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RÉSUMÉ – Cet essai analyse la théorie stéréotomique de Philibert De l’Orme, publiée dans son *Premier tome de l’architecture* (Paris, 1567). Il se concentre sur la relation entre la pratique architecturale de Philibert De l’Orme et sa théorie stéréotomique, en soulignant que cette relation n’est pas directe ni évidente. Cette compréhension du choix des contenus que De l’Orme fait pour son traité permet une lecture plus nuancée de sa transcription des voûtes en pierre sous forme d’épures.

MOTS-CLÉS – Architecture de la Renaissance, traités d’architecture, stéréotomie, géométrie, Philibert De l’Orme

ABSTRACT – This essay explores Philibert de L’Orme’s theory of stereotomy, published in the *Premier tome de l’architecture* (Paris, 1567). It focuses on the relation between de L’Orme’s practice and theory of stereotomy. It shows that this relation is neither direct nor obvious. By doing so it complicates the understanding of de L’Orme’s choice of material for the treatise and it provides a more nuanced reading of his translation of stone vaults into paper diagrams.

KEYWORDS – Renaissance Architecture, Architectural Treatises, Stereotomy, Geometry, Philibert de L’Orme

FROM STONE TO PAPER

Philibert de L'Orme, the *Premier tome de l'architecture* (1567), and the Birth of Stereotomic Theory

Philibert de L'Orme (1514-1570) engaged with architectural theory late in life, at a moment when his career as practitioner had come to a sudden halt. The son of a master mason from Lyon, young de L'Orme followed the dynastic tradition of the building trade and started off his career as an apprentice stonemason.¹ Unlike the vast majority of his peers, though, in his early twenties de L'Orme took a *voyage d'Italie* and spent three years in Rome (1533-1536) studying both ancient and modern architecture. There, de L'Orme also built connections with prominent fellow expatriates, including Cardinal Jean Du Bellay, King Francis I's ambassador to the Holy See. Once back in France, Du Bellay provided the architect with not only his first major commission, the design of the Château de Saint Maur (1541), but also access to the court circles.² At court, de L'Orme thrived. In 1545, Francis I charged him with the supervision of the works and fortifications of Brittany and, in 1548, his successor, Henri II, appointed him surveyor of the royal works, the highest administrative office an architect could aspire to at court, and one thus far reserved for members of the nobility.³ For the king and

1 On de L'Orme's career, see Anthony Blunt, *Philibert de l'Orme*, London, Zwemmer, 1958 and Jean-Marie Pérouse de Montclos, *Philibert De l'Orme, architecte du roi (1514-1570)*, Paris, Mengès, 2000.

2 De L'Orme cites his Roman stay throughout the *Premier tome*, and at length at the beginning of Book V (Philibert de L'Orme, *Premier tome de l'architecture*, Paris, Morel, 1567, f° 131r°). On his relations with Du Bellay, see Yves Pauwels, "Philibert de l'Orme et ses cardinaux: Marcello Cervini et Jean du Bellay," in Frédérique Lemerle, Yves Pauwels, and Gennaro Toscano, eds., *Les Cardinaux de la Renaissance et la modernité artistique*, Villeneuve d'Ascq, Institut de recherches historiques du Septentrion, 2009, p. 149-156.

3 De L'Orme provides a description of his tasks as surveyor in his 1562 memoir, *Instruction de Monsieur d'Ivry dict de Lorme, abbé de Saint Sierge et cestui n° architecteur du roy*, in Adolphe Berty, *Topographie historique du vieux Paris*, Paris, Imprimerie nationale, 1866-1897, vol. 2, p. 179-185.

his circle de L'Orme also produced, during the following decade, some of France's most celebrated architectural works, including Francis I's funerary monument (1548-1558), the Château d'Anet (1547-1555), and the Château Neuf de Saint Germain en Laye (b. 1557). De L'Orme's fortune came to an abrupt end in July 1559, when, following the death of Henri II, he was dismissed from all his responsibilities. According to a passage in the *Premier tome*, this is when the architect, stripped of work and honors, turned to theory.⁴

The *Premier tome* is the first comprehensive architectural treatise written in French and one of the most fascinating theoretical texts of its time. It was published in two installments: the first, under the title of *Nouvelles inventions pour bien bâtir et à petits frais*, came out in 1561 and comprised two books dedicated to a timber construction method de L'Orme claims to have invented.⁵ The remaining nine books of the treatise were issued six years later as the *Premier tome de l'architecture* (1567). As its title indicates, the *Premier tome* was supposed to be followed by a second volume, which never saw the light of day.⁶ Yet, as it stands, the book is not a manifestly incomplete treatise of architecture, with the organization of content following a clear and original logic modeled after the phases of construction of a building, from foundation to roof: Book I introduces the patron and the architect and discusses the choice of site; Book II deals with the foundation; Books III and IV focus on stonemasonry and stereotomy (i.e., walls and their openings, staircases, and vaults); Books V, VI, and VII focus on the orders; Book VIII describes the composition of façades; and Book IX focuses on fireplaces and chimneys. The two prior volumes published on carpentry—the *Nouvelles inventions*—were the logical complement to this structure, and were in fact added as Books X and XI to subsequent editions of the treatise.

4 Philibert de L'Orme, *Premier tome...*, op. cit., f° 259r°. The treatise is available online at <http://architectura.cesr.univ-tours.fr/Traite/Images/Les1653Index.asp>, last accessed on 23 May 2017.

5 Philibert de L'Orme, *Nouvelles inventions pour bien bâtir et à petits frais*, Paris, Morel, 1561. The treatise is available online at <http://architectura.cesr.univ-tours.fr/Traite/Images/Masson643Index.asp>, last accessed on 23 May 2017.

6 On the genesis of the *Premier tome*, see Sara Galletti, "Philibert de L'Orme's Divine Proportions and the Composition of the *Premier tome de l'architecture*," *Architectural Histories*, n° 2, 2014, 12, p. 1-11, DOI: <http://doi.org/10.5334/ah.bh>

The *Premier tome* is truly different from all previous architectural treatises. First, de L'Orme brings extensive hands-on experience into his writing. While all fifteenth- and sixteenth-century theoreticians of architecture were also practitioners, the vast majority of them started writing early on in their careers. De L'Orme, instead, had decades of practice behind himself when he wrote the *Nouvelles inventions* and the *Premier tome*, and, thanks to his appointment as surveyor under Henri II, this experience went well beyond the limits of his own work. Second, de L'Orme brings a critical approach to authoritative sources both textual and built. More radically than any theoretician before him, de L'Orme breaks away from the works of both Vitruvius and Alberti; is critical of the architectural canon, ancient and modern alike; favors the extravagant over the mainstream among the models from antiquity; and promotes inventiveness over submissiveness to ancient and modern norms. Moreover, de L'Orme discards many of the topics discussed by his predecessors, especially the scholarly dissertations on ancient buildings and techniques for which he sees no modern application. Instead, he treats at length subjects that have no classical precedent, most notably in his discussion of stereotomy in Books III and IV.⁷

Stereotomy is the art of cutting stones into particular shapes for the construction of vaulted structures. The size, shape, and assembling technique of their components (voussoirs) is what distinguishes stereotomic vaults, such as the annular vault covering the lower portico in the courtyard of Charles V's Palace in Granada (Fig. 1), from the broader family of stone vaults, such as those covering the nave of the Church of Saint Séverin in Paris (Fig. 2). In Granada, the large (compared to the overall dimensions of the vault) voussoirs were individually cut to fit each other precisely and then assembled like the pieces of a three-dimensional jigsaw puzzle. In Saint Séverin, instead, the vaults' severies (the compartments comprised between the ribs) were built using smaller stones of standard shape and size which, like bricks, are held together by the mortar that fills the joints. The curvatures of the Granada vault result from the precise shaping of its voussoirs, while those of the Saint Séverin vaults result from the wedge-like shaping of their mortar fillings.

7 On the originality of the *Premier tome*, see also Jean Guillaume, "Philibert de L'Orme: un traité différent," in Id., ed., *Les traités d'architecture de la Renaissance: actes du colloque tenu à Tours du 1^{er} au 11 Juillet 1981*, Paris, Picard, 1988, p. 347-354.



FIG. 1 – Pedro and Luis Machuca, annular stereotomic vault, 1562-1569, courtyard, Palace of Charles V, Granada. Photo © Sara Galletti.

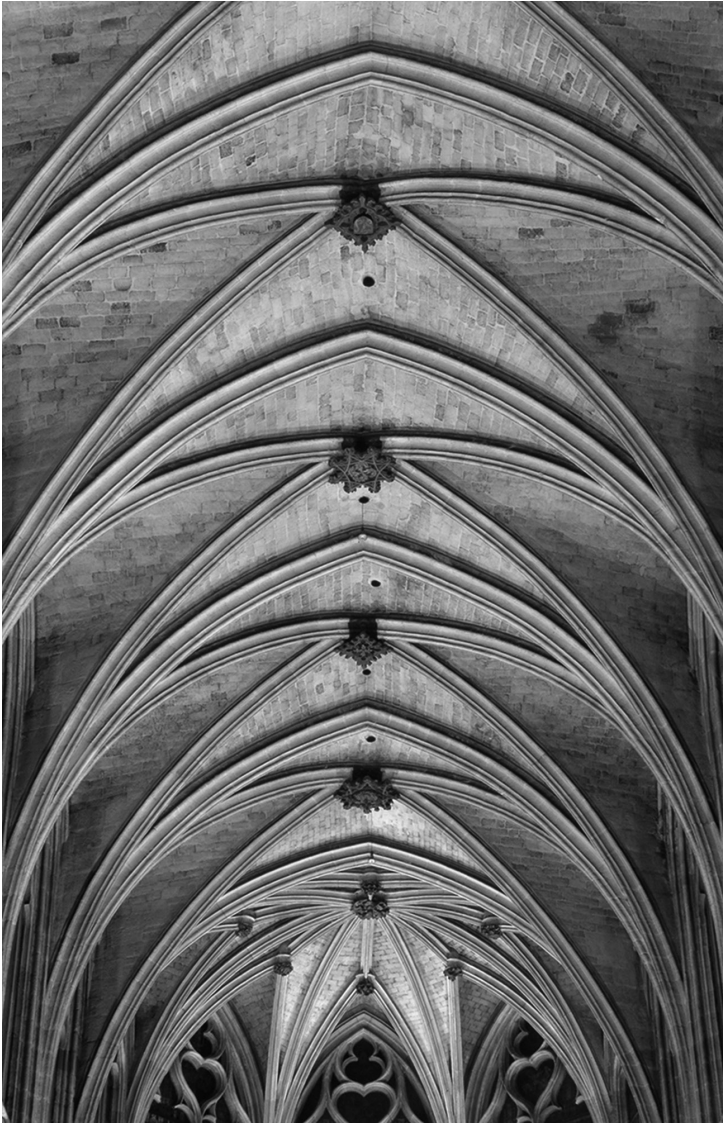


FIG. 2 – Non-stereotomic rib vaults, Church of Saint Séverin, Paris, second half of the 15th cent. Photo © Romanceor (Own work) GFDL <http://www.gnu.org/copyleft/fdl.html> or CC BY-SA 3.0 <http://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons.

Stereotomy is an ancient art that has been practiced over a wide chronological span, from Hellenistic Greece to contemporary Apulia, and across a broad geographical area, centered in the Mediterranean Basin but reaching far beyond—from Cairo to Gloucester and from Yerevan to Braga.⁸ The art is best known for the variety of acrobatic masterpieces produced in early modern France and Spain, such as the floating staircase of the Lonja de Mar in Barcelona or the composite vault in the City Hall of Arles. It is also known for a substantial body of theory that started with the treatises of architects such as de L'Orme and Alonso de Vandelvira (1544-1625) and engaged practitioners and mathematicians alike in a heated debate through the eighteenth century.⁹ By focusing on the geometry of solids, this body of theory also crucially contributed to the definition of Gaspard Monge's theory of descriptive geometry, the branch of mathematics concerned with the two-dimensional representation of three-dimensional objects.¹⁰ As Joël Sakarovitch has shown, modern solid geometry owes a substantial debt to the practice of stereotomy and to the experiments in complex vaulting conducted by generations of architects, *appareilleurs* (setters), and stonecutters.¹¹

De L'Orme was not the first author to write about stereotomy—Villard de Honnecourt (ca. 1230), Pedro de Alviz (ca. 1550), and Hernán Ruiz el Joven (ca. 1550), among others, had included stereotomic problems in their manuscripts.¹² However, de L'Orme was the first to

8 On the Mediterranean history of stereotomy, see Sara Galletti, "Stereotomy and the Mediterranean: Notes Toward an Architectural History," *Mediterranea: International Journal on the Transfer of Knowledge*, n° 2, 2017, p. 73-120, DOI: <https://doi.org/10.21071/mijtk.v0i2.6716>

9 Philibert de L'Orme, *Premier tome...*, op. cit. and Geneviève Barbé-Coquelin de Lisle, ed., *El tratado de arquitectura de Alonso de Vandelvira*, Madrid, Confederación Española de Cajas de Ahorros, 1977.

10 Gaspard Monge, *Géométrie descriptive: leçons données aux Écoles normales l'an 3 de la République*, Paris, Gabay, 1798.

11 Joël Sakarovitch, *Épures d'architecture: de la coupe des pierres à la géométrie descriptive, XVI^e–XIX^e siècles*, Basel, Birkhäuser, 1998. Among the fundamental works on the history of stereotomy, see also Jean-Marie Pérouse de Montclos, *L'architecture à la française: du milieu du XV^e à la fin du XVIII^e siècle*, Paris, Picard, 1982 and José Carlos Palacios, *Trazas y cortes de cantería en el Renacimiento español*, Madrid, Instituto Juan de Herrera, 1990.

12 On these manuscripts, see Pedro Navascues Palacio, *El Libro de arquitectura de Hernán Ruiz el joven*, Madrid, Escuela Técnica Superior de Arquitectura, 1974; Claude Lalbat,

provide a theory of stereotomy by giving organized, systematic form to a comprehensive corpus of case studies. Moreover, de L'Orme's choice to print this material and to include it in a broader treatise on architecture made it available to a much wider audience than the circles of initiated professionals to whom stereotomy treatises like Vandelvira's *Libro de trazas* (ca. 1585) were addressed.¹³ This editorial choice made de L'Orme's a far better known and studied book than Vandelvira's throughout early modern and modern times, despite the fact that Vandelvira's drawings are often easier to understand and his methods more accurate.

While de L'Orme's books on stereotomy are largely recognized as groundbreaking, they are also often construed as unfiltered transcriptions of building practices compiled by an overly ambitious stonemason. It is not rare to find de L'Orme referred to as "*maître*" and "mason" in modern discussions of his written work, and his theory of stereotomy has been described as "curious casuistry" deserving attention for its oddity rather than for its engagement with complex matters of geometry and construction.¹⁴ A substantial portion of the literature dedicated to de L'Orme's theory focuses on issues of proprietorship and the so-called masons' secret—which the architect supposedly betrayed with the publication of the *Premier tome*—while limited attention is paid to its scholarly content, particularly in the field of geometry, and its possible sources.¹⁵ Thus, modern scholarship has often reinforced sixteenth-century bias about de L'Orme as lowly social background and overbearing personality, exemplified by the "god of masons" epithet Bernard Palissy coined for him, at the

Gilbert Marguerite and Jean Martin, "De la stéréotomie médiévale: la coupe des pierres chez Villard de Honnecourt, I and II," *Bulletin monumental*, n° 145, 1987, and n° 147, 1989, p. 387-406 and 11-34 respectively; and Ricardo García Baño and José Calvo López, "Los recursos gráficos en el manuscrito de cantería atribuido a Pedro de Alviz (BNE MS 12686)," in Francisco Hidalgo Delgado and Concepción López González, eds., *XI Congreso Internacional de Expresión Gráfica Aplicada a la Edificación (Valencia 2012)*, Valencia, Universidad Politècnica de València, 2012, p. 157-165.

13 On the circulation of Vandelvira's manuscript among practitioners, see Geneviève Barbé-Coquelin de Lisle, ed., op. cit., p. 20.

14 See in particular Jean-Marie Pérouse de Montclos, *L'architecture à la française...*, op. cit., 3rd ed., 2013, p. 80-95. The quotes are found at p. 80, 85, and 93-94.

15 See, for instance, Philippe Potié, *Philibert de l'Orme, figures de la pensée constructive*, Marseille, Parenthèses, 1996.

expense of fresh analysis of his theoretical work.¹⁶ In the pages that follow, I will try to complicate our understanding of de L'Orme as theoretician of stereotomy by focusing in particular on his choice of material.

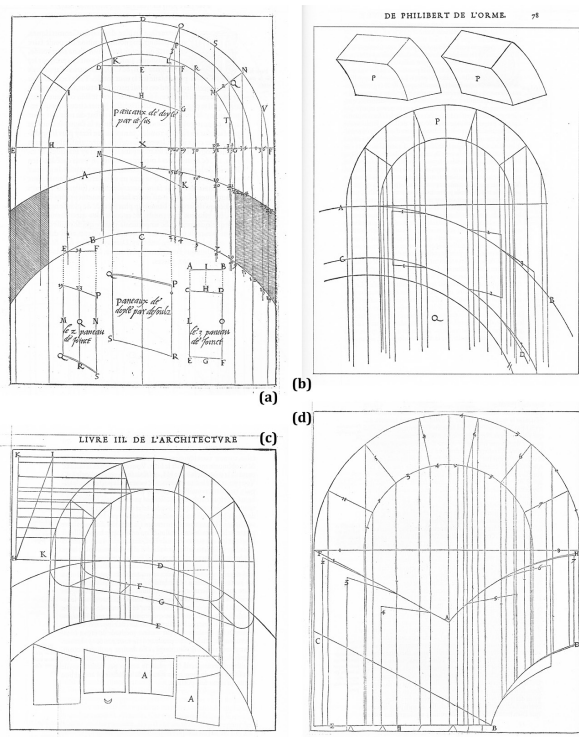


FIG. 3 – Philibert de L'Orme, (a) arch in a circular wall, (b) skew arch in a curved wall, (c) skew arch in an inclined circular wall, and (d) corner arch in a partially curved wall (Philibert de L'Orme, *Premier tome...*, op. cit., f^o 77r^o, 78r^o, 79v^o and 81v^o).

In Books III and IV, de L'Orme illustrates 32 case studies, 27 of which are dedicated to stereotomic vaulted structures, three to rib vaults (including one made of wood), and two to spiral staircases. Combined, the two books comprise 79 folios and include

16 Marie-Madeleine Fragonard, ed., *Bernard Palissy: Œuvres complètes*, Mont-de-Marsan, Éditions InterUniversitaires, 1996, vol. 2, p. 24.

51 illustrations, 30 in full-page format. The vaulted structures are organized in 11 typologies that include inclined barrel vaults, skew and corner arches, arches inserted in curved walls, groin vaults, domes, trumpet vaults, and helical barrel vaults. The geometric complexity of the selected case studies dictates their order of appearance, from the simplest (i.e., the inclined barrel vault) to the most complex (i.e., the helical barrel vault of the Vis de Saint Gilles type).¹⁷ The same applies to the variants presented for each type. In the section dedicated to arches that open in curved walls, for instance, de L'Orme first illustrates a standard model—an arch opening in a circular wall (Fig. 3a)—and then proceeds to illustrate less common examples featuring skew and corner arches as well as inclined and curved walls (Fig. 3b-d). Some notable exceptions to this organizing principle are the inclusion of case studies that pose little or no stereotomic challenge, such as the above-mentioned rib vaults, and the reverse order of the section dedicated to trumpet vaults, which opens with one of the most complex examples, that of the trumpet vault de L'Orme himself designed for the king's cabinet at the Château d'Anet (Fig. 4).¹⁸ These exceptions are a reflection of the broader scope and ambitions of the *Premier tome* as a whole, which trump, at times, the internal logic of the section dedicated to stereotomy. Rib vaults were still largely in use in de L'Orme's time and, as vaults made of stone, they fit the chapters dedicated to stereotomy better than any other section of the treatise. As to the Anet trumpet, de L'Orme's pride in showcasing such an extraordinary work seems to have taken precedence over any other consideration.

17 Philibert de L'Orme, *Premier tome...*, op. cit., f^o 59v^o and 125v^o. As Sakarovitch has noted, the inclined barrel vault de L'Orme illustrates at the beginning of Book III is far from simple (Joël Sakarovitch, op. cit., p. 149-157). Of those illustrated in the *Premier tome*, however, the inclined barrel vault is the only structure that features a solid-plane intersection instead of a more challenging interpenetration of solids.

18 Philibert de L'Orme, *Premier tome...*, op. cit., f^o 89r^o, non-extant. The only custom-cut elements of a typical rib vault are the voussoirs that compose the ribs. Since ribs are linear elements lying on vertical planes, the plans and sections of these vaults provide the shapes of their voussoirs with no need for the designers to develop any of the *traits* (geometric constructions) distinctive of stereotomic works. On the distinction between stone vaults and stereotomic vaults, see Sara Galletti, "Stereotomy and the Mediterranean..." op. cit.

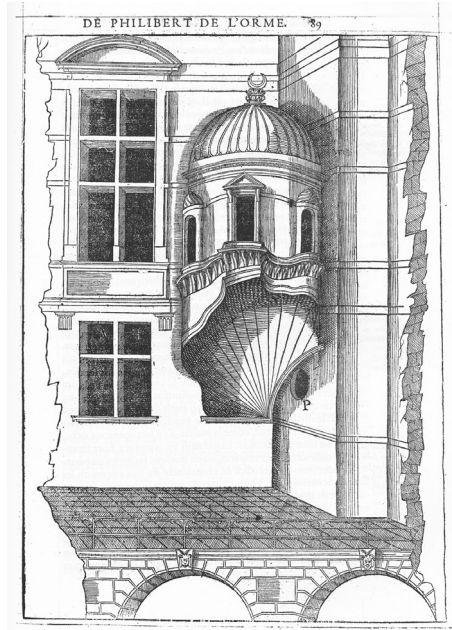


FIG. 4 – Philibert de L'Orme, trumpet vault, ca. 1552, Château d'Anet (Philibert de L'Orme, *Premier tome...*, op. cit., f° 89r°).

De L'Orme makes clear that his material on stereotomy derives directly from practice. The author states not only that he has no knowledge of any previous publication on stereotomy, be it ancient or modern, but also that no available edition of Euclid is sufficiently “illustrated”—that is, interpreted—to provide a theoretical basis for the practice of stereotomy, thus indicating that his work has no direct theoretical sources.¹⁹ He also makes regular reference to practice, frequently mentioning the tools and vocabulary stonemasons apply to stereotomy and their ability to understand the basics of his material—for instance, he writes that “several capable workers will understand these geometric constructions at first sight”—and giving many detailed comments on his own experience and works, in particular at the châteaux d'Anet and Fontainebleau.²⁰ Also, de

19 Philibert de L'Orme, *Premier tome...*, op. cit., f° 87v° and 62r°.

20 On the tools, see in particular Chapter IV of Book III (Philibert de L'Orme, *Premier tome...*, op. cit., f° 54v°-57v°). Mentions of practitioners' vocabulary of stereotomy are found

L'Orme lays no claim to having invented the methods illustrated in the *Premier tome*, thus indicating that the bulk of his material derives from existing practices and identifying his role as author as consolidating such practice into theory. Indeed, the transfer of the practical experience of stereotomic vaults onto paper with the purpose of further disseminating and diversifying the art of stereotomy is the main function of Books III and IV of the *Premier tome*, their *raison d'être*.

Yet the modes and implications of such transfer are not obvious. Contrary to what readers may expect, there is in fact no direct correspondence between the vaults de L'Orme built and those he includes in the treatise. Further, de L'Orme's selection of vaults clearly indicates that Books III and IV were not intended as either a catalogue of his own œuvre or as a pattern book from which practitioners may pick and choose models ready for (re)production. Rather, Books III and IV were intended to be a proper theory of stereotomy, one that reveals complex geometry problems and provides examples from a broad range of practices.

Of the many stereotomic vaults de L'Orme designed during his career, only one is illustrated in the *Premier tome*, the trumpet vault of Anet. The extraordinary dome of the Anet chapel (Fig. 5) does not appear in the treatise, even though de L'Orme deals extensively with domes in a nine-folio section that covers six different types and features eight illustrations, five of which are full-page. Likewise, the trumpet vaults of the Hôtel Bullioud (Fig. 6) are missing from the treatise, even though the section on trumpets is the largest of Books III and IV, with a total of 19 folios and 18 illustrations. The same is true of the treatise's section on staircases, which features single and double spirals as well as three helical barrel vaults of the Vis de Saint Gilles type, but does not include either the floating staircase de L'Orme designed for the Tuileries Palace or the horseshoe stairways he realized at Anet and Fontainebleau, the latter of which he describes as supported by a "rampant vault like the Vis de Saint Gilles, but more difficult."²¹

throughout Books III and IV, and the same is true of indications of their knowledge of basic stereotomic forms—the citation here is taken from f^o 61v^o. References to de L'Orme's own stereotomic works are found in particular at f^o 88r^o-99v^o, 112r^o and 125r^o (Anet) and at f^o 85r^o and 124v^o-125r^o (Fontainebleau).

21 Philibert de L'Orme, *Premier tome...*, op. cit., f^o 124v^o-125r^o. Restitution hypotheses for de L'Orme's floating staircase in the Tuileries Palace are found in Jean-Marie Pérouse de Montclos, "La vis de Saint-Gilles et l'escalier suspendu dans l'architecture française du

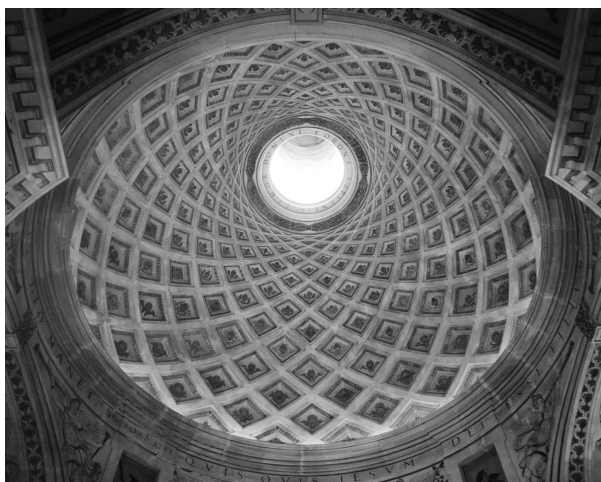


FIG. 5 – Philibert de L'Orme, dome, 1549–1552, chapel, Château d'Anet. Photo © Sara Galletti.



FIG. 6 – Philibert de L'Orme, trumpet vaults, 1536, Hôtel Bullioud, Lyon. Photo © Sara Galletti.

xvi^e siècle,” in Jean Guillaume, ed., *L'escalier dans l'architecture de la Renaissance: actes du colloque tenu à Tours du 22 au 26 mai 1979*, Paris, Picard, 1985, p. 267. A restitution of de L'Orme's horseshoe staircase at Fontainebleau is found in Jean Guillaume, “L'escalier dans l'architecture française: la première moitié du xvi^e siècle,” *Ibid.*, p. 243.

On the other hand, the *Premier tome* features vaults de L'Orme seems to never have employed in his buildings, as well as vaults with which the architect was visibly unfamiliar, such as the dome featuring a single, helical course (Fig. 7 left). As Enrique Rabasa Díaz has pointed out, de L'Orme's geometric construction for this type of dome is incorrect.²² De L'Orme's mistake is likely due to lack of experience, as no evidence shows that the architect ever designed a single-, helical-course dome, and no testimonies show that such vaults were constructed in sixteenth-century France. The oldest known example of this type is featured in the thirteenth-century Sultan Han Caravanserai of Sultanhanı, in central Anatolia (Fig. 8), and a number of examples are found in sixteenth-century buildings in Spain, such as those designed by Jerónimo Quijano and Rodrigo Gil de Hontañón in the cathedrals of Murcia and Plasencia. Not surprisingly, the correct geometric construction for this vault first appeared in Vandelvira's *Libro de trazas* (Fig. 7 right). The case of the single-, helical-course dome is not the only one in which de L'Orme provides the incorrect geometric construction for a vault he never realized in practice: in his *La théorie et la pratique de la coupe des pierres* (1737-1739), Amédée-François Frézier points out other similar cases, such as the dome featuring courses disposed on a triangular plan.²³ Nor is it the only instance in which the architect illustrates a vault type that was commonly employed in Spain but rarely in France: the corner arches de L'Orme includes in Book III were a common feature of fifteenth- and sixteenth-century Spanish architecture (many are found in Valencia, Soria, Úbeda, Valladolid, and Trujillo), but the only examples known in France are found in the Château de Graves, in the Midi-Pyrénées region.²⁴ These cases show not only that de L'Orme was aware of stereotomic practices outside of France, as José Calvo López has recently suggested, but also that his ambition as a theoretician of

22 Enrique Rabasa Díaz, "The single coursed ashlar vault," in Santiago Huerta, ed., *Proceedings of the First International Congress on Construction History, Madrid, 20-24 January 2003*, Madrid, Instituto Juan de Herrera, 2003, vol. 3, p. 1681-1683.

23 Philibert de L'Orme, *Premier tome...*, op. cit., f^o 116^v and Amédée-François Frézier, *La théorie et la pratique de la coupe des pierres et des bois, ou traité de stéréotomie à l'usage de l'architecture*, Strasbourg, Dousseker, 1737-1739, vol. 2, p. 350-351.

24 Jean-Marie Pérouse de Montclos, *L'architecture à la française...*, op. cit., 3rd ed., 2013, p. 296. On Spanish examples, see Ricardo García Baño and José Calvo López, "El arco por esquina y rincón en los tratados y manuscritos de cantería del renacimiento hispánico," *EGA. Revista de expresión gráfica arquitectónica*, no. 25 (June 2015), p. 128-137.

stereotomy went well beyond the illustration and promotion of his own productions and inventions.²⁵

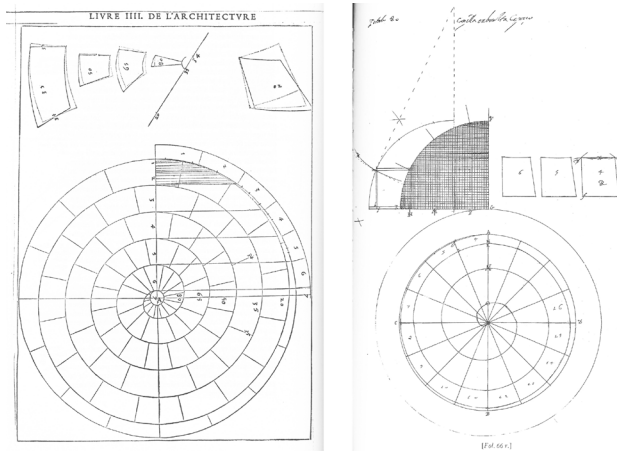


FIG. 7 – Domes featuring single, helical courses. Left: Philibert de L'Orme, *Premier tome...*, op. cit., f° 119v°. Right: Alonso de Vandelvira, in Geneviève Barbé-Coquelin de Lisle, ed., op. cit., vol. 2, f° 66r°.



FIG. 8 – Dome with single, helical course, Caravanserai of Sultan Han, Sultanhanı (Aksaray), 13th cent. © Claude Valette (Own work) [GFDL, <https://commons.wikimedia.org/w/index.php?curid=15015965>].

25 José Calvo López, “Philibert De l’Orme and Spanish Stereotomy,” in Frédérique Lemerle and Yves Pauwels, eds., *Philibert De L’Orme: un architecte dans l’histoire, arts, sciences, techniques*, Turnhout, Brepols, 2015, p. 199–213.

It is also of note that de L'Orme does not illustrate the standard models of many of the vault types he deals with in Books III and IV, such as the semi-spherical dome with concentric courses or the symmetrical conical trumpet vault supporting a cylindrical body, the most common types in their respective families and abundantly featured in later treatises. He avoids discussion of these basic models even when they feature in his own practice and could therefore be instrumental in the promotion of his work. This is the case for the south trumpet of the Hôtel Bullioud, which is a standard *trompe dans l'angle* featuring regular, symmetrical geometric forms (see Fig. 6 left), and for the semi-domes of the cryptoporticus of Anet, which are standard quarter-spheres with concentric courses, neither of which are illustrated in the *Premier tome*. Indeed, de L'Orme shows no interest in providing a systematic record of his stereotomic oeuvre for marketing purposes. The same is true of the *Premier tome* as a whole, which stands as a counter-example to Andrea Palladio's *Four books on architecture* (1570) in its avoidance of the illustrated-catalogue approach to the author's work.

De L'Orme not only avoids several of the basic stereotomic models, but he also indulges in the illustration of many of the eccentric ones, such as joined corner arches, rampant trumpet vaults of irregular geometries, domes featuring rectangular and triangular plans and non-concentric courses, and a square variant of the Vis de Saint Gilles vault type. This same approach is manifest in other sections of the *Premier tome*, such as the one dedicated to the orders, where de L'Orme minimizes his discussion of the orthodox forms but regales his readers with a wide variety of extravagant ones, including fictitious ancient models and newly-minted inventions such as the French orders.²⁶ The author explicitly identifies the function of these extravagant models, at least with respect to stereotomy, as theoretical—that is, their inclusion affords him more latitude for theoretical exploration. At the beginning of the section on trumpet vaults, for instance, de L'Orme informs his readers that:

A trumpet vault can be built on a right, obtuse, or acute angle, and it can take any form one wishes in elevation: straight, projecting square, half a hexagon, or octagon, or round. And one can build straight, concave, or rampant trumpet vaults or vaults of any type one can think of, depending on the needs and the

26 On the orders in the *Premier tome*, see especially Yves Pauwels, "Les Français à la recherche d'un langage. Les ordres hétérodoxes de Philibert de L'Orme et Pierre Lescot," *Revue de l'Art*, n° 112, 1996, p. 9–15.

constraints of the chosen site. All sorts of vaults can be built in the form of trumpets, and all of them can be built hanging in the air with no support on the ground other than on the side walls, all with the *same method* for tracing.²⁷

The author then proceeds to demonstrate this method by showing, through four case studies, that the *traits* of a trumpet vault—the geometric constructions necessary to obtain the 1:1 scale drawings of the sides of the voussoirs—remain the same no matter how extravagant its shape, because the geometric problem underlying all trumpet types, independently of their specific form, is the development (flattening) of a conic surface (Fig. 9). The same is true of the chapters de L'Orme dedicates to domes, where the variety of shapes in plan and section along with the assortment of solutions for the setting of the voussoirs and the geometry of their courses serve the purpose of demonstrating that, no matter what specific form a stereotomic dome is given, the key to its execution invariably lies in the development of the doubly curved surface of the sphere.²⁸ To de L'Orme, the geometric difficulty—pushed, at times, to absurdity—of the vaults illustrated in the *Premier tome* is instrumental in making an argument about geometric methods and not in amassing a collection of vault specimens. In other words, de L'Orme's goal is to provide readers with a proper theory of stereotomy rather than a collection of vaulting recipes.

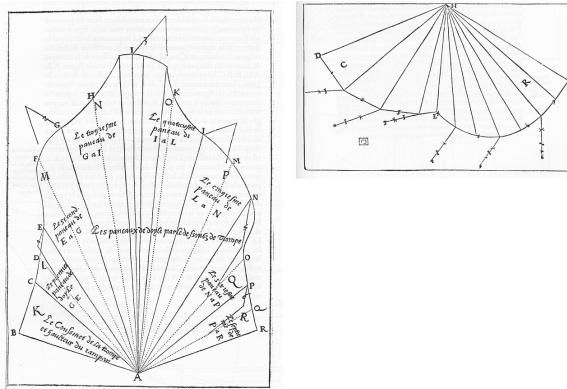


FIG. 9 – Philibert de L'Orme, development of conic surfaces (Philibert de L'Orme, *Premier tome...*, op. cit., f^o 95v^o and 105r^o).

27 Philibert de L'Orme, *Premier tome...*, op. cit., f^o 89v^o. My emphasis.

28 Ibid., f^o 111v^o–118v^o.

Some of the geometric constructions and methods illustrated by de L'Orme are of particular interest in the context of sixteenth-century mathematical knowledge and its dissemination. Books III and IV of the *Premier tome* not only demonstrate a number of triangulation and rotation methods that will be codified by Monge as tenets of descriptive geometry, but they also show geometric constructions that, in de L'Orme's time, seem to have been unknown outside of the building trades. This is the case with the conical-sectioning of the sphere that de L'Orme repeatedly shows in his chapters on domes, and which provides an alternative to the methods for the development of the sphere employed by Renaissance cartographers (Fig. 10).²⁹ The method illustrated by de L'Orme is a relative of the pseudo-conic projections that gave birth, in the sixteenth-century, to heart-shaped maps such as those produced by Johannes Stabius and Johannes Werner. In this method, the sphere is construed as composed by separate cone sections belonging to a series of stacked, overlapping cones (Fig. 11). The non-developable, doubly curved geometry of the sphere is thus simplified to that of the cone, which can be developed. While this method was introduced in the world of cartography in 1825 by Ferdinand Hassler, it was already well known among Spanish practitioners of stereotomy in the first half of the sixteenth century, as shown by the tracings found on the Cathedrals of Seville and Murcia (Fig. 12).³⁰ It was later illustrated in Spanish stereotomy manuscripts, and often with clearer drawings than those of the *Premier tome*, as is the case in Vandelvira's *Libro de trazas*.³¹ Like corner

29 On cartographic projections employed in the Renaissance, see John P. Snyder, *Flattening the Earth: Two Thousand Years of Map Projections*, Chicago, University of Chicago Press, 1993, p. 1-54, and particularly p. 42–43 on the proto-polyconic projections illustrated by de L'Orme.

30 On Hassler's projection, see John P. Snyder, op. cit., p. 117-122. On the Murcia tracing, see José Calvo López *et al.*, "The Tracing for the Sail Vault at the Murcia Cathedral Vestry: Surveying a 16th-Century Full-Scale Working Drawing," *International Journal of Architectural Heritage: Conservation, Analysis, and Restoration*, vol. 7, n° 3, 2013, p. 275-302; on the Seville one, see José Antonio Ruiz de la Rosa, "Evolución de las tradiciones operantes en Arquitectura: el dibujo sobre soporte pétreo," in Carlo Inglese and Antonio Pizzo, eds., *I tracciati di cantiere: disegni esecutivi per la trasmissione e diffusione delle conoscenze tecniche*, Rome, Gangemi, 2016, p. 24. On the possible contact between cartographers and stereotomists in sixteenth-century Spain, see Francisco Pinto Puerto, *Las esferas de piedra: Sevilla como lugar de encuentro entre arte y ciencia del Renacimiento*, Seville, Diputación de Sevilla, 2001.

31 For instance, in Geneviève Barbé-Coquelin de Lisle, ed., op. cit., f° 61r°.

arches, stereotomic domes were common features of fifteenth- and sixteenth-century Spanish architecture but were a rare currency in France, where only a handful of them predate de L'Orme's chapel in Anet.³² It is thus possible that the conical-sectioning method for the solution of the sphere's doubly curved geometry was developed in Spain, and that de L'Orme's treatise was the means by which it was first introduced to French practitioners and mathematicians.

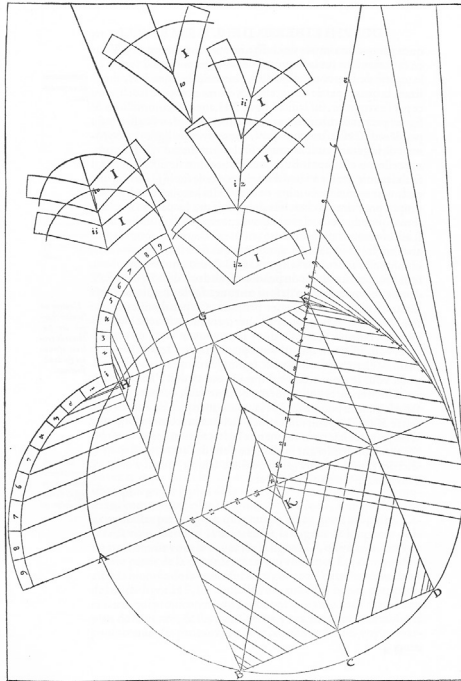


FIG. 10 – Philibert de L'Orme, development of a spherical surface (Philibert de L'Orme, *Premier tome...*, op. cit., f^o 115v^o).

32 Pérouse de Montclos's survey of French early modern stereotomic vaults includes four buildings featuring domes that pre-date the chapel at Anet: the Château de Moulins, the cloister of the Abbey of St Martin in Tours, the Pendentif de Valence, and the Château de Bournazel (Jean-Marie Pérouse de Montclos, *L'architecture à la française...*, op. cit., 3rd ed., 2013, p. 284-316). In the case of the Château de Moulins, though, the available historical documentation does not clarify whether the dome was, in fact, stereotomic or not (Ibid., p. 148).

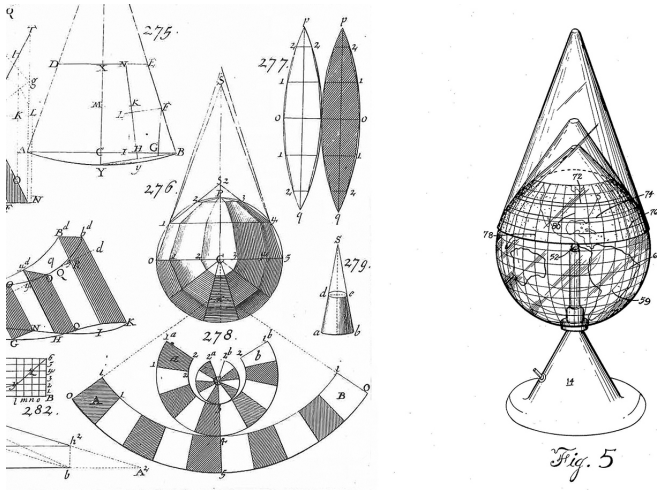


FIG. 11 – Left: Amédée-François Frézier, conical-sectioning of the sphere (Amédée-François Frézier, *op. cit.*, vol. 1, pl. 23). Right: polyconic map projection demonstrator (Joseph A. Stieber and John B. Weldon, patent 2932907 filed on 16 January 1959, fig. 5).

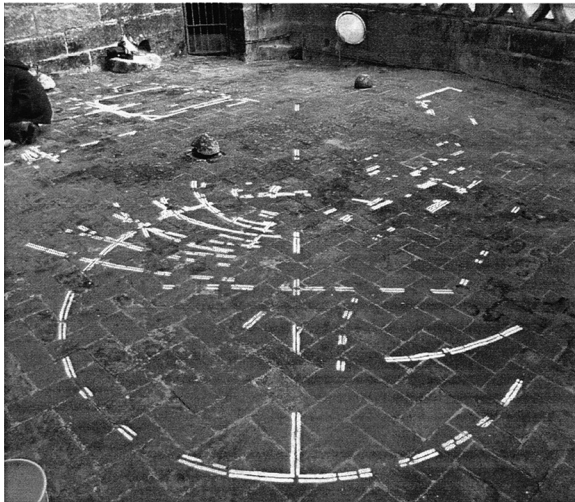


FIG. 12 – Tracing for the dome in a choir chapel of Seville Cathedral (José Antonio Ruiz de la Rosa, *op. cit.*, p. 24).

While de L'Orme's theory of stereotomy has been the object of a substantial amount of literature, thorough analyses of the content, structure, sources, and theoretical ambitions of Books III and IV of the *Premier tome* are still lacking. De L'Orme's choice of material on stereotomy is far less banal than has been recognized thus far, as is the relation between his built and theoretical stereotomic work. De L'Orme's books are neither a catalogue of the author's oeuvre nor a collection of recipes; rather, they are an ambitious, if at times faltering, attempt at theorizing one of the most fascinating and complex techniques in the history of pre-modern construction. Far from constituting a "curious casuistry," de L'Orme's deliberate selection of eccentric case studies serves the purpose of shifting the reader's attention from specific vault models to the common geometric methods and constructions that underlie them. Some of these geometric constructions were unknown to mathematicians of de L'Orme's time, and the *Premier tome* was likely the means by which they were first introduced to a French readership. Finally, Books III and IV also show ample evidence of de L'Orme's awareness of stereotomic practices in Spain, which he eagerly integrates in his theory, albeit with varying degrees of success. These observations show de L'Orme's horizon as a theoretician to have been far more complex, intellectually engaged, and internationally oriented than has been admitted thus far. Indeed, they invite a reassessment of his written work, certainly in the field of stereotomy but also, more broadly, in that of architectural theory.

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