of context and too often unknown or underexploited.

Our knowledge of frames would also benefit greatly from comparisons with the domain of furniture – more studied and better known – which shares many similarities with our topic of study, both at the level of production techniques and the décor and, by this, their chronology.

Similarly, the study of the iconography would fundamentally support this research, with all that is assumed through historical criticism. It should be noted that windows are a recurrent theme in medieval iconography.

Window frame inv. 3079 fully participates in this dynamic of representation, the richness of the interior décor integrated into the decoration of the living space affirming the status of owner who ordered it. The detailed ironwork of the hinges, angle brackets and plates with decorations of leaves, scrolls and sea monsters, the quality of the joinery and the materials used make it one of the more notable specimens preserved from the 16th century.

Notes

1 On the history of the museum, see: *Liber memorialis 1835-1985*, Brussels, 1985 and Montens, 2008.

2 Archives of the RMAH, note from the Minister of Internal Affairs to the director of the museum, Brussels, March 22, 1884. Authors' translation of: '*Le gouvernement tient essentiellement à ce que le musée soit un lieu d'enseignement pour nos industries d'art, et à ce qu'il collectionne les meilleurs modèles plutôt que les pures curiosités*'.

3 See, for example, the speech of the Catholic politician Van Der Linden at the House of Representatives in 1897 (*Annales parlementaires de la Chambre*, 8th June 1897). Authors' translation of: '*la richesse nationale dans ce qu'elle a de plus séduisant et de plus élevé, dans les produits de l'art*'.

4 Authors' translation of: '*châssis en chêne pourvu de ses volets et de ses anciennes ferrures, dans ces dernières le ferronnier s'est plu à répéter souvent le même motif, le dauphin etc. Travail du 16e siècle*'.

5 He himself was Charles Van Herck's father, whose collection of drawings and terracotta was acquired in 1996 and 1997 by the King Baudouin Foundation and deposited in two different museums in Antwerp (Baisier *et al.*, 2000; Allard, 2000).

6 Our thanks to Mr. Oosterbosch, archivist at the State Archives in Antwerp who kindly allowed us to search the inventory of the archives of the art dealer and auction room Eugène and Charles Van Herck in Antwerp.

7 For example, in 1894, the museum bought from Eugène Van Herck a backgammon board from the 17th century for a very similar price, 225 francs; and in 1899, the museum acquired five objects from him, including a rosewood chair, three wooden boxes and an earthenware inkwell from Luxembourg.

8 Authors' translation of: '*avoir chaud ou voir clair*'.

9 Note that some paintings of the Flemish Primitives show casements in which the four wings are paned; this arrangement appears, however, to be uncommon.

10 See www.chassis-fenetres.info, *Fiche thématique 2.1.*: 2 (author: A. Tiercelin, 2007) and article no. 10 in this volume (Tiercelin).

11 For this window frame, see: Polain, 1906.

12 As the author indicates, interpretation of this date remains problematic because the frame has traditionally been dated to the start of the 17th century, like the Maison Pickmann where it was installed (Houbrechts, 2008: 160).

13 The protocol for the dendrochronological study can be consulted in this volume (article no. 4) or online (Fraiture, 2013a).

14 Slow growth is characterised by rings less than 1 mm thick, rapid growth by rings greater than 2 mm (Fraiture, 2007; Beuting, 2011).

15 Studies are in progress in different European laboratories to refine determination of these provenances. This is, however, a difficult issue to resolve, given the transport of logs by rivers (Houbrechts, 2002; Houbrechts, 2008; Fraiture, 2013b) and in particular the massive exportation of Baltic oak to western Europe (Fraiture, 2009; Wazny, 2011; Zunde, 2011; Fraiture, 2016).

16 See, for example, Baillie, 1984; Tossavainen, 1994; Zunde, 1998-1999.

17 Regarding the discovery of the use of 'Baltic' wood in art by dendrochronology, see Baillie *et al.*, 1985; Eckstein *et al.*, 1986. For the use of Baltic oak in Flemish paintings, see, for example, Vynckier, 1992; Kemperdick and Klein, 1997; Fraiture, 2013a.

18 The rigourous climate of these regions causes slow growth of the trees, producing a soft wood resistant to warping. In addition, competition between individuals in these dense forests leads to a straight or rectilinear growth of the oaks, an appreciable quality for the production of long planks.

19 See, for example, articles no. 2 and 4 in this volume.

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Summary

Like other museums of decorative arts, the Royal Museums of Art and History (RMAH) conserve a significant collection of window elements acquired after building demolitions. This kind of collection is often poorly known and rarely studied. This contribution presents the detailed study of a window frame that installed in the two lower openings of a stone casement window. Its decoration and the quality of its joinery make it one of the more notable examples conserved for the 16th century. The research conducted combines archaeological description and drawings, archival research on the provenance of the frame and dendrochronological dating compared to stylistic dates and iconography. It thus constitutes a milestone in the establishment of a research methodology, the systematic application of which would lead to the construction of a database that can be used to create a typochronology of window frames in the Low Countries.

12.1

12

Grand staircase and joinery works on the Lange Vijverberg, The Hague (The Netherlands) in light of documents

Ada de Wit[1]

Key words

Staircase / Joinery / Holland / Late 17^{th} century / Archives

Introduction

Seventeenth-century bills for constructing a house, that are detailed enough to provide insight into historic carpentry and joinery, rarely survive. Documents on the building of the house of Simon de Brienne (born in Jouy-le-Châtel and died in The Hague in 1707) on the Lange Vijverberg, The Hague are as unique as they are meticulous. The papers date from 1698-1702 and include an extensive description of joinery work, revealing names of craftsmen, amount of time taken and materials spent on particular tasks, dimensions of constructional elements and prices of material and labour.

The house on the Lange Vijverberg, today's number 11, was rebuilt in the past and there is nothing left of the late 17^{th}-century grand interiors described in the bills. The sole survivor is a magnificent staircase removed from the house in 1928 and installed seven years later in the newly built Museum Boijmans, Rotterdam (currently Museum Boijmans Van Beuningen), where it still stands (fig. 12.1-2). The documents on building the house in The Hague shed light on the authorship of the staircase, its construction and original decoration.

The main goal of this paper is to make researchers interested in historic carpentry and joinery aware of the richness of this newly discovered archival material. The author of this article is an art historian; therefore, much attention is given to documents referring to the decoration of the staircase, which is one of the grandest examples of late 17^{th}-century wooden staircases in the Netherlands.

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Fig. 12.1-2 Staircase from 11 Lange Vijverberg, The Hague, carved in limewood by Willem van Sundert, 1699-1700. Museum Boijmans Van Beuningen, Rotterdam. Photos: Jannes Linders, Rotterdam

12.2

Simon de Brienne's new house

The house on the Lange Vijverberg was bought on behalf of Simon de Brienne in 1698. At that time De Brienne was in London, where, together with his wife Maria Germain, they kept the offices of the wardrobe- and house-keepers to William III and Mary II at Kensington Palace. De Brienne's career at the court of William III began in 1669 in The Hague, when the latter was still the Prince of Orange (Graswinckel, 1944: 7). Simon de Brienne, a Frenchman from birth, was appointed as chamberlain to William but following promotion in 1700 he became his first barber.[1] His posts at the court were not the only source of his income: in 1676 De Brienne was appointed a postmaster to France and Brabant, which, at that time, was a lucrative position.

In 1699 the De Briennes retired from court life and moved back to The Hague. By then, the work on their new house on the Lange Vijverberg was well advanced. The building had an attractive and prestigious location in the heart of The Hague: it overlooked the waters of the Hofvijver and was situated opposite the Binnenhof, then the seat of the States General and the *Stadtholder*.

De Brienne did not save money on his new dwelling. The existing house on the Lange Vijverberg was bought in 1698 for 20000 guilders but its four-year rebuild cost an additional 40000 guilders (Graswinckel, 1944: 25). Gijsbert Blootelingh, a controller and land surveyor of works of the County of Holland, supplied specifications for construction and drawings; he also supervised the whole project. Two other masters played important roles in the building process and charged the highest prices for their work – the carpenter Johannes Swaartveger (14595 guilders) and the mason Jacobus Coster (11238 guilders).[2] Additional payments were made to the slater Cornelis van der Burgh, stone mason Dirck Drijfhout, woodcarver Willem van Sundert, plumber De Hondt, decorative painter Simon Classon, glassmaker Cornel Van Goch and locksmith Hendrick Schooff. All these masters worked with their apprentices and journeymen.

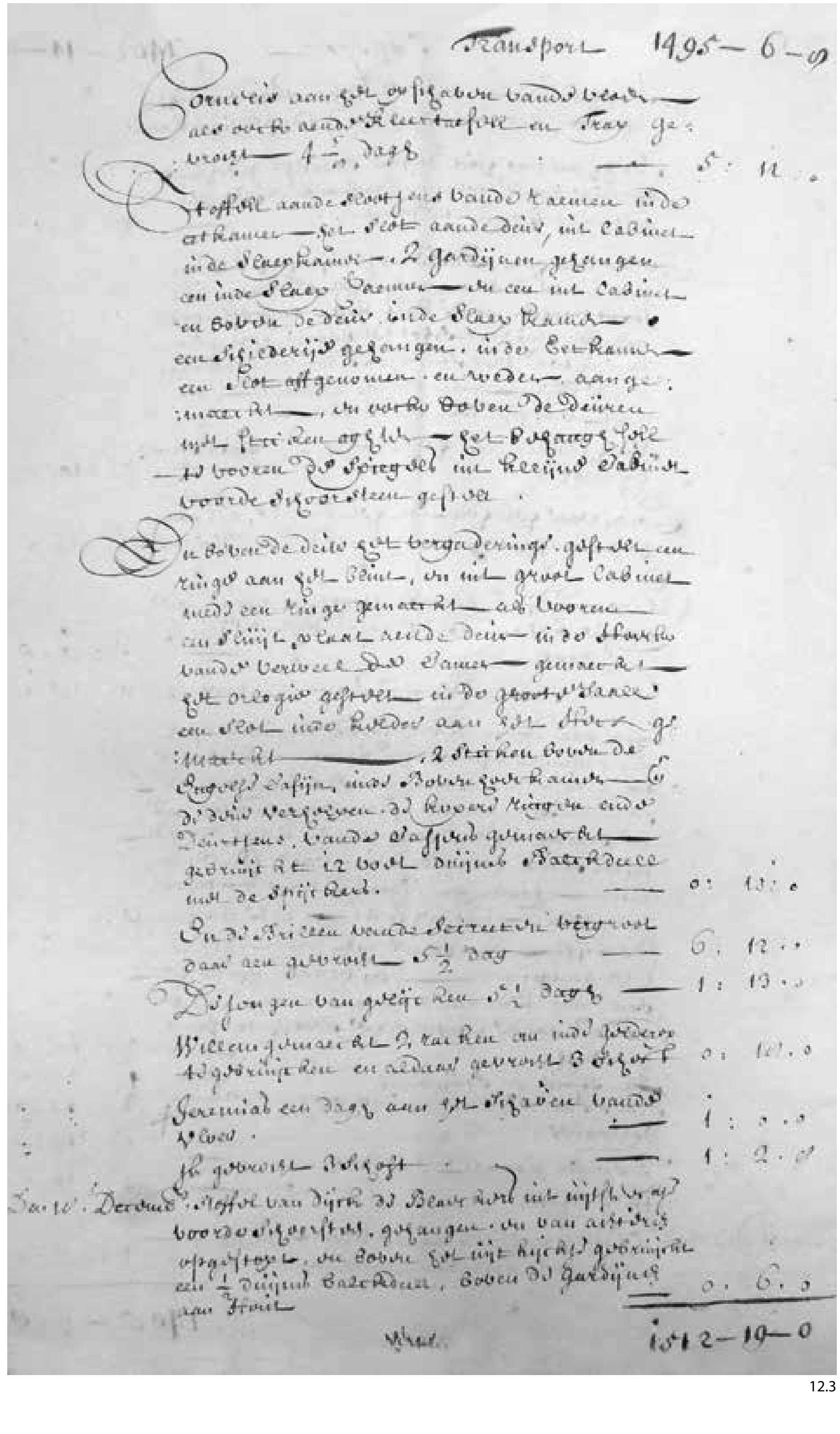
Marcus de Vrint was paid for staying 'day and night' in the house during its rebuild to ensure that neighbours would not experience any inconvenience. This thoughtful action did not, however, prevent neighbours' complaints: Mrs Ter Hove reported damages caused by De Brienne's craftsmen, who broke through the walls and roof of the house she rented from Mr Van Reinenburgh.[3]

The rebuild of the house on the Lange Vijverberg included all the interiors, the basement and the attic. Moreover, the large staircase was fitted, a balcony built and the windows and the lead on the roof were replaced.[4] Some works were also done in a coach house on the Hoge Nieuwstraat, a street running behind the house, parallel to the Lange Vijverberg. The major works on De Brienne's house were completed by 1701 but some lesser works and the last payments were made in 1702.

Unfortunately, the De Briennes only lived together in their new house for a short time. Maria died in 1703 and Simon de Brienne four years later. They had no children and their legacy came under the management of the Orphan Chamber Delft, whose archive is now stored in the Archives of Delft. The Orphan Chambers were municipal institutions and the executors of the properties of persons who left underage heirs. After De Brienne's death, the house on the Lange Vijverberg was sold. Since then it has changed hands many times. The last resident was a Belgian envoy Prince A. de Ligne, who lived at 11 Lange Vijverberg until 1927. In 1928 the house was rebuilt and its interiors converted to offices. In that year the grand staircase built for Simon de Brienne was donated to Museum Boijmans by C.W.F.P. Baron Sweerts de Landas Wyborgh, who was both a broker and a member of the Commission of Museum Boijmans. Today the staircase is the only remnant of the fine interiors, but we can learn more from the bills kept, amongst De Brienne's papers, in the Archives of Delft.[5]

Carpentry and joinery works

Three bills written by Johannes Swaartveger are to be found among De Brienne's documents in Delft, covering a period between 1699 and 1702 (fig. 12.3). The first one, 31 pages long, describes work done between September 1699 and January 1701 and contains a few notes about additional work, not included in the



Transport 1495 — 6 — 9

1512 — 19 — 0

12.3

Fig. 12.3 Sample page of Swaartveger's bill (Archief Delft, Archief van de Weeskamer Delft, vol. 72, fol. 11854).

original project, which had been conducted in January and August 1699. The second bill, just a few pages shorter, includes works done between January and September 1701 and the third one, only three pages long, reports works done from October 1701 to June 1702.

Some bills, especially from the initial stage of the building project, are probably missing. De Brienne noted in his expenditure book that the first payments to 'Swaartveger carpenter' had been made in September 1698. From this document we know that Swaartveger received in total 14595 guilders in 17 separate payments. Each note gives a date and amount paid by De Brienne to the carpenter and is signed below by Swaartveger. These notes confirm that most of the works were done by 1701:

September 1698 – 500 guilders
November 1698 – 500 guilders
December 1698 – 500 guilders
January 1699 – 500 guilders
March 1699 – 500 guilders
May 1699 – 500 guilders
June 1699 – 500 guilders
August 1699 – 2000 guilders
January 1700 – 2000 guilders
March 1700 – 1000 guilders
June 1700 – 1000 guilders
September 1700 – 1000 guilders
November 1700 – 500 guilders
December 1700 – 550 guilders
April 1701 – 1000 guilders
September 1701 – 1100 guilders
September 1702 – 945 guilders

Johannis Swaartveger was both a master carpenter and a master joiner of the Guild of Saint Joseph in The Hague. This means that he delivered two masterpieces and paid the due fee twice: the first time when he became a master carpenter in 1684 and the second when he became a master joiner in 1687.[6] On the Lange Vijverberg he was responsible for all woodwork and employed other craftsmen; his bills mention 22 names and one 'boy', surely an apprentice.

All the declared costs were based on labour work counted in *schoft*, which is a quarter of a working day, and amount of material used, including nails, glue and wood. Usually, the sort of wood is not specified with the exception of oak.

The bills provide insight into woodwork in the house; however precision in descriptions varies. Sometimes Swaartveger is laconic, at other times he goes into great detail. The existing house was mainly refurbished, so not much constructional carpentry work was done, contrary to extensive joinery work. Occasionally it is explicitly written that an old window frame or a mantelpiece was replaced with a new one. We know that Swaartveger's team started with some 'adjustments' in the attic and that afterwards they were engaged for many months in making window and door frames, doors, window shutters, mantelpieces, wall panelling, pilasters, portals, cupboards, shelves, etc. Moreover, they made beds, some tables and benches, bookcases, and mirror and picture frames. All these elements are simply named in the bills, excepting more important objects for which additional information was provided, for instance 'remaking a frame of the portrait by Rubens'.

Furthermore, the craftsmen's duties were not limited to carpentry or joinery but covered decorators' tasks as well; they hung pictures, mirrors and curtains, nailed carpets, placed clocks and installed door locks. They also helped to set an iron rail and marble mantels and cooperated with other craftsmen, especially with a woodcarver, for whom they prepared boards (*lijsjes de welcke doorden Beelthouwer souden gesneden worden*), and a painter, who is mentioned several times by Swaartveger.

Simon Classon, a painter, provided separate bills for his work done between 1698 and 1702 as well as a detailed account of the types of paint used. Together with his seven journeymen, he carried out work to both the outside and the inside of the house; to the latter belonged the painting of window frames, doors, mantelpieces and decorative woodcarving, often in a way to imitate more precious materials, for instance oak, boxwood or marble. For all his extensive work he was paid 1376 guilders.

It has already been said that the main work in the house was done by 1701 or, more precisely, by the end of 1700. After that, minor work was undertaken, such as constructing small elements, fixing and gluing various objects, improving previously executed woodworks and cleaning panelling.

Interiors

Different terminology is used in the bills, often without consistency. For instance, in Dutch panelling is usually called *lambrisering* but there are also phonetically written versions of French *boiserie*. In various places 'English windows' and 'English window frames' are mentioned, probably referring to sash windows, visible in the drawing of the Lange Vijverberg from 1719 (fig. 12.4). This kind of window was introduced in Holland c. 1685 (de Haan, 2005: 269).[7] The word 'English' occurs several times, Swaartveger writing as well about gluing damaged English chairs and installing English locks in doors. All these English elements are not surprising in the context of De Brienne's service at the English court.

The bills reveal names of various rooms in the house, however, their exact disposition is today unknown. Traditionally for Dutch houses there was a front and a back house and consistently front and back rooms (*achter-* and *voorsalet*, *achterkamer*). The following rooms are mentioned in the documents: great or large room (*groot salet*), great cabinet, dining room (*eet saal*), gallery with glass doors, corner room, bedroom with garderobe, cabinet, blue room (*Blauwe Kamer*),[8] small cabinet and olive cabinet (*Olijven Cabinet*). Interestingly, there was also a smoking room (*Roockkamer*) and a secret room (*het secreet*) where joiners made a footstool (*voetbankje*) and some compartments for papers (*twee backjes voor de papieren*). The basement was divided into several rooms: there

12.4

was a small front basement, a basement, a basement under the corner room and a peat basement (*turff kelder*). There the joiners made, for instance, special shelves for apples, pots and pans and bottle racks. There were also two kitchens – a large and a small one – and servants' and maids' rooms. The property had, in addition to its main entrance on the Lange Vijverberg, a back entrance via a 'gallery' on the Hoge Nieuwstraat; a stable and a coach house were also located on this street.

Staircase

The staircase from 11 Lange Vijberberg is a great example of the grandeur of De Brienne's interiors. It is truly monumental, having three flights of stairs running around a large open well and a balustrade consisting of nine panels carved in limewood. The panels are decorated with acanthus scrolls and animal

Fig. 12.4 *Lange Vijverberg*, Daniel Marot the Younger, 1719, pen and grey wash, with pencil, 16.4 × 19.6 cm (Haags Gemeentearchief, The Hague).

motifs – eagles' and dolphins' heads (fig. 12.5) and snakes – ; the sloping panels are additionally enriched with bandwork, which is a French ornament popular in Holland at the end of the 17th century, made up of geometrical sections. We know from archival pictures of the staircase still *in situ*, before its dismantling in 1928 (fig. 12.6), that the current layout of the staircase precisely repeats its original situation.

Thanks to the accuracy of Swaartveger's bill we can find information referring to the construction of the staircase, called 'the great staircase' (*de groote trap*) or simply 'the staircase', different from other stairs in the house, mentioned as: staircase to the maids' room, staircase to the basement, stairs to the courtyard, stairs to the Hoge Nieuwestraat and 'secret stairs'. However, the information on work on the staircase that we receive from the bills is incomplete.

Joinery works on the staircase are first mentioned on 18 September 1700 when two joiners began to work on wainscoting and cupboards under the staircase. They continued their tasks until the end of November, accompanied by four other craftsmen. They made frames, doors, shelves and locks to the cupboards under the staircase. Unfortunately, we do not know what the cupboards looked like as they no longer exist. In December 1700 and then again in February 1701 the 'boards' of the staircase were planed. In January 1701 a clock was placed on the staircase (no further details were provided). In the summer of 1701 wooden floors were laid on the landings and the staircase. Finally in June 1702 the handrail of the staircase was planed.

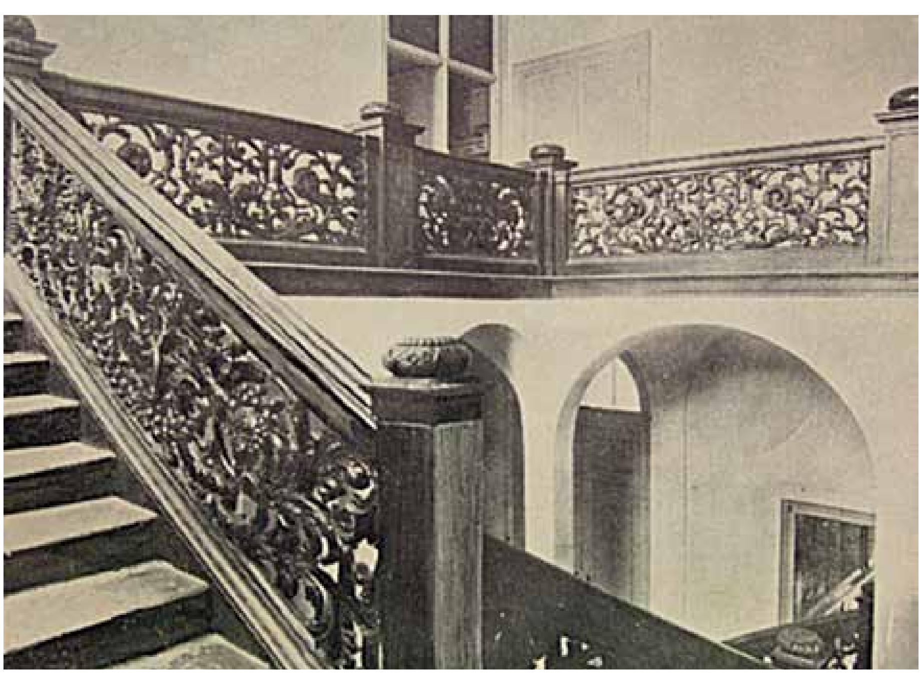
Woodcarver

The woodcarver who carved the decoration of the balustrade is not mentioned in Swaartveger's bills, but his name is revealed in De Brienne's expenditure book, in which payments to the sculptor were registered. At that time the words 'sculptor' and 'woodcarver' were often used interchangeably.[9]

'WVSundert' was paid 993.5 guilders for carving various decorations in the house. Three notes referred to the staircase (fig. 12.7). On 23 October 1699 he received 200 guilders 'in advance' for the woodcarving of the staircase. In January 1700 he received an additional 100 guilders for the same work, also 'in advance'. Three months later he was paid 150 guilders for carving 'nine pieces' for the staircase, which undoubtedly refers to the nine panels of the balustrade.

'WVSundert' refers to Willem van Sundert, a woodcarver who regularly appears in documents from the late 17th century but who, so far, has been known from one work only, the wall board with a coat of arms made in 1699 for the Water Board of Kennemerland and West Friesland.[10] Willem van Sundert became a master sculptor in The Hague in 1683 and, in 1700 he and Johannes Sonnemans became the first headmen of a newly established guild for sculptors working in wood, lead or plaster.[11] We learn from an announcement of sale in the newspaper *Oprechte Haerlemsche Courant* from 12 January 1690 that Van Sundert had his atelier on Molenstraat. The advertisement is about a sale of goods bequeathed from an *ingenieur*, Abraham Saem which was to take place in Van Sundert's house on 16 January.[12]

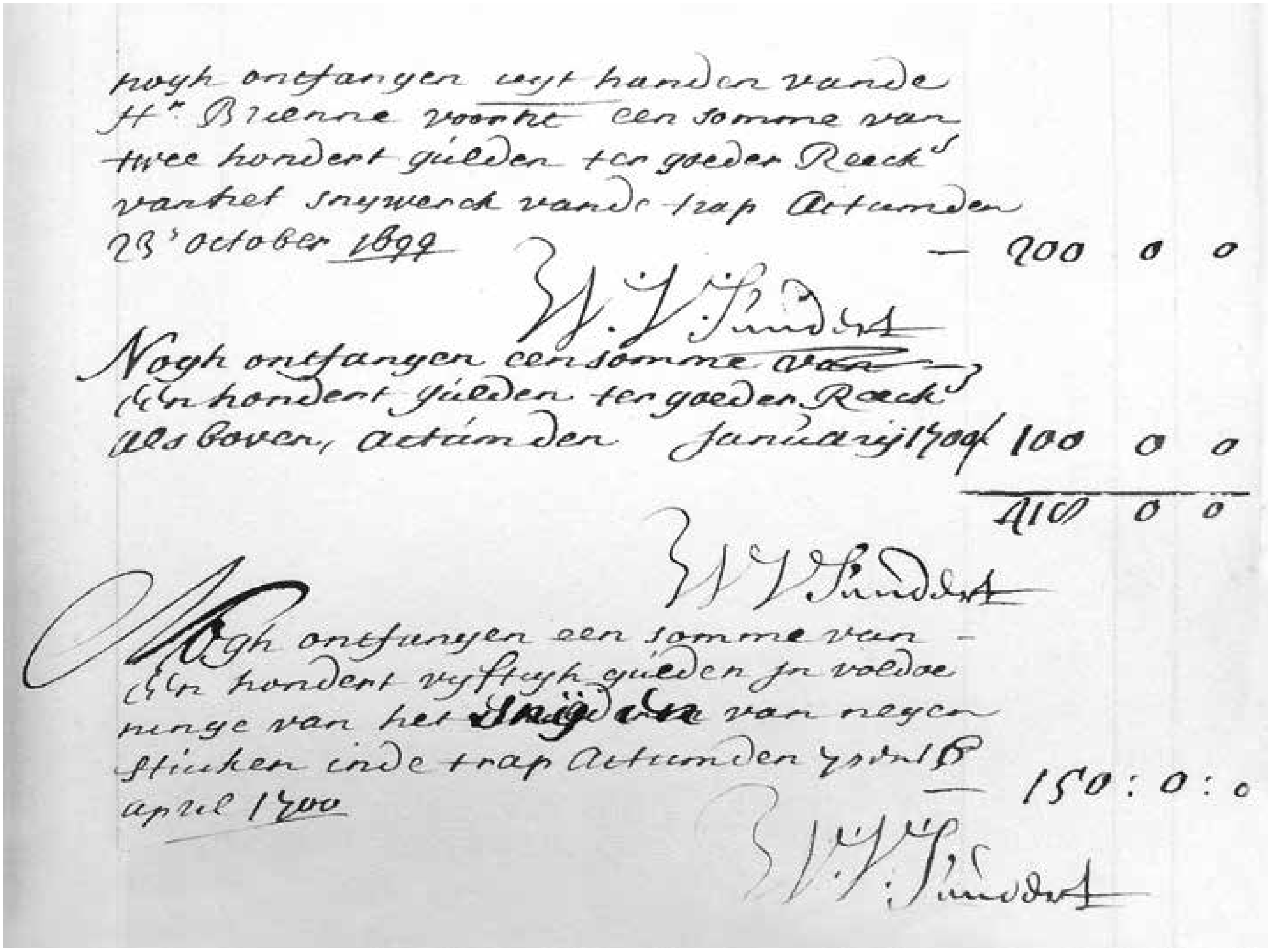
12.5



12.6

Fig. 12.5 Fragment of balustrade of staircase from 11 Lange Vijverberg, The Hague, carved in limewood by Willem van Sundert, 1699-1700. Museum Boijmans Van Beuningen, Rotterdam.

Fig. 12.6 Staircase at 11 Lange Vijverberg, The Hague, c. 1927 (Verslag van het Museum Boijmans te Rotterdam over het jaar 1928).


nogh ontfangen uyt handen vande
Hr. Brienne voorts een somme van
twee hondert gulden ter goeder Reeck^s
vanhet snywerck vande trap actum den
23 october 1699 — 200 0 0
W. V. Sundert
Nogh ontfangen een somme van
Een hondert gulden ter goeder Reeck^s
als boven, actum den Januarij 1700 100 0 0
410 0 0
W. V. Sundert
Nogh ontfangen een somme van
Een hondert vyftigh gulden in voldoe
ninge van het Snijwerck van negen
stucken inde trap actum den [illegible]
april 1700 — 150 : 0 : 0
W. V. Sundert

12.7

Painter

In his bill for work done in 1700, the painter Simon Classon mentioned covering the carved ornamental panels of the Great Staircase with an oil primer (*geolij gront verf*) and painting the doors of the staircase in the colour of oak. On 10 and 11 June 1701 he painted two panels in order to test a colour and between 16 and 20 June painted the whole balustrade and the panelling with paint made of finely ground pigment, the frames in the colour of oak and the carved panels in *ael* colour. In 17th-century Dutch the latter probably refers to brown-grey shades of eel (*ael*). The staircase is mentioned by Classon in one more note, which contains descriptions of additional work, not included in the original planning. In September 1699 he already knew that he would have to glue 'the nine pieces of woodcarving in the staircase'; this was before Van Sundert had carved them.

The paint layers were probably removed after the staircase had been given to the museum: indeed one archival picture from 1927 indeed shows the panel on the first landing with a dark and slightly shiny surface.

Fig. 12.7 Fragment of Simon de Brienne's expenditure book with payments made to woodcarver Willem van Sundert for carving the decoration of the staircase (Archief Delft, Archief van de Weeskamer Delft, vol. 72, fol. 11859).

Conclusion

The scale of the staircase with its open well and the quality of the carved decoration makes the staircase exceptional in the Netherlands. Seventeenth-century Dutch staircases, especially in town houses, were generally rather small as a result of the narrow and deep plots on which town houses were built. Large and highly decorative staircases reflected the social positions of their owners and that was certainly true in case of Simon de Brienne and his great staircase. Making such a structure required the cooperation of various craftsmen. Luckily for us, the papers documenting the rebuild of the house on the Lange Vijverberg survived, providing much information on late 17th-century joinery but also on this particular staircase, thus making it even more unique.

Notes

1 In 1669 De Brienne was appointed *kamerdienaar* to Prince Willem, in 1671 he was called *camerling* to His Highness and later *valet de chambre*. According to a contemporary English-Dutch dictionary, all these terms mean 'chamberlain'. See: Sewel, 1735.

2 Information on payments made by De Brienne to particular craftsmen is to be found in his *Kasboek van uitgaven voor het huishouden*, 1698-1702. See: Delft, Archief Delft, Archief van de Weeskamer Delft, vol. 72, fol. 11859.

3 Delft, Archief Delft, Archief van de Weeskamer Delft, vol. 72, fol. 11854.

4 On 12 August 1698 De Brienne was granted permission to build a balcony. See: van Diepen, 1938: 147.

5 De Brienne's archive includes, for instance, his testament, inventory and various papers regarding his properties. All information provided in this article on works done in the house on the Lange Vijverberg is taken from the original bills and De Brienne's expenditure book. See: Delft, Archief Delft, Archief van de Weeskamer Delft, vol. 72, fol. 11854, 11859.

6 The Hague, Haags Gemeentearchief, Ambachtsgilden en bussen, vol. 376-1, fol. 98.

7 Sash windows were first applied c. 1685 in Slot Zeist and Palace Het Loo in Apeldoorn.

8 It is not clear whether the name of the room referred to a blue colour of wall hanging or perhaps a display of Oriental porcelain or Delftware (Delft Blue). De Brienne's inventory reveals that he owned a collection of porcelain. Simon de Brienne was responsible for creating an inventory of Mary II's collection of porcelain at Kensington Palace. See: Shulsky, 1990: 47.

9 Willem van Sundert was a woodcarver (*beeldsnijder*) but in the documents he is mentioned as a sculptor (*beeldhouwer*). The two terms were often used interchangeably, although they actually refer to two different professions. The difference between the two terms did not lie only in material, wood or stone, but also between decorative or figural works. See: Fock, 1989: 27.

10 van Agt, 1953: 29. The board is today in the collection of Hoogheemraadschap Hollands Noorderkwartier in Heerhugowaard.

11 The Hague, Haags Gemeentearchief, Confrerie Pictura en Tekenacademie, vol. 164-1, fol. 10 and Oud archief van de gemeente 's-Gravenhage 1313-1815, vol. 350-1, fol. 4863.

12 The complete advertisement reads: '*Op den 16 January, 's namiddags ten 2 uuren praecijs, sal men in 's Gravenhage ten huyse van Willem van Sundert, Beelthouder voor aen in de Molestraet, verkopen eenige Goederen, nagelaten by wijlen den Ingenieur Abraham Saem; bestaende in een Draey-Banck met sijn Bijsels en verder toebehoren, mitsgaders eenige Mathematise en Last-Vuurwerkers Instrumenté; als mede eenige Boeken, daer aen dependere.*'

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van Agt J.F., 1953. *Waterland en omgeving*, Den Haag: 186 p.

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Summary

While doing research on a late 17th-century grand staircase made for a house at 11 Lange Vijverberg, The Hague and now conserved in the Museum Boijmans Van Beuningen, Rotterdam, The Hague, the author discovered surprisingly complete and detailed documentation on the building of this house. The papers date from 1698-1702 and include the house owner's expenditure book and various bills, which provide insight into joinery of the period. At the same time, the documents shed light on the authorship of the staircase, which is the sole survivor of the original interiors. This article contains a brief description of the documents found and the history of the staircase. The house on the Lange Vijverberg belongs to a small group of well documented Dutch houses from the late 17th and early 18th centuries and it is of value to make researchers aware of these archive files so that they can be consulted in further studies.

13.1

13

Indoor joinery and furniture made for 18th-century houses in Liège (Belgium)

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Translation from French: Anna Little – Rebecca Miller

Key words

Architecture / Space / Domestic interior / Furniture / Wood / Staircase / Wainscoting / *Rendages proclamatoires*

* An asterisk in the text refers to the glossary at the end of the article (table 13.1).

Introduction

Though few 18th-century houses in Liège (Belgium) have conserved their original wooden furniture or fittings, archival research reveals that these elements constituted a key aspect of the domestic interior (fig. 13.1).

The present work draws largely on a series of public announcements known as *Rendages proclamatoires** which concerned property belonging to orphans sold by public auction. From 1697 to 1765, these sources provided descriptions of 257 houses situated within the city walls.[1] A wide variety of house types are covered, ranging from the most modest dwellings, which comprised a single living space, to the ample residences of the upper classes, complete with coach entrances.

In Liège, ordinary medium-sized houses were generally constructed on long and narrow plots of land and were composed as follows: on the ground floor, the first room, giving onto the street, was known as the kitchen (*cuisine**, the French term);[2] behind this, a second room, called a chamber (*chambre**) gave onto a small courtyard (*scaillie**, the Walloon term); upstairs, there were two

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Fig. 13.1 Straight staircase, Hôtel de Crassier, 1706. © KIK-IRPA, Brussels (B181571) other chambers and sometimes a third room, designated by the term *pendice**.[3] The third room generally formed a mezzanine situated above the entrance hall, typically rather long and narrow, sometimes containing the staircase (fig. 13.2). In addition to these living spaces, there was a cellar, dug out below ground level, and an attic – in fact often several attics, superimposed beneath the steeply slanted roofs. A second, sometimes even a third house often occupied the end of the plot.

Description of the living spaces in Liégeois houses

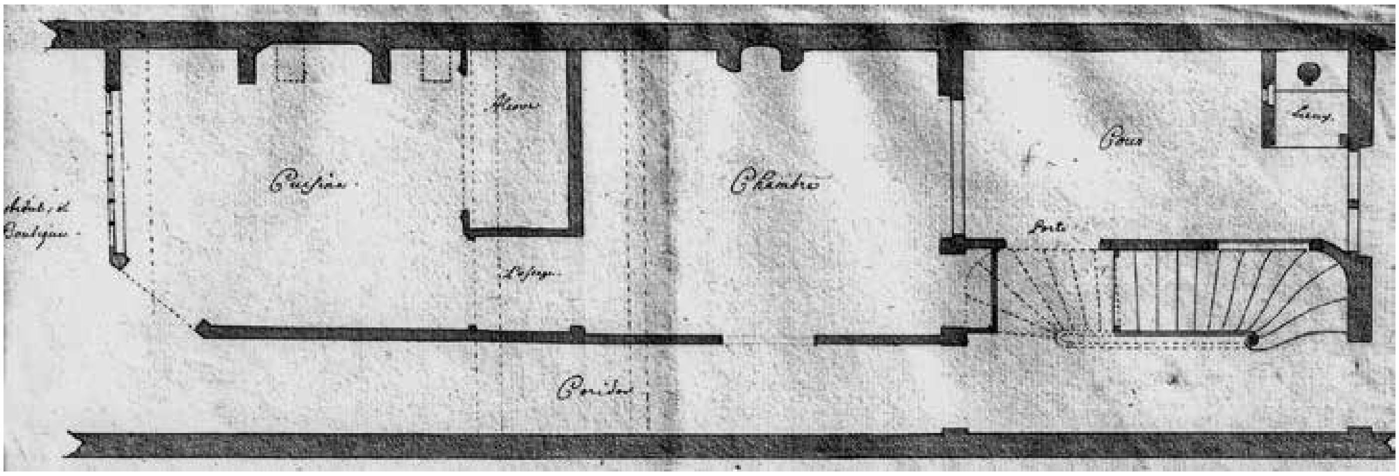
Kitchen: principal living space in an ordinary house

In standard family houses, woodwork was particularly present in the kitchen. 93% of the descriptions studied mention the kitchen, which very often formed the principal living space. Sometimes it was the only room in the house which was heated, in which case it was used not only to cook in, but also to eat, meet, and even sleep in. In the smallest houses studied, the brick-paved kitchen formed the entire living space of the house, completed only by a pantry, situated below the stairs, an attic and a cellar.

In about 70% of Liégeois dwellings, one entered directly into the kitchen. This was a well-kept room, often wainscoted – a feature designated in the sources by the term *banchés**, derived from *bâchî**, the Walloon word for wood panelling. In the more luxurious houses, the walls were sometimes decorated with ceramic tiles or a combination of wainscoting and tiles: 'decorated with new and very pretty wainscoting inlaid at the bottom with fine porcelain tiles, and above with surrounding paintings, a nice chimney, a very good box-bed with a small attached wardrobe, and a cupboard, all also of very beautiful new woodwork'.[4]

Houses were generally equipped with a certain amount of custom-made furniture. Such furniture was commonplace in the kitchen, which typically included several built-in trunks-cum-benches, wall shelves used to store plates, and a box-bed – designated in the earlier part of the 18th century by the expression *forme de lit enclose** (fig. 13.3) or *forme de lit fermante**, and later by the word *alcôve**. The sources suggest that the wainscoting and the furniture were often provided together. Wardrobes and cupboards were often fitted into the spaces on either side of the box-bed. These beds were present in the kitchen in 58% of the houses studied. Kitchen furniture also commonly included benches used as beds, cupboards, sometimes with open-work doors, wardrobes, dressers, buffets and cutlery cabinets: 'a nice kitchen with wainscoting all around, in which there is a box-bed, an openwork-screened cupboard, wall shelves to store plates, three trunk-benches, and a long bench' (1697); 'a wainscoted kitchen, in which there is a dual-panelled wardrobe, a dual-panelled cupboard, a nice box-bed and two small attached cupboards' (1697); 'a kitchen with a large cupboard and a pantry and a box-bed, the entire kitchen decorated with wainscoting and small dressers' (1731); 'a large kitchen with a permanent buffet, a sculpted box-bed, two small cupboards in the form of a buffet' (1761).[5]

In several descriptions of more exclusive and larger houses, the room termed as the kitchen appears to have served as a living room rather than an actual



13.2

13.3

Fig. 13.2 *Projekt für ein Ladenhaus* [house with shop], Jean-Joseph Couven, s.d., Suermondt-Ludwig-Museum, CBK 232. Photo: Albert Lemeunier

Fig. 13.3 Ensemble composed of a box-bed, a trunk-bench and panelling, c. 1600-1650, collections of the Grand Curtius Museums. © KIK-IRPA, Brussels (B178626) kitchen. In such cases, the houses had a separate room for cooking, often erected in the courtyard. In this kind of 'living room-kitchen', the joinery was refined. Sculpted and varnished wainscoting, varnished or painted cornices and sculpted mantelpieces surmounted by moulded shelves were all common: 'a large and commodious kitchen embellished with varnished wainscoting on two walls, tiles on the other walls with a double varnished oak cornice above and fine paintings and on two walls of the kitchen there are six cupboards with doors also serving as embellishment to the same kitchen from which we enter a small courtyard with a pump, leading to another small kitchen that exits onto the Rue de la Tête de Bœuf' (1723).[6]

Chamber: a multifunctional space

Woodwork was also used in the chambers. Chambers were found in the majority of houses and like kitchens were often multifunctional spaces comparable to today's living rooms. The term bedroom (*chambre à coucher**) only appeared quite late in the 18th century. In point of fact, box-beds were only found in chambers in 18% of the houses studied, as compared to 58% wherein these beds were found in the kitchen. Otherwise, however, chambers tended to have similar fittings as kitchens, with joinery playing an important role, notably in the form of wainscoting and sculpted chimney breasts.

Shops: a ground-floor commercial space facing the street

When the house was used for commercial activities, the room giving onto the street served as the shop. Behind this was the kitchen, which sometimes led into a ground-floor chamber. The shop was often equipped with custom-made fitted furniture – in particular niches (*potales**) for exposing merchandise, sometimes fronted by openwork screens (*treilles**) – and by counters, designated in the sources by the Walloon word *cangliettes**. A Walloon dictionary published in Liège in the 18th century defines a *cangliette* as a 'kind of table with a drawer that could be locked with a key in which shopkeepers kept their money and/or on which money was counted out'.[7]

*Cabinet**, living room and dining room: patrician spaces

The number, size and distribution of the rooms that a given house contained varied according to the size and shape of the plot on which it was built and the financial circumstances of the owner. In addition to the kitchen and a number of chambers, houses owned by the wealthier citizens generally included a small private room termed *cabinet* reserved for different functions (small salon, waiting room, study, dressing room, etc.), a living room (*salle**) and a dining room (*place à manger** or *salle à manger**).

Woodwork appears to have been much used in both cabinets and dining rooms. The cabinets were very often wainscoted and contained chimney-breasts decorated with sculpted joinery, as well as box-beds. Dining rooms too were often wainscoted and frequently contained a good deal of fitted furniture

Fig. 13.4 Dining room, Rue Saint-Thomas. © KIK-IRPA, Brussels (B168464) (fig. 13.4). Inventories made on the death of owners often mention cupboards containing various items of tableware and linen, including cups and pots for coffee, tea and hot chocolate, the ingredients and utensils for the preparation of these beverages, as well as condiments and other sought-after foodstuffs. Designated by the term sideboard (*buffet**), it would appear that this essentially utilitarian piece of furniture, found in the kitchens of the most modest houses, came to acquire rather prestigious status in well-to-do dining rooms: 'a small ground floor room with wainscoting, in which remain a cupboard or sideboard and a golden copper tapestry' (1703).[8]

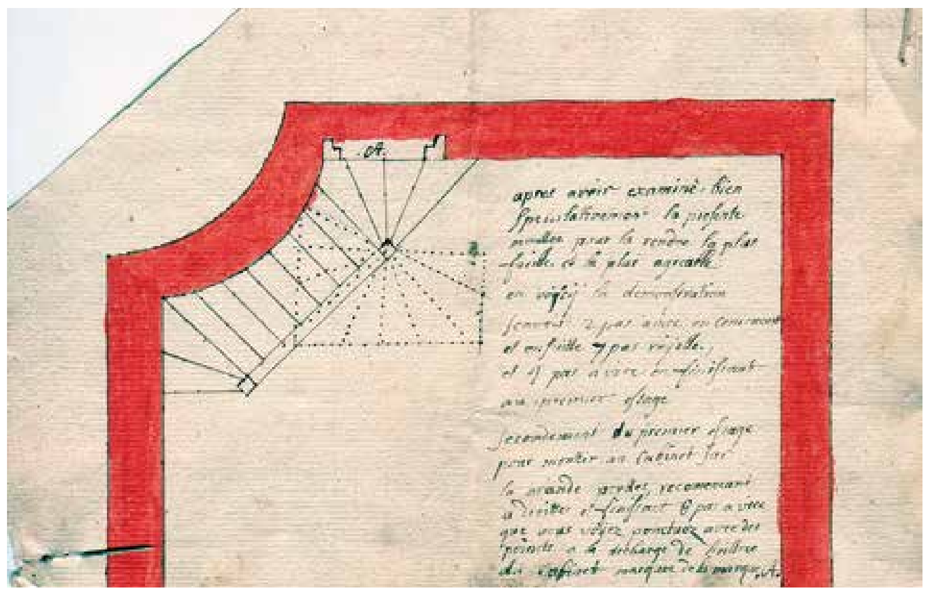
Staircases: small and large

One wooden element was systematically present in all houses, regardless of their size or quality: this was the staircase. In many of the descriptions studied, this means of vertical displacement is called a *montée** (literally: an ascent) rather than an *escalier** (staircase). Modern 18th-century houses always contained indoor staircases. These generally led up from the entrance hall or, in smaller houses, which tended to lack this entrance hall, directly from the kitchen – in which case, they added to the quantity of woodwork present in this room.

13.4

Sources from the later 18th century make reference to *montées royales** or *montées faites à la royale**. This, it would seem, designated a new type of staircase, initially found in the more well-to-do houses. Several documents indicate the nature of this novelty, amongst which are a series of drawings presenting projects for modifying one of the staircases in the Château de Longchamps at the request of its owner, the Baron of Selys, who also owned a town-house in Liège.

In these drawings, the new *pas royaux** (literally: royal steps) are contrasted with the traditional *pas à vis** (spiral steps) (fig. 13.5).[9] Similarly, in one of the descriptions furnished by the *Rendages proclamatoires*, a *montée royale* is again



13.5

contrasted with a *montée à vis**. It would thus appear that the term *montée royale* simply designated a straight staircase – a design which, decidedly more practical than the traditional spiral staircase, rapidly became a feature of the average family house as well as those of wealthier citizens.

In the descriptions of the more well-to-do houses, one also often finds the term *grand escalier**. This hierarchic specification tended to be used when a single house contained more than one staircase. It did not, however, always designate the largest staircase in the house, but rather the main stairway, reserved for the use of the masters and their guests, as opposed to that used by the servants. The term was, for example, never used for the stairs leading up to the attics, which served to store foodstuffs and furniture and/or to lodge the servants. In the early 18th century, the *grand escalier* became floating stairs, attached to a wall on one side only and turning around an open central space (fig. 13.6): an *escalier suspendu à jour central**, inspired by experiments with this form initiated in France in the mid-17th century. Contrary to the French tradition, which tended to associate staircase design with stereotomy, wood continued to be favoured in Liège and, with the exception of steps leading down to cellars, staircases were invariably constructed in wood, with just one or two stone steps at the bottom on the ground floor.

Fig. 13.5 Project to change the layout of a stairway at the Château de Longchamps (Archives de l'État à Liège, Famille de Selys Longchamps, no. 1454, c. 1720).

13.6

Social status: between *convenance** and *bienséance**

During the *Ancien Régime*, architecture was prevalently conceived as a highly regulated science answering two central principles, frequently developed upon in architectural treatises. These were *convenance* and *bienséance*. In a word, the principle of *bienséance* required that architecture echo, even affirm, the social status of the occupant; that of *convenance* required that it correlates the use or function of the edifice and each of its constituent spaces.[10] The total correlation between a given edifice, its occupant and its function applied to all aspects of the architectural art: choice of site, elevation design, spatial organisation, number of rooms, richness of ornamentation, etc., as well as choice of materials. Architecture was thus conceived as the perfect accord, the harmonised union of all the parts of a given edifice with respect to both each other and the whole.[11]

As a significant part of 18th-century Liégeois architecture, woodwork participated in the application of these principles. A number of aspects serve to illustrate this. Street-facing façades, for example, tended to reflect the social standing of the people who lived behind them, particularly in the case of the wealthier classes. The most prestigious citizens of Liège – the canons of the

Fig. 13.6 Straight staircase, Hôtel de Clercx d'Aigremont, 1767. Photo: Agnès Celentin, 2009

13.7

cathedral chapter and the aristocratic families – tended to favour decidedly sober façades. These were people whose elevated social status had been firmly established for generations and who presumably did not feel the need to reaffirm their superiority through the outer aspect of their houses. The *nouveaux riches*, on the other hand, including merchants and other social climbers, not only chose to build their houses where they were most on view – the busiest thoroughfares and docks –, but also made a point of endowing them with ostentatiously rich façades. Sometimes the indoor woodwork joined forces with the outside decor to enhance still further the effect of these façades as, for example, when the inside shutters were adorned with sculpted decoration which could be admired from outside when they were shut (fig. 13.7).

However, it must be noted that the descriptions provided by the *Rendages proclamatoires* rarely mention window frames, inside shutters, doors or partitions. These elements do figure in other types of documents, for example, building estimates or property evaluations.[12]

In the course of the 18th century, standard family houses became increasingly comfortable. Elements previously reserved for the residences of wealthy citizens began to appear in comparatively modest houses, to the point where it is fair to speak of a phenomenon of architectural democratisation. For example, as mentioned, straight staircases became the norm, rendering movement between upper and lower floors far easier than in the days of the narrow spiral staircase.

The presence of well-crafted woodwork also became increasingly widespread, notably in the living room-kitchen, the principal living space of average-size houses. One of the earliest mentions of decorative joinery in the kitchen of a new average-size house dates from 1707: 'A large kitchen with a sculpted box-bed with mouldings, a pantry, mouldings to store plates, a water pump'.[13] By the 1770s, such elements were commonplace in comparatively modest houses: 'a kitchen facing the street with tiles, stone basements and wood cornice decorated above with paintings, similarly the chimney mantel is decorated with wood and a painting of Christ, the window jambs in wood as well and all that is not covered with porcelain is panelled with woodworking with two cupboards below the windows, the kitchen is also paved with dressed stone, also a box-bed decorate with tiles and a cupboard above' (1763).[14]

Concerning the concept of *convenance*, we also observe in Liège the links existing between types of rooms and the materials used for their furniture and fittings. It would seem, for example, that dining rooms were always floored with wooden floorboards – even when all the other rooms on the ground floor were paved in stone. Such was, for example, the specification given in an estimate drawn up by Renoz in 1775 for a house commissioned from him by the Chevalier de Chestret.[15] In the same estimate, Renoz again singled out the floorboards destined for the dining room by specifying that each one would be cut out of a single piece of wood, while those of all the upstairs rooms would simply be made of good dry oak.[16] A second example is provided by a case where the client desired the habitual positions of kitchen and dining room to be inverted, thus causing the estimate to be modified and the builder instructed to floor the room originally intended for the kitchen with wood instead of stone, in accordance with its new function as a dining room.[17]

Fig. 13.7 Shutter, Hôtel Vandermaesen, 1766.

Terminology and its social implications

The terms used to refer to the various parts of houses and the architectural elements they contained provide another example of the connection between 18th-century Liégeois architecture and social status.

The documents analysed for this study reveal a multiplicity of terms for many of the parts, furnishings and fittings of Liégeois houses. The choice of one or another term seems to have been determined by a number of factors. These notably include changing trends in the use of language and the social standing of both the author of the document and the person for whom it was destined – normally either the owner of the house or, in the case of a building project or a sale, the owner-to-be.

Terms regularly employed in the descriptions of modest houses were, for example, often prefixed with the word grand (*large*) when applied to noble residences. But there was also a choice of specific terms, which were clearly deemed more or less suitable according to the standing of the house in question. The upper floors of larger houses, for example, were accessed by way of an *escalier* (staircase) or a *grand escalier* rather than a *montée*. As Cambresier, the author of a Walloon-French dictionary dating from 1787 explains: the term *montée* pertains to the vocabulary of the lower classes and designates a 'small staircase in a modest house'.[18]

Another example concerns wainscoting. The French term for wood panelling, *lambris**, appears relatively infrequently in the descriptions studied. The word only entered Liégeois vocabulary very gradually over the course of the 18th century and only became broadly used in the final decades. It is found, for example, in a document concerning the sale of national property dating from the 1790s. Earlier in the century, it principally appears in documents written by architects, thus illustrating the way certain terminological trends were linked to the status of the authors of the documents under consideration. Architects noticeably privileged terms in use in Paris and architectural treatises. *Lambris* had notably been presented as a novelty and a luxury in d'Aviler's *Cours d'architecture* ('Architecture courses') and the French term connoted ease and comfort (d'Aviler, 1720).

The earliest occurrence of *lambris* appears in the 1737 *Rendages*. The term is used for chambers, *cabinets* and dining rooms, but never for kitchens. It also tends to be reserved for houses of some importance. In inventories of furniture drawn up on the death of prestigious citizens, it is systematically a question of *lambris*: the term *banchés* never appears. Sometimes the word *boiseries** (woodwork) is used, and in these cases, the social connotations seem to be neutralised. As far as these descriptions allow one to judge, the choice of either *lambris* or *banchée* does not indicate a difference in the quality or finish of the woodwork.

Finally, the terminological choices adopted in the descriptions studied can be linked to a general change in the use of language. Over the course of the 18th century, the terms in use in Liège gradually grew closer to those in France, or at any rate, those found in contemporary French literature available in Liège. The change affected all levels of society and can be observed in descriptions of houses of all types. Walloon terms also tended to be replaced by French equivalents. Thus, the phenomenon of architectural democratisation went hand in hand with a form of linguistic democratisation, the differences in the vocabulary used by different social classes diminishing notably towards the end of the *Ancien Régime*. For example, the term *alcôve*, reserved in the earlier part of the century for box-beds owned by prestigious citizens, progressively came to be used for all such beds, replacing more or less entirely the expression *forme de lit enclose*. Similarly, from the 1750s onwards, the term *escalier* became widely used and *montée* rare. By the end of the century, the French expression *escalier dérobé** (concealed staircase) was in current use.

Conclusion

The study of a sample of houses for a given period and region, using archives such as the *Rendages proclamatoires*, demonstrates variations in treatments that correspond to the differentiated social status of the inhabitants. The example of Liège during the 18th century shows a concept proper to the society of the *Ancien Régime*, strictly hierarchical, whose principles were dictated by the architectural treatises of the period. This correlation between social status and architecture, which is also reflected in the terms used to describe it, marks architecture at all scales: placement, wall composition, size, decoration, choice of materials, techniques, etc.

In this context, it appears that the wooden furniture and fittings of 18th-century Liégeois houses can clearly be seen to be pertinent to far more than the history of joinery alone: they also tell the story of Liege's domestic living spaces in terms of social structure and cultural change. As such they eloquently illustrate the fact that it is only by taking into account the *Ancien Régime*'s conception of architecture as a 'total entity' that we can today work towards establishing an increasingly just, coherent and complete understanding of ancient edifices.

French and / or Walloon	**English**
allée	entrance hall
banché, bâchî (Walloon term), *lambris, boiseries*	wainscoting – wood panelling
bienséance	affirmation of social status (architectural principle)
boutique	shop
buffet	sideboard
cabinet	small salon, waiting room, study, dressing room
cangliette (Walloon term)	counter
cave	cellar
chambre	chamber
chambre à coucher	bedroom
convenance	affirmation of use/function of a building and its components (architectural principle)
cuisine	kitchen
dispense (Walloon term)	pantry
escalier dérobé	concealed staircase
escalier suspendu à jour central	floating staircase (attached on one side and turning around an open central space)
forme de lit enclose/forme de lit fermante, alcove (later termed)	box-bed
grand escalier	main stairway
grenier	attic
montée, escalier	staircase (literally an ascent)
montée royale	straight staircase
pas à vis, montée à vis	spiral steps
pas royaux	'royal steps'
pendice	mezzanine
potale (Walloon term, for exposing merchandise)	niche
Rendages proclamatoires	public announcements which concerned property belonging to orphans sold by public auction
salle	living room
salle à manger/place à manger	dining room
scaillie (Walloon term)	small courtyard
treilles (Walloon term)	openwork screens

Tab. 13.1

Table 13.1 Glossary of French and/or Walloon terms with their English equivalents.

Notes

1 Liège, Archives de l'État, Officialité, *Rendages proclamatoires*, reg. 33-37, 1697-1765.

2 Walloon is a Romance language, also considered to be a dialect of French, that was spoken particularly in southern French-speaking Belgium (Wallonia). One of its forms, 'Liège Walloon' continued to be widely used, alongside French, until the 20th century. In 18th-century Liege, French was used primarily by scholars and by the upper classes. The Department of Dialectology at the University of Liège is active in the study of the Walloon dialects and contributes to keeping them alive, along with other associations including the Société de Langue et de Littérature wallonnes (SLLW).

3 This analysis examines the public auction of houses of the *Cité* from 1697 to 1765, a total of 318 acts (Gilles, 2012). Some of these did not provide a description while others proposed several houses per sale. This results in a total of 257 houses that were described. Some include properties destined for professional activities, mainly shops (n=96 or 38%), breweries (n=16 or 6%) and tanneries (n=16 or 6%). In this group, 34 houses (14%) are set apart by a higher degree of opulence: 21 private homes, five houses with shops, four breweries and four tanneries. Finally, 11 buildings described are patrician homes with a carriage entrance. A true typology has not yet been established for this sample set. To do so, all of the houses should be precisely located on the cadastral map (work in progress) but on the basis of the descriptions, it appears that most of the ordinary homes and houses with shops have the spatial organisation proposed in this article, corresponding to their placement on a long and narrow parcel, frequent in the *Cité*.

4 Author's translation of: '*ornée de neuf et très belles boiseries incrustées par le bas de fines porcelaines, et par-dessus tout alentour de peintures, d'une belle cheminée, d'une très belle forme de lit, d'une petite garde-robe y jointe, et d'une armoire, le tout aussi de très belle boiserie neuf*'. Liège, Archives de l'État, Officialité, *Rendages proclamatoires*, reg. 37, fol. 67sq., December 1754.

5 Author's translations of: '*une belle cuisine avec toccage banchée tout à l'entour, dans laquelle y resteront une forme de lit fermante, une armoire à treilles, des planches à mettre des plats, trois bancs à coffre, et un long banc*' (1697); '*une cuisine banchée tout à l'entour, dans laquelle cuisine il y a une garde-robe à deux feuillets, item une autre armoire à deux feuillets, une belle forme enclose et deux petites armoires contigües*' (1697); '*une cuisine tout le long de laquelle il y a une belle garde-robe très commode et une dispense et dans icelle cuisine se trouve une couche enfermée et toute la dite cuisine garnie d'une boiserie et de petites armoires de commodité*' (1731); '*une belle grande cuisine avec un buffet permanent item une forme enclose en forme de garde-robe sclupturée, deux petites armoires en forme de buffet*' (1761). Liège, Archives de l'État, Officialité, *Rendages proclamatoires*, reg. 33, fol. 23v°*sq.*, 1697; reg. 33, fol. 62*sq.*, 1697; reg. 35, fol. 291*sq.*, 1731; reg. 37, fol. 246*sq.*, 1761.

6 Author's translation of: '*une grande et commodieuse cuisine embellie d'une boiserie vernie de deux côtés, des porcelaines des deux autres côtés au dessus desquelles règne une double corniche de bois de chêne verni et de fines peintures et des deux côtés de la même cuisine il y a six armoires à portes fermantes servant aussi d'embellissement à la même cuisine d'où on entre dans un petit escaillie avec une pompe, qui conduit à une autre petite cuisine qui a sa sortie dans la dite rue de la Tête de bœuf*' (1723). Liège, Archives de l'État, Officialité, *Rendages proclamatoires*, reg. 35, fol. 85r°*sq.*, 1723.

7 Author's translation of: '*Cangliette, comptoir, f. m. Sorte de table où il y a communément un tiroir fermant à clef, & dont les marchands se servent, soit pour compter leur argent, soit pour le serrer*.' Cambresier, 1787: 22.

8 Author's translation of: '*une sallette par terre avec toccage, dans laquelle demeurera pour appendices encore une armoire ou buffet et une tapisserie de cuir doré*' (1703). Liège, Archives de l'État, Officialité, *Rendages proclamatoires*, reg. 33, fol. 148*sq.*, 1703.

9 'After having attentively examined the stairway to make the climb easier and more agreeable, here is the explanation, two spiral steps to start followed by seven straight steps, and four spiral steps to the first storey. Second, from the first storey to the cabinet above the large door, turning to the right, and to finish, eight spiral steps shown by dotted line to the right of cabinet entryway marked with the letter A.' Author's translation of: '*Après avoir examiné bien speculativement la presente monttee pour la rendre la plut facille et la plus agreable, en voicÿ la demonstration scavoir 2 pas a vice en comencant et ensuitte 7 pas roÿalle, et 4 pas a vice en finissant au premier estage. Secondement du premier estage pour monter au cabinet sur la grande porttes, recomencant a droittes et finissant 8 pas a vice que vous voÿez ponctuez avec des poincts a la decharge de l'enttree du cabinet marquee de la marque A.*' Liège, Archives de l'État, Famille de Selys Longchamps, no. 1454, c. 1720.

10 On the principles of *convenance* and *bienséance*, dictated by theoreticians of architecture during the *Ancien Régime*, see in particular Szambien, 1986: 92-98, 177-199; Köhler, 1994: 237-246; Kruft, 1994: 141-153; Carbonnier, 2006: 284-287; Gady, 2008: 135; Medvedkova, 2007: 107-111, 120-125.

11 On these theoretical principles, see for example the following architectural treatises: Blondel, 1737-1738, Blondel, 1771-1777, Boffrand, 1745; Briseux, 1743, 2 vol.; d'Aviler, 1720 [1st ed. 1691], Le Camus de Mézières, 1780.

12 See for example: Liège, Archives de l'État, Famille de Moreau, 43, *Acte d'estimation et de description de la maison claustrale appartenant à la demoiselle de Nuvolara…* 20 January 1719; Famille de Crassier, 1010, *Devis et conditions pour les ouvrages et réparations à faire à la maison devant Saint-Georges à Liège habitée ci-devant par M. de Favereau conformément aux plans et dessins faits par le Sr Faÿn architecte*, 15 October 1760.

13 Author's translation of: '*Une grande cuisine dans laquelle il y a une forme de lit enclose de bois travaillé, avec des moulures, une belle dispense, des moulures à placer des plats, une pompe à tirer de l'eau.*' Liège, Archives de l'État, Officialité, *Rendages proclamatoires*, reg. 33, fol. 301*sp.*, 1707.

14 Author's translation of: '*une belle cuisine ayant vue sur la rue garnie à l'entour de belles porcelaines, avec basements de pierre et corniche de beau bois et au dessus ornée de peintures de même le manteau de la cheminée est garni de beau bois avec un christ en peinture item le montant des fenêtres et tout ce qui n'est pas ornée de porcelaine est revêtu de belles boiserie avec deux belles armoires au dessous des dites fenêtres item la dite cuisine est pavée de belles pierres de taille item une forme enclose ou alcôve garnie en dedans de porcelaine avec encore une armoire au dessus*' (1763). Liège, Archives de l'État, Officialité, *Rendages proclamatoires*, reg. 37, fol. 299*sq.*, 1703.

15 Liège, Archives de l'État, Notaire A.J. Ansiaux, *Devis ou conditions pour bâtir à neuf une maison pour Monsieur le chevalier de Chestret capitaine de Vierset*, fol. 283-286, 17 May 1775.

16 Liège, Archives de l'État, Notaire A.J. Ansiaux, *Devis ou conditions pour bâtir à neuf une maison pour Monsieur le chevalier de Chestret capitaine de Vierset*, fol. 283-286, 17 May 1775.

17 Liège, Archives de l'État, Notaire A.J. Ansiaux, *Devis et conditions pour rebâtir et restaurer le bâtiment faisant face sur la Meuse, appartenant à Mr le chevalier de Chestret*, fol. 64-67, 29 March 1775.

18 Author's translation of: 'Montée, *f. f. Petit escalier d'une petite maison, nettoyer, balayer une montée, il n'est en usage que parmi le peuple.*' Cambresier, 1787: 121.

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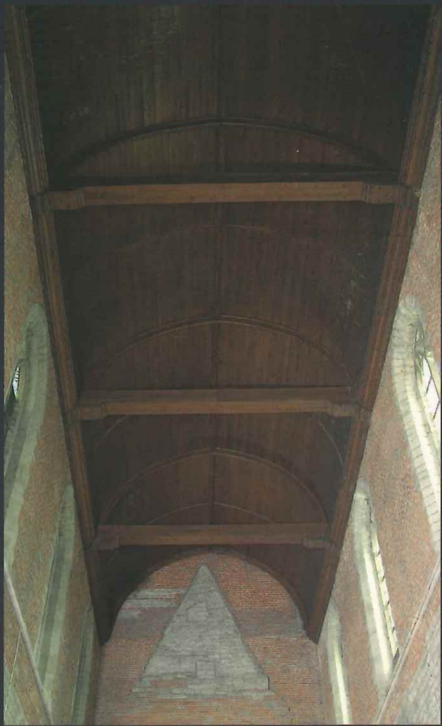
Summary

Though few 18th-century houses in Liège (Belgium) have conserved their original wooden furniture or fittings, archival research reveals that these elements constituted a key aspect of the domestic interior. The present work draws largely on a series of public announcements that exists, known as *Rendages proclamatoires*, which concerned property belonging to orphans sold by public auction. From 1697 to 1765, these sources provided descriptions of 257 houses situated within the city walls. The wooden furniture and fittings of 18th-century Liégeois houses can clearly be seen to be pertinent to far more than the history of joinery alone: they also tell the story of Liège's domestic living spaces in terms of social structure and cultural change. As such they eloquently illustrate the fact that it is only by taking into account the *Ancien Régime*'s conception of architecture as a total entity that we can today work towards establishing an increasingly just, coherent and complete understanding of ancient edifices.



From the examination of the historiography of finishing work in wood for architecture from the medieval to modern period, it is clear that this field of research is the poor relation of historical and archaeological studies, with the lion's share focusing on the structural work of carpentry. It is on the basis of this observation that the present work has been produced, which results from a conference held in Brussels in 2013. The work demonstrates first the real interest in an approach to finishing work for the study of ancient buildings and the establishment of a precise chronology for their phases of layout as well as in obtaining better understanding of material cultures and ways of living. Second, it reiterates that the limit between carpentry and joinery was often porous, sometimes artificial. Finally, the work stresses that an overall approach to the use of wood is crucial to comprehensively address the organisation of a building, the logic of its construction and its 'utilisation', and more generally, the complex history of the buildings studied. This work, which thus represents a first step toward an overall approach of 'wood material' in European architecture, includes thirteen contributions divided into two thematic sections in keeping with current research practices. The first addresses the divide between structural and finishing work via the question of flooring, ceiling and roofing techniques. The second focuses intrinsically on finishing work by examining the contribution of this craft domain to the organisation, comfort and ornamentation of houses.

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