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STORIA DELL'ARCHITETTURA
UNIVERSITÀ DEGLI STUDI
DI FIRENZE

LE TECNICHE COSTRUTTIVE NEGLI SCRITTI DI ARCHITETTURA IN EUROPA TRA RINASCIMENTO E PRIMA ETÀ MODERNA

2020

70 DELLA ARCHITETTVRA

go,ma a vna certa particolare parte della città, della quale, tratteremo insie-
me con le altre cose del suo genere, quando membro per membro tratteremo di simili opere publiche. Nel fondare sotto gli ordini delle colonne,non fa mestiere tirare adilungo vna fossa tutta cõtinouata ripiena di muraglia,ma è cosa conueniente fortificare prima il luogo doue tu vuoi porre le sedie & il letto di esse colonne:& da l'uno a l'altro gittare poi archi voltando il dorso di qual'se l'uno verso il profondo, di modo che il ricinto & lo spazzo del primo piano,serua per corda di detti Archi.

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OPVS INCERTVM
Rivista del Dipartimento di Architettura
Sezione di Storia dell'Architettura e della Città
Università degli Studi di Firenze

Pubblicazione annuale
Registrazione al Tribunale di Firenze
n. 5426 del 28.05.2005
ISSN 2239-5660 (print) ISSN 2035-9217 (online)

Nuova Serie, anno VI | 2020

Le tecniche costruttive negli scritti di architettura in Europa tra Rinascimento e prima Età Moderna

Construction Techniques and Writings on Architecture in Renaissance and Early Modern Europe

a cura di Caterina Cardamone e Pieter Martens

In copertina
C. Bartoli, *L'architettura di Leonbatista Alberti. Tradotta in lingua Fiorentina da Cosimo Bartoli Gentil'huomo e Accademico fiorentino. Con l'aggiunta de Disegni*, Firenze 1550, p. 70.

Tutti i saggi sono sottoposti a un procedimento di revisione affidato a specialisti disciplinari, con il sistema del 'doppio cieco'.

All essays are subjected to a double-blind peer review process prior to publication.

L'opera è stata realizzata grazie al contributo del DIDA
Dipartimento di Architettura | Università degli Studi di Firenze
via della Mattonaia, 8 50121 Firenze

Con il sostegno della Vrije Universiteit Brussel

Published by Firenze University Press | Università degli Studi di Firenze
Firenze University Press
Via Cittadella, 7 - 50144 Firenze, Italy
www.fupress.com

SOMMARIO

OPVS INCERTVM

Caterina Cardamone, Pieter Martens

LE TECNICHE COSTRUTTIVE NEGLI SCRITTI DI ARCHITETTURA IN EUROPA TRA RINASCIMENTO E PRIMA ETÀ MODERNA

This thematic issue of Opus Incertum *explores the complex relationship between construction practices and architectural writings in early modern Europe. Through selected case studies from Italy, France, Portugal and the Low Countries, it considers how allegedly oral building traditions were confronted with writing, how they adapted their time-honoured methods to theoretical frameworks, and how they used drawing in support of writing for the communication of technical know-how. Various texts on building materials and construction methods are examined to assess why and how they transmitted technical knowledge and how they related to actual building practice; the literary and rhetorical aspects of technical passages on construction are analysed to illuminate their role within the architectural treatise as a whole; and translations and adaptations of internationally circulating texts on construction are looked at to see if and how these were adjusted to local circumstances.*

La questione sollevata in questo numero di *Opus Incertum*, *Le tecniche costruttive negli scritti di architettura in Europa tra Rinascimento e prima Età Moderna (Construction Techniques and Writings on Architecture in Renaissance and Early Modern Europe)*, è stata discussa per la prima volta in occasione di un convegno organizzato tra Bruxelles e Namur nel febbraio 2015. Il convegno indagava il complesso rapporto tra cultura costruttiva e teoria architettonica mettendo in evidenza tre aspetti: le possibili connessioni tra trattati di architettura e pratica di costruzione; gli aspetti retorico-letterari inerenti alla scrittura di tecnica; la questione della traduzione e dell'adattamento a circostanze locali dei trattati italiani nella loro circolazione in Europa[1].

Un primo gruppo di cinque saggi, dedicati al primo tema, quindi ai legami tra trattatistica e prassi costruttiva, è stato pubblicato nel 2017 sulla rivista *Aedificare*[2], con i contributi di Pier Nicola Pagliara (sull'esperienza costruttiva nel *De re aedificatoria* di Leon Battista Alberti), Gianluca Belli (sulle volte nell'architettura di Giuliano da Sangallo), Francesco Benelli (sul disegno e la costruzione del capitello ionico in Antonio da Sangallo il Giovane), Hubertus Günther (su Philibert de L'Orme e la tradizione francese di costruzione delle volte) e Sara Galletti (su Philibert de L'Orme e la nascita della teoria della stereotomia).

Questo numero di *Opus Incertum* si concentra invece sugli altri due temi, ovvero gli aspetti letterari e retorici che presiedono alla scrittura di tecnica e i problemi di traduzione e adattamento del lessico tecnico nella circolazione internazionale dei testi.

Un approccio storiografico prevalente ha lungamente portato a eludere un aspetto, nella scrittura dei trattati, che viene ora affrontato in ambiti disciplinari estranei alla storia dell'architettura, come ad esempio la storia della scienza. Nella lettura storiografica corrente, infatti, il trattato non è considerato uno strumento adatto a veicolare informazioni tecniche e i passaggi tecnici vengono raramente analizzati nel loro contenuto – con poche ma interessantissime eccezioni. Nello studio dei trattati viene piuttosto evidenziata la costruzione retorica del testo nel contesto del mecenatismo rinascimentale: i passaggi tecnici vengono quindi letti come elementi che mettono in evidenza con chiarezza la mutua dipendenza tra principe e tecnico.

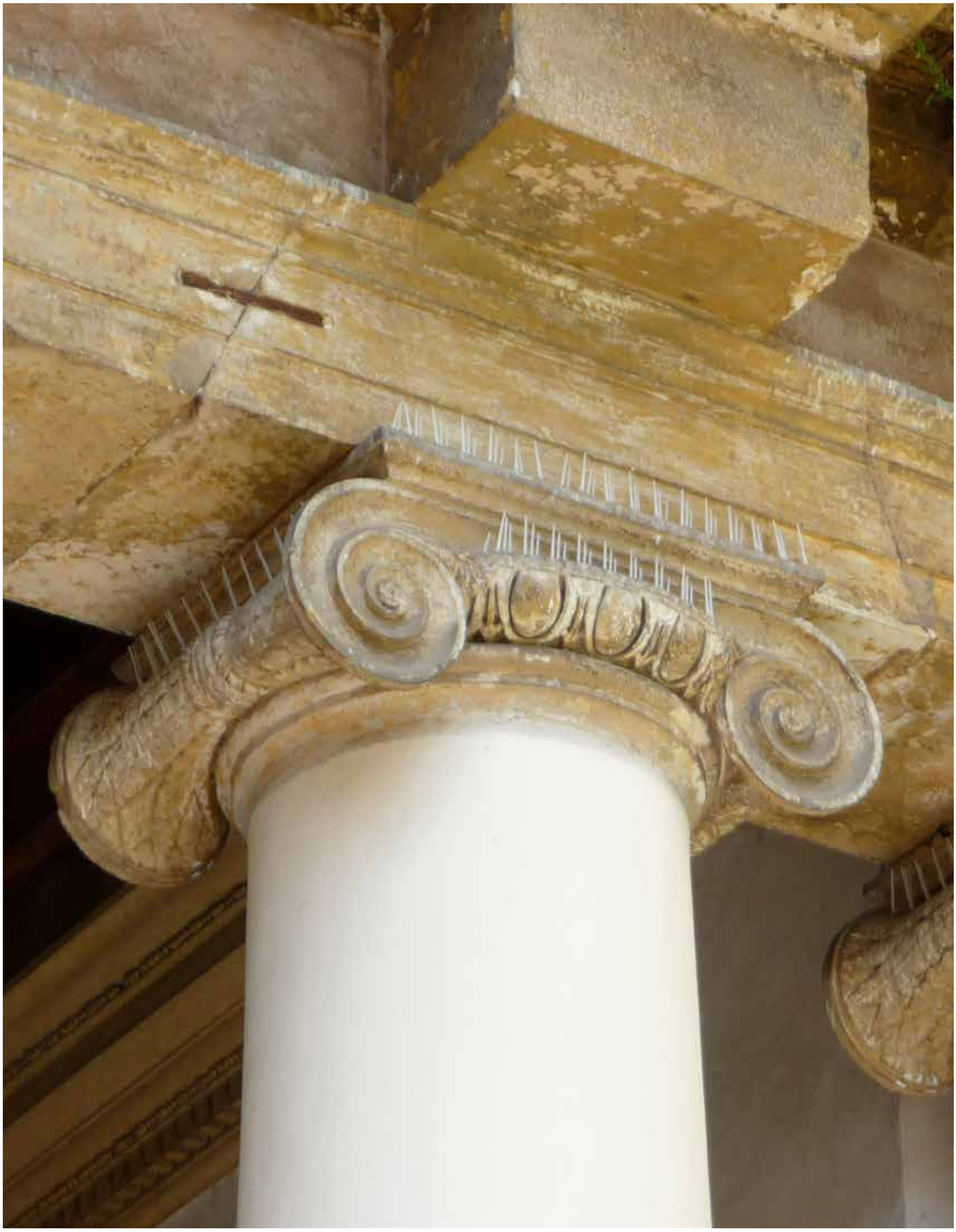
Ci si può chiedere allora di che cosa scrivano gli autori quando scrivono di tecnica e quali siano gli argomenti tecnici che meglio si prestano a trasmettere un messaggio autopromozionale, a rafforzare l'autorevolezza dell'architetto che scrive, a elevarne lo *status* e l'attendibilità.

La questione che viene qui sollevata è quindi se le indicazioni contenute nei passaggi tecnico-costruttivi dei trattati possano effettivamente esaurirsi nella necessità autopromozionale che in parte presiede alla scrittura del trattato e in che misura possano invece essere lette come vettori di una specifica cultura tecnico-costruttiva. Sembra ormai chiaro che la portata dei passaggi tecnico-costruttivi travalichi i riferimenti vitruviani; piuttosto, in alcuni casi, le annotazioni tecniche costituiscono uno straordinario e sottovalutato documento della prassi costruttiva.

Ulteriori spunti, nello studio delle informazioni costruttive, possono provenire dalle modalità della loro circolazione attraverso i trattati. Un'analisi delle informazioni che vengono mantenute, adattate o eliminate in fase di traduzione può fornire interessanti elementi sul valore che i lettori contemporanei attribuiscono ai passaggi tecnico-costruttivi, sull'attenzione che i passaggi tecnici ricevono dai contemporanei, e sul pubblico dei loro lettori.

L'argomento esige alcune precauzioni e precisazioni. Se il rapporto tra testo e architettura costruita all'interno di un contesto culturale specifico è già abbastanza spinoso, la questione diventa ancora più complessa quando si passi ad analizzare differenti contesti costruttivi, la scrittura di tecnica all'interno di questi contesti e le loro interazioni. La storia dell'architettura all'inizio dell'Età Moderna in Europa è una storia di interazioni culturali, scambi di idee e cono-

Opus Incertum (2020) pp. 8-11 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12356 www.fupress.com/oi



pagina 9

Fig. 1 *A. Palladio, Palazzo Valmarana, Vicenza 1566. Dettaglio dell'ordine nel cortile con architrave tripartito.*

scenze, non esclusivamente unidirezionali a partire dall'Italia, scambi reciproci più o meno forti tra regioni differenti. Tuttavia, mentre le idee architettoniche viaggiano facilmente da una regione all'altra, trasportate su carta e nelle menti di committenti o architetti, le tecniche di costruzione sembra non si spostino facilmente, legate come sono ai materiali e alle maestranze locali. Anche la circolazione delle maestranze non implica automaticamente la circolazione delle tecniche. Da questo punto di vista non deve sorprendere che molti dei trattati di architettura più diffusi e tradotti in questo periodo (Andrea Palladio, Vignola, Vincenzo Scamozzi, Hans Vredeman de Vries), durante la loro circolazione in Europa, vengano fortemente riadattati e rimaneggiati nei passaggi in cui discutono di materiali e tecniche di costruzione – mentre soffrono solo marginalmente in fase di traduzione dove vengono affrontate questioni formali e concettuali. Inoltre, i trattati che si concentrano soprattutto su argomenti tecnici, in generale, non vengono tradotti in altre lingue. Questo succede ad esempio per la maggior parte dei testi cinquecenteschi che si occupano di carpenteria o stereotomia – si pensi ai trattati di Mathurin Jousse o Philibert de L'Orme, che esistono soltanto in francese. Un interessante esempio in positivo è invece la latinizzazione quattrocentesca del trattato di Filarete: le dettagliate informazioni tecniche del trattato in volgare passano quasi sistematicamente nella versione dedicata a Mattia Corvino. La questione che rimane aperta è se l'interesse per le indicazioni tecniche dell'*architettonico libro* in un contesto costruttivo così lontano da quello dell'autore si esaurisca anche in questo caso sulla base di considerazioni retoriche legate alla definizione dell'immagine del committente.

In generale, la scarsa fortuna dei passaggi tecnici dei trattati italiani in traduzione sembrerebbe confermare l'approccio storiografico che vuole le tecniche costruttive saldamente ancorate a tradizioni locali. Un esempio per tutti è l'adattamento di Pierre Le Muet del primo dei quattro libri di Palladio, il *Traicté des cinq ordres d'architecture desquels se sont servy les anciens. Traduit du Palladio, augmenté de nouvelles inventions pour l'art de bien bastir* (Paris 1645) nel quale "à l'usage des Français" sono eliminati i capitoli che trattano di materiali[3], perché, come viene spiegato, "beaucoup de choses sont extremement differentes de celles qu'on pratique aujourd'huy en France"[4] e quindi inutili per il lettore francese. Il volume di Le Muet, tuttavia, non è un semplice compendio degli ordini e non è del tutto privo di indicazioni costruttive, la cui analisi potrebbe fornire ulteriori elementi sulle modalità di lettura e circolazione del trattato italiano: potrebbe permettere di stabilire cosa ancora merita attenzione, in fase di traduzione e adattamento, di una differente tradizione costruttiva. Inoltre, anche dove nelle traduzioni i passaggi tecnico-costruttivi sono quasi sistematicamente eliminati – si pensi alle edizioni al di fuori dell'Italia dell'*Idea dell'architettura universale* di Scamozzi, che riducono il volume a un trattato sugli ordini – o riscritti – come nel caso della parziale traduzione tedesca del trattato di Palladio, *Die Baumasterin Pallas* (Nürnberg 1698) – ciò non significa tuttavia che questi adattamenti non forniscano elementi interessanti per definire l'approccio critico a una pratica costruttiva consolidata.

In questo numero di *Opus Incertum*, ai contributi legati al convegno (Cardamone, Gilles, Lemerle, Pauwels) se ne sono aggiunti altri sollecitati attraverso una *call for papers* (Galletti, Goudeau, Günther, Marconi, Ollagnier e Rousteau-Chambon, Tavares da Conceição, Wolf). Congiuntamente, gli undici contributi illustrano approcci molto diversi alla problematica, anche perché la nozione di "scritti di architettura" e quella di "tecniche costruttive" sono state tenute intenzionalmente ampie. Da un lato, gli scritti presi in considerazione comprendono in-

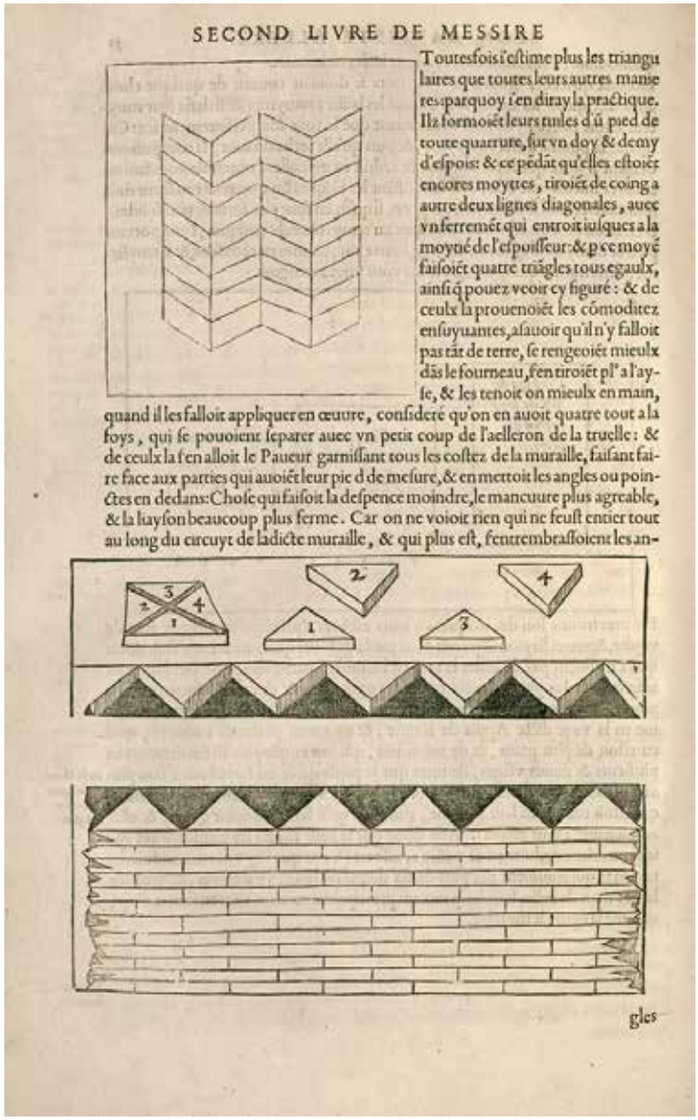
* Vorremmo ringraziare in apertura di questo numero Gianluca Belli, che ha seguito con fiducia e incoraggiato fin dall'inizio questo nostro progetto. Il nostro grazie anche a Daniela Smalzi per il suo prezioso lavoro redazionale. Un ringraziamento anche alla nuova direttrice della rivista, Emanuela Ferretti, per la sua attenzione all'iniziativa e ad Helen Spande per la lettura dei testi in inglese. Infine, ci teniamo a ringraziare i lettori anonimi per il loro decisivo contributo alla crescita di questo numero.

[1] *Les techniques constructives dans les écrits d'architecture entre Italie, France et anciens Pays-Bas (XVI^e^-début XVIII^e^ siècle)*, convegno internazionale, Namur (Université de Namur) e Bruxelles (Palais des Académies), 26-27 febbraio 2015, organizzato dall'Université catholique de Louvain in collaborazione con l'Université de Namur. Comitato organizzatore: Philippe Bragard, Caterina Cardamone, Ralph Dekoninck, Pieter Martens, Mathieu Piavaux.

[2] *Building Techniques in Architectural Treatises: Construction Practices versus Technical Writings*, éd. C. Cardamone, P. Martens, "Aedificare. Revue internationale d'histoire de la construction", 2, 2017, pp. 25-162, 269-275, 279-283.

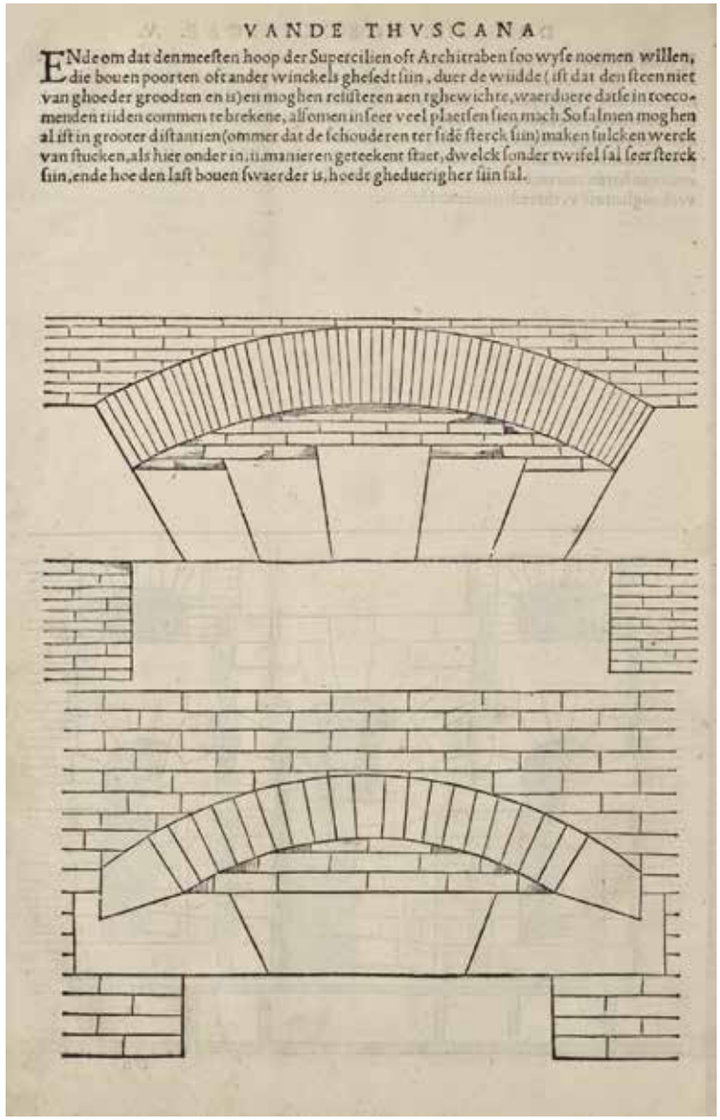
[3] P. Le Muet, *Traicté des cinq ordres d'architecture...* , Paris 1645, accessibile in linea con presentazione di Frédérique Lemerle sul sito del CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/ENSBA_LES646.asp; consultato il 15 settembre 2020).

[4] Ivi, p. 115.


SECOND LIVRE DE MESSIRE

Toutesfois i'eſtime plus les triangu laires que toutes leurs autres manie res: parquoy i'en diray la practique. Ilz formoiét leurs tuiles d'vn pied de toute quarrure, fur vn doy & demy d'eſpois: & ce pédát qu'elles eſtoiét encores moyttes, tiroiét de coing a autre deux lignes diagonales, auec vn ferremét qui entroit iuſques a la moytié de l'eſpoiſſeur: & p ce moyé faiſoiét quatre triágles tous egaulx, ainſi q pouez veoir cy figuré: & de ceulx la prouenoiét les cómoditez enſuyuantes, aſauoir qu'il n'y falloit pas tát de terre, ſe rengeoiét mieulx dás le fourneau, ſen tiroiét pl' a l'ayſe, & les tenoit on mieulx en main, quand il les falloit appliquer en œuure, conſideré qu'on en auoit quatre tout a la foys, qui ſe pouoient ſeparer auec vn petit coup de l'aelleron de la truelle: & de ceulx la ſen alloit le Paueur garniſſant tous les coſtez de la muraille, faiſant faire face aux parties qui auoiét leur pie d de meſure, & en mettoit les angles ou poinctes en dedans: Choſe qui faiſoit la deſpence moindre, le mancuure plus agreable, & la liayſon beaucoup plus ferme. Car on ne voioit rien qui ne feuſt entier tout au long du circuyt de ladicte muraille, & qui plus eſt, ſentrembraſſoient les an-

gles


VANDE THVSCANA

ENde om dat den meeſten hoop der Supercilien oft Architraben ſoo wyſe noemen willen, die bouen poorten oft ander winckels gheſedt ſiin, duer de wiidde (iſt dat den ſteen niet van ghoeder groodten en is) en moghen reiſteren aen rghewichte, waerduere datſe in toecommenden tiiden commen te breken, alſomen in ſeer veel plaetſen ſien mach So ſalmen moghen al iſt in grooter diſtantien (ommer dat de ſchouderen ter ſidē ſterck ſiin) maken ſulcken werck van ſtucken, als hier onder in ii. manieren geteekent ſtaet, dwelck ſonder twiſel ſal ſeer ſterck ſiin, ende hoe den laſt bouen ſwaerder is, hoede ghedueriger ſiin ſal.

fatti non solo trattati di architettura ben noti (tra cui quelli di Filarete, Francesco di Giorgio, Philibert de L'Orme e Claude Perrault), ma anche libri a stampa meno studiati su aspetti specifici della costruzione (Jeroen Goudeau e Nicoletta Marconi) e testi di altra natura: manoscritti, annotazioni su disegni, corrispondenza tra costruttori e committenti (Margarida Tavares da Conceição), resoconti di viaggio (Hubertus Günther), corsi accademici come quello di Philippe de La Hire (Claire Ollagnier e Hélène Rousteau-Chambon), dizionari, inventari, atti di vendita e altri documenti d'archivio (Isabelle Gilles). Dall'altro, le tecniche costruttive esaminate seguono un'accezione piuttosto ampia: vengono discusse tradizioni costruttive specifiche come la stereotomia (Sara Galletti), opere di fortificazione (Margarida Tavares da Conceição e Jeroen Goudeau), di manutenzione e restauro come le impalcature (Nicoletta Marconi), macchine di cantiere (Sophie Elaine Wolf), mulini a vento, chiuse e addirittura costruzioni navali (Jeroen Goudeau). Alcuni contributi si concentrano invece sulla cultura costruttiva e la riflessione critica intorno alla costruzione (Caterina Cardamone, Yves Pauwels, Frédérique Lemerle), l'insegnamento accademico (Claire Ollagnier e Hélène Rousteau-Chambon), la rappresentazione grafica delle tecniche costruttive (Sophie Elaine Wolf, Sara Galletti), gli aspetti commerciali dell'editoria (Jeroen Goudeau), la terminologia tecnica (Isabelle Gilles, Jeroen Goudeau, Frédérique Lemerle, Margarida Tavares da Conceição).

I saggi rendono conto della molteplicità dei possibili approcci all'argomento e della varietà delle situazioni e delle implicazioni del tema in diversi contesti storici, in un ambito cronologico che arriva fino alla nascita di una specifica manualistica architettonica.

Fig. 2 *Traduzione francese del De re aedificatoria di Leon Battista Alberti: Jean Martin, L'Architecture et Art de bien bastir..., Paris 1553, f. 32v.*

Fig. 3 *Traduzione neerlandese delle Regole generali (1537) di Sebastiano Serlio: Pieter Coecke van Aelst, Generale reglen der architecturen op de vyve manieren van edificien... , Antwerpen 1539, f. Diiv.*

Caterina Cardamone

"ANCORA NEL FARE S'ADATTERANNO MEGLIO CHE CON PAROLE NON SI PUÒ DIRE": ALCUNE CONSIDERAZIONI SUI PASSAGGI TECNICO-COSTRUTTIVI NELL'*ARCHITETTONICO LIBRO* DI FILARETE

This contribution focuses on the many passages in Filarete's treatise that deal with technical issues. "Ridiculous and silly", as Giorgio Vasari put it, Filarete's architettonico libro *(written between the late 1450s and 1466; first partially printed in 1890) has only recently been read as a source for Quattrocento building practice. In the following pages, some common elements in Filarete's passages that deal with building techniques are highlighted. In general, these passages seem to be of relevance for the literary construction and the dialogue; they consistently evince an empirical attitude, express results of direct observation, and convey coherent reflections on the instruments of the architect and on the meaning of writing. By no means a definitive assessment, this contribution raises some historiographical questions about the link between the writing of architectural treatises and building culture in the early modern period.*

"Illeggibile"[1], il trattato di architettura di Antonio Averlino detto il Filarete (1400 ca.-post 1465) ha un valore ormai riconosciuto come fonte per la cultura costruttiva e progettuale del Quattrocento[2]. I passaggi tecnico-costruttivi dell'*architettonico libro*, che richiedono ancora un'analisi sistematica per quanto riguarda i contenuti[3], presentano alcuni caratteri generali che verranno discussi nelle pagine che seguono: una posizione determinante nella costruzione letteraria, un deciso atteggiamento empirico e una chiara componente di riflessione epistemologica[4]. Il trattato assume quindi un valore di fonte anche per la cultura empirica diffusa nel contesto in cui questo viene prodotto; il campo di indagine risulta ampliato, e ulteriori elementi vengono aggiunti nel cercare di definire la relazione tra scrittura di tecnica e dinamiche di committenza. Senza l'ambizione di essere esaustivo, questo contributo intende sollevare alcune questioni storiografiche preliminari sul significato della scrittura di tecnica nel trattato di Filarete, in un ambito al confine tra differenti discipline – storia della letteratura, dell'architettura, della tecnologia, della costruzione e della scienza – ambito che offre ancora vasti margini di ricerca.

La preminenza di argomenti tecnici

I passaggi dedicati alla tecnica costituiscono un punto centrale già nella costruzione letteraria del *De architectura* di Vitruvio e su di essi si fondano temi sensibili come l'origine e il raffinamento dell'architettura[5] (fig. 1). Nella trattatistica rinascimentale, gli argomenti tecnico-costruttivi potrebbero quindi essere intesi in prima istanza come un riferimento vitruviano determinante che stabilisce l'autorevolezza del trattato e il suo legame con l'antico[6].

Nel caso del trattato di Filarete (fine degli anni Cinquanta del Quattrocento-1466)[7], i passaggi tecnico-costruttivi hanno una posizione preminente nella costruzione letteraria[8]. Le "materie pertinenti allo edificare", le "cose opportune" all'organizzazione del cantiere vengono introdotte già nei primi fogli del libro I[9], discusse lungamente nel II – dal ruolo dell'architetto nel cantiere all'approvvigionamento dei materiali e all'apparecchiatura delle "cose opportune per lo fundamento" della città[10] – diventano poi il tema centrale del terzo libro *de aedificatione urbis*[11]. Filarete tratta della materia relativa all'edificare come di una questione prioritaria ad una concretissima costruzione dell'immaginaria Sforzinda, dettagliata fino al computo e alla stima dei costi e dei materiali[12].

Ancora più significative sono, nella narrazione, le incertezze di Filarete riguardo all'ordine da dare alla materia nell'esposizione, le esitazioni tra la priorità da attribuire alla costruzione concreta, l'approvvigionamento dei materiali e il disegno:

> A me par pure dovere cominciare in prima a edificare questa città; ma innanzi, come t'ho detto, farò prima el disegno; poi, secondo mi parrà e secondo ne verrà il bisogno di tutte quelle cose le quali faranno mestiero, allora dichiareremo tutte le sopradette cose, o vero io da poi ne farò uno trattato di per sé[13].

La preminenza degli argomenti tecnici nello scritto di Filarete ha un ulteriore aspetto. Nella narrazione, le questioni tecnico-costruttive sono spesso sollevate dal signore, da suo figlio e da madonna. Nel libro III è il signore cui il trattato è inizialmente dedicato, Francesco Sforza, che si informa sul tipo di terra da scegliere nella produzione dei laterizi[14]; nella costruzione dell'ospedale di Sforzinda è suo figlio Galeazzo Maria che chiede spiegazioni sulla pulizia dei destri[15]. L'esempio più rilevante rimane tuttavia nel libro XVI l'attenzione di una donna, Bianca Maria Visconti, per le questioni costruttive relative alla chiesa del romito:

> 'Dimi quanto il facevi tu grosso quello fondamento'. 'Io l'avevo ordinato di quattro braccia grosso di quelle di Bergamo, le quali sono una oncia meno e uno decimo men che quelle di Milano'. 'E io voglio siano braccia cinque grosse, perché a me pare che quanto più è grosso il fondamento debba essere migliore'[16].

La rilevanza degli argomenti tecnico-costruttivi nella struttura dialogica può essere letta come portatrice di un messaggio retorico ambivalente:

Opus Incertum (2020) pp. 12-21 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12357 www.fupress.com/oi

PERCHE' honoſamto tu eſſere' excellente' et dile
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domo ppetua & degnia fama o Magnifico Piero den
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intendere' modi & miſure' dello hedificare' queſta et
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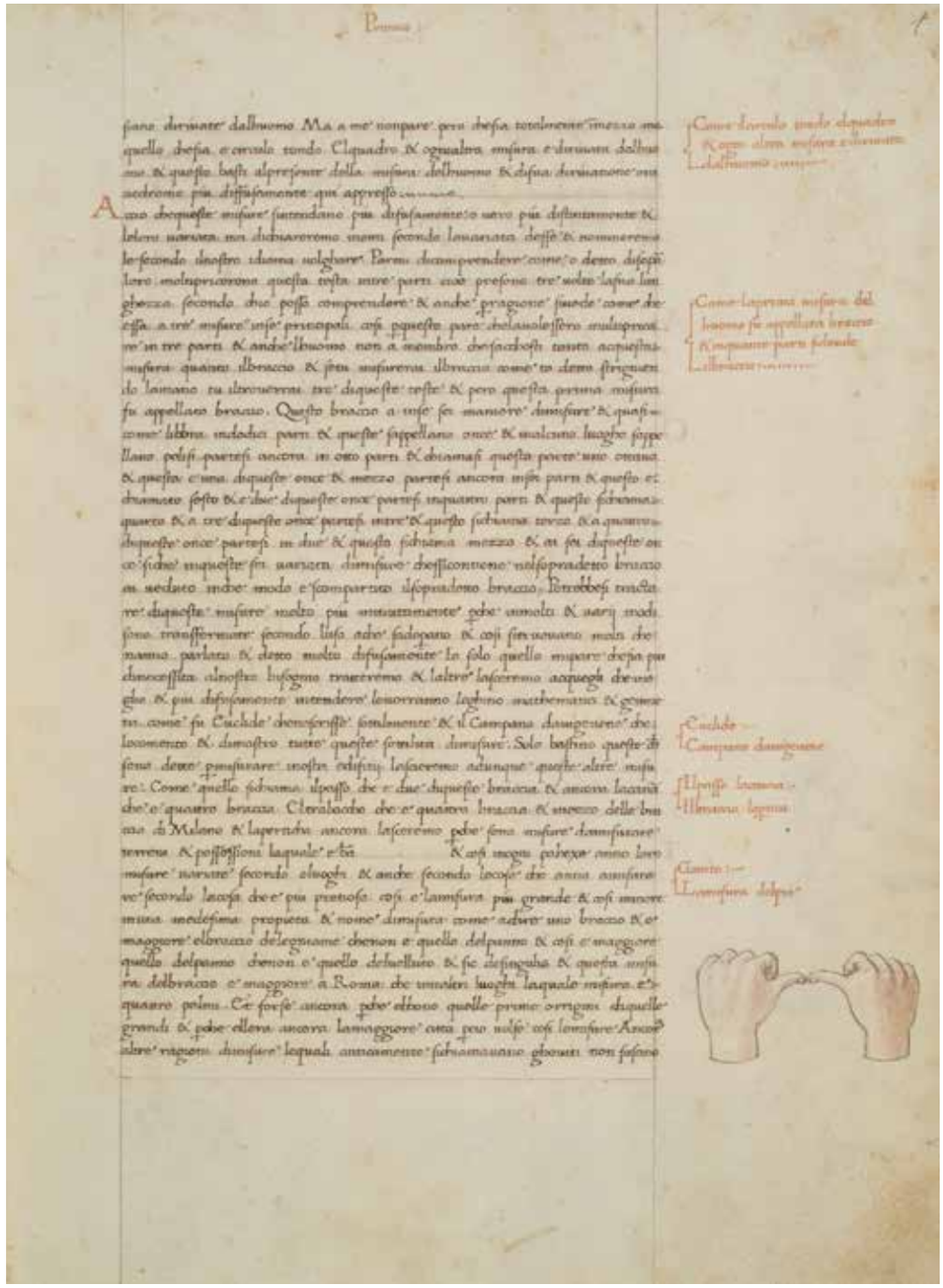
gniſſimo riputo tenghaleti diporta dire che que'
ſto ſidica acompiacenza ne audumpta conſiderato
da luteſtimonanza appare' nelli excelſi diſitij fatti plo magnifico & degniſſimo
tuo padre' Coſimo & pte' ancora ſtabiliti & hordinati inmiquali lornatiſſima a
cappella della immaculata deſerti diſirenze & altre degne' coſe' inſirenze & di
fuori non che propinqui alla noſtra citta mafuori della toſcana muarij luoghi
i Milano una degnia caſa come' nelmagneſimo quinto libro ſiriche' coſi altri di
fitij ploro fatti malaſciamo horta ſtare' nelle' parti noſtre' dicalta mapermſtro
allinfedeli amo fatto falbricare' & hedificare' degni hedifitij done ſiervona a
queſti noſtri tempi huomini priuati eſſere' diuenuti fama & degnia loda quanto
queſte laltre' loro uirtu & particularita dreſiconuerrebbe' loro nomuoglio dire
quanto fu laprudenza & lhumanita diconſeruare' loſtato diſe' & della ſua repu
blica & coſi ancora acreſcerlo manomuoglio inqueſto diſtendere' palopreſente' pche'
ilnoſtro ſuggetto non e' ſtrone' dello hordine' delli hedifici & laquale' optimamete'
auete' meſſo & dreſſa uero ſpecchio inſan lorenzo inſan Marcho & neghalti che
uedere' ſipoſſono ſiche' auendomi affaticato acomponere' queſta hopa ſtimai ple
migioni ſopradette' & ancora plabenuolenza & amore' che' riporto & ate'
eſſere' grato uederla & pqueſto ate' ladirizzo benche' non come' ſiconuenne
bbe' ſia degnia ſi priſpecto dilua magnificenza & ſi ancora peſſa hopa che
meritterebbe' eſſere' inlatino & none' inuolghare' maſtimando io dopin eſſere' in
teſa & ancora' pche' inlatino ſeneruona dadegniſſimi huomini eſſe' ſtate dele
quali credo noſia coproſo. Come ſiſia pigliala non come da Veetruuio ne dallial
tri degni architetti ma come' daltuo filareto Architetto Auſonio auerunorio
ſtentino ilquale' fece' leporte' diſtupiero di Roma dbronzo ſolpite didegnie' mem
orie' di Vgenio quarto ſommo pontifice' ſotto ilquale' lefabricai & nolla citta
di Milano iloloriolo alberghi depoueri dicto ſotto Franceſco ſforza duca quart
dumilano elquale' colla ſua mano laprima pietra nelfondamento colloco & altre to
ſe' pme' tieſſa hordinate lachieſa maggiore di Bergamo Ancora hordinai & iqueſto

Auctor Antonius Auſonius

pagina 13
Fig. 1 *Averlino detto il Filarete, Trattato di architettura… cit. Pagina di frontespizio (BNCF, Magliabechiano II.I.140, f. 1r; © Ministero per i beni e le attività culturali e per il turismo / Biblioteca Nazionale Centrale di Firenze).*

Fig. 2 *Averlino detto il Filarete, Trattato di architettura… cit. Misura del braccio (BNCF, Magliabechiano II.I.140, f. 4r; © Ministero per i beni e le attività culturali e per il turismo / Biblioteca Nazionale Centrale di Firenze).*



con la scrittura di un trattato tecnico viene affermata l'autorità e il nuovo ruolo dell'architetto-artigiano, indispensabile d'altro canto al signore nella sua strategia di definizione di un'immagine pubblica. In primo luogo, quindi, la competenza tecnica contribuisce a rafforzare lo status dell'architetto[17], che in alcuni casi – ma solo incidentalmente nel caso dell'*architettonico libro* – fa ben valere il segreto dell'arte che lo rende indispensabile al principe[18].

In un trattato inteso probabilmente per un uso interno alla corte[19], i passaggi tecnico-costruttivi appaiono d'altro canto necessari al signore per accrescere il controllo esercitato sugli aspetti materiali della costruzione[20]. La costruzione fa parte degli ambiti nei quali il signore deve poter intervenire, e alcuni passaggi sembrano confermare questa lettura[21], fornendo al signore gli strumenti per un giudizio autonomo sull'architettura che passa anche attraverso questioni costruttive di *firmitas*[22] e non solamente attraverso i modi dell'architettura (fig. 2). Anche in questo caso, la scrittura di argomenti tecnici potrebbe sembrare esclusivamente funzionale al consolidamento dell'immagine e dell'autorità del signore[23].

Un ulteriore elemento per la discussione di questo punto, tuttavia ambiguo nel significato, proviene dalla versione latina del trattato (fine degli anni Ottanta del Quattrocento)[24]: qui, pur sfrondando abbondantemente le digressioni narrati-

[1] F. Milizia, *Opere complete risguardanti le belle* arti, II (*Dizionario delle belle arti del disegno ed. corretta ed arricchita di moltissimi vocaboli*), Bologna 1827, p. 27. Nel giudizio sul trattato, Francesco Milizia segue la tradizione inaugurata da G. Vasari, *Le Vite de' più Eccellenti Pittori, Scultori, e Architettori*, Firenze 1568, III, pp. 243-247. Sulla fortuna del testo si vedano M. Beltramini, *Antonio Bonfini. La latinizzazione del trattato di architettura di Filarete (1488-1489)*, Pisa 2000, pp. III-V e Ead., *Le illustrazioni del Trattato d'architettura di Filarete: storia, analisi, fortuna*, "Annali di Architettura", XIII, 2001, pp. 40-43.

[2] Il valore come fonte è stato messo in evidenza soprattutto da H. Saalman, *Early Renaissance Architectural Theory and Practice in Antonio Filarete's* Trattato di Architettura, "The Art Bulletin", XLI, 1959, 1, pp. 89-107. Più di recente, H.W. Hubert, *In der Werkstatt Filaretes: Bemerkungen zur Praxis des Architekturzeichens in der Renaissance*, "Mitteilungen des Kunsthistorischen Institutes in Florenz", XLVII, 2003, 2-3, pp. 311-344 e A. Dressen, *Pavimenti decorati del Quattrocento in Italia*, Venezia 2008, pp. 11, 38, 60, 235-241.

[3] Alcuni aspetti sono stati analizzati in J.R. Spencer, *Filarete's Description of a Fifteenth Century Italian Iron Smelter at Ferriere*, "Technology and Culture", IV, 1963, 2, pp. 201-206 e C.S. Smith, *Granulating Iron in Filarete's Smelter*, "Technology and Culture", V, 1964, 3, pp. 386-390.

[4] Il valore degli scritti tecnici medievali e rinascimentali come fondamento per la nascita di una "new science" è un aspetto largamente dibattuto nell'ambito della storia della scienza. Si vedano P.H. Smith, *The Body of the Artisan. Art and Experience in the Scientific Revolution*, Chicago 2004 (con riferimento al contesto fiammingo) e gli studi di Pamela Long, in particolare *Artisan/Practitioners and the Rise of the New Sciences, 1400-1600*, Corvallis 2011.

[5] Questo aspetto è stato messo in evidenza da Maarten Delbeke durante il convegno *Building Techniques and Writings on Architecture between Italy, France and the Low Countries* (Namur e Bruxelles, 26-27 febbraio 2015). Il riferimento è alla prefazione del libro II sui materiali da costruzione: il raffinamento delle tecniche architettoniche porta gli uomini "dalla vita belluina e selvatica alla mite socievolezza". Vitruvio, *De architectura*, a cura di P. Gros, Torino 1997, I, pp. 123-125. Più in generale, sugli aspetti retorici del *De architectura* si veda P. Gros, *Vitruve et les ordres*, in *Les traités d'architecture de la Renaissance*, actes du colloque (Tours, 1-11 juillet 1981), éd. J. Guillaume, Paris 1988, pp. 49-59: 58. Sul legame tra studi vitruviani e cultura artigianale un contributo significativo è quello di Long, *Artisan/Practitioners*… cit., pp. 8 e 62-93.

[6] P.O. Long, *Openness, Secrecy, Authorship. Technical Arts and the Culture of Knowledge from Antiquity to the Renaissance*, Baltimore-London 2001, p. 127 per il caso di Roberto Valturio.

[7] J.R. Spencer, *La datazione del trattato del Filarete desunta dal suo esame interno*, "Rivista d'arte", III s., XXXI, 1958, pp. 93-103; L. Grassi, *Introduzione*, in A. Averlino detto il Filarete, *Trattato di architettura*, a cura di A.M. Finoli, L. Grassi, Milano 1972, pp. XI-XIII; Beltramini, *Le illustrazioni del Trattato d'architettura*… cit., p. 30. Per la datazione si veda anche F. Cagliotti, D. Gasparotto, *Lorenzo Ghiberti, il "sigillo di Nerone" e le origini della placchetta "antiquaria"*, "Prospettiva", 85, 1997, pp. 37-38.

[8] Tra gli studi sul genere letterario possiamo citare: J. Onians, *Alberti and ΦΙΛΑΡΕΤΗ. A Study in their Sources*, "Journal of the Warburg and Courtauld Institutes", XXXIV, 1971, pp. 96-114; S. Lang, *Sforzinda, Filarete and Filelfo*, "Journal of the Warburg and Courtauld Institutes", XXXV, 1972, pp. 391-397; A. Tönnesmann, *Il dialogo di Filarete. L'architetto, il principe e il potere*, "Arte Lombarda", n. s., 155, 2009, 1, pp. 7-11; B. Hub, *Persuasive Wort-Bild-Strategien in der Architekturtraktaten der italienischen Frührenaissance*, in *Bilder in historischen Diskursen*, herausgegeben von F. Eder *et al.*, Wies-

ve, Antonio Bonfini mantiene di regola le informazioni tecniche che, nella loro nuova veste latina, contribuiscono decisamente all'autorevolezza antichizzante dello scritto[25]. La circostanza può essere letta come segno di interesse da parte dei contemporanei nei confronti dei passaggi costruttivi, e contemporaneamente conferma come sia soprattutto su argomenti tecnologici che Mattia Corvino basi l'esercizio della "virtù regale della magnificenza"[26].

Come vedremo, tuttavia, la lettura dei passaggi tecnico-costruttivi dell'*architettonico libro* come esclusivamente funzionali all'autopromozione dell'architetto e alla costruzione dell'immagine del principe risulta indebolita e resa più complessa da ulteriori elementi. L'innegabile componente retorica, in ogni caso, non permette di escludere che nella discussione di argomenti tecnici Filarete riproponga condizioni reali nella trasmissione della conoscenza, che avviene oralmente nel dialogo tra il signore e l'architetto[27]. Forse idealizzandole[28], Filarete potrebbe trascrivere nel trattato situazioni reali, come la dieta di Mantova del 1459 in cui è altamente verosimile la sua presenza accanto a Francesco Sforza[29], o le discussioni relative alla costruzione della chiesa di San Sigismondo a Cremona voluta da Bianca Maria Visconti[30]. Una lettura complessiva del trattato, "ridicolo e sciocco", che consideri questi elementi di veridicità – senza ridurre esclusivamente la narrazione a un'innegabile funzione autopromozionale – potrebbe aggiungere ulteriori tratti allo studio delle dinamiche di committenza.

Un atteggiamento empirico

Come si diceva, sebbene manchi ancora uno studio esaustivo sul contenuto e le prescrizioni dei passaggi tecnici nella loro interezza, alcune considerazioni generalissime sulle informazioni tecnologiche nel loro complesso sono tuttavia possibili. Il trattato risulta decisamente "down to earth"[31]: è ricco di considerazioni che dipendono dall'osservazione diretta ed è vissuto all'interno del cantiere, probabilmente un cantiere tardo gotico[32].

Consideriamo ad esempio la trattazione delle pietre da far calcina, nel libro III. Filarete propone una rassegna degli usi locali, afferma di aver "veduto e provato" che le migliori sono le pietre dei fiumi, in particolare Adda e lago di Angera. A Roma – riporta – "hanno una vantaggiata pietra, cioè tevertina", a Firenze l'alberese; sconsiglia l'uso del marmo per far calcina, osservato a Roma, "solo per questa miseria di non mandare a' luoghi dove ella nasce, ed èvene copia non troppo distante e anche assai comoda a condurla per rispetto del fiume"[33].

Nel brano in questione si rispecchia una cultura costruttiva assai ricca, acquisita nel corso dei frequenti spostamenti. Questa ricchezza di riferimenti permea in generale il trattato e ne costituisce un aspetto determinante (fig. 3)[34]. Filarete è a suo agio nel descrivere le tecniche di fondazione con pali in acqua "secondo si fa a Vinegia"[35], nel trattare di ingegneria idraulica, secondo una tradizione lombarda[36] o fiorentina[37], è a suo agio nell'utopia sociale che passa attraverso la solida organizzazione del cantiere e soprattutto attraverso la scala del cantiere. Conosce il cantiere fiorentino della prima metà del Quattrocento[38], i materiali e le tecniche costruttive di Roma antica e moderna[39] e, in un'occasione, il confronto tra antico e moderno si basa esplicitamente su considerazioni costruttive, ovvero sulla constatazione della *firmitas* degli archi antichi. Gli "archi tondi e grandi [veduti a Roma] stare forti"[40] vengono infatti contrapposti agli archi acuti dei moderni sulla base di considerazioni statiche.

La ricchezza di riferimenti del trattato, nella descrizione delle tecniche di costruzione, non è una circostanza del tutto originale – si pensi al *De re aedificatoria* di Leon Battista Alberti[41].

baden 2014, pp. 111-144. Una lettura del trattato come *roman à clef* in P. Tigler, *Die Architekturtheorie des Filarete*, Berlin 1963, p. 26.

[9] Libro I, f. 1*v* (Firenze, Biblioteca Nazionale Centrale – d'ora in avanti BNCF –, *codice Magliabechiano* II, I, 140). Viene aggiunto tra parentesi il riferimento all'edizione Averlino detto il Filarete, *Trattato di architettura*… cit., I, p. 7.

[10] Libro II, f. 11*r* (I, p. 53).

[11] Nell'organizzazione della materia il riferimento più immediato per Filarete è ovviamente il *De re aedificatoria* che viene ripreso per i contenuti del terzo libro (l'esecuzione dell'opera).

[12] Libro IV, ff. 22*r-v* (I, pp. 90-94). Sulla questione dell'utopia nella costruzione della città si veda H. Günther, *Utopische Elemente in Filarete's Idealstadt Plusiapolis*, in *Utopie, Fiktion, Planung*, herausgegeben von A. Dietl *et al.*, Regensburg 2014, pp. 197-220.

[13] Libro II, f. 11*v* (I, p. 53).

[14] Libro III, ff. 15*v*-16*r* (I, pp. 68-69).

[15] Libro XI, f. 79*v* (I, pp. 303-304).

[16] Libro XVI, f. 123*v* (II, p. 463). Sulla chiesa degli eremiti di San Girolamo, cui il passaggio si riferisce, si veda J. Gritti, *Filarete e la chiesa degli eremiti di san Girolamo: "…nel modo ch'io ordinai a Bergamo, che era bella"*, "Arte Lombarda", n.s., 155, 2009, 1, pp. 139-159. Un'interessante annotazione sulle competenze nelle questioni di architettura da parte di Barbara di Brandeburgo, moglie di Ludovico Gonzaga, in A. Calzona, *Ludovico III Gonzaga, principe «intendentissimo nello edificare»*, in *Il principe architetto*, atti del convegno internazionale (Mantova, 21-23 ottobre 1999), a cura di A. Calzona *et al.*, Firenze 2002, pp. 257-278: 270.

[17] Sulla questione del legame tra *techne* e *praxis*, la definizione di un nuovo status per l'artigiano connessa alla legittimazione dell'autorità del principe attraverso la scrittura del trattato tecnico, si rimanda allo studio di Long, *Openness*… cit., passim, in particolare p. 5, 14, 103, 106; sul complesso rapporto tra architetto e committente si veda *Il principe architetto*… cit. Nel caso specifico di Antonio Averlino cfr. H. Günther, *Society in Filarete's Libro Architettonico between Realism, Ideal, Science Fiction and Utopia*, "Arte Lombarda", n.s., 155, 2009, 1, pp. 56-80: 57 e P. Coen, *Il Trattato di Antonio Averlino, detto il Filarete: il ruolo di Galeazzo Maria Sforza, i "libri del disegno" e la realtà socio-professionale di un architetto al servizio del principe*, in *Vincenzo Foppa: tecniche d'esecuzione, indagini e restauri*, a cura di M. Capella, Milano 2002, pp. 233-245. Sulla committenza Sforza si rimanda inoltre a E.S. Welch, *Art and Authority in Renaissance Milan*, New Haven-London 1995.

[18] Cfr. Long, *Openness*… cit., in particolare pp. 134-136, sulla deliberata omissione di informazioni nel cosiddetto *Trattato I* (intorno al 1470) di Francesco di Giorgio.

[19] L'uso interno alla corte è evidente per la preziosa versione latina del trattato (Beltramini, *Antonio Bonfini. La latinizzazione*… cit.). Si veda in proposito anche la nota successiva.

[20] Sull'utilità della scrittura di tecnica per il signore si veda Long, *Openness*… cit., in particolare il capitolo 4: *Authorship on the Mechanical Arts in the Last Scribal Age*: pp. 102-142. Sull'uso del libro di Filarete interno alla corte, in particolare M. Reinoso Genoni, *Vedere e 'ntendere. Word and Image as Persuasion in Filarete's Architettonico Libro*, "Arte Lombarda", n.s., 155, 2009, 1, pp. 23-38; Hub, *Persuasive Wort-Bild-Strategien*... cit., e Id., *Filaretes Libro architettonico oder das illustrierte Architekturbuch in Zeiten der Oralität*, intervento in *Wege des Wissens in Kunst, Architektur und scienza des Humanismus. Studientag am Arbeitsbereich Baugeschichte und Denkmalpflege der Universität Innsbruck* (Innsbruck, 14.-15. April 2016).

[21] Libro XV, f. 115*r* (II, pp. 434-435). Nel passaggio in questione Filarete esplicitamente scrive per "insegnare" al signore a riconoscere chi è effettivamente "intendente" di architettura.

Fig. 3 *Averlino detto il Filarete, Trattato di architettura… cit. Cassero di pioppo con punte in ferro e ponte sull'Indo (BNCF, Magliabechiano II.I.140, f. 94v; © Ministero per i beni e le attività culturali e per il turismo / Biblioteca Nazionale Centrale di Firenze).*

Anche la ricchezza di riferimenti all'esperienza diretta si ritrova altrove nella trattatistica, ancora una volta nel *De re aedificatoria*[42] e negli scritti di Francesco di Giorgio[43]. Nel passaggio del *De re aedificatoria* dedicato all'uso della calcina, ad esempio, i riferimenti letterari si alternano a considerazioni che dipendono dall'osservazione diretta, come viene esplicitamente sottolineato: "da parte nostra abbiamo accertato…"; "del pari, ho osservato che in Gallia"; "noi, per esperienza diretta"; "ho notato quattro specie di gesso presenti in Italia"[44]. In un ambito che esula dagli scritti di architettura, il riferimento all'esperienza diretta è forte e insistito già in epoca medievale, nella descrizione dei fenomeni di fisica[45]. Nel *libro* di Filarete, che può essere quindi ricondotto ad una più ampia tradizione scritta, la prova e l'osservazione diventano elementi centrali sui quali poggia l'autorità del discorso – un aspetto che, come vedremo, potrebbe essere messo in relazione con l'apprezzamento, nell'ambiente delle corti italiane e in particolare di quella milanese, nei confronti di esperienza diretta e "practical knowledge"[46].

Proprio sull'osservazione e sull'esperienza, Filarete basa alcune sue critiche a Vitruvio. Il riferimento a Vitruvio[47] potrebbe essere considerato come uno degli elementi chiave della costruzione letteraria – nel dimostrare la sua familiarità con il testo antico l'autore intende rafforza-

[22] Solo a titolo di esempio, libro VII, f. 50*v* (I, p. 196) e libro VIII, f. 59*v* (I, p. 231) passaggio discusso in Saalman, *Early Renaissance Architectural Theory*… cit., pp. 91 e 97 per il forte legame tra *firmitas* e *venustas* nel trattato, comune a tutta la cultura fiorentina del Quattrocento.

[23] Si veda Long, *Openness*… cit., p. 5, a proposito del valore che ha "the display of technical knowledge in order to enhance one's social status or political power".

[24] Beltramini, *Antonio Bonfini. La latinizzazione*… cit., p. V, p. IX e in generale VI-XIX per la cronologia.

[25] Nel libro III, "nel descrivere le qualità dei diversi materiali da costruzione, Bonfini attinge direttamente alla fonte antica per il brano che decanta le caratteristiche ignifughe del legno di larice, arricchendo il racconto [di Filarete] di particolari […] del tutto assenti nel testo volgare" (Beltramini, *Antonio Bonfini. La latinizzazione*… cit., p. XXXVI e pp. XXXVI-XXXVII per un confronto dei passaggi in questione).

[26] Ivi, p. VII. Sono proprio le illustrazioni dei ponti nel manoscritto in volgare ad attirare l'attenzione del monarca, come risulta dalla dedica a Matteo Corvino: ivi, p. XXV e pp. 6-7 per il testo latino.

[27] Sulla veridicità dei dialoghi, si veda L. Olschki, *Geschichte der neusprachlichen Wissenschaftlichen Literatur*, I (*Die Literatur der Technik und der angewandten Wissenschaften vom Mittelalter bis zur Renaissance*), Vaduz 1969[2], p. 114 (prima ed. Heidelberg 1919); Günther, *Society in Filarete's Libro Architettonico*… cit., p. 58 sostiene che la posizione forte dell'architetto nei dialoghi potesse non essere distante da una situazione reale; Tigler, *Die Architekturtheorie des Filarete*… cit., p. 26 ipotizza che anche il ritrovamento del libro d'oro possa rifarsi a un episodio reale. Per le modalità di trasmissione di competenze tecniche in un contesto fiorentino, si rimanda al recente intervento di H. Burns, *The Lesson of Lorenzo: "Kitchen Cabinets" and Inter-class Friendships as Workshops for Innovation in Cinquecento Venice*, intervento in *Wege des Wissens*… cit.

[28] Welch, *Art and Authority in Renaissance Milan*… cit., pp. 147-148 sul trattamento economico di Filarete a Milano e più in generale sul rapporto con Francesco Sforza nel caso della costruzione dell'Ospedale Maggiore.

[29] Ringrazio Maria Beltramini per aver attirato la mia attenzione su questo punto e per la preziosa discussione sulla veridicità dei dialoghi. Per la partecipazione di Filarete al corteggio sforzesco a Mantova nel 1459 si veda M. Beltramini, *Questioni di stile? Francesco Sforza, Filarete e l'Ospedale Maggiore di Milano*, in *Architettura e identità locali*, a cura di L. Corrain, F.P. Di Teodoro, Firenze 2013, I, pp. 393-404: 393 con riferimento a L. Bertolini, *Ancora su Alberti e Filarete. Per la fortuna del* De pictura *in volgare*, in *Gli Antichi e i Moderni. Studi in onore di Roberto Cardini*, a cura di L. Bertolini, D. Coppini, Firenze 2010, I, pp. 125-166: 126-127 nota 6 e quindi a M. Simonetta, *Il Duca alla Dieta: Francesco Sforza e Pio II*, in *Il sogno di Pio II e il viaggio da Roma a Mantova*, atti del convegno internazionale (Mantova 13-15 aprile 2000), a cura di A. Calzona *et al.*, Firenze 2003, pp. 247-285: 266.

[30] Gritti, *Filarete e la chiesa degli eremiti di san Girolamo*… cit.

[31] Saalman, *Early Renaissance Architectural Theory*… cit., p. 89.

[32] Ivi, passim e Hubert, *In der Werkstatt Filaretes*… cit., p. 312, che mette in relazione la stesura del trattato con il contesto del cantiere tardo gotico del duomo di Milano. Anna Maria Finoli e Liliana Grassi (Averlino detto il Filarete, *Trattato di architettura*… cit., I, pp. 232-233, nota 1) mettono invece in relazione il sistema proporzionale "a due quadri, a uno e mezzo, a uno diamitro" suggerito da Filarete nel libro VIII con una cultura di matrice implicitamente greco-classica.

[33] Libro III, f. 15*r* (I, p. 66).

[34] Un'interessante lettura di Filarete come "assimilatore" in Beltramini, *Le illustrazioni del Trattato d'architettura*… cit., p. 40.

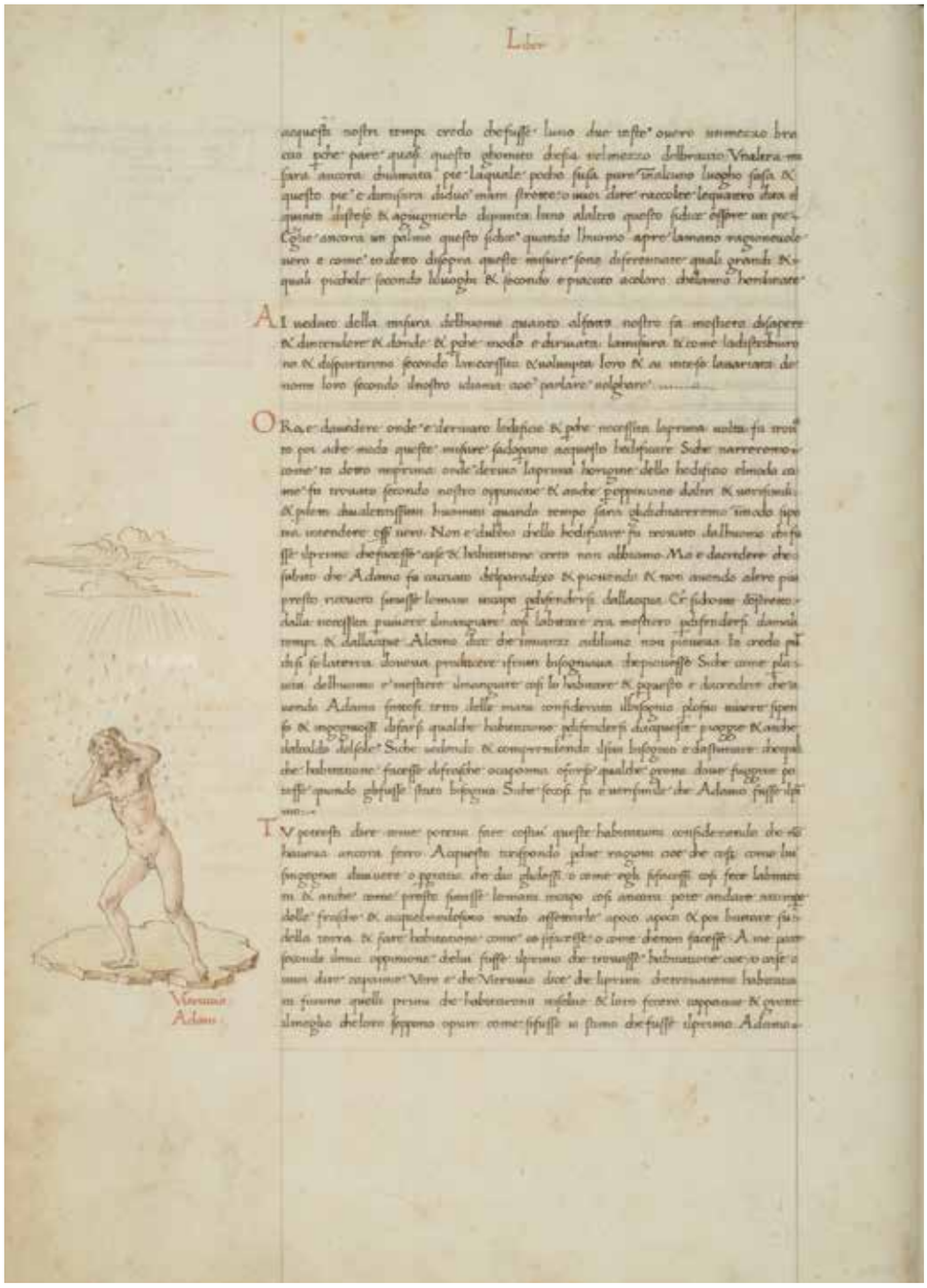


Fig. 4 *Averlino detto il Filarete, Trattato di architettura… cit. Adamo si protegge dalle intemperie (BNCF, Magliabechiano II.I.140, f. 4v; © Ministero per i beni e le attività culturali e per il turismo / Biblioteca Nazionale Centrale di Firenze).*

re uno status al quale ambisce e allude in diversi punti della narrazione[48]. Il ricorso ad un approccio che potremmo definire empirico, in un passaggio di critica al *De architectura*, rende tuttavia più complessa questa lettura:

> Vetruvio dice come il bellico è il mezzo della figura de l'uomo e che è come dire il punto d'uno sesto che si giri intorno, farà uno circulo, e quello sarà il punto centrico e di qui fa nascere l'arco. Ell'è assai buona ragione a confermare il nostro proposito che tutte le misure / siano dirivate da l'uomo, ma a me non pare, però, che sia totalmente in mezzo[49].

Le critiche a Vitruvio non sono rare nella trattatistica. Vitruvio viene criticato per la "scabrosità" del linguaggio, per la discrepanza tra le informazioni riportate nel testo e ciò che è deducibile dalle rovine[50], ma il commento di Filarete, in questo contesto, sembra dipendere da un approccio diverso, un'osservazione empirica, già attestata in Ghiberti, e qui confortata da una misurazione che finisce per intaccare il sistema proporzionale antropocentrico vitruviano. Il trattato antico, l'osservazione e lo studio empirico della natura sono rivestiti, nello scritto di Filarete, della stessa autorità[51]. In alcuni casi, come questo, l'osservazione e la pratica prevalgono sull'uso delle fonti.

Se la critica a Vitruvio ha già un precedente nei *Commentari* di Ghiberti, proprio su questo punto[52], lo stesso atteggiamento empirico emerge

[35] Libro XIII, f. 94*v* (I, p. 362).
[36] Günther, *Society in Filarete's Libro Architettonico*… cit., pp. 60 e 63.
[37] R.A. Goldthwaite (*The Building of Renaissance Florence. An Economic and Social History*, Baltimore-London 1980, p. 21) fa notare come i sistemi di scolo descritti da Filarete fossero in uso nella Firenze contemporanea.
[38] Saalman, *Early Renaissance Architectural Theory*… cit.
[39] Si vedano il passaggio sui marmi nel libro III, ff. 16*v*-17*r* (I, p. 71, p. 74) e nel libro IX, f. 67*r* (I, p. 256) quello su "una certa pasta di calcina" osservata nel Colosseo. Filarete descrive in Lazio, tra l'altro, la ferriera a Grottaferrata, libro XVI, f. 127*v* (II, p. 478).
[40] Libro VIII, f. 60*r* (I, p. 231).
[41] Sull'argomento sono decisivi gli studi di Pier Nicola Pagliara. Di recente si veda P.N. Pagliara, *L'esperienza costruttiva nel De re aedificatoria di Leon Battista Alberti*, in *Building Techniques in Architectural Treatises: Construction Practices versus Technical Writings*, éd. C. Cardamone, P. Martens, "Aedificare. Revue internationale d'histoire de la construction", 2017, 2, pp. 37-65. Maria Beltramini ha sottolineato come l'impulso alla redazione del trattato possa provenire proprio da Alberti: Beltramini, *Questioni di stile?*... cit., p. 393. Si veda Bertolini, *Ancora su Alberti e Filarete*… cit., per la conoscenza degli altri scritti albertiani, oltre al *De re aedificatoria*, da parte di Filarete.
[42] Cfr. Pagliara, *L'esperienza costruttiva*… cit., soprattutto p. 41 dove viene messa in evidenza "la preminenza dell'osservazione e della verifica diretta rispetto alle fonti scritte" nelle pagine dedicate ai legnami.
[43] Long, *Openness*… cit., pp. 134-137 e Ead., *Artisan/Practitioners*… cit., pp. 41-47; si veda anche il contributo di Sophie Elaine Wolf (*Francesco di Giorgio on Mechanics: A Quattrocento Lesson on the Transmission of Knowledge*) in questo volume.
[44] L.B. Alberti, *L'architettura. De re aedificatoria*, a cura di P. Portoghesi, G. Orlandi, Milano 1966, I, pp. 152 e 154.
[45] Ringrazio Ivano Dal Prete per i preziosi suggerimenti che hanno permesso di meglio contestualizzare il trattato di Filarete all'interno di un'ampia tradizione di scritti tecnici in volgare. Un esempio precoce di "artisanal epistemology" è *La composizione del mondo colle sue cascioni* di Restoro d'Arezzo (1282), pittore e orafo: cfr. I. Dal Prete, *The Ruins of the Earth. Learned Meteorology and Artisan Expertise in Fifteenth-Century Italian Landscapes*, "Nuncius", 33, 2018, pp. 415-441. Nello stesso articolo Dal Prete ricorda che Leon Battista Alberti è autore della prima descrizione nota in letteratura degli strati geologici (ivi, p. 430, con riferimento a Alberti, *L'architettura*… cit., p. 178). Una separazione netta tra i differenti ambiti della scienza, ancora nel Quattrocento e all'inizio del Cinquecento, non riproduce la situazione reale. Per gli studi di geologia di Leonardo da Vinci, cfr. ivi, pp. 432-441 con ampia bibliografia precedente.
[46] Per il caso della corte milanese si rimanda a M. Meserve, *Nestor Denied: Francesco Filelfo's Advice to Princes on the Crusade against the Turks*, "Osiris", XXV, 2010, 1, pp. 47-65.
[47] Per la forte presenza di Vitruvio, la cui lettura è mediata dagli umanisti milanesi, si vedano Lang, *Sforzinda, Filarete and Filelfo*… cit.; Beltramini, *Le illustrazioni*… cit., p. 27; Long, *Artisan/Practitioners*… cit., pp. 73-80.
[48] Filarete vince la veste del signore con la scommessa di terminare la costruzione delle torri in due giorni, libro V, ff. 31*v*-32*r* (I, pp. 126-127); è invitato ripetutamente a desinare alla tavola del signore, libro IV, f. 28*v* (I, p. 116), libro V, f. 31*v* (I, p. 126: "a' piè della sua tavola"); libro VI, ff. 44*v*-45*r* (I, p. 174: "in una tavola non troppo di lunga da la sua"). Elementi interessanti sul contesto e sul valore del *libro* di Filarete nel processo di definizione della professione di architetto in E. Merrill, *The* Professione di Architetto *in Renaissance Italy*, "Journal of the Society of Architectural Historians", LXXVI, 2017, 1, pp. 13-35, in particolare pp. 21-23.

con nettezza ancora maggiore in un passaggio dell'*architettonico libro* in cui stavolta, nel trattare dell'origine dell'architettura, Filarete si trova a discutere la tradizione del diluvio universale. La questione è se piovesse prima del diluvio, se Adamo avesse necessità di proteggersi dalle intemperie e fosse quindi il primo costruttore (fig. 4):

> Sì come costretto dalla necessità per vivere il mangiare, così l'abitare era mestiero per difendersi da' mali tempie dall'acque. Alcuno dice che innanzi a diluvio non pioveva, *io credo pur di sì*: se la terra doveva producere i frutti, bisognava che piovesse[53].

Filarete aggiunge alla discussione del fenomeno una nota basata sull'osservazione empirica ("se la terra doveva producere i frutti, bisognava che piovesse"), secondo un atteggiamento probabilmente consueto nell'ambito degli artigiani suoi contemporanei, ed è ormai assodato che sia proprio questo atteggiamento empirico a fornire i presupposti per il metodo scientifico che si delineerà nei decenni successivi[54].
La rilevanza della riflessione e dell'osservazione autonome emerge anche in altri ambiti– la costruzione dei ponti, la scelta dei legni per la costruzione delle fondazioni – in cui Filarete pur riprendendo una tradizione consolidata nella letteratura, non manca di sottolineare ripetutamente il valore della propria esperienza:

> [le tavole] io gli farò pure di rovore, perché di questo *n'ho veduto la sperienza*, ché *ho veduto* di quello essere stato tempo infinito sotto l'acqua essere divenuto nero come carbone, essere più duro mille volte che se fusse stato fuori dell'acqua o sopra terra[55].

È lo stesso atteggiamento che spinge Filarete a generalizzare, in un passaggio sulla costruzione di Plusiapolis, alcune osservazioni di fisica idraulica[56], e, in un ulteriore punto, a fare riferimento a una pratica che potremmo definire sperimentale – non del tutto estranea a una cultura artigianale anche in epoca premoderna[57]. Si tratta della descrizione di due colonne in pietra dura fine che Filarete vede nell'Aracoeli. La questione che Filarete discute è se queste pietre siano naturali o artefatti – un argomento che apre uno scorcio sulla cultura empirica artigianale all'interno della quale il trattato è prodotto:

> Vogliono alcuni ch'elle sieno misture fatte artificialmente, il che par quasi mezzo verisimile per quelle tali misture che appaiono in esse e' varii colori; per queste misture di colori dicono molti che le facevano artificiosamente, come ho detto. Io ho ben veduto a Roma molti che paiono proprio misture, e massime due colonne / che sono in Araceli, che c'è dentro molte e varie ragioni di colori e pezzi assai grandi che paiono proprio fatti manualmente. Ma non è per ciò, perché io n'ho fatto pruova e messole al fuoco, al quale sono molto dure e per un aspro fuoco si vetrificano, sì che se fusse mistura, non farebbe quella resistenza e non vetrificherebbe, per la qual cosa io non lo credo, perché non è verisimile[58].

Il passaggio prosegue sottolineando ulteriormente e con vigore il valore attribuito alla prova diretta:

> Credo bene si possa fare mistura con calcina e con pietre e altre cose che sono durissime, perché n'ho provate alcune le quali, quando accadrà, le potrai vedere e imparare, perché, come dico, l'ho provate, e son durabili e fortissime[59].

L'accento posto sull'esperienza, così come una continua riflessione che emerge dal trattato sul valore di questa, sono uno straordinario documento di quella che è stata definita "artisanal epistemology", e che possiamo ipotizzare caratterizzi la cultura artigianale fiorentina già dai secoli precedenti[60].

Riflessioni epistemologiche

Il valore epistemologico dell'osservazione diretta, della "sperienza", della presenza sul cantiere, viene sottolineato esplicitamente in diversi punti. Il trattato è caratterizzato infatti da una rifles-

[49] Libro I, ff. 3*v*-4*r* (I, p. 20). Il riferimento è al *De architectura*, III, 1, 3 (Vitruvio, *De architectura*… cit., I, pp. 238-239).
[50] Alberti, *L'architettura*… cit., II, p. XXX. Per uno studio della questione, in un periodo tuttavia successivo, si rimanda a *Antonio da Sangallo the Younger and the Making of the Ionic Capital*, in *Building Techniques in Architectural Treatises*… cit., pp. 95-117.
[51] Il commento di Filarete conferma quindi un'ipotesi di studio di Long, *Artisan/Practitioners*… cit., p. 8: la tradizione vitruviana offra un terreno comune a artigiani e accademici per l'analisi empirica di questioni costruttive cruciali, in questo caso questioni proporzionali.
[52] Su questo punto si veda Liliana Grassi, Averlino detto il Filarete, *Trattato di architettura*… cit., I, pp. 20-21, nota 2 con riferimento a L. Ghiberti, *I commentari*, a cura di O. Morisani, Napoli 1947, p. 214. Per la trascrizione del passaggio, *Der dritte Kommentar Lorenzo Ghibertis*, herausgegeben von K. Bergdolt, Weinheim 1988, p. 562: "Ancora non mi pare del centro sia el bellico, parmi debba essere dove è 'l membro genitale et doue e' nasce ouero ou'è la inforcatura umana. Ancora mi pare el suo centro non possa in altro luogo poter porsi altro che in detto luogo". Come fa notare Bergdolt, in un precedente passaggio (ivi, p. 552) Ghiberti riprende invece la tradizione vitruviana: "Ancora il meco centro del corpo dell'uomo naturalmente è l'umbilico sendo el punto della sexta, intorno farà il cierchio toccante la mano lo meco dito d'essa e ancora e piedi uedesi d'essa statua essere tanto l'alteca quanto la largeca, toccando sempre la stremità del cierchio".
[53] Libro I, f. 4*v* (I, p. 24), il corsivo è mio. Il passaggio è commentato in J. Rykwert, *La casa di Adamo in Paradiso*, Milano 1991, p. 139.
[54] Sull'atteggiamento empirico si veda nota 4. In questo passaggio Filarete, riprendendo una credenza apparentemente già diffusa all'epoca in cui scrive, propone il diluvio come un discrimine, come evento che segna un termine per il clima edenico attestato dalla *Genesi* ("alcuno dice che innanzi a diluvio non pioveva"), credenza che ha il vantaggio di conciliare le leggi di fisica terrestre dedotte dall'osservazione con quelle che dipendono invece dalla lettura della *Genesi*. Si noti che Filarete non mette qui in discussione il fenomeno di un diluvio universale, come invece avviene nelle università già in epoca medievale. Sulla questione: I. Dal Prete, *Climate and Meteorology: From Aristotelian Natural Philosophy to the Eighteenth Century*, in *Encyclopedia of Early Modern Philosophy and the Sciences*, edited by D. Jalobeanu, C.T. Wolfe, Cham 2019, pp. 1-8; K.A. Vogel, *Sphaera terrae - das mittelalterliche Bild der Erde und die kosmographische Revolution*, Dissertation zur Erlangung des Doktorgrades, Universität Göttingen 1995.
[55] Libro XIII, f. 95*r* (I, p. 363), il corsivo è mio. Il passaggio prosegue riportando l'esperienza avuta sul cantiere del duomo di Bergamo. Non si tratta di considerazioni originali (per l'uso del legno di rovere si veda Alberti, *L'architettura*… cit., I, p. 120). È significativo tuttavia l'accento posto sull'esperienza personale che conferma quanto acquisito anche per via letteraria.
[56] Libro XIII, f. 99*r* (I, p. 378): "Ma quanto non fusse stato, pure vi sarebbe andata, perché tanto sale l'acqua quanto discende". Si tratta dell'approvvigionamento d'acqua per la fortezza di Plusiapolis. Sarebbe auspicabile un confronto su questioni di ingegneria idraulica con quanto osservato da Mariano Taccola: cfr. M. Taccola, *Liber tertius de ingeneis ac edifitiis non usitatis*, Milano 1969, pp. 137-138.
[57] Long, *Artisan/Practitioners*… cit., pp. 31-37.
[58] Libro III, ff. 17*v*-18*r* (I, p. 76).
[59] Libro III, f. 18*r* (I, p. 77).
[60] Smith (*The Body of the Artisan*… cit., pp. 59-93) dedica un capitolo all'"artisanal epistemology" in un contesto fiammingo e germanico. Secondo Pamela Smith in questo ambiente gli artigiani "articulated ideas about the pursuit of natural knowledge – an epistemology" (ivi, p. 59).

sione ininterrotta sulla "scienzia di grande intelletto" che è l'architettura, "che non sanza grande studio si acquista"[61]. Si tratta di incidentali ma cruciali osservazioni che lasciano emergere una riflessione coerente sulla validità e la rilevanza degli strumenti – scrittura, disegno, osservazione diretta – per la correttezza e l'affidabilità della trasmissione delle conoscenze tecniche e sul valore della scrittura come veicolo di questa trasmissione[62].

Alla scrittura viene attribuito un ruolo ben preciso ma secondario nella trasmissione delle conoscenze costruttive. Non solo opera letteraria, la scrittura viene presentata nella narrazione innanzitutto come uno strumento indispensabile di supporto alla memoria, una funzione che del resto condivide con il disegno. Nel libro VI è il signore che interviene direttamente nella progettazione della rocca, e si rivolge a Filarete:

> Truovami un paio di seste o due e una riga, ché te lo voglio disegnare in su un foglio tutto il fondamento, e poi seguiterai secondo ti dirò; e truova uno libro, e scriverrai tutte queste cose, misure e modi ch'io ti dirò, a ciò che se pure t'uscisse di mente, che tu possa ricorre alla scrittura del libro per riavella. 'Ecco le seste, il libro e la riga'. Fa' ricordo, adunque, in questo sesto libro di queste dette misure in questa forma[63].

Il concetto viene ripreso alla lettera solo alcune pagine dopo, ed è sempre il signore ad insistere sul valore mnemonico della scrittura: "Scrivi, acciò che quando t'uscisse di mente, tu abbia da poterla riavere"[64]. Nel libro VII, l'argomento viene nuovamente affrontato quando Galeazzo Maria Sforza passa nella bottega di Filarete per imparare il disegno[65]. L'edificio a cui Filarete sta lavorando "saria difficile a tenere a mente se non si scrivesse"[66]. Nella finzione letteraria, tuttavia, è il figlio del signore che intraprende la scrittura materiale del libro VII, non soltanto perché "vulunteroso" ma soprattutto perché "veloce"[67] – più veloce, possiamo supporre, dell'artigiano che detta[68]. "Far […] ricordo"[69] è quindi una delle funzioni principali della scrittura come emerge dal trattato, supporto indispensabile per la trasmissione di argomenti scabrosi che devono essere letti, studiati e memorizzati[70].

Filarete si dimostra tuttavia scettico sulle effettive potenzialità della scrittura per la trasmissione di un sapere tecnico[71]. L'inadeguatezza della scrittura nella trasmissione dettagliata delle conoscenze tecniche cresce con la complessità di queste conoscenze, come nel caso del forno per la colatura dei metalli descritto nel libro XVI, "il quale è in uno modo fatto che male a parole si può dare a 'ntendere, neanche per disegno non bene in tutto si può intendere, pure il meglio si potrà e che saperrò vi dirò, e con disegno tanto che quanto sarà possibile il chiariremo" (fig. 5)[72].

Nonostante alcune esitazioni, alcune elusioni nella trascrizione di informazioni tecniche possano in parte essere chiarite da una considerazione generale sul "non detto" che apre il libro II[73], lo scetticismo di Filarete nei confronti della scrittura non è completamente riconducibile a questo unico punto. La riflessione sulla scrittura costituisce un vero e proprio filo conduttore del trattato che riemerge ad esempio nella descrizione del monastero benedettino, nel libro XI[74], e, alcuni fogli dopo, in quella dell'ospedale di Sforzinda, a proposito del quale "tutto non si può dire come a vedere coll'occhio"[75]. La scrittura non coglie i dettagli, è lenta e tortuosa nell'*ekphrasis*, nella descrizione degli ornamenti, dei particolari[76] e dello spazio[77].

Questa "fatica" nella scrittura viene solo parzialmente alleviata dalla possibilità di trasmettere le informazioni attraverso il disegno.

> E così per ordine si farà tutto, e ancora nel fare si faranno meglio che per disegno non si può mostrare, neanche a parole si possono dire queste cose come quando si fanno, se colui che fa le sa ordinare[78].

[61] Libro XIII, f. 100*r* (I, p. 381).

[62] Sull'argomento, più in dettaglio, si veda C. Cardamone, *Alcune note sulla scrittura di tecnica nel* Trattato di architettura *di Antonio Averlino*, *Materia, Struttura e Filologia. Nuovi contributi sull'Architettura del Rinascimento*, atti del convegno internazionale in onore di Pier Nicola Pagliara (Roma, 23 aprile 2018), a cura di F. Benelli, in corso di stampa. Considerazioni analoghe a quelle di Filarete nel *De re aedificatoria*, in apertura al VI libro, è possibile abbiano un valore principalmente letterario. Si veda V. Biermann, *L'introduzione al VI libro e le* virtutes dicendi *retoriche*, in *Leon Battista Alberti teorico delle arti e gli impegni civili del* De re aedificatoria, atti del convegno (Mantova, 17-19, 23-25 ottobre 2003), a cura di A. Calzona *et al.*, Firenze 2007, pp. 605-617.

[63] Libro VI, f. 37*v* (I, p. 148). Sul passaggio in questione si rimanda a Coen, *Il Trattato di Antonio Averlino, detto il Filarete… cit.*, p. 237.

[64] Libro VI, f. 39*r* (I, p. 153).

[65] Sul principe e la pratica del disegno si veda Calzona, *Ludovico III Gonzaga… cit.*, soprattutto pp. 268-269.

[66] Libro VII, f. 46*v* (I, p. 180). Sul valore della scrittura per "tenere a mente" procedimenti tecnici che iniziano a diventare troppo complessi già nella prima metà del Quattrocento: Long, *Openness… cit.*, pp. 117-118 e in generale il paragrafo sul *German-language Writings on Gunpowder Artillery and Machines*, pp. 117-122. Sull'argomento si vedano anche M. Carpo, *L'architettura dell'età della stampa: oralità, scrittura, libro stampato e riproduzione meccanica dell'immagine nella storia delle teorie architettoniche*, Milano 1998, pp. 29-31, 39-44 e Id., *Architecture. The Rise of Technical Design and the Fall of Technical Memory in the Renaissance*, in *Memory and Invention*, edited by A.M. Busse Berger, M. Rossi, Florence 2009, pp. 23-36.

[67] Libro VII, f. 46*v* (I, p. 180).

[68] In diversi passaggi Filarete esprime un certo imbarazzo nel non padroneggiare a sufficienza il mezzo, ad esempio libro XIII, f. 93*r* (I, p. 355): "Benché a me pur fusse fatica lo scrivere, pure per ubidire il Signore, mi missi a scrivere".

[69] Libro VII, f. 54*r* (I, p. 209). La scrittura emerge dal trattato anche come strumento per veicolare un'eredità culturale. Il libro d'oro di Plusiapolis è infatti lasciato ai posteri "acciò che possino avere notizia delle nostre cose" (libro XIV, f. 105*r*; I, p. 398).

[70] Libro VII, f. 47*r* (I, pp. 181-182): "Io vel dirò e dirovi come io ho fatto, ma metterete ben mente a scrivere, perché sono queste cose dell'edificare molto scabrose per loro medesime, e questo è per tanti variati modi e nomi delle cose le quali s'adoprano, ma io mi sforzerò quanto sarà possibile dirle chiare".

[71] All'epoca in cui Filarete scrive, è ancora aperta la questione sul tipo di informazione meglio veicolabile attraverso la scrittura o attraverso il disegno. Nel trattato, a causa delle modalità di riproduzione manoscritta, la quasi totalità delle indicazioni dimensionali passa attraverso il testo e non il disegno: Beltramini, *Le illustrazioni… cit.*, p. 25. Per un contesto, Carpo, *L'architettura nell'età della stampa… cit.*, in particolare p. 141 per il caso del trattato di Filarete. La questione più generale riguarda l'utilità e le potenzialità di uno strumento nuovo per l'architetto. Questo aspetto è stato discusso da Francesco Benelli in occasione del convegno *Building Techniques and Writings on Architecture between Italy, France and the Low Countries… cit.*

[72] Libro XVI, f. 127*r* (II, pp. 475-476). In diversi punti Filarete insiste sull'"apertura" e sulla chiarezza della sua scrittura: ad esempio libro VII, f. 47*r* (I, p. 182); libro XV, f. 121*r* (II, p. 452) a proposito delle cose "oscure". La non trasmissibilità di un sapere tecnico attraverso la scrittura non dipende quindi dalla difesa di un segreto tecnologico, vedi nota 16.

[73] Libro III, f. 14*v* (I, p. 65): "Benché io so che queste son cose che non bisognano troppo insegnare, perché sono cose grosse e sono tanto usate che so che le sapete molto bene".

[74] Qui Filarete sottolinea che "né per disegno, neanche a parole si può così espricare né dimostrare come quando si mura": libro XI, f. 78*v* (I, p. 298).

[75] Libro XI, f. 81*r* (I, p. 310).

[76] Libro XI, f. 82*v* (I, p. 317).

[77] Dopo una lunga descrizione degli interni dell'ospedale di Milano, nel libro XI, f. 83*r* (I, p. 319), Filarete conclude che "molte cose ci feci, le quali sarebbe difficile a poterle discrivere, né darle a 'ntendere chi coll'occhio non vedesse ogni cosa".

[78] Libro X, f. 74*v* (I, p. 282).

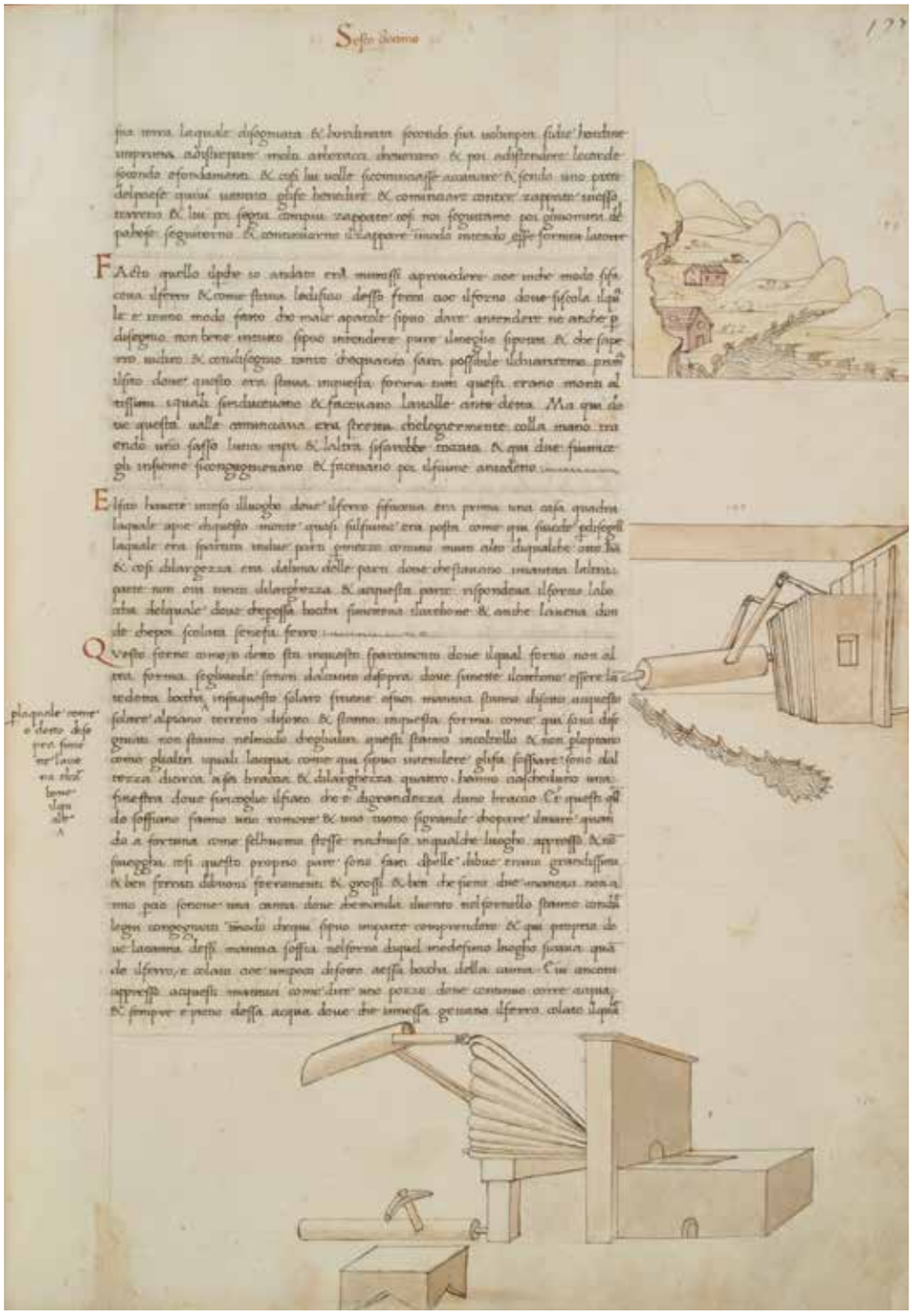


Fig. 5 *Averlino detto il Filarete, Trattato di architettura… cit. Officina e mantice per la lavorazione del ferro (BNCF, Magliabechiano II.I.140, f. 127r; © Ministero per i beni e le attività culturali e per il turismo / Biblioteca Nazionale Centrale di Firenze).*

In diversi punti, Filarete esprime una presa d'atto. Il disegno rimane un'astrazione lontana dalla concretezza dell'architettura costruita[79]:

> Credi ancora, quando noi edificheremo [Sforzinda], che con più diligenza e più cose assai noi faremo che io non ti mostro nel disegno, in modo che credo che molto più ti piacerà allora che non ti fa adesso il disegno; perché io ancora ho questo per uso: ch'io voglio sempre migliorare l'opera che la mostra. Sì che, se per questo disegno io non t'avessi così sadisfatto nell'animo, non dubitare che ti ristorerò nel fare d'essa opera, ché voglio che ogni persona la commendi sommamente, e maravigliesi della bellezza di questi edificii e d'essa città[80].

La perizia tecnica non sembra veicolabile attraverso il disegno: la *firmitas* così strettamente legata alla *venustas* in tutto l'*architettonico libro*[81] resta esclusa dalla rappresentazione grafica, sfugge alla trasmissione scritta del trattato – e risulta trasmissibile soltanto attraverso l'osservazione diretta.

Sono possibili diverse letture per la riflessione di Filarete sul valore della scrittura. La prima è principalmente letteraria: lo scetticismo di Filarete potrebbe dipendere direttamente dal *De architectura*, nel quale a più riprese viene messa in evidenza la debolezza dell'*ekphrasis* e, con

[79] Vedi nota 83.
[80] Libro II, f. 14*v* (I, p. 64).
[81] Soprattutto Saalman, *Early Renaissance Architectural Theory*… cit.
[82] Sull'argomento: Carpo, *L'architettura nell'età della stampa*… cit., p. 23. L'insufficienza della scrittura viene sottolineata nella *captatio benevolentiae*: "non è infatti in quanto eccelso filosofo né in quanto eloquente retore né in quanto filologo scaltrito nei più raffinati metodi del suo sapere che mi sono sforzato di scrivere questo trattato, ma da architetto, quale sono, fornito di una cultura di base". Vitruvio, *De architectura*… cit., I, p. 25.

intenti retorici, l'insufficienza della scrittura dell'architetto[82].

Questa interpretazione non sembra tuttavia esaurire il significato delle considerazioni epistemologiche di Filarete. Le tecniche di costruzione risultano ancora dal trattato legate alla particolare organizzazione del cantiere: non solo il disegno e la parola non possono cogliere la complessità della costruzione concreta ma è la costruzione nella sua prassi corrente che si sottrae alla scrittura e al disegno. I modi sono ancora schematici e vengono sviluppati e dettagliati in fase di esecuzione[83]. Nell'ottica dell'organizzazione del cantiere di cui è testimone Filarete, l'edificare non è del tutto controllabile attraverso il disegno e la scrittura: implica soluzioni empiriche, un'adattabilità alle situazioni contingenti che non possono essere fissate preventivamente su carta, ovvero "ancora nel fare s'adatteranno meglio che con parole non si può dire"[84].

Anche il signore concorda con Filarete sulla necessaria economia della descrizione scritta per poi adattare un progetto schematico in fase di realizzazione:

> Questi simili edificii, Signore, ogni cosa che in esso arà a essere non si può dire a parole, ma quando si faranno, allora i maestri e anche chi sarà sopra a far fare questi adatteranno e' luoghi secondo e' bisogni. 'Tu di' vero. Basta, quando si faranno allora s'adatteranno tutte le cose secondo e' loro bisogni'[85].

C'è un'ultima considerazione sulle riflessioni di Filarete. Queste potrebbero essere lette nel contesto dell'apprezzamento per la conoscenza pratica documentato nelle corti italiane già a metà del Quattrocento. Filarete potrebbe seguire una strategia autopromozionale simile a quella di Francesco Filelfo che, come emerge dalla sua corrispondenza, si presenta come stratega e topografo che ha conoscenza diretta e concreta dell'impero d'oriente e della cultura ottomana, oltre che come erudito grecista, con lo scopo di acquisire una posizione più stabile proprio presso la corte milanese[86].

Tuttavia, ulteriori elementi mettono nuovamente in discussione una lettura esclusivamente in chiave retorica del valore attribuito all'esperienza nel trattato. La nettezza con la quale viene documentato il confronto tra due culture costruttive sembra rimandare piuttosto a situazioni reali. La cultura di adattamenti empirici dell'architetto[87] deve misurarsi alle differenti aspettative del signore, come ben risulta da un brano del libro V. A Filarete viene chiesto di adattare le sue spiegazioni, rinunciando alla sua terminologia tecnica e alle sue convinzioni consolidate:

> 'Se a voi piace, la intenzion mia è ad uno quadro'. 'Dimmi pure quante braccia, [replica il signore] non intendo quadro'[88].

Lo stesso impatto risulta da un passaggio del libro XIII, in cui Filarete esprime "la fatica nello scrivere" da superare "per ubidire il Signore"[89]. Queste considerazioni sembrano confermare il valore del trattato come fonte per la cultura costruttiva quattrocentesca; una simile lettura del trattato può permettere nuove acquisizioni in ambiti come le dinamiche di committenza e gli strumenti di trasmissione della conoscenza.

Questo, in conclusione, il contesto per uno studio delle informazioni tecnologiche nel *libro*. Pur senza cercare di districare il nodo della portata retorica dei passaggi tecnico-costruttivi, nello studio di queste informazioni sembra imprescindibile tenere in considerazione apporti che provengano da differenti discipline: un'analisi del genere letterario e una migliore sistemazione dell'*architettonico libro* all'interno della storia della scienza e della tecnica.

[83] Ringrazio Maria Beltramini per aver attirato la mia attenzione sul Santo Spirito di Brunelleschi. Sul cantiere fiorentino, si veda F. Quinterio, *Note sul cantiere quattrocentesco: le fabbriche tardo brunelleschiane*, in *Filippo Brunelleschi. La sua opera e il suo* tempo, atti del convegno internazionale (Firenze, 16-22 ottobre 1977), Firenze 1980, II, pp. 645-654; Id., *Note sul cantiere fiorentino del Quattrocento: l'orbita Michelozziana*, "Granducato", 1978, 9, pp. 102-115; R. Gargiani, *Princìpi e costruzione nell'architettura italiana del Quattrocento*, Roma-Bari 2003, con un capitolo dedicato a Filarete (Parte quarta, III: *Costruire all'antica: Filarete a Milano*, pp. 224-230).

[84] Libro XVII, f. 133*v* (II, p. 500).

[85] Libro X, f. 72*v* (I, p. 278). Il passaggio viene ripreso quasi alla lettera nello stesso libro X, f. 74*v* (I, p. 282). Si veda anche libro IX, f. 58*v* (I, p. 225): "E ben sapete che nel fare si riadatterà ancora alcune cose meglio, secondo i propositi che accaggiono a più comodità e bellezza … E poi, come è detto, nel fare voi e vostro padre potrà agiugnere e minuire come a voi parrà". Una simile prassi emerge anche in una lettera di Ludovico Gonzaga del 10 febbraio 1455 (Archivio di Stato di Mantova, *Archivio Gonzaga*, busta 2885, libro 28, carta 4*r*) citata in Calzona, *Ludovico III Gonzaga*… cit., pp. 269-270.

[86] La lunga vicenda del progetto di crociata per l'inverno 1464 è analizzata in Meserve, *Nestor Denied*… cit., soprattutto p. 64 per il ruolo di topografo e stratega che Filelfo si attribuisce nella sua corrispondenza. Margareth Meserve sottolinea in generale come "the valorisation of practical expertise took hold very early in Italian political culture" (ivi, p. 51). Per il legame tra Antonio Averlino e Francesco Filelfo, M. Beltramini, *Francesco Filelfo e il Filarete. Nuovi contributi alla storia dell'amicizia fra il letterato e l'architetto della Milano sforzesca*, "Annali della Scuola Normale Superiore di Pisa, Classe di Lettere e Filosofia. Quaderni", IV s., 1996, 1-2, pp. 119-125.

[87] Saalman, *Early Renaissance Architectural Theory*… cit., pp. 91-93 e 101.

[88] Libro V, f. 33*r* (I, p. 131).

[89] Libro XIII, f. 93*r* (I, p. 355) in cui Galeazzo Maria chiede ad Antonio Averlino di scrivere una lettera per il padre, perché l'architetto ha avuto esperienza diretta e ha "veduto" la valle del fiume Indo: "'[la lettera] non la voglio far fare ad altri, io voglio che la scrivi tu: perché tu hai veduto, tu saprai meglio narrare la cosa in che modo sta. E come l'arai fatta mosterra'mela e poi la manderemo, si che fa' presto'. Benché a me pur fusse fatica lo scrivere, pure per ubidire il Signore, mi missi a scrivere". Anche nelle pagine dedicate alla "scabrosa" astrazione del disegno in scala potrebbe essere ugualmente evidente il confronto con una cultura distante dal cantiere, dalla bottega e dalla pratica del disegno e il tentativo di avvicinarsi ad essa: "E mi ti pare avere inteso, perché se tutte le misure dirivano da l'uomo secondo la sua forma, si ché, fingendo l'uomo essere così piccolo, così poi sono le misure che da lui si tolgono e così alle proporzioni si fa e' disegni delli edifici che, benché questo disegno sia piccolo a vederlo noi che siamo grandi, se gli uomini fussono picciolini come questi, gli parrà grande questo come a noi pare e sarà quando sarà murato e fornito; e tanti uomini starà in questo, tanti ne starà in quello piccolo di quelli uomini piccoli": libro VII, f. 47*r* (I, p. 182).

Sophie Elaine Wolf

FRANCESCO DI GIORGIO ON MECHANICS: A QUATTROCENTO LESSON ON THE TRANSMISSION OF KNOWLEDGE

This article discusses the illustrations and descriptions of machines in the two main theoretical writings of Francesco di Giorgio, dating from the 1480s and 1490s, respectively. First, the singular characteristics of the two writings are highlighted, enabling us to characterize the earlier work as a "handbook" and the later one as a "treatise". Then a small selection of machines is examined, with special regard for the use of technical terminology in the volgare *text and for the representational methods of the individual drawings. This offers new insights into Francesco di Giorgio's approach in representing three-dimensional machines in drawings and underscores his eminent role among Quattrocento engineers. The article further contributes to our understanding of Quattrocento architectural theory by offering English translations of all the* volgare *passages quoted.*

The Sienese artist and architect Francesco di Giorgio (1439-1501) left us two writings on architecture and mechanics, dating respectively from the 1480s and the 1490s[1]. Both are written in the Tuscan *volgare* and exist only in manuscript form. The two works differ significantly in content and form, but both treat architecture in a broad sense, including fortification, civil and religious architecture, and mechanics. I propose to call the earlier writing a "handbook" and to maintain the conventional term "treatise" for the later one[2]. While the handbook deals with technical aspects in great detail – more than half of it being devoted to engineering – and is strongly orientated towards practice, the treatise focuses much more on architecture and fortification and appears to address more directly an erudite readership. Both writings are characterized by their extensive and didactic use of drawings, which was not a feature of the few contemporary architectural writings of Alberti and Filarete. Only in the much later conceived and, more importantly, printed books of the Cinquecento were illustrations used programmatically[3]. In this essay, after describing the main characteristics of the handbook and the treatise, I shall address a set of mechanical devices and highlight Francesco's innovative method of communicating mechanical-architectural knowledge[4].

The handbook exists in the form of two manuscripts – the Saluzzianus 148 (Turin, Biblioteca Reale) and the Ashburnham 361 (Florence, Biblioteca Medicea Laurenziana) – which are non-autograph copies, composed probably in Francesco's workshop[5]. They have no table of contents, but one can divide the handbook into chapters, each with different stylistic and rhetorical characteristics[6]. The mechanical sections use rhetorical and structural features from contemporary abacus and geometry manuals that had a long tradition, going back to the twelfth century. These include directly addressing the reader by employing the personal pronoun "*tu*", the frequent use of the formulas "*Se (per altro modo) […] alzare/fare […] vorremo*", "*(Similmente) Faccisi*" and "*(Sì) Anco […] ordenare/fare*", as well as connecting the phrases with the conjunction "*e*"[7]. The structure – short paragraphs and case-studies – also derives from these models[8]. Nevertheless, Francesco innovates the approach by strengthening the role of the image: every single paragraph is associated with a specific drawing, while a linking system of numerals (Arabic or Roman), letters or symbols placed at the end of the paragraph is implemented – even if only partially[9]. However, the correct association is clarified mostly by the layout as drawings are usually placed next to the paragraph (in the left or right margin). Traditionally, practical manuals were illustrated, mainly with regard to measuring methods, but not nearly with such continuity and rigor as is done by Francesco[10].

The treatise, preserved in the first part of the Codex Magliabechianus II.I.141 (Florence, Biblioteca Nazionale Centrale), shows greater cohesion in its organization, featuring a prologue with a list of the individual *trattati* (chapters) and a conclusion[11]. Every chapter has a preface, but the internal structure and layout of the individual chapters varies depending on the topic. Francesco brings together all the mechanical topics in the last chapter, where he proceeds from one general question to the next, explaining each with a small selection of illustrated solutions. Compared to the handbook, the rhetoric of the treatise is more sophisticated and concise, even if Francesco maintains a certain simplicity in his expressions. He again operates with case studies, but these can also be used to infer more general rules or be employed as a starting point to develop similar devices. Francesco suggests in discussing the *tirari* (cranes)[12]:

> And with this I shall conclude the part on the lifting machines for building because from [the example of] these ones it is easy to compose others[13].

Thus, the case studies are characterized as examples representing a much wider range of possible machines[14]. Consequently, the treatise features far fewer drawings than the handbook, and the ones present are drawn on a bigger scale. Each page of the mechanical section has its text written in one single large column and is illustrat-

Opus Incertum (2020) pp. 22-33 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12358 www.fupress.com/oi

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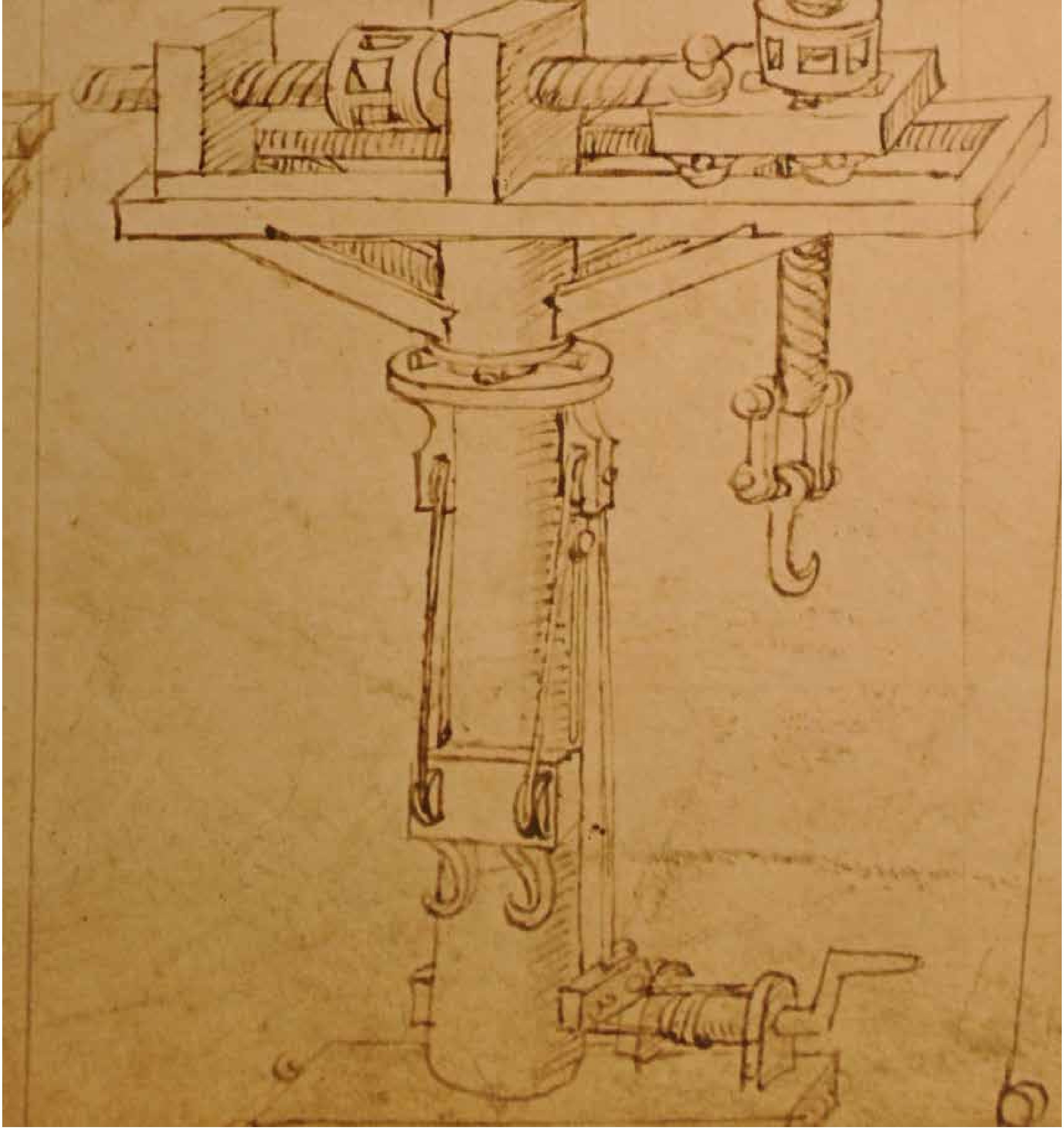


pagina 23
Fig. 1 *Portable mechanical device, from Codex Ashburnham 361, f. 46r (in di Giorgio Martini, Trattato di architettura… cit., f. 46r).*

ed with up to three drawings placed in the broad margins or directly above the text column. In connecting the two elements, the linking system is applied, even though there is no real need for it, since little or no confusion might arise in the pairing. Overall, I consider the drawings in both writings as real protagonists alongside the text, rather than just embellishment.

In the handbook, Francesco rarely explains the function of the drawing explicitly, so it may be useful to consider the passage where he laments the inadequacy of the word[15]:

> As difficult as it may seem to demonstrate everything through drawings, it is equally impossible to express all things by words. That is because in the things there are so many varied elements to be found, fragmented and opposed to one another. Therefore, it is necessary to make models of almost every single object. Considering that to the mind of the architect, many things seem so easy that he is certain to be able to realize them, one learns that when realizing them one might find many deficiencies which are only corrected with difficulty. For my part, not confiding in myself, I have experimented a good share of all the inventions which are to be shown here[16].

As judging neither the drawing nor the word alone would be sufficient to explain complex devices, Francesco stresses the necessity of the model (*modello*), by which he clearly means three-dimensional models. Furthermore, he states that he used models for experiments, which may allow conclusions about the functionality of the device when built full-scale.

Highly suitable for testing out the applicability of his own ideas and concepts, the model is also the most efficient instrument for communicating ideas. The frequent references to *spirienza* (experience), *spirimento* (experiment), and similar processes stress the importance Francesco attributes to experiment and autoptic observation[17]. This aspect is strengthened further in the introduction to the mechanical section of the treatise, where he elucidates his unwillingness to make his inventions public:

> because I have elaborated all of them with great difficulties, neglecting my own subsistence. Therefore, it does not seem appropriate to me that these should be made public and thereby be annihilated the invention, as the secret is in the detail.

He also states having demonstrated the ownership of inventions occasionally by explaining them in person[18]. Given the paramount importance of experimentation through models, Francesco must have asked himself how to incorporate the proofs into his writings. Drawing probably seemed a suitable solution, even if Francesco was conscious of the limitations of drawing in expressing three-dimensionality and could not consider it a perfect equivalent to a model. However, reflecting on the differences between two-dimensional drawings and three-dimensional models, Francesco establishes the limits within which a drawing may be used to fulfill (partially) the function of a model. The drawing becomes a visual proof of the functionality of the device, as is shown by frequently recurring expressions like "as the illustration demonstrates" and similar phrases[19]. In both the handbook and the treatise, the interplay of description and drawing of specific devices was necessary to demonstrate the accuracy of his inventions. In the treatise, drawing is additionally dignified as the main tool of the architect: sight being the most noble of all senses – Francesco here takes his argument from Aristotle – the use of drawings acquires a humanistic and philosophical meaning[20]. The main function does not change, but, thanks to this theoretical enhancement, the drawing becomes more apt to transmit his ideas to the erudite strata of society. Because of its versatility and dignity, drawing is welcomed among every group of architectural enthusiasts.

I shall now compare handbook and treatise by looking at four mechanical devices that are dis-

* I would like to thank Caterina Cardamone and Pieter Martens for the fruitful discussion that helped shape this article. My contribution presents aspects of my doctoral thesis (tutor Prof. Bruno Klein, TU Dresden) which is to be concluded soon. One preliminary piece of information: the translations given are meant to facilitate reading but are by no means literal translations of the complex fifteenth-century *volgare*. Major additions to the original wording are evidenced in square brackets, while in parentheses I repeat the original technical term wherever it seems helpful. The original *volgare* text is quoted in the footnotes and is based on Ashburnham 361 or Magliabechanius II.I.141, transcribed following the parameters of F. di Giorgio Martini, *Trattati di architettura, ingegneria e arte militare*, a cura di C. Maltese, I-II, Milano 1967 (II vol).

[1] Francesco di Giorgio was trained in Siena where he worked as artist and engineer (1460s); later he was employed at the ducal court in Urbino by Federico da Montefeltro and then Guidobaldo da Montefeltro, from 1475 to 1488; in the 1490s he worked in Naples and Siena. See in general: *Francesco di Giorgio architetto*, a cura di F.P. Fiore, M. Tafuri, Milano 1994. Maltese's interpretation of the two writings as two versions of a treatise entitled *Trattato I* and *Trattato II* is now widely accepted, see di Giorgio Martini, *Trattati*… cit., I, *Introduzione*. On their dating see also the well-argued chronology in M. Mussini, *Francesco di Giorgio e Vitruvio. Le traduzioni del "De Architectura" nei codici Zichy, Spencer 129 e Magliabechiano II.I.141*, Firenze 2003, with extensive discussion on previous critics.

[2] In this way I intend to distinguish the two writings more clearly. The major differences between them have already been stressed by P.O. Long, *Picturing the Machine: Francesco di Giorgio and Leonardo da Vinci in the 1490s*, in *Picturing Machines 1400-1700*, edited by W. Lefèvre, Cambridge-London 2004, pp. 117-142.

[3] Leon Battista Alberti's *De re aedificatoria* was not illustrated. Filarete's *Trattato di architettura* (1460s) does not illustrate systematically every object discussed, and his use of illustrations as enhanced decoration reveals a different attitude towards them. Illustrated editions of Vitruvius from the Cinquecento are those of Fra Giocondo, Cesare Cesariano, and later Daniele Barbaro. Thereafter, Sebastiano Serlio employs illustrations more systematically. For an introduction, see *Paper Palaces. The Rise of the Renaissance Architectural Treatise*, edited by V. Hart, P. Hicks, Yale 1998; A. Payne, *The Architectural Treatise in the Italian Renaissance: Architectural Invention, Ornament, and Literary Culture*, Cambridge 1999. On the impact of printing, see M. Carpo, *Architecture in the Age of Printing: Orality, Writing, Typography, and Printed Images in the History of Architectural Theory*, Cambridge 2001. All give a quite general outline of the architectural treatise's 'genre'.

[4] The descriptions here discussed are to be found in the chapters (as Maltese divides them): "Geometria […]"; "Leve di ruote e mulini; sorgenti […]"; "Modi per elevare e condurre acqua […]", see di Giorgio Martini, *Trattati*… cit., I.

[5] Thus, they were under his direct control. See also M. Mussini, *La trattatistica di Francesco di Giorgio: un problema critico aperto*, in *Francesco di Giorgio architetto*… cit., pp. 378-399, who suggested (p. 379) that the two manuscripts were produced in the workshop, a hypothesis which I strongly support. In the same article Mussini explains the dating of Codex Ashburnham 361 to ca. 1480-1482 and of Codex Saluzzianus 148 to ca. 1482-1486 (pp. 380, 382).

[6] The division in chapters is not explicitly given but can be induced from the content. When revising Maltese's division, the handbook can appear more concise and systematic, but the chapters still show different characteristics. In my opinion the handbook is closely connected to Francesco's training and looks like a collection of separate writings rather than a com-

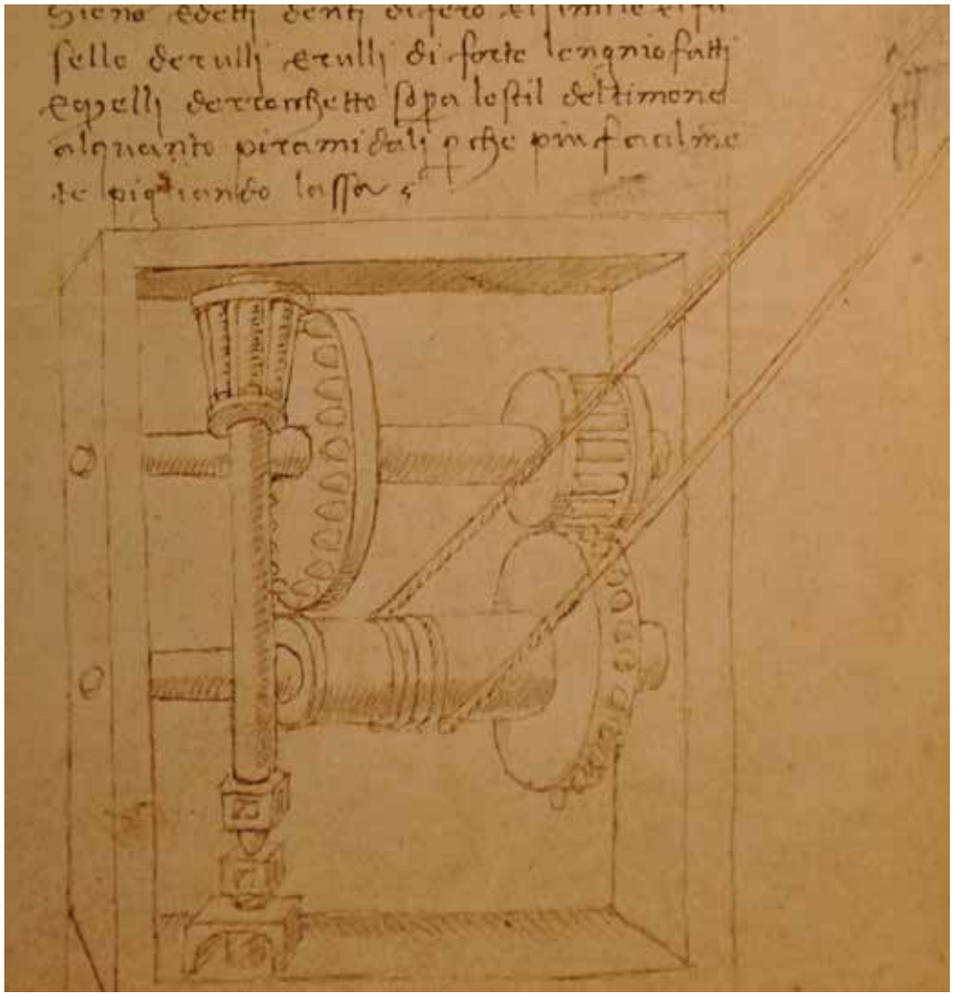


Fig. 2 *Mechanical device with rope, from Codex Ashburnham 361, f. 44v (in di Giorgio Martini, Trattato di architettura… cit., f. 44v).*

cussed and illustrated in both writings[21]. The catalogs of machines are not identical: in the handbook, the section on winches alone presents thirty different machines[22]; the treatise instead features only twenty-one mechanical devices in total, twelve of them related to the construction process. Thus, it turns mechanics into an ancillary discipline for architecture and building practice[23].

The first device is a rope winch described in the handbook as follows:

> Another [example:] one should build a frame of timber with a horizontal rod (*traversato fuso*) on which the spur gear (*dentata ruota*) of six feet goes, which is moved by the lantern gear (*rullato rocchetto*) [mounted] on the vertical rod. This [rod] is positioned in equilibrium (*bilicato*) on the screw (*vite*) where the draught animal turns the capstan bars. On the rod above the spur gear is a lantern gear (*rullato rocchetto*) two feet in diameter which connects with the teeth of the spur gear (*dentata ruota*). The latter moves the drum (*curba*) mounted on the same rod as the spur gear. The spur gear (*dentata ruota*) has a diameter of five feet and the drum of two feet. This is shown in figure V. The teeth are to be made of iron and likewise the shafts (*fusi*) of the lantern gears (*rulli*) of strong wood. The shafts of the lantern gear (*rochetto*) should be made quite pyramidal in shape because thereby they engage more easily[24].

The *armadura* is part of nearly every mechanical device, but is usually called *telaio* or *castello*[25]; here Francesco additionally specifies it to be made of timber. Furthermore, he indicates the source of power, the *bestia* (draught animal). He gives indications on the measurements – for the *dentata ruota* (spur gear) and *rocchetto* (cage gear) – and on the material, specifying *ferro* (iron) for the *denti* (teeth) of the gearwheel and *forte legno* (resilient timber) for the roll. Thus, Francesco furnishes a thorough description of the instrument. The illustration (fig. 2) (the draught animal is missing) allows for a discussion on a distinct feature of the drawing's convention[26]. The frame is depicted in axonometric projection, but this is contradicted by the bottom view of the vertical rod, which thus appears to intersect with the lower horizontal rod, making any movement impossible. However, this

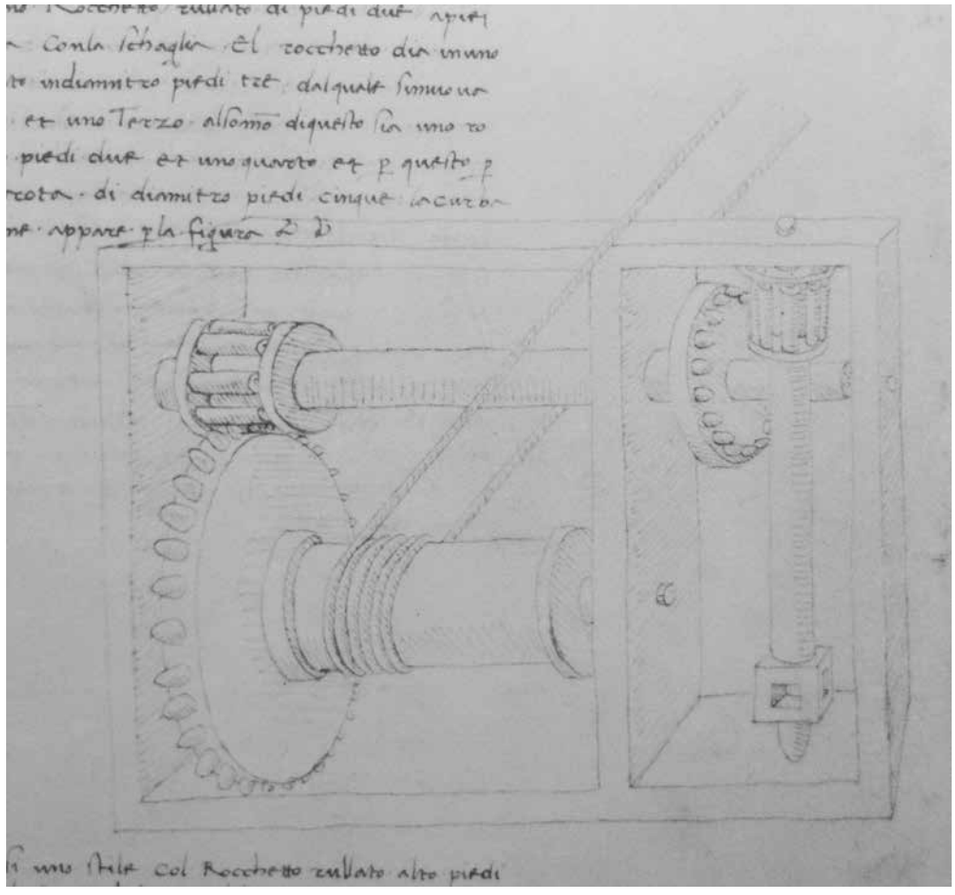
pletely uniform book. I suggest that these two manuscripts do not derive from a single model but were instead realized by combining various sources. This would have been possible if they were indeed executed in Francesco's workshop. Without making an intermediate copy, he could have given instructions to use directly the various writings he had composed during his career, as well as those done *ex novo* for the handbook. This would have shortened the whole process and makes it easier to explain certain differences between the two copies. It also explains the necessity of linking text and images, if we imagine Francesco writing a description of machine drawings that already existed in a sketchbook. For further discussion, see my forthcoming doctoral thesis.

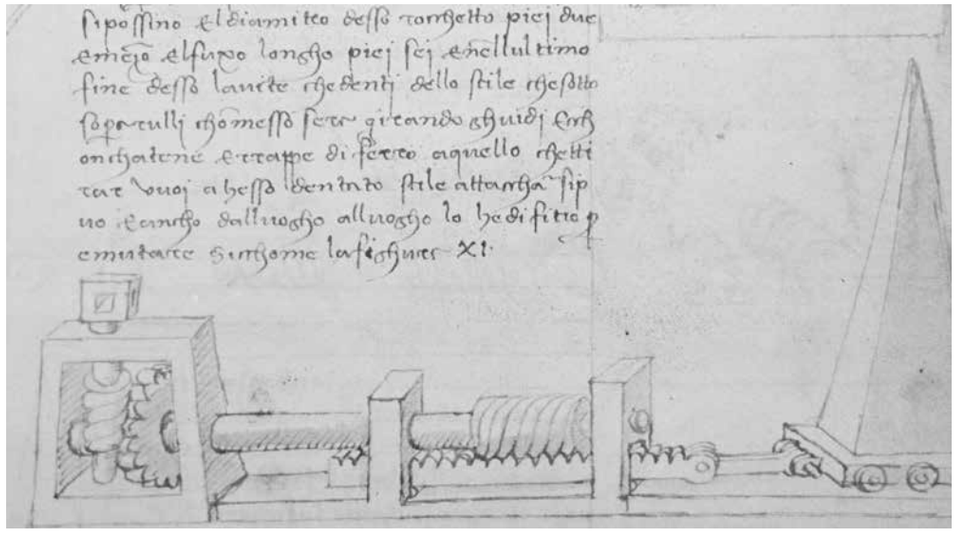
[7] On representations of machines, see *Picturing Machines 1400-1700*, edited by W. Lefèvre, Cambridge-London 2004 (including Pamela O. Long's chapter on Francesco di Giorgio and Leonardo da Vinci). Most useful are *Prima di Leonardo. Cultura delle macchine a Siena nel Rinascimento*, catalogo della mostra (Siena, 9 giugno-30 settembre 1991), a cura di P. Galluzzi, Milano 1991 and P. Galluzzi, *Gli ingegneri del Rinascimento da Brunelleschi a Leonardo da Vinci*, catalogo della mostra (Firenze, 22 giugno 1996-6 gennaio 1997), Firenze 1996. Some aspects of practical mathematics in E. Ulivi, *Scuole d'abaco e insegnamento della matematica*, in *Il Rinascimento Italiano e l'Europa*, V (*Le scienze*), a cura di A. Clericuzio, G. Ernst, Treviso 2008, pp. 403-420. On the manual tradition, see S.K. Victor, *Practical Geometry in the High Middle Ages. Artis cuiuslibet consummatio, and the Pratike de geometrie*, Philadelphia 1979; W. Van Egmond, *Practical Mathematics in the Italian Renaissance. A Catalog of Italian Abacus Manuscripts and Printed Books to 1600*, Supplemento agli Atti dell'Istituto e Museo di Storia della Scienza, Firenze 1981 (see p. 16 on codified structure). On drawings in manuals, see E. de Laurentiis, *Il disegno geometrico nei trattati del Quattrocento a Firenze*, "Atti dell'Istituto Veneto di Scienze, Lettere ed Arti", CLIII, 1994-1995, pp. 95-125.

[8] Galluzzi stresses the intimate connection between the first treatise (our "handbook") and the medieval tradition of knowledge transfer in the *bottega*, see Galluzzi, *Gli ingegneri*… cit., p. 44.

[9] In the handbook's manuscripts, the linking system is nearly always applied; mostly the link is given in the text but missing in the drawing. This might be due to erroneous copying, but Francesco apparently did not correct these deficiencies. Only one section of Ashburnham 361 applies the system as a whole: f. 33*r*-35*r*, see F. di Giorgio Martini, *Trattato di architettura. Il Codice Ashburnham 361 della Biblioteca Medicea Laurenziana di Firenze*, I-II, Firenze 1979. The corresponding section in Saluzzianus 148 has no links in the drawings; further discussion in my thesis.

[10] Two things should be mentioned. The most important is the handbook's intimate relationship with the *Codicetto* (Codex Urb. Lat. 1797 of the Biblioteca Apostolica Vaticana, Rome), which is an autograph sketchbook of Francesco, who used it up to at least the second half of the 1470s, collecting drawings from various sources, see Mussini, *La trattatistica*… cit., pp. 379-380. The codex is online: https://digi.vatlib.it/view/MSS_Urb.lat.1757 (consulted 27 March 2019). Secondly, the handbook's section on geometry is closely related to an anonymous "Trattato di geometria pratica" (edited in Anonimo Fiorentino, *Trattato di geometria pratica: dal Codice L.IV.18 (sec. 15) della Biblioteca Comunale di Siena*, a cura di A. Simi, Siena 1993). A hint to this relation was given in F. di Giorgio Martini, *La praticha di giometria dal Codice Ashburnham 361 della Biblioteca Medicea Laurenziana di Firenze*, a cura di G. Arrighi, Firenze, 1970, pp. 2-3. After a detailed comparison of the two works, inspired by Arrighi's hint, I suggested in the original manuscript of this article (2016) that the two works must have had a common model. Meanwhile, Angeliki Pollali claimed the close relationship with the Codex L.IV.18 as her own discovery, though without mentioning Arrighi's suggestion, see A. Pollali, *Design Method and Mathematics in Francesco di Giorgio's Trattati*, in *Visual Culture and Mathematics in the Early Modern Period*, edited by I. Alexander-Skipnes, New York-London 2017, pp. 32-51. Arrighi's hint has been mostly overlooked, perhaps because Galluzzi did not mention it when discussing geometry, see Galluzzi, *Gli ingegnieri*… cit., p. 6.





confusion is only in the eye of the beholder who expects to see a "coherent" axonometric projection. Francesco offers instead a combination of views: single parts follow a particular projective logic to show key aspects adequately – Francesco refers to the medieval tradition of flat representation – whilst integrating the whole into modern projection for an overall representational logic. By doing so, he reveals his consciousness about the overall viewing habits tending towards increased familiarity with linear perspective[27].

The same device is discussed in the treatise as the fourth type of the *argani* (cranes)[28]:

> Another way to make [such a machine] is to make a rod thick one and a third feet and as long in height as is necessary. On top of it there is positioned a lantern gear (*rullato rocchetto*) of two feet and at its bottom end is a cube on a peg (*stampa con la scaglia*). The lantern gear engages with a crown gear (*ribecco per piano dentato*) with a diameter of three feet, which moves a rod one and a third feet thick with at its end a lantern gear of two and a quarter feet in diameter. The latter engages with the teeth of the

[11] The treatise in Codex Magliabechianus II.I.141 dates from 1496-1500 (Mussini, *La trattatistica*… cit., pp. 386-388); the additional translation of Vitruvius' *Ten Books on Architecture* is probably earlier. See Mussini, *Francesco di Giorgio*… cit., chapter 3. The Codex S.IV.4 (Siena, Biblioteca Comunale degli Intronati), not discussed here, has hardly any drawings and dates to 1496-1497 (Mussini, *La trattatistica*… cit., p. 385). None of them is autograph. Maltese thinks that the fourth manuscript pertains to a different, earlier phase, see di Giorgio Martini, *Trattati*… cit., I, pp. XLVIII-LI, p. LVI.

[12] Describing the *argani* (cranes), Francesco explains different positions of a roller and relative advantages, see di Giorgio Martini, *Trattati*… cit., II, p. 496. Francesco continuously employs the term *argano*, which translates as winch, as pars pro toto to indicate the crane. Long thinks Francesco "suggests that readers will be able to read about one kind of mill […] and then discover other types", see Long, *Picturing the Machine*… cit., p. 128. Her quotation ("delli latri simili da li lettori possino essere trovati") is contained only in Codex S.IV.4 (see note 11), so I think it might serve only as confirmation of what is expressed in the Magliabechianus II.I.141. Galluzzi, too, notes the treatise's essentiality and presentation of common principles: "Francesco veniva così distinguendosi dalla tradizione consolidata nelle botteghe di affrontare ogni questione tecnica e ogni dispositivo meccanico come un caso a sé stante", P. Galluzzi, *Macchine senesi: ricerca antiquaria, spirito di innovazione e cultura del territorio*, in *Prima di Leonardo*… cit., p. 38.

[13] "E con questi è da por fine alla parte degli instrumenti per tirare pesi per edificare, sì perché (da) questi facilmente delli altri si porrà componare". In my transcriptions (here and subsequently) I follow the exact wording of Magliabechianus II.I.141 in comparison with Maltese's and following his standards of transcription, see di Giorgio Martini, *Trattati*… cit., II, p. 499.

[14] Examples are introduced with: "In altro modo", "Per altra via", etc. Maltese suggests the treatise had undergone stylistic revision by a humanist, see di Giorgio Martini, *Trattati*… cit., I, pp. LI sg. On the streamlined content see Galluzzi, quoted above (note 13); on concentrating the examples to exemplify and safeguard one's knowledge, see also Long, *Picturing the Machine*… cit., p. 128 and pp. 130-131. Long rediscussed the two works in P.O. Long, *Artisan/Practitioners and the Rise of the New Sciences, 1400-1600*, Corvallis 2011, especially pp. 41-47, stressing that the later work was much better suited for an erudite readership, with which I fully agree.

[15] However, when quoting the architect's abilities from Vitruvius, he explicitly mentions the paramount relevance of the drawing: "E pertanto bisogna che in più facultà isperto sia. In prima in nelle descrezioni delle figure o dipenture como sono disegnatori […] siccome detto, quanto el disegno necessario sia in prima è da vedere, senza el quale nissuna forma comporre né edificar si può", di Giorgio Martini, *Trattati*… cit., I, p. 37.

[16] Also note that for Francesco the mental idea eventually reveals incompleteness and flaws once realized. "Quantunque difficil sia in disegno ogni cosa demostrare, neanco per scrittura in alcun modo molte cose spriemar non si può, perché son tante le varietà delle cose interrotte e opposite l'una all'altra che a occupare si vengano, e però necessario quasi di ciascuna cosa modello fare. Posto che molte cose all'animo dell'architetto paia facile, e che riuscir li debba, che mettendolo in effetto gran mancamenti in essi truova, in ne' quali con difficultà reparar vi può. Io per me delle invenzioni che qui demostrate seranno, d'assai buona parte, in me non confidando, spirienza ho veduta". The statement introduces the levers and mills, see di Giorgio Martini, *Trattati*… cit., I, p. 142. A partial translation in Long, *Picturing the Machine*… cit., pp. 122-125, inspired my translation of the sentence "Considering […] difficulty", though mine is more literal. About one mill Francesco states that "meglio figurato che discrivar si può", see di Giorgio Martini, *Trattati*… cit., I, p. 148.

[17] Francesco mentions experiments also when writing on pumps: "i pestrini […] avendo spirimentato molte varie e nove fantasie da potersi in molti luoghi esercitare con acqua o senza" (di Giorgio Martini, *Trattati*… cit., I, p. 142), and states having studied singular aspects, see di Giorgio Martini, *Trattati*… cit., I, pp. 144-145, p. 169. In the treatise, he writes about columns "le quali proporzioni io con gran diligenzia e non con piccola fatiga per sperienza ho trovato, visto e misurato più e più volte, sicché […] concludare la regola generale, come el altre universali conclusioni da le sue particulari riceve verità e notizia", see di Giorgio Martini, *Trattati*… cit., II, pp. 378.

Fig. 3 *Mechanical device with rope, from Codex Magliabechianus II.I.141, 92r (in di Giorgio Martini, Trattati… cit., II, tav. 319).*

Fig. 4 *Hauling machine, from Codex Ashburnham 361, f. 45r (in di Giorgio Martini, Trattato di architettura… cit., f. 45r).*

> spur gear five feet in diameter and the drum of two and a half feet in diameter, as is shown in the figure yy[29].

Here, the description features detailed measurements without specifying the material. The illustration (fig. 3) shows a new composition of the device, in two separated spaces. The larger one hosts the drum and the smaller one the capstan. Once again, the draught animal is missing. The changes attest to Francesco's effort of revising not only the selection of devices and their description but also the instruments themselves.

The second device to be discussed is found among the hauling machines of the handbook:

> One should make a frame and at its end a box. In this box is the worm wheel (*rocchetto*) and the worm (*vite*) moves the former; the latter can be operated from above [the box] through the crank (*manovella*). The diameter of the worm wheel is two and a half feet and the moved rod is six feet long. At the rod's end, there is a worm which connects with the spur rack (*stile*) below. The latter rests on connected rollers and is moved by the worm. And the object you wish to move can be attached to the spur rack (*dentato stile*) by chains and links of iron (*catene e rappe di ferro*). This [machine] can also be changed between one place and another. This is shown in figure XI[30].

This short description furnishes only some measurements and little information on materials. However, from other descriptions, one may draw some general assumptions: the frames can be assumed to be made of timber – as recommended in a previously quoted description – and the worms of iron, as indicated for another device[31]. Still, the reader does not get sufficient information and the illustration (fig. 4) integrates it only partially. For example, one infers that *stile* indicates the (toothed) rack[32]. Some aspects remain obscure, such as the proportion between the machine and the obelisk, which seems odd; the last sentence, too, is equivocal. Francesco writes that the device "can also be changed (*peremutare*) between one place and another", which allows two interpretations: either he intends the device to be moved from one place to another, or he intends it to be adapted to different circumstances. Let us look at how the device is described in the treatise to gain a better understanding[33]:

> Make a rod made of iron three feet or two and a half feet long and half a foot in diameter, where there is the cube (*stampe*) of the lever or a frame where the lever end may be inserted. This rod shall have a worm one and a quarter feet thick which connects with a worm wheel (*rotetta dentata*) with a diameter of two and a half feet. The worm wheel moves a horizontal rod (*stile per piano*), two-thirds feet thick and seven feet long. At its head there is a worm made of bronze one and a quarter feet in diameter, which is positioned upon the rack (*scala dentata*) which is half a foot thick and large and seven feet long. Below this rack, there shall be rollers made of bronze which run on rails covered in iron (*trave coverte di ferro*). At the end of the rack, there shall be attached (*inpernare*) links (*chiavi*) made of iron which are linked together in such way that one can remove one link after another as needed, while the machine itself remains untouched. The whole machine shall be enclosed in a frame of wood (*banconi o modelli di legno*) and held together by large iron belts. And because there are positioned the shafts it shall be easier to move [the object], as shows the figure[34].

The description offers many details about materials and measurements, which might indicate that Francesco, in the meantime, had realized the relevance of these aspects for the device's functionality and for its explanation to non-practitioners. In the illustration (fig. 5), one sees all the details clearly. The most useful is the representation of the *rulletti di bronzo* (small bronze rollers) on which the toothed rack is moved back and forth; also, the *chiavi* (links) which might be added or taken away as necessary can be discerned as a connecting element. Strikingly, we do not find any reference to the movability or versatility of the device. Francesco instead de-

[18] See di Giorgio Martini, *Trattati…* cit., II, p. 550: "più volte abbi firmato el proposito di non manifestare alcuna mia macchina o instrumento, perché avendo quelli intesi con grave mio incomodo, postponendo le necessità del vitto mio, non mi pare conveniente di poi sono a luce mandata sia annullata la invenzione, consistendo il secreto in piccola cosa. Ma questo ancora saria piccola molestia quando una maggiore non seguisse, peroché facendosi li ignoranti ornati delle fatighe delli altri, usurpando quelle che si gloriano quello che non è loro invenzione […] ma quando le opare loro potessero essare presenti a qualunque le ragioni mie leggesse, facilmente si mostraria le ragioni mie tutte essare vere, come più volte nell'esamine alli astanti ho dimostrato". On authorship, see P.O. Long, *Openness, Secrecy, Authorship. Technical Arts and the Culture of Knowledge from Antiquity to the Renaissance*, Baltimore-London 2001; Long, *Picturing the Machine…* cit., p. 128.

[19] "(Sic)come la figura manifesta/dimostra", etc. Thus the demonstrative drawing always represents a specific device and may refer to a model.

[20] In the treatise, Francesco discusses drawing in various parts; for example, in the conclusion: "quelli che di questa mia operetta desiderano consequire alcuno frutto, e questo è che questi tali s'ingegnino avere qualche intelligenzia del disegno, perché senza quello non si può bene intendare le composizioni e parti dell'architettura". See di Giorgio Martini, *Trattati…* cit., II, p. 505. On vision as the most noble sense, see di Giorgio Martini, *Trattati…* cit., II, p. 399.

[21] For the mechanical terminology, see E. Calchini, *Glossario dei termini tecnici nel Trattato I (Ms. Saluzziano 148) di Francesco di Giorgio*, in *Prima di Leonardo…* cit., pp. 452-470.

[22] The two handbook manuscripts show minor differences – which in one instance are relevant to the discussion – but one cannot establish a clear hierarchy regarding thoroughness or richness of details in text and/or drawing. The drawings in Ashburnham 361 often lack details, but sometimes they feature improvements that are absent in Saluzzianus 148. The only consistency is that the Saluzzianus 148 drawings have captions, which are missing in Ashburnham 361.

[23] At the beginning, the first chapter reads: "Grandi pesi bisogna muovare da luogo ad luogo nello edificare dove senza ingegnio le forze poco vagliono, e similmente l'aqua a longa distanzia et in gran quantità trarre, e non meno è utile e necessario in molti luoghi far mulini […] pistrini a vento o senza […] adunque è conveniente a perfezione dell'opara ponere forme delle comuni più potenti e utili di ciascuna delle ditte spezie de instrumenti", see di Giorgio Martini, *Trattati…* cit., II, p. 550 (apparato delle varianti). Subsequently Francesco expresses his unwillingness to make his inventions public (see note 18).

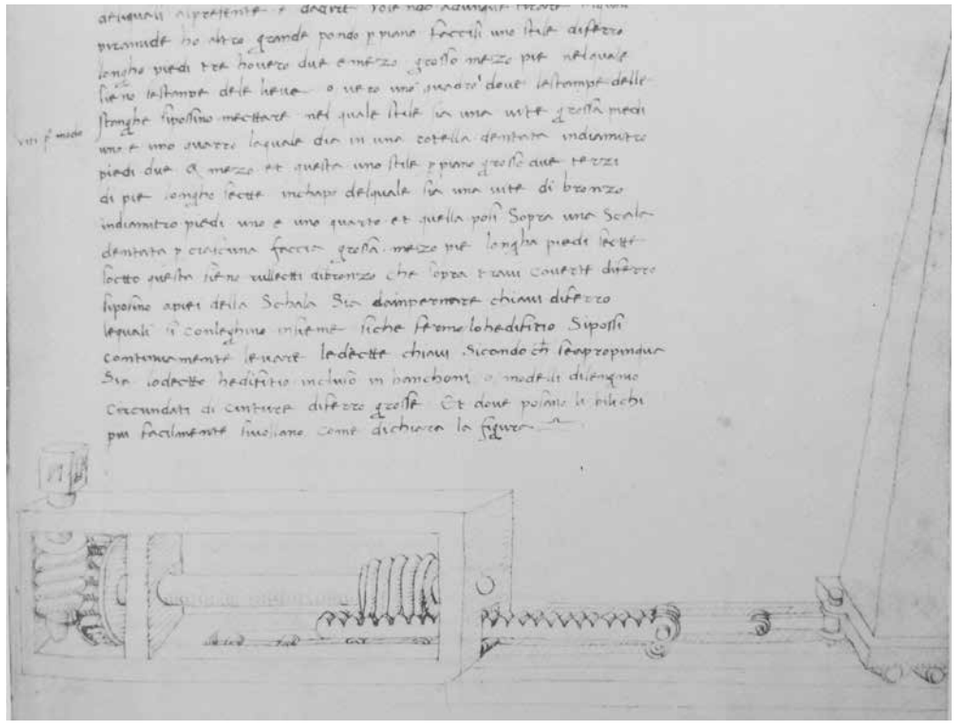
[24] See Ashburnham 361, f. 44*v*/Saluzzianus 148, f. 50*r*. "Anco faccisi un armadura di legname col traversato fuso dove la dentata ruota di sei piei va, cacciata dal rullato rocchetto del diritto stile sopra al mozzo della vite bilicato, dove la bestia el timon guidando. E nello stil di sopra della dentata ruota un rullato rocchetto in diamitro piè due, e in su denti della ruota che la curba guida che sopra a lo stile d'essa sarà, in diamitro detta ruota piei cinque e la curba due. Siccome la figura V manifesta. Sieno i detti denti di ferro, e simile el fuso de' rulli e rulli di forte legno fatti. E quelli del rochetto sopra lo stil del timone alquanto piramidali perché più facilmente pigliando lassa", see di Giorgio Martini, *Trattati…* cit., I, p. 191. The original text leaves some ambiguity regarding the material of the shaft.

[25] For example di Giorgio Martini, *Trattati…* cit., I, pp. 190-191. Francesco recommended making lifting devices out of timber: "le lieve de' grandi pesi non con canapi sono da fare, ma un fortissimo castello di diritti traversi e ben legati legni", see di Giorgio Martini, *Trattati…* cit., I, p. 189.

[26] An earlier version of this device can be found in the *Codicetto*, f. 166*r*.

Fig. 5 *Hauling machine, from Codex Magliabechianus II.I.141, 93r (in di Giorgio Martini, Trattati… cit., II, tav. 321).*

Fig. 6 *Portable mechanical device, from Codex Saluzzianus 148, f. 52r (in di Giorgio Martini, Trattati… cit., I, tav. 95).*



scribes the *banconi* or *modelli* (large tables or frames), which were not part of the description in the handbook[35]. Thus, we might hypothesize that in the handbook's description Francesco wanted to point out the device's portability but later came to the conclusion, expressed in the treatise, that the device required more stability to be effective[36]. Such a reconsideration seems even more likely when we consider that the present device was not Francesco's own invention. Instead, it was part of a series of several machine designs based on Filippo Brunelleschi's machines for the construction of the cupola of Florence Cathedral[37]. Thus, Francesco worked on improving a device that was essentially known through drawings without any verbal description. These drawings were copied many times and are present, in a fairly identical manner, in a number of machine drawing compilations such as Bonaccorso Ghiberti's *Zibaldone* (Florence, Biblioteca Nazionale Centrale, Banco Rari 228, f. 126*v*)[38]. Regarding Francesco's version, his genuine contribution consists in the description and, for the treatise, in his attempts to improve the device[39].

A third device explicitly dedicated to construction is in the handbook preceded by a statement on its portability[40]:

> One might also put a post on a cart. At the top of it, the construction (*edifizio*) is positioned on small rollers (*rulli*) in the manner of a compass (*a uso di bossola*) [i.e. slewing-gear]; here the horizontal and vertical screws enable one, thanks to the screw nuts with holes (*stampate vezzose*) and the screws (*lomache*) at both ends, to raise or lower any weight attached to the hook of the screw, and to set it down wherever one wishes. Under the compass (*bossola*) there are two pegs (*caviglie*) and two pulleys (*carrucole*); the ropes are tied to these pegs. These ropes pass by the pulleys of the wooden stopper with hooks (*uncinato ceppo*), but first they pass by the pulleys above the pegs and then go down to the two pulleys below [the wooden stopper]. And [the rope] is coiled up easily thanks to the lantern gear which turns the spur wheel[41].

The jack's mobility is stressed along with the possibility of rotating its top 360 degrees horizontally, thanks to a slewing-gear (*bussola sopra rulli*)[42]. However, to understand the complex description of the various passages of the ropes, one needs the illustration (fig. 1)[43]. Thus, one discerns which pulleys and pegs the description refers to and gains a better understanding of the device as operating in two steps. Interestingly, the gear-moved jack described is represented exclusively in the drawing in Saluzzianus 148, f. 52*r* (fig. 6), while the Ashburnham 361, f. 46*r* shows a simplified hand-moved jack. In the treatise, the device, described as *argano* (crane), is more easily understood:

> Finally, regarding the cranes [operating] with ropes, there is a way by which the prepared stones and other heavy weights can be lifted up and brought to any place (*a sesta in ogni parte locare*) which might suit

[27] The rotational view continued to be employed, e.g. in Robertus Valturius' *De re militari*. On axonometric representation, see M. Scolari, *Oblique Drawing. A History of Anti-Perspective*, Cambridge 2012 (Italian edition *Il disegno obliquo. Una storia dell'antiprospettiva*, Venezia 2005). On the engineer's representational method, see *Prima di Leonardo*… cit.; Galluzzi, *Gli ingegneri*… cit., and D. Lamberini, *Machines in Perspective. Technical Drawings in Unpublished Treatises and Notebooks of the Italian Renaissance*, in *The Treatise of Perspective: Published and Unpublished*, proceedings of the symposium (Washington, 7-8 November 1997), edited by L. Massey, New Haven-London 2003, pp. 212-234.

[28] See Magliabechianus II.I.141, f. 92*r*. "Pigliando principio dalli argani è da dichiarare alcuni modi per li quali con ragione maggior peso e più facilmente si porrà movare", see di Giorgio Martini, *Trattati*… cit., II, p. 495; again, the winch (*argano*) serves to indicate the whole crane.

[29] "In altra forma si puo fare facendo uno stile grosso uno piede e un terzo per diritto, di quella altezza che fusse di bisogno. Nel sommo del quale sia uno rocchetto rullato di piedi due, a piedi di questo stile sia la stampa con la scaglia. El rocchetto dia in uno ribecco per piano dentato, in diametro piedi tre, dal quale si muova uno stile grosso piedi uno et uno terzo, al sommo di questo sia uno rocchetto rullato in diametro piedi due et uno quarto e per questo percuoti sopra li denti della rota di diametro piedi cinque, la curba d'essa due e mezzo, come appare per la figura yy", see di Giorgio Martini, *Trattati*… cit., II, p. 497.

[30] See Ashburnham 361, f. 45*r*/Saluzzianus 148, f. 50*v*. "Faccisi el telaio e la cassa a la sommità d'esso. In nella quale el rocchetto e la vite battendo sopr'esso, la qual di fuore le manuelle operar si possino. El diamitro d'esso rocchetto piè due e mezzo, el fuso longo piei sei, e nell'ultimo fine d'esso la vite che denti dello stile che sotto sopra rulli commesso serà girando guidi. E con catene e rappe di ferro a quello che tirar vuoi a esso dentato stile attaccar si può. E anco da luogo a luogo lo edifizio peremutare, siccome la figura XI", see di Giorgio Martini, *Trattati*… cit., I, p. 192.

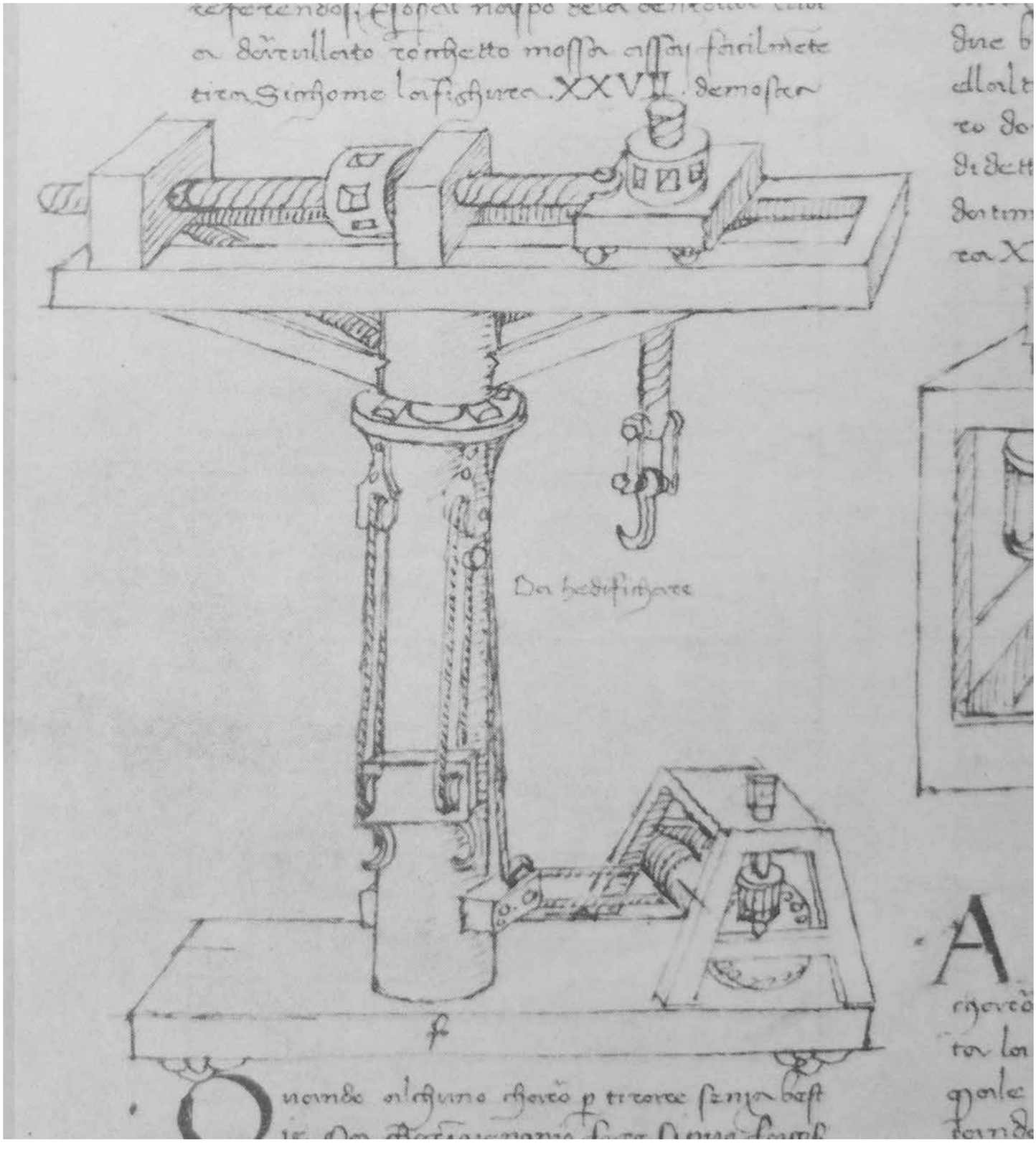
[31] On the worm made of iron, see for example di Giorgio Martini, *Trattati*… cit., I, p. 192. Other descriptions furnishing detailed measurements are discussed in Long, *Picturing the Machine*… cit., p. 122ff.

[32] A sketch of this device can also be found in the *Codicetto*, f. 167*v*.

[33] See Magliabechianus II.I.141, f. 93*r* and the introduction: "Molti pesi bisogna alcuna volta movare nello edificare che per forza di canapi non saria possibile, donde è necessario per altri instrumenti metallici a questo fine pervenire, delle forme delli quali al presente è da dire", see di Giorgio Martini, *Trattati*… cit., II, pp. 551-552 (appendix).

[34] See di Giorgio Martini, *Trattati*… cit., II, p. 498: "faccisi uno stile di ferro di longhezza di tre piedi overo due e mezzo, grosso mezzo piè, nel quale sia le stampe delle lieve overo uno quadro dove le stampe delle stanghe si possino mettere, nel quale stile sia una vite grossa piede uno et uno quarto la quale dia in una rotetta dentata in diametro piedi due e mezzo, e questa uno stile per piano, grosso due terzi di piè, longo sette, in capo del quale sia una vite di bronzo in diametro piedi uno et uno quarto et quella posi sopra una scala dentata per ciascuna faccia grossa mezzo piè, longa piedi sette; sotto questa sieno rulletti di bronzo che sopra travi coverte di ferro si posino; da piei della scala sia da inpernare chiavi di ferro le quali si colleghino insieme siché, fermo l'edificio, si possi continuamente levare le ditte chiavi secondo che se appropinqua. Sia lo ditto edificio incluso in banconi o modelli di legno, circundati di cinture di ferro grosse. Et dove posano li bilichi più facilmente si vollano, come dichiara la figura". The concluding comment is ambiguous if not unintelligible, but when considering the drawing one can hypothesize that it explains the rods of the obelisk's transportation platform.

[35] di Giorgio Martini, *Trattati*… cit., II, p. 498, see also Calchini, *Glossario*… cit., p. 454 and 461.



the architect. Its composition is realized by building a cart on wheels on which one shall position an upright post with a height equal to the desired building. Below the compass-joist (*bossola*) one locates the pulleys of the block and tackle (*carrucole*) where the rope of the lower pulleys (*taglie*) go. The rope is doubled by them and then goes to the pulleys which are attached on the lower part of the post. In passing through them the rope then engages with the winch (*argano*). Afterward, on top of the compass-joist there is positioned a doubled frame with [a piece similar to] a shim (*riparella*) at the top end of the rod of the compass-joist, through which passes the screw. At the other side of the shim there is a screw nut with holes (*stampe o femminelle*). On this frame is positioned a small carriage (*mozzo rulla-*

[36] Obviously, the increased stability goes together with increased weight, which would essentially impede movability.
[37] For an introduction, see Galluzzi, *Gli ingegneri…* cit. Moreover, Gustina Scaglia interpreted drawings from the second half of the fifteenth century as documenting inventions by Brunelleschi for the Florentine cupola, see G. Scaglia, *Drawings of Machines for Architecture from the Early Quattrocento in Italy*, "Journal of the Society of Architectural Historians", 25, 1966, 2, pp. 90-114. Scaglia dates the combination of worm-gear and screw and slider to 1436, based on stylistic attribution of the capital shown in the device's represen-

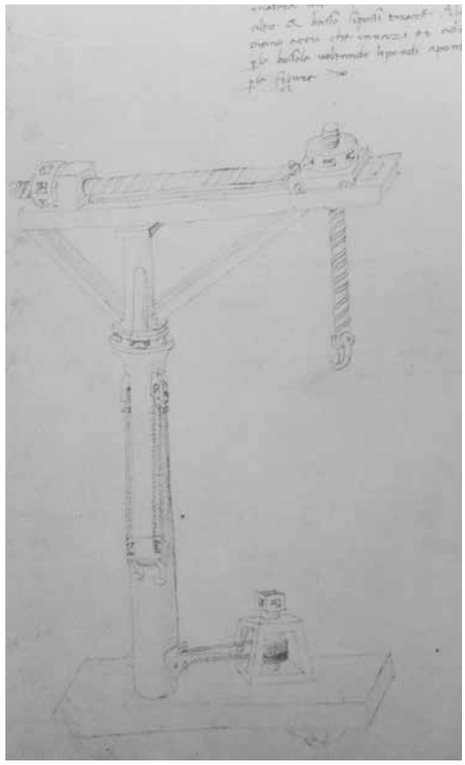


Fig. 7 *Portable mechanical device, from Codex Magliabechianus II.I.141, 92v (in di Giorgio Martini, Trattati… cit., II, tav. 320).*

tation in Codex S. IV. 5, f. 86*v* (Siena, Biblioteca Comunale), while the worm-rack was developed at "some unknown time, but surely before the obelisk series", see Scaglia, *Drawings…* cit., p. 106-107. Scaglia's bold hypotheses, however, lack conclusive evidence.

[38] See Scaglia, *Drawings…* cit., p. 108, fig. 19 and Appendix A for the stated correspondence with other machine drawings, that is: with Codex Palat. 767, f. 197*r*; Codex Marc. Ital. Z 86, f. 35*r*; Codex Barberini Lat. 4424, f. 62*r*-b; Codex NL 383, f. 21*v* (Turin, Biblioteca Reale) and Codex S.IV.1, f. 128*v* (Siena, Biblioteca Comunale). Dating of one manuscript before another cannot be clearly established.

[39] Similarly, Gianluca Belli has proposed that most of the hauling machines were essentially theoretical experiments, see G. Belli, *Colonne, obelischi, piramidi. Le macchine per lo spostamento dei grandi pesi,* in *Prima di Leonardo…* cit., pp. 147-154, see p. 147.

[40] "Quando alcuno edifizio a murare s'avesse, faccisi el lavoro del legname sopra a rotelli", di Giorgio Martini, *Trattati…* cit., I, p. 194, see Saluzzianus 148, ff. 51*v*-52*r* (all devices labelled *per/da hedificare*) and Ashburnham 361, f. 46*r*.

[41] See Ashburnham 361, f. 46*r*/Saluzzianus 148, f. 52*r*. "Anco l'antenna sopra rullato carrozzo si facci. E in nella sommità, dove lo edifizio a uso di bossola sopra rulli posto, che le viti per piano e per diritto, dove per le stampate vezzose e lomache innanzi e indrietro, alto e basso ciascun peso dall'oncin della vite preso, dove a te piace posando fermar si può. E sotto della bossola due caviglie e carrucole, a le quali caviglie el canape attaccato, per le carrucole dell'oncinato ceppo passando, entrando per quelle da le caviglie a quelle due dabasso referndosi. E sopr'al naspo della dentata ruota dal rullato rocchetto mossa assai facilmente tira, siccome la figura XXVII demostra", see di Giorgio Martini, *Trattati…* cit., I, p. 195. The closing remark corresponds more directly to the drawing in Codex Saluzzianus 148, f. 62*v*, where one discerns a reel with spur and lantern gear combination, see fig. 6.

[42] This efficient metaphor is used also for another construction jack, see Calchini, *Glossario…* cit., p. 453.

[43] No model of this crane is to be found in the *Codicetto*.

[44] See Magliabechianus II.I.141, f. 92*v*. "Finalmente quanto al tirare di canapi, è da porne uno modo per el quale le pietre concie e altri gran pesi in alto e a sesta in ogni parte locare si possi dove all'architetto piacesse. La forma di questo è fac-

> *to*) through which passes a second screw, on which is fixed the screw nut with holes, by which one can raise and lower [the objects]. At the carriage is attached the horizontal screw so that one can move the weight back and forth and by turning the compass-joist the objects can be collocated, as is shown better in the figure[44].

Here Francesco first combines the two steps of the movement – *tirare* (lift) and *locare* (positioning) – but later explains them one by one. The reference to the necessary height of the *intenna* (post), which should correspond to the height of the building under construction, is interesting, and so is the fact that he again employs the term *bossola* (in the sense of turntable)[45]. He specifies details such as the horizontal screw moved by a *vezzosa* (screw nut), the doubled frame (*telaio duplicato*), and the position of the screw on a small carriage (the *mozzo rullato*)[46]. Thus, the description offers more details and, most importantly, new technical expressions (also *locare a sesta*, *riparella*, *femminella*), but gives only relative measurements. Therefore, the relevant improvement of the vocabulary and the structure indicates Francesco's increased understanding of the description's ambiguities. The illustration (fig. 7) reveals a little gem in its representational method: while the main features are similar to the handbook, the junction of the upright post and the superimposed screw is drawn in a transparent view. The upper horizontal part rests on a vertical pillar, fixed with two diagonal battens, and the transparent view reveals that it fits loosely on a round peg. Thus, one discerns how the complete rotation of the upper part is obtained. Francesco had employed partial transparency before, in the handbook, so I suggest that in this case he applies it intentionally to improve the transmission of information, which again attests to his effort of revision[47].

We should briefly address the striking lack of measurements in both the handbook and the treatise, which might be considered a strategy. It would be necessary to have a professional education (or to consult a professional) to assemble the device. I agree with Long that generally simplifying the descriptions stems partially from a fear of theft[48]. In this case, it might be caused by the specificity of the device itself, as its measurements depend on the ones of the building under construction. Moreover, we need to take into account that the device again goes back to an invention of Brunelleschi. We do not have an original drawing, but only a short description in the "Vita" of Brunelleschi[49], as well as various drawings representing the crane in copy books dating approximately from the 1470s onwards[50]. Francesco interestingly shows an additional feature, the *bossola*, which seems to have exactly two parallels. One is a near-identical copy of Francesco's representation made by Antonio da Sangallo the Younger (GDSU, 1449 A*v*)[51]. More interestingly, there is also a drawing of Leonardo da Vinci in the Codex Atlanticus, f. 105B*v* showing a similar device but with further developed elements[52]. I therefore believe that the rendering of the *bossola* in transparent view is an authentic invention of Francesco, as he probably would have reflected other aspects of Leonardo's version, had he known it[53]. Evidently, the crane was quite well studied and discussed at the time, and Francesco further contributed to its notoriety and visual representation.

I shall now consider the last device in the handbook, described as follows:

> The cranes for heavy objects should not be done with ropes but with strong frames of horizontal and vertical, well-connected timber rods. On each side of the frame there should be a vertical spur rack which is moved by turning the worms on their top. The ladders (*scale*) have a horizontal linkage at which the weight is attached by iron chains and thereby the weight is raised. Raising the iron links and chains they can be shortened as necessary in continuously supporting the weight at the bottom.

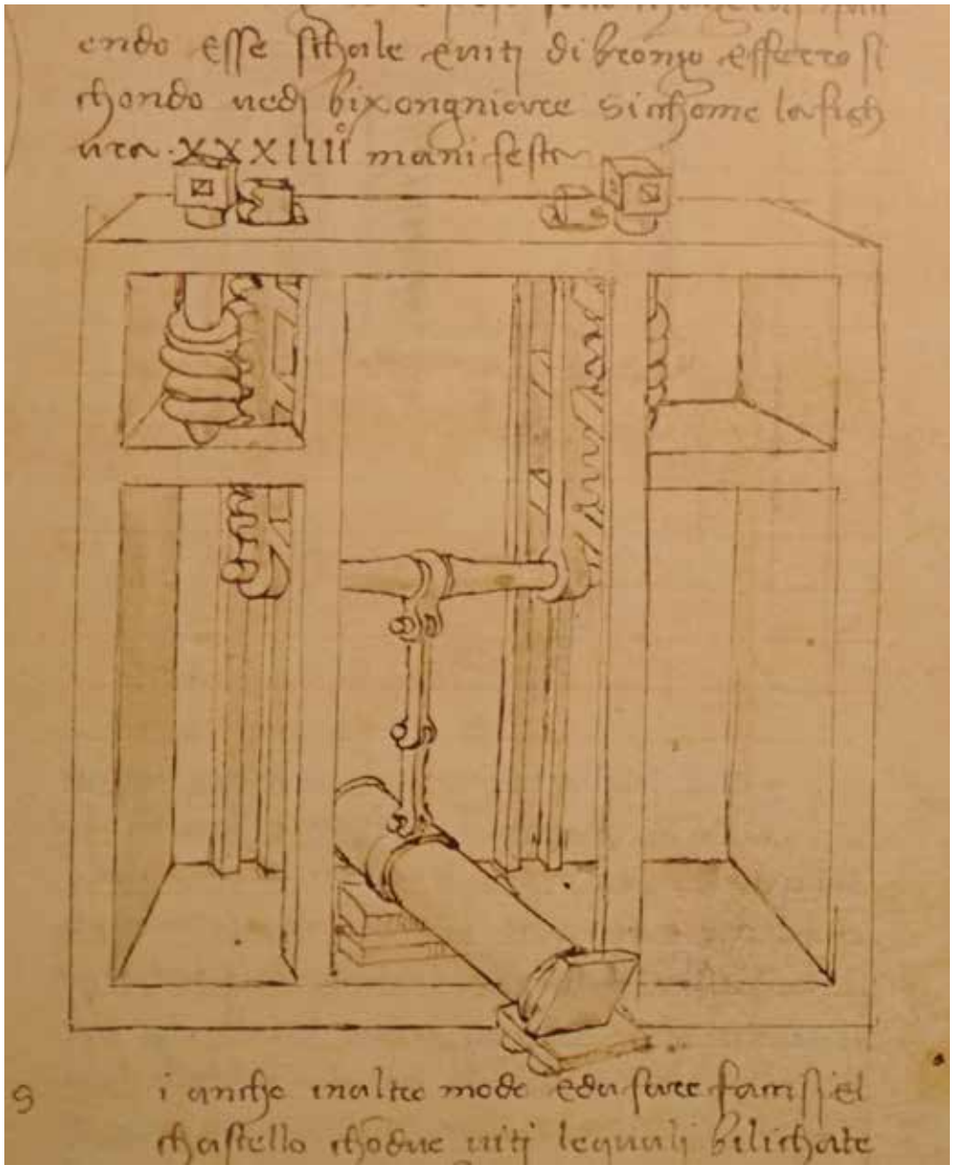


Fig. 8 *Mechanical device for heavy objects, from Codex Ashburnham 361, f. 44r (in di Giorgio Martini, Trattato di architettura… cit., f. 44r).*

> The ladders and worms should be made of bronze and iron as you think necessary. This is shown in figure XXXIIII[54].

In the handbook, Francesco discusses this machine at the beginning of the section. The wording is sometimes obscure and omits details such as the source of power, which is not specified, neither in the text nor in the illustration (fig. 8)[55]. The interplay between the spur rack and the worms is also quite improbable. Thus, especially after considering the drawing, we may doubt the device's functionality, not least because its dimensions are obviously symbolic: the weight of an entire column could never be supported by such a small construction. The whole description can be considered a typical example of the many difficulties which the reader of the handbook might face.

We understand this better when comparing it with the respective passage in the treatise:

> To lift up in the air heavy weights it is necessary to build different instruments: these shall be made of a frame of the strongest wood with doubled and stiffened rods vertically and horizontally, inside which the crane is contained. Then one should make two racks both six feet long with the attachments for the levers, half a foot in size. At their lower end, one must position worms of bronze, each with five coils and one and a quarter feet wide; these engage with two spur racks (*scale dentate*), each half a foot wide and deep, which slide on small rollers contained in the chase. At the feet of these spur racks, there are the rings for the horizontal rod (*chiavarda da traverso*) which holds the attachments (*chiavi*), which hang down due to their weight. The latter should be composed of various parts which can be connected because when lifting up the weight and supporting it continuously

cendo uno carrozzo sopra li rulli nel quale sia posata e ferma una intenna dell'altezza che debba essere lo edificio, et in essa sotto la bossola s'ordini le carrucole dove vadi el canape delle taglie; el quale, duplicato in esse, pervenga a due calcesi nell'infima parte dell'albero; el canape, passando per quelli, all'argano si conferisca. Dopo questo al sommo della bossola sia ordinato el telaio duplicato dove sia una riparella, al sommo dello stile della bossola, per la quale passi la vite, e di rietro a quella la vezzosa con le stampe o femminelle. Sopra del telaio sia uno mozzo rullato per lo quale passi una altra vite, sopra di cui si posi la vezzosa con le stampe sue, acciò che alto e basso si possi tirare. Al mozzo d'essa sia connessa la vite per piano, acciò che inanzi e indietro el peso tirare si possa, e così per la bossola voltando, li pondi a ponto si porranno collocare, come appare meglio per la figura", see di Giorgio Martini, *Trattati*… cit., II, pp. 497-498; on *sesto* and *stampe* (equivalent of *femminella*), see Calchini, *Glossario*… cit., p. 467.

[45] See Calchini, *Glossario*… cit., pp. 453-454.

[46] The horizontal frame had to be provided with a central passageway to allow the horizontal movement of the vertical screw – a fact which the reader discerns only in the drawing, however.

[47] He uses them extensively in the drawings on pumps in the handbook but used them already in his *Codicetto*.

[48] Long states: "it appears that his simplifying strategy involves more than simply wanting to present a more general and rationalized account of mills. This becomes apparent when he immediately plunges into a lengthy biographical lament", see Long, *Picturing the Machine*… cit., p 128, referring to the previously quoted admonition on having one's ideas stolen (see note 18).

[49] The description concerns a demonstration given by Brunelleschi between 1417 and 1419 in preparation of the construction of the cupola and is part of the "Vita of Brunelleschi" attributed to Antonio Manetti. Scaglia, *Drawings*… cit., p. 98-99 quotes the relevant passage and discusses the connection of the crane's rotation to ship construction.

[50] Scaglia lists different codices and reproduces the drawing of S.IV.5, f. 17*r*. Some of the cited codices date after the writings of Francesco (Magl. XVIII.V.2, f. 37*r*; S.IV.1, f. 126*v*; Palat. 767, f. 201; and drawing GDSU, 1449A*v* attributed to Antonio da Sangallo the Younger); the connections of the others to Francesco are not fully established (S.IV.5, f. 17*r*; NL 383, f. 19*r*; Cod. II.III.314, f. 42; Cod. Atlanticus, f. 37*v-b*, 309*r-b*). Moreover, she remarks that in a copy of Taccola's *De machinis* of the Biblioteca Marciana a similar drawing has been added: cod. Lat VIII, 40 (=2941), f. 88*r*; see Scaglia, *Drawings*… cit., p. 113/Appendix A.

[51] See Scaglia, *Drawings*… cit., p. 98. On Antonio da Sangallo the Younger's copies after Francesco, see *Prima di Leonardo*… cit., p. 245-346, hypothesizing mediation through Giuliano da Sangallo. See also G. Scaglia, *Drawings of Machines, Instruments, and Tools*, in *The Architectural Drawings of Antonio da Sangallo the Younger and his Circle*. I (*Fortifications, Machines, and Festival Architecture*), edited by Ch.L. Frommel, N. Adams, Cambridge 1994, pp. 81-92.

[52] In Codex S.IV.5, f. 17*r* and the similar drawing in Ghiberti's *Zibaldone* the element is not present. Galluzzi, *Gli ingegnieri*… cit., pp. 114-115 shows a drawing of Ghiberti of a similar turnable crane (Florence, Biblioteca Nazionale Centrale, Banco Rari 228, f. 107*v*) and the drawing from Leonardo da Vinci's Codex Atlanticus, f. 105B*v*. While Ghiberti features the more basic version of the crane, Leonardo already shows a *bossola* which appears to be more elaborate than the one of Francesco.

[53] However, Mussini's dating of the treatise to 1496-1500 makes it possible that it was influenced by Leonardo, whom Francesco met around 1490 in Milan. See P.C. Marani, *Leonardo, Francesco di Giorgio e il tiburio del Duomo di Milano*, "Arte Lombarda", 62, 1982, 2, pp. 81-92.

[54] See Ashburnham 361, f. 44*r*/Saluzzianus 148, f. 51*v*. "Perché le lieve de' grandi pesi non con canapi sono da fare, ma un fortissimo castello di diritti traversi e ben legati legni. E da ogni banda d'esso castello per diritto un dentato stile è da fare, i quali da le vite prese sopra colle manuelle girando le scale ch'el traverso dall'una e l'altra serà colle catene del ferro al peso collegate con esso peso si elevarà. E così alzandosi, rappe e catene del ferro scemando sicondo farà di bisogno, quan-

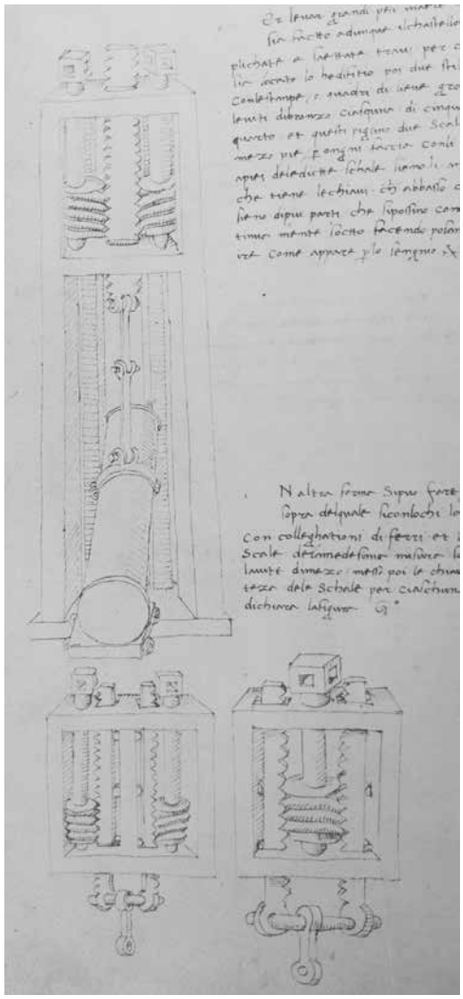


Fig. 9 *Mechanical device for heavy objects, from Codex Magliabechianus II.I.141, 93v (in di Giorgio Martini, Trattati… cit., II, tav. 322).*

with a [growing] pedestal, these attachments can be shortened, as is shown at the sign X[56].

The description is structured differently, and three illustrations accompany it (fig. 9): the one above represents the entire crane, the two images below show only the screw mechanism. One would expect the description to refer to the complete drawing, but it describes instead the left one of the partial drawings. Francesco gives precise dimensions and materials, and the reader can now fully understand that *scale dentate* indicates the spur racks. In the handbook, there was a distinction between *dentato stile* (spur rack) and *scale* (ladder), which indicated the ladder-like frame in which the spur rack was integrated. In the present device, this has been replaced, and the spur racks slide on rollers attached to a vertical support. The description has been changed accordingly and thus gains clarity, featuring crucial technical elements and terms. A further novelty regarding the strategy of visual communication is revealed as the device is shown by one overall view with two separate variations for screw-rack connections added as individual drawings. However, only these two additional lifting mechanisms are described, while the one featured in the general view is not mentioned. Thus, the deliberate omission of a detail in the drawing is accompanied by a more concise description. This appears to be a precise strategy to enhance efficiency. The use of partial representations might be rooted in Francesco's sketchbook practices, but adapting this strategy for an external, non-professional readership is quite an innovation, as it requires from the reader a certain ability in interpreting drawings or having at his disposal an expert to explain the text[57]. That the column-lift was generally popular among Francesco's fellow engineers is attested by the numerous variations of the device recorded in various copy books and by Antonio da Sangallo the Younger's discussion of the general drawing of Francesco (GSDU, 1443 Ar)[58].

In conclusion, the characteristics of the two writings may be summarized as follows. The rhetoric of the handbook is similar to traditional manuals in that it resembles a spoken discourse and includes plenty of details, which, however, are not provided systematically. Thus, a large part of the actual transmission of knowledge is left to the drawings. In Francesco's handbook, these drawings are often ambiguous, mainly due to the complexity of the topics addressed. In this aspect, the handbook departs from the immediate intelligibility of traditional manuals. The treatise is far better structured, and the technical terminology is explained more systematically; furthermore, the content has been streamlined. The featured devices have been perfected in two main aspects: their function and their verbal explanation. The drawings are improved as well: they now feature all the essential details discussed in the descriptions and tend to employ representational methods that are easily accessible. Thanks to the enhanced congruency between description and drawing, the reader is able to associate the technical terms with specific parts of the devices. As a result, the user can autonomously acquaint himself or herself with the terminology and the logic of the drawings.

Having compared the two writings, I think we should regard the conditions under which the reader might be autonomous as the key to his identification and, thus, to the main purpose of the texts. For the handbook, a reader with pre-existing technical knowledge and skills would be able to understand and profit from the information in the book. This kind of reader is to be found mainly among professionals such as engineers and architects. Therefore, I think that the readership Francesco addressed in his first writing were his peers. While in Urbino, he compiled a beautiful handbook putting together his

do nell'alzare el peso sotto calzerai, facendo esse scale e viti di bronzo e ferro sicondo vedi bisognare, siccome la figura XXXIIII (sic) demostra", see di Giorgio Martini, *Trattati…* cit., I, p. 189. There, however, instead of "rappe e catene" we read "le rampe delle scommesse catene". On the support of the column, see di Giorgio Martini, *Trattati…* cit., I, p. 189 n. 6 Maltese explains the gradual adding of plates.

[55] An earlier version of the device is shown in the *Codicetto*, f. 168*v*.

[56] See Magliabechianus II.I.141, f. 93*r*. "Per levare grandi pesi in aria, altri instrumenti fanno di bisogno: sia fatto adonque el castello di legname fortissimo di duplicate e saettate travi per diritto e traverso, nel quale sia collocato l'edifizio, poi due stili ciascuno longo piedi sei con le stampe o quadri delle lieve, grossi piedi mezzo; da piè d'essi sieno le viti di bronzo ciascuna di cinque pani grossi uno piè et uno quarto, et questi piglino due scale dentate ciascuna grossa mezzo piè per ogni faccia con i rulli nella loro incassatura, a piei delle dette scale siano gli anelli per la chiavarda da traverso che tiene le chiavi che abasso discendano per lo peso, e queste sieno di più parti che si possino connettere, perché salendo il peso, continuamente sotto facendoli posamento, le chiavi si possino diminuire, come appare per il segno -X-", see di Giorgio Martini, *Trattati…* cit., II, p. 499.

recent and previously researched material, covering all the areas an architectural practitioner had to master in order to be acknowledged as a humanist and to meet the rising standards of the learned architect, for whom there was an increasing demand among patrons and courtiers. Seen in this way, the two handbook manuscripts were possibly not conceived as models for copies (to be sold or given to clients), but as originals forming part of the library of Francesco and his workshop and which he could lend out to friends and colleagues. Additionally, the handbook served as a portfolio which Francesco could present to his patron, Duke Federico da Montefeltro, and to potential other patrons. In such circumstances, Francesco would have been present to guide his patron through the reading, complementing the information with additional technical specifications, thereby demonstrating his vast knowledge. The handbook can thus be regarded as a strong statement of the self-awareness of a late Quattrocento architect who created his own book to fulfill his increasing ambition and his need to present himself as a learned professional of a new age. The treatise instead unites all the research done by Francesco and his erudite assistants on ancient architecture and his experiences in matters of fortification. The writing testifies to his work for Federico da Montefeltro and to the high regard in which Francesco was held at the court of Urbino, resulting in an encomiastic memory of the Duke. Thus, the treatise reflects Francesco's professional development, which had taken place at the court of Urbino, but also his subsequent experiences, such as those gained during his work in Naples. Ultimately, the treatise documents Francesco's rethinking of architectural and engineering theory. In its new form with revised content, the treatise reveals a completely new concept of his architectural writing, which now fulfills the demands of a scholarly book and meets the related language standards. It preserves, however, important features of Francesco's background as a practitioner, such as the use of the vernacular. It is presented in a humanistic language, with additional learned information that may be appreciated by the erudite strata, and without disregarding information that is more oriented towards application. The treatise can therefore reward every reader, regardless of his architectural or technical training, with a literary lesson on architecture and (technical) drawing. However, in order to be used for actual construction, it still required the assistance of a practitioner. Being both practitioner and scholar, the architect would know how to strike the right note when addressing courtiers and, in this way, figures like the author Francesco di Giorgio became instrumental to the treatise's success. As such, the treatise presents itself as an ideal instrument to mediate between the different classes and personalities involved in the creation of architecture, who could now all access – albeit on different levels – its extensive teachings. In sum, it constitutes a perfect representative of the new society of learning which came into being in the Renaissance.

[57] Only much later, in Sebastiano Serlio's Third Book, on antiquities, do we find something similar, when he shows variations for the upper part of the Colosseum.
[58] There he compares it to another device, similar to one of Francesco's, Magliabechianus II.I.141, f. 94*r*. Whereas Antonio criticizes the use of racks with movable rollers for not being sufficiently stable (see *The Architectural Drawings*… cit., cat. 219), Francesco does not elaborate further on the differences between the two. Another column-lift is shown in the handbook, Ashburnham, f. 46*r*/Saluzzianus, f. 51*v*, and has an equivalent in Ghiberti's *Zibaldone*, see Scaglia, *Drawings*… cit., p. 109 and appendix A, without detailed discussion.

Hubertus Günther

THE FRENCH WAY OF BUILDING IN ROME: S. AGOSTINO AND SS. TRINITÀ DEI MONTI

In Renaissance Rome several churches were built which deliberately adopted a German or French architectural style and which therefore shed interesting light on the tension between the Gothic tradition and the new all'antica *manner. This article first discusses the examples of S. Maria dell'Anima and S. Agostino to illuminate this phenomenon, and then focuses on the SS. Trinità dei Monti, which in 1520–1521 was explicitly described as having been "made in the French manner". Here it is argued that this qualification referred not only to the fact that the church had been built using stones imported especially from France, but also, and more specifically, to its Gothic parts, most notably the choir and the vault (including a star vault similar to that of the Cathedral of Amiens), which here were combined in a striking manner with the* all'antica *articulation of the lower walls of the nave.*

This paper addresses the topic of a deliberate choice of style to convey identity and purpose in contrast to the idea of a continuous development of style as the sole factor determining architectural design. At the beginning of the modern era, builders primarily had to decide whether to keep the Gothic tradition or to take up the new *all'antica* manner[1]. In Italy, a famous example of this choice is the Cathedral of Pienza, which Pope Pius II (1459-1462) expressly wanted to be built according to the model of the late Gothic *Hallenkirchen* (hall churches), which he had admired in Germany. However, its architect Bernardo Rossellino designed the architectural articulation largely in the manner of the Italian Renaissance[2]. At about the same time, in the mid-fifteenth century, the Senate of Venice decided to build the main entrance to the Arsenal in the new *all'antica* style, probably to express the spirit of progress, while the main entrance to the Doge's Palace (Arco dei Foscari) had to retain Gothic elements, probably in consideration for the venerable tradition of the Venetian government. Alfonso of Aragon probably had similar reasons when, at the beginning of his reign (1443), he considered how to rebuild the Castel Nuovo in Naples: he had designed the triumphal entrance façade in the new *all'antica* style to celebrate the beginning of the new era under the rule of the House of Aragon in the kingdom of Naples, while the Sala dei Baroni was given a magnificent Gothic shape with respect to the tradition of the nobility who assembled there. Some contemporary commentaries suggest that the ancient architecture, which was to be revived in the Renaissance, had the stigma of paganism, while it seems that the Gothic was sometimes associated with the sacred[3]. Therefore, in Italian churches the choir area was occasionally distinguished by Gothic elements (Cathedral of Pienza, S. Zaccaria in Venice, from 1458). This approach was rare in Italy, but in France, sacred buildings often adopted a Gothic or a Gothicizing style while secular buildings adopted the new Renaissance style. In many French Renaissance castles, the chapel preserves a Gothic style – in contrast to the rest of the building. King François I of France had the town hall of Paris built in a Renaissance style, while the great parish church of Saint-Eustache in the centre of Paris was built in a Gothic style with a superficial adaptation of the decor to the Renaissance style. Even before this time, Franco-Flemish book illuminations distinguished between Gothic and Renaissance styles for the sacred and the secular. A well-known example of this is the representation by Jean Fouquet of the patron in adoration of the Madonna in the *Livre d'heures* of Étienne Chevalier (c. 1452-1460, Musée Condé, Chantilly). The Madonna sits enthroned in a Gothic portal, while the patron kneels before her in a Renaissance courtyard.

Patrons who built their places of residence in the new Renaissance style, when building abroad, often adapted to the style prevalent there, even when it was considered retrograde and unsightly in their own towns. Examples from the fifteenth century include the filial branches of the Medici bank in Milan and Bruges or the palace of Cardinal Giuliano della Rovere in Avignon. Duke Francesco Sforza of Milan wanted to complete the Ca' del Duca in Venice in "forma moderna e lombarda", i.e. the way in which people built in his country, but the façade overlooking the Grand Canal was to be designed "al modo veneziano", on the grounds, as his *chargé d'affaires* wrote, that the Venetians liked their own way of building better than other modes of building[4].

Paolo Cortesi and Pietro Summonte stated in 1510 and 1524, respectively, that during the Middle Ages, in southern or central Italy, German, French and Spanish rulers had built in the style of their home countries. This will be explained in more detail later. During the Renaissance, Rome, as the centre of Christianity, offered foreign builders the opportunity to show the world what the architecture of their own nation was like[5].

In Rome, an explicit testimony to the demonstration of different national architectural styles has long been known: it is contained in the decision of the German brotherhood in Rome to build their church of S. Maria dell'Anima

Opus Incertum (2020) pp. 34-53 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12359 www.fupress.com/oi

pagina 35
Fig. 1 *Church of SS. Trinità dei Monti, Rome. Façade (photo H. Günther).*

(1499). Most of the foreign inhabitants of Rome and most of the pilgrims to Rome came from the German Empire. At that time the protector of the brotherhood was Cardinal Francesco Tedeschini Piccolomini, a nephew of Pope Pius II, who wanted to build the cathedral in Pienza as a hall church after the German model. In the decision to build their church, the brotherhood stated their intention: "so that we do not appear to be unequal to the other nations and behind them", they wanted to have a new church built for the praise and glory of God, for the "honour of our Germanic nation and for the adornment of the city of Rome", to be designed in a German style ("Alemannico more compositum")[6]. They wanted to build a hall church in the Gothic style. The intention to build in the Gothic style is indirectly shown by the fact that they appointed construction workers from the Strasbourg region. A few months later, however, the brotherhood dismissed the German workers and commissioned Italian workers to build in the Renaissance style. They retained the layout of a hall church but with variants. Due to the change of plans, it is not certain what was meant by *Alemannico more*: the Gothic style, which was usually called *maniera tedesca* in Italy, or the disposition of the hall church, which at that time was particularly widespread in Central Europe and was also renowned abroad because of its clarity, brightness and manageability. However, the nearby church of the Kingdom of Castile, S. Giacomo degli Spagnoli, which was built during the pontificates of two Spaniards, Calixtus III and Alexander VI, a little previously, had also been designed as a hall. Outside Central Europe, the hall churches spread mainly in Spain, especially in Castile[7].

France was politically most influential at the Curia during the time when Rome, after its descent caused by the exile of the Curia in Avignon and the schism, rose again to be the occidental metropolis. Under Pope Sixtus IV, Cardinal Guillaume d'Estouteville, Archbishop of Rouen in Normandy and representative of the King of France at the Curia, held the office of chamberlain, the highest ecclesiastical rank after the Pope, and therefore was responsible for the urban renewal of Rome. The kings of France repeatedly threatened the popes with invasions of Italy in order to enforce their claim to the Kingdom of Naples. The overwhelming influence of King Louis XII even triggered fears that the election of a French pope and the withdrawal of the Curia to Avignon might take place again[8].

The Augustinian Church of S. Agostino, built by Cardinal d'Estouteville in 1479-1483 as his burial place close to his residence at one of Rome's most important traffic centres, is an obvious, though not an explicitly guaranteed, example of the demonstration of national architecture in Rome (fig. 2)[9]. The identity of the patron is pointed out all too clearly: his name appears on the façade with his rank and offices:

> GVILLERMVS. DE. ESTOVTEVILLA. EPISC. OSTIEN. CARD. ROTHOMAGEN. S. R. E. CAMERARIVS. FECIT / M.CCCC.LXXXIII.

Inside, his coat-of-arms is often displayed on the walls and keystones. The shape of the interior is French, but similar to the cathedral of Pienza and S. Maria dell'Anima; the articulation is largely adapted to the Renaissance style. In 1942 Piero Tomei presented a polemical but, nevertheless, apt style analysis of S. Agostino from the point of view of the classicist, who was still struck by the deviations from the regularity of the Italian Renaissance[10]. In summary, he criticizes the elongated proportions of the interior, of the nave and side aisles, arcades and vaults, etc. All this belongs to a Gothic church, he notes. Decoration in Renaissance style would be a bad disguise. The semi-columns, which are used as articulation, would be far too low to comply with

[1] P. Frankl, *The Gothic*, Princeton 1960; H. Hipp, *Studien zur "Nachgotik" des 16. und 17. Jahrhunderts in Deutschland, Böhmen, Österreich und der Schweiz*, Diss., Universität Tübingen 1979; M. Hesse, *Von der Nachgotik zur Neugotik. Die Auseinandersetzung mit der Gotik in der französischen Sakralarchitektur des 16ten, 17ten und 18ten Jahrhunderts*, Frankfurt am Main 1984; L.S. Sutthoff, *Gotik im Barock. Zur Frage der Kontinuität des Stiles außerhalb seiner Epoche*, Münster 1990. I have dealt with various aspects of the deliberate choice of styles during the Renaissance in general and in particular from this point of view with the two churches of S. Agostino and SS. Trinità. The present contribution is intended to explore individual aspects of the subject matter and point out new correlations. My contributions to individual aspects, especially to the two churches, are quoted below when we treat them. For the conscious choice of styles in general, see H. Günther, *Was ist Renaissance? Eine Charakteristik der Architektur zu Beginn der Neuzeit*, Darmstadt 2009, pp. 50-80; Id., *Visions de l'architecture en Italie et dans l'Europe du Nord au début de la Renaissance*, in *L'invention de la Renaissance*, éd. J. Guillaume, Paris 2003, pp. 9-26; Id., *Die ersten Schritte in die Neuzeit. Gedanken zum Beginn der Renaissance nördlich der Alpen*, in *Wege zur Renaissance. Beobachtungen zu den Anfängen neuzeitlicher Kunstauffassung im Rheinland und in den Nachbargebieten um 1500*, herausgegeben von N. Nußbaum, Köln 2003, pp. 30-87; Id., *Gotik in der Architektur der internationalen Renaissance*, in *Echters Werte. Zur Bedeutung der nachgotischen Baukultur um 1600 unter Fürstbischof Julius Echter von Mespelbrunn*, herausgegeben von S. Bürger, I. Palzer, Berlin-München 2017, pp. 179-205.

[2] L.H. Heydenreich, *Pius II. als Bauherr von Pienza*, "Zeitschrift für Kunstgeschichte", VI, 1937, pp. 105-146; M. Brandis, *"La maniera tedesca". Eine Studie zum historischen Verständnis der Gotik im Italien der Renaissance*, Weimar 2002, pp. 125-138.

[3] H. Günther, *Die Gotik als der europäische Baustil*, in *Europäische Erinnerungsorte*, II (*Das Haus Europa*), herausgegeben von P. den Boer, H. Duchardt, München 2012, pp. 137-150.

[4] L. Beltrami, *La "Ca' del Duca" sul Canal Grande ed altre reminiscenze sforzesche in Venezia*, Milano 1900; W. Wolters, *"al modo veneziano" und nicht "alla moderna". Zu den Anfängen der venezianischen Renaissancebaukunst*, "Römisches Jahrbuch für Kunstgeschichte", XXXVIII, 2007-2008, pp. 205-230: 219.

[5] H. Günther, *Rom um 1500: Ausländische Nationen stellen ihre Architektur aus-Gotische Lokaltraditionen und Renaissance*, in *Architektur im Museum: 1977-2012. Winfried Nerdinger (Festschrift)*, herausgegeben von U. Kiessler, München 2012, pp. 95-109.

[6] F. Nagl, *Urkundliches zur Geschichte der Anima in Rom*, Rom 1899, pp. 65ff.; J. Schmidlin, *Geschichte der deutschen Nationalkirche in Rom, S. Maria dell'Anima*, Freiburg 1906; J. Lohninger, *S. Maria dell'Anima. Die deutsche Nationalkirche in Rom*, Rom 1909, pp. 38ff.; further literature listed by B. Baumüller, *Santa Maria dell'Anima in Rom. Ein Kirchenbau im politischen Spannungsfeld der Zeit um 1500*, Berlin 2000; *Identità e rappresentazione. Le chiese nazionali a Roma, 1450-1650*, a cura di A. Koller, S. Kubersky-Piredda, Roma 2015, pp. 43-53.

[7] G. Weise, *Die Hallenkirchen der Spätgotik und Renaissance im mittleren und nördlichen Spanien*, "Zeitschrift für Kunstgeschichte", IV, 1935, pp. 214-227; Id., *Die spanischen Hallenkirchen der Spätgotik und der Renaissance I, Alt und Neukastilien*, Tübingen 1953; P. Sesmat, *Les "églises-halles". Histoire d'un espace sacré (XII[e]-XVIII[e] siècle)*, "Bulletin Monumental", CLXIII, 2005, pp. 3-81.

[8] L. von Pastor, *Geschichte der Päpste seit dem Ausgang des Mittelalters*, III (*Geschichte der Päpste im Zeitalter der Renaissance von der Wahl Innozenz' VIII. bis zum Tode Julius' II. 1484-1513*), Freiburg im Breisgau-Rom 1924, pp. 741f.; F. Bardati, *Hommes du roi et princes de l'Église romaine. Les cardinaux français et l'art italien (1495-1560)*, Roma 2015.

their constructive task of supporting the vaults. These "strange incongruities, discordances, mergers of two styles" would show that the architect "had the best experience as a constructor, but not the ability to confer artistic value to a building". The avant-garde of the Renaissance criticised Gothic buildings with similar words. Tomei calls the features that he criticises *Gothic*, but they do not belong to the Italian Gothic, instead they are typical of the French Gothic or overall of medieval, even Romanesque buildings in Normandy (such as the Abbey of Jumièges). The architects of S. Agostino, Jacomo da Pietrasanta and Sebastiano Fiorentino, both from Tuscany, did not otherwise stand out with such deviations from the norms of the Italian Renaissance. Cardinal d'Estouteville had his architecture in his Normandy diocese built in the Gothic style that was customary there, while he left it to Antonio da Como to design the cloister of S. Oliva in Cori in the Lombard style that the architect had learned in his homeland. Apparently, d'Estouteville commissioned the architects of S. Agostino to adapt the interior of S. Agostino to the style customary in France, or more precisely in his diocese of Rouen, though he permitted integrating Renaissance *décor*.

The design of many French churches, especially that of Saint-Eustache in Paris, followed S. Agostino in so far as it has a Gothic form with super-slender proportions combined with decoration in the Renaissance style, which integrates columns with antique elements, but, basically uses them like Gothic vaulting shafts[11]. In France, the idea circulated that although the Gothic style produced unsightly decorations, its tectonics were admirable. This idea was only formulated in the course of Classicism, but it has a long prehistory that can be traced back to about the time of Saint-Eustache. French Renaissance writers often admired Gothic buildings for their boldness (*hardiesse*) and lightness (*légèreté*), i.e. for the refined tectonics of Gothic architecture. From the first French guide books at the beginning of the Renaissance (Gilles Corrozet) to Classicism, these two characteristics were repeatedly praised in individual buildings[12]. The authors from Gilles Corrozet and Etienne Pasquier up to Germain Brice (1684) and beyond describe the Sainte-Chapelle as the climax of this kind of construction, as "l'ouvrage le plus hardy"[13]. The critical Italian variant thereof was pronounced by Torquato Tasso in a report of his travels in France during 1570-1571 by commenting on the churches there:

> *l'architettura è barbara, e si conosce che è stato avuto solo riguardo a la sodezza e a la perpetuità, e niente a l'eleganza e al decoro*[14].

The same arguments then return in French architectural theory for the defence of Gothic architecture. A typical example of this is Antoine Le Paultre (1652), who rejected Gothic decor, but wrote admiringly about the tectonics:

> *Ceux qui ont bâti les eglises gothiques, se sont efforcez de rendre leurs ouvrages durables et les faisant paroitre surprenans, en faire concevoir autant d'admiration que de respect; ils ont tellement réussi dans ce genre de bâtir, que ses ouvrages qui subsistent depuis plusieurs siecles, leur ont acquis la réputation d'etre les plus hardis ouvriers qui ayent élévé des édifices*[15].

Since then, the special tectonics of Gothic architecture have increasingly been dealt with in art theory. As unsightly as Gothic ornament still seemed, the bold construction aroused admiration. In this sense, a French encyclopaedia summarises in 1752:

> *Architecture gothique, c'est qui est éloignée des proportions antiques, sans corrections de profils, ni de bon goût dans ses ornemens chimériques. Elle a beaucoup de solidité et de merveilleux*[16].

Since the seventeenth century in France, the precepts of Gothic construction have been explicitly presented as a model for new architec-

[9] The building includes in the eastern part older structures, but they have been adapted so much to the new concept that they are not visible. Cf. R. Samperi, *L'architettura di S. Agostino a Roma (1296-1483). Una chiesa mendicante tra Medioevo e Rinascimento*, Roma 1999.
[10] P. Tomei, *L'architettura a Roma nel '400*, Roma 1942, pp. 123-128.
[11] A.M. Sankovitch, *A Reconsideration of French Renaissance Church Architecture*, in *L'Église dans l'Architecture de la Renaissance*, actes du colloque (Tours, 28-31 mai 1990), éd. J. Guillaume, Paris 1995, pp. 161-180; H. Zerner, *L'art de la Renaissance en France. L'invention du classicisme*, Paris 1996, pp. 13-54.
[12] Hesse, *Von der Nachgotik zur Neugotik*... cit., pp. 36ff., 53ff.; R.D. Middleton, *The Abbé de Cordemoy and the Graeco-Gothic Ideal. A Prelude to Romantic Classicism, Part 1*, "Journal of the Warburg and Courtauld Institutes", XXV, 1962, pp. 278-320: 294ff.; W. Herrmann, *Laugier and Eighteenth Century French Theory*, London 1962, pp. 235-248. J. Voss, *Das Mittelalter im historischen Denken Frankreichs*, München 1972; J. Vanuxem, *L'art du Moyen Age vu par les contemporains de Louis XIV*, "Le XVIIe siècle", 114-115, 1977, pp. 85-98; Günther, *Gotik als der europäische Baustil*... cit.
[13] G. Corrozet, *Les antiquitéz chroniques de Paris*, Paris 1550, p. 68; Voss, *Das Mittelalter*... cit., pp. 135f.; E. Pasquier, *Les recherches de la France*, éd. M.M. Fragonard, F. Roudaut, Paris 1996 (première édition 1621), I, p. 783. In 1612 it is repeated also by a German writer. Hipp, *Studien zur "Nachgotik"*... cit., p. 612.
[14] Letter to Conte Ercole de' Contrari, Ferrara, 1572. T. Tasso, *Lettere*, a cura di E. Mazzali, Torino 1978, I, p. 27.
[15] A. Le Paultre, *Les oeuvres d'architecture*, Paris 1652, p. 37.
[16] Voss, *Das Mittelalter*... cit., p. 203.

Fig. 2 *Church of S. Agostino, Rome. Nave (photo H. Günther).*

ture. In the course of the conscious conception of a modern French Classic style, architects from Claude Perrault to Marc-Antoine Laugier made reference to it. The starting point for this development was the construction of the city façade of the Louvre (1665-1667 competition) which Colbert apparently wanted to be a model for the new French Classicism[17]. As the main element of classical Greek architecture, the freestanding columns were recognised, which, in contrast to the usual illusionary articulation of the Italian Renaissance, express the real tectonics of loading and bearing weight. This context recalled the tectonics of Gothic architecture with its free-standing pillars. Gothic architecture was approved to follow a principle of carrying a burden similar to that of Greek antiquity. Claude Perrault, in his Vitruvian commentary (1684), expressly emphasized the "lightness" of Gothic construction as a French tradition:

> *Le goust de nostre siècle , ou moins de nostre nation, est différent de celuy des Anciens et peut-estre qu'en cela il tient un peu du Gothique: car nous aimons l'air le jour et les dégagements […] mais supposé que le Gothique en general est à considerer tout ce qui le compose ne fust pas le plus beau genre d'architecture, je ne pensois pas que tout ce qui est dans le Gothique fut à rejetter. Le jour dans les edifices et les dégagements dont il s'agit, sont des choses en quoy les Gothiques different des Anciens: mais ce n'est pas en cela que le Gothique est à reprendre*[18].

François Blondel went so far as to praise even the elongated proportions of Gothic cathedrals by referring to those of Milan Cathedral as demonstrated in the Vitruvian commentary of Cesare Cesariano (1521)[19].

SS. Trinità dei Monti

Just as for S. Agostino, a prominent place in Rome was chosen for the SS. Trinità dei Monti; the church stands on the slope of the Pincio, visible from afar (figs. 1, 3). The church belonged to the convent founded on the Pincio in 1474 by the French Minims, an austere mendicant order which was widespread in France and whose founder, Francesco di Paola (1416-1507), was active in Paris from 1483 and was held in high esteem at the French royal court[20]. The kings of France supported the order, promoted the canonisation of Francesco (1519), and financed the construction of the convent on the Pincio from the very beginning. Their representatives at the Holy See supervised the work: at first Cardinal Jean Bilhères de Lagraulas and after his death in 1499, Cardinal Guillaume Briçonnet, who was from 1497 to 1507 Archbishop of Reims, then of Narbonne. The guide to Rome published by Francesco Albertini in 1510 deals with the SS. Trinità dei Monti together with the national churches, because it had been begun by the French king and attended to by a French car-

[17] J.M. Pérouse de Montclos, *L'architecture à la française XVI^e, XVII^e, XVIII^e siècles*, Paris 1982, pp. 236-253 ("Le classicisme français").
[18] Vitruve, *Les dix livres d'architecture*, éd. C. Perrault, Paris 1684, pp. 79ff. (Vitruvius 3. 2).
[19] F. Blondel, *Cours d'architecture enseigné dans l'Académie Royale d'Architecture*, Paris 1675-1683, V, pp. 774ff.
[20] F. Bonnard, *Histoire du couvent royal de la Trinité du mont Pincio à Rome*, Roma-Paris 1933; P. Pecchiai, *La Trinità dei Monti*, before 1965, unpublished printing proofs in the Bibl. Hertziana, signature Dt. 4690-5651; L. Salerno, *Piazza di Spagna*, Napoli 1967, pp. 27-42; C. D'Onofrio, *Scalinate di Roma*, Roma 1973, pp. 131-208; *La Trinité-des-Monts redécouverte: arts, foi et culture. Trinità dei Monti riscoperta. Arti, fede e cultura*, catalogue d'exposition (Rome, 12 juin-8 septembre 2002), éd. Y. Bruley, Rome 2002; C. Di Matteo, *L'église et le couvent de la Trinité-des-Monts à Rome. Les décors restaurés*, Dijon 2015; *La chiesa e il convento della Trinità dei Monti. Ricerche, nuove letture, restauri*, a cura di C. Di Matteo, S. Roberto, Roma 2016, with further literature.

Fig. 3 *Church of SS. Trinità dei Monti, Rome. Interior (photo H. Günther).*

dinal[21]. From then on, the guides to Rome mention the patronage of the kings of France, and the inscription on the façade also announces it:

> S(ANCTAE). TRINITATI. REGUM. GALLIAE. MVNIFICENTIA. ET. PRIOR(VM). ELEMOSYNIS. ADIVTA. MINIMOR(VM). SODALITAS. STRVXIT. AC. D(E)D(IT). ANNO. D(OMINI). M.D.LXX.

In the Baroque era the kings of France erected the great staircase that leads from the Pincio up to the SS. Trinità; they also wanted to emphasize their patronage there, but the popes opposed their thirst for representation, and in the meantime the complex unjustly came to be called the Spanish Steps[22].

I have found a contemporary account, ignored until now, which explicitly states that the church was built in the French style. The testimony is provided by two travel companions of the Abbot of Clairvaux, Dom Edme de Saulieu, who came to Rome at the turn of the year 1520-1521 to pursue the reform of the Cistercians wanted by the king of France. Above all, his intention was to limit the pernicious influence that the Holy See exerted by awarding French benefices to members of the Curia. The French wanted to control their clergy themselves, however the Pope maintained his lucrative privilege. The ancestral heritage was defended in many areas as in architectural styles.

The travelogue states on 31 December 1520:

> *Le dernier jour du dict mois, fumes a la Trinite qui est une eglise de nouveau edifiée et faicte selon la mode francoise. La cause estoit quil y avoit ung convent de Minimes tous françoys, lesquelz commencoient a faire ung beau lieu.*

On 6 January 1521, the report repeats that the church was built in the French style because the convent was French, adding that it was littered with fleurs de lis, the emblem of the kings of France, and in several places bore the coat-of-arms of France:

> *Le VI, jour de lepiphanie, Monseigneur et moy allames dire messe et disner au couvent des Minimes, nomme la Trinite. Les religieux estoient quasi tous francois, et leglise faicte a la mode francoise et semee de fleurs de lis, et en plusieurs lieux, les armes de France*[23].

Edme de Saulieu and his companions were not experts in architecture and express little interest for art in their travelogue. Surely they did not recognize by themselves that the SS. Trinità was built in the French style, but rather reflected what the Minims told their visitors when showing them the church. The intention to build the church *a la mode francoise* also seems to have been mentioned in the files of the convent, which have been lost, but probably entered into the chronicle of the convent written short-

[21] F. Albertini, *Opusculum de mirabilibus novae & veteris urbis Romae*, Roma 1510, fol. X 2*v*.
[22] Salerno, *Piazza di Spagna*... cit.; D'Onofrio, *Scalinate di Roma*... cit.; *La scalinata di Trinità dei Monti*, a cura di L. Cardelli, Milano 1996.
[23] *Relation d'un voyage a Rome, commencé le XXIII du moi d'aout 1520, et terminé le XIV du mois d'Avril 1521, par Révérend père en Dieu Monseigneur Dom Edme, XLI^e abbé de Clairvaux*, éd. Harmand, "Mémoires de la Société d'Agriculture, des Sciences, Arts et Belles-Lettres du Département de l'Aube", s. II 2, 15, 1849-1850, pp. 143-235: 203ff.; for Dom Edme cf. *Peregrinatio hispanica, voyage de Dom Edme de Saulieu, abbé de Clairvaux, en Espagne et au Portugal, 1531-1533*, éd. C. de Bronseval, M. Cocheril, Paris 1970.

Fig. 4 *Church of SS. Trinità dei Monti, Rome. Crossing (photo H. Günther).*

Fig. 5 *Church of SS. Trinità dei Monti, Rome. Right transept (old chapel of St. Michael; photo H. Günther).*

ly after 1806 by Father Charles-Pierre Martin[24]. Briçonnet's intention to present *la mode francoise* is also expressed by the fact that he had the delicate architectural elements of the church made from French stone, i.e. from the precious coloured limestone of the Roussillon quarries located in his archdiocese of Narbonne, had them carved in France and moreover had a French artist, Guillaume de Marcillat, paint the stained glass windows. The laborious transport of the stones from France to Rome attracted so much attention that Albertini in his Guide to Rome drew attention to it[25]. The figurative stained glass windows, which are treated below, were as clearly related to France as the fleurs de lis and coats-of-arms that Edme de Saulieu noted.

In order to be able to assess the statements in the travelogue, we must trace what Dom Edme could see of the SS. Trinità. For this purpose, we first present the essential known data of the building's history (figs. 1, 3-7). In 1502 Cardinal Briçonnet laid the foundation stone for the church. As is obtained from the aforementioned chronicle of the convent, the building materi-

[24] Rome, Archives des Pieux Établissements de la France à Rome et à Lorette, Fonds courant 884bis. C.P. Martin, *Histoire du couvent royal des Minimes français de la très Sainte Trinité sur le mont Pincius à Rome*, éd. M.G. Canzanella-Quintaluce, Rome 2018, p. 114.

[25] Albertini, *Opusculum de mirabilibus*... cit.; Mariano da Firenze, *Itinerarium Urbis Romae*, a cura di E. Bulletti, Roma 1931, pp. 220f.

al of the convent seems to have been partly prepared before 1499 under Cardinal Bilhères de Lagraulas, the predecessor of Briçonnet as orator of the King of France at the Holy See[26]. The work progressed rapidly at the beginning: according to the travel report, the church was largely completed by 1520. In any case, at that time the entire eastern part with choir and transept as well as at least the first bay of the nave with its side chapels were executed, but probably more bays were finished. In 1513 a side chapel was handed over to a patron; in the following year two side chapels were completed; on 4 November 1514 three further side chapels were commissioned. The contract stipulates that they were to be built on the model of the first two[27]. At least by 1527, at the Sack of Rome, the four bays originally planned had been completed. One of the two side chapels of the fourth bay west of the transept was handed over around 1526. The painting of the nave and of the side chapels had also started before the Sack of Rome. Edme de Saulieu had certainly seen the earliest of these frescoes, because they are still as described, in the circle of Perugino (fig. 6). The construction was interrupted by the sack of the city; the invaders plundered the convent. From 1540 the church was extended by a further two bays and finally the prominent double-tower façade was erected.

The parts of the SS. Trinità that Dom Edme saw are no longer completely preserved (fig. 3). The choir was demolished in 1676 and replaced by the present construction. The vaults of the nave, including the clerestory, were remodelled in 1774. The walls of the nave below the clerestory, the side chapels, the crossing and the two arms of the transept have retained their original form (figs. 4-6). I have attempted to reconstruct how the SS. Trinità looked like when Dom Edme visited it (fig. 7)[28]. The result has been adopted recently, essentially unchanged, but without a new evaluation of the sources[29]. My reconstruction is mainly based on four eyewitness accounts: that of the journey of Edme de Saulieu, one of a visitation of the SS. Trinità on 12 January 1629[30], another published by Carlo Bartolomeo Piazza in 1703[31], and, especially, the detailed report in the compendium on Roman Churches written by Giovanni Antonio Bruzio shortly after 1662, which has not been published[32]. In addition, there is the abovementioned chronicle of the SS. Trinità written by Charles-Pierre Martin, who perhaps used the archives of the SS. Trinità, now lost.

The SS. Trinità adopts the building type of a church without aisles (*Saalkirche*). It has a nave with chapels on each side and, as was often the case with this type of building at the time, a distinctly secluded eastern section (fig. 3). The eastern part originally comprised a polygonal choir with an ante-bay, and the surviving crossing and transept, which terminates on the outside in the same alignment as the side chapels (figs. 4-5). A chapel was connected to each arm of the transept in the east[33]. Their original entrances which opened onto the east walls of the transept have been preserved, but their interiors were altered during the Baroque rebuilding. The ante-bay of the choir situated between the two side chapels of the transept was similar in disposition to the present situation[34].

The lower zone of the church is entirely in the Renaissance style. The walls of the nave are articulated by an order of pilasters with Doric capitals and a mighty Ionic-Corinthian entablature. Between the pilasters, arcades with round arches lead into the side chapels, which all have the same shape: an almost square ground plan, a groin vault with cylindrical caps and a round-arched window (fig. 6). The imposts of the arcades continue under the beginnings of their vaults. There is no further architectural articulation in the side chapels. The crossing is separated from the nave by deeply protruding pilasters

[26] Martin, *Histoire du couvent royal*... cit., p. 114: "le cardinal Briçonnet projeta le dessein d'un monastère en règle avec une église à la française, et en fit tracer le plan par les plus habiles architectes. Il en conmença l'execution avec les matériaux qu'avait achetés le cardinal Jean de Lombez, et au mois d'avril de l'an 1502, il jeta les fondements de l'église du côté de l'orient et y forma le grand autel et les deux chapelles collatérales. Il déboursa du sien pour le seul objet 1700 écus d'or au soleil et fit venir par mer de Narbonne les pierres de taille toutes préparées pou former le dit maîrtre-autel, et jusqu'aux vitres pour les fenêtres, sur lesquelles maître Guillaume de Marseille l'avait peint en posture de suppliant aux pieds de saint Juste et de saint Pasteur". Jean de Lombez, Cardinal Bilhères de Lagraulas, bishop of Lombez, died in 1499. Martin, p. 617 says: The unexpected death of King Charles VIII and the death of Cardinal Bilhères "retardèrent l'execution de l'édifice matériell du couvent [...]. Le cardinal Briçonnet, qui succéda au défunt dans l'emploi d'orateur à Rome, lui succéda aussi dans son zèle pour l'avancement de cette maison. Aux materiaux qu'il trouva, il ajouta ceux qu'il avait fait tailler ou polir à Narbonne, qu'il destina à former le choeur et une partie de la nef de l'église".

[27] Roma, Archivio di Stato, *Not. Capitolino St. De Amannis*, 61, p. 156; D'Onofrio, *Scalinate di Roma*... cit., p. 369.

[28] H. Günther, *Demonstration avantgardistischer Architektur "à la mode françoise" an der SS. Trinità dei Monti in Rom*, in *Aufmaß und Diskurs: Festschrift für Norbert Nußbaum zum 60. Geburtstag*, herausgegeben von J. Jachmann, A. Lang, Berlin 2013, pp. 187-211 (in particular: p. 199, fig. 8; p. 201, fig. 9); Id., *Der ursprüngliche Chor der SS. Trinità dei Monti in Rom und der Glasmaler Guillaume de Marcillat*, in *Licht(t)räume: Festschrift für Brigitte Kurmann-Scharz zum 65. Geburtstag*, herausgegeben von K. Georgi, B. von Orelli-Messerli, Petersberg 2016, pp. 76-83 (in particular: p. 78, fig. 2; p. 80, fig. 4).

[29] S. Roberto, *La chiesa della Trinità dei Monti. Un prezioso e problematico palinsesto architettonico, tra XVI e XVIII secolo*, in *La chiesa e il convento della Trinità dei Monti. Ricerche, nuove letture, restauri*... cit., pp. 94-114. Roberto assumes that the windows in the upper galleries were round-arched, without systematically considering the evidence of the sources. In addition to the sources mentioned above, there is also the *veduta* mentioned below of SS. Trinità by Charles-Louis Clérisseau, which Roberto does not consider.

[30] Roma, Archivio Segreto Vaticano, *Congr. Visite Apostol.*, 3, 1624-30.

[31] C.B. Piazza, *La gerarchia cardinalizia*, Roma 1703, pp. 642-644.

[32] G.A. Bruzio, *Ecclesiae Romanae urbis nec non Collegia Cannonicorum caeterorumque presbyterorum ac virorum monasteria regularia quaecumque*, XII (*De aede SS. Triadis in Pincio ac coenobio Minimorum Gallorum S. Francisci de Paula*), Roma, Biblioteca Apost. Vaticana, *Cod. Vat. Lat.*, 11881, foll. 121-143. First consulted for the reconstruction of the SS. Trinità by Bonnard, *Histoire du couvent royal de la Trinité*... cit., p. 28, but only partially considered, then after, to my knowledge, not systematically exploited.

[33] Bruzio, *Ecclesiae Romanae urbis*... cit., fol. 125*v*, counts twelve chapels in the longitudinal direction (six side chapels on both sides of the nave) and five in the transverse direction (the two arms of the transept, the choir and the two side chapels).

[34] Günther, *Demonstration avantgardistischer Architektur*… cit., p. 199, fig. 8; Id., *Der ursprüngliche Chor der SS. Trinità dei Monti*... cit., p. 80, fig. 4.

Fig. 6 *Church of SS. Trinità dei Monti, Rome. Guerrieri chapel, exterior view (photo H. Günther).*

and parts of entablatures in the manner of the articulation of the nave (figs. 3-4). This articulation is repeated at all four corners of the crossing and continues in the transept. The entrances to the side chapels, which adjoined the transept to the east, are similar to those of the side chapels of the nave. The articulation further to the east, beginning with pilasters and a transverse arch above it, belongs to the remodelling of the choir during the 17th century.

The vaulted zone begins directly above the order of pilasters. Originally, the design there changed abruptly to the Gothic style. Bruzio (fol. 125*v*) calls the old windows in the clerestory of the nave "Gothic" and describes them as filled with tracery, with a central column, a tondo above and other curves:

> *fenestrae decem gothicae marmore interstinctae (columella media oculum aliaque ovata sustinente) et omnes vitreae.*

In contrast, he calls the windows of the side chapels simply round-arched without addition: "fenestra hemisphyrica vitrea". Two views of the SS. Trinità from the south, the one published by Giovanni Battista Falda in 1667-1669[35], the other drawn by Charles-Louis Clérisseau around 1749-1754[36], vaguely confirm Bruzio's statements that the windows of the side chapels were, as they are today, round-arched and with-

[35] G.B. Falda, *Il nuovo teatro delle fabriche, et edificii, in prospettiva di Roma moderna, sotto il felice pontificato di N.S. papa Alessandro VII*, III (*Il terzo libro del novo teatro delle chiese di Roma date in luce sotto il felice pontificato di nostro signore papa Clemente IX*), Roma 1667-1669, fig. 18.
[36] *La Trinité-des-Monts redécouverte...* cit., p. 16.

out tracery, while those in the clerestory were pointed-arched, each divided by a central support, which carried trefoils and a tondo above. The 1514 building contract, quoted above, contains the commission to make six travertine windows in addition to the three side chapels; this might also have included the tracery in the clerestory, unless it was made in France of limestone from Roussillon.

In the crossing and in the transept, the upper zone is still preserved in its original form (figs. 4-5). The partition arches are ogival (except the eastern one, which was altered together with the choir). The cross arms, like the side chapels of the nave, are covered with groin vaults, but the caps, unlike those in the side chapels, are ogival. The crossing is covered with a Gothic vault, the ribs of which form a four-pointed star. In the longitudinal or east-west direction, it has an approximately semi-circular cross-section, similar to the present barrel vault in the nave and choir. In the transverse direction, where the width is considerably smaller, it has a pointed-arch cross-section. The caps are built in brick masonry with layers that run parallel to the sixteen apex lines of the caps. The ribs are set on short pieces of vaulting shafts above the entablature. They are uniform, without differentiation according to their position, and profiled in late-Gothic style with overlaps in the initial area.

The descriptions of the SS. Trinità that were written before the Baroque interventions treat the entire central space of the church as a single unit, running from the western end to the sanctuary; the two arms of the transept and the sanctuary are considered as chapels. Bruzio continues after the description of the "Gothic" windows in the clerestory of the nave: from there the vault rises, with ribs wonderfully diverging in different directions: "Tollitur inde concameratio cum fasciis mire deversatis". The report of the visitation of the SS. Trinità in 1629 states regarding the shape of the church that it had only one nave, was paved with bricks and covered with an elaborately intertwined vault:

> *unicam habet navem, cuius lithostratum est lateritum; caelum vero tegitur concamerata testudine artificiose laqueata*[37].

Even before the 1774 intervention, Piazza claims that the vault of the nave and the windows were made entirely of stone. In reality, as indicated above, the vault of the crossing consists of bricks, only the ribs are made of cut stone. Piazza means, therefore, that the vault had ribs of cut stone. The large thermal window, which opens in the façade directly below the vault, shows that the longitudinal caps have throughout retained the same semi-circular cross-section as in the crossing (fig. 1). The descriptions testify that the nave was covered with a ribbed vault. Since they do not distinguish between the crossing and the parts adjoining in the longitudinal direction, it is likely that the whole church was covered with star vaults as in the crossing; the vault certainly fanned out in the choir, but hardly changed in the nave, because the bays there have similar dimensions as the crossing. The vaults of the two bays, which were added to the nave from 1540 onwards, apparently also retained Gothic elements, and this in the Rome where shortly before Michelangelo had taken over the direction of the construction of St. Peter's. Since there were no precise terms for such complex Gothic elements as star vaults, the eyewitnesses were forced to apply somewhat poetic paraphrases. They certainly did not refer to simple cross vaults, as in the side chapels and in the transept, for there was a clear term for this (*cruciata* or as nowadays *cruciera*, used even in 1514 in the building contract for the side chapels).

Piazza indicates that the new Baroque choir is larger than the original one, and this is confirmed by some old representations of the

[37] Roma, Archivio Segreto Vaticano, *Congr. Visite Apostol.*, 3, 1624-30, fol. 27*r*.

SS. Trinità, however vague they may otherwise be, and in plans of the area (in sixteenth-century plans of Rome and in a plan by François d'Orbay for the construction of a staircase at the Pincio in front of the SS. Trinità, 1660)[38]. Bruzio (fol. 125*v*) specifies the original dimensions:

> *Absidem longam habes palmos sex et triginta ac semis, latam vero septem et triginta ac quadrans tres.*

The "apse", as he calls the choir, was therefore 37 ¾ Roman *palmi* wide, in contrast to the nave, which, as he aptly says, is 42 *palmi* wide (1 *palmo* = 22,34 cm). The choir was 2 ⅛ *palmi* (47 cm) recessed on each side. This was maintained in its Baroque reconstruction. The "length of the apse", i.e. the depth of the choir, was 36 ½ *palmi*. So the choir was almost as deep as it was wide[39]. It was divided in depth into two approximately equal parts. One half comprised the anterior bay between the side chapels of the transept, the other half the chevet. The measurements indicate that the chevet formed either an apse with a semi-circular ground plan according to the old Roman tradition or a polygon according to the Gothic manner[40].

The visit report of 1629 states that the high altar stands in the choir under a vault and is illuminated by three large windows with stained glass:

> *continet 7 supra 10 sacella quorum maius in abside positum est sub fornice tribusque amplis fenestris (quae vitreis specularibus clauduntur) illustrator.*

Bruzio confines himself to addressing these windows when he treats the choir. Obviously, they completely determined his impression of the church. After he had described the vault of the church, he only writes, again taking the entire main space as a unit, that the nave was illuminated and adorned by a very large glass window in the choir, which was also Gothic (like the windows in the clerestory) and divided into three large windows:

> navis tota, quae luce donatur [...] ab amplissima fenestra vitrea quae in eadem abside, pariter gothica et in amplas tres fenestras parata quaeque et lucem impartitur Aedi et sacello ornatum (fol. 125*v*).

Apparently, the large windows were so close together that they could all seem like a single very large window, which was divided by slender mullions. Elsewhere (fol. 130*v*) Bruzio speaks of the stained glass in the three windows that extended over the entire width of the choir. In these windows, he also reports (foll. 330*v*-331*r*), marble mullions were set in the Gothic manner:

> *Magnis his fenestris interiectae columnellae marmoreae more Gothico et quidem visu dignissime.*

The walls of the anterior bay were closed because of the adjacent side chapels of the transept. Presumably the anterior bay, so called up to now, formed a unit with the chevet. This results in a typical Gothic choir with the usual fivefold closure, the walls of which opened to the east largely as windows with tracery[41].

All windows – in the choir as well as in the side chapels and in the clerestory – were filled with figurative stained glass[42]. Bruzio states this (foll. 125*v*, 130*v*), Piazza confirms it for the nave and side chapels. Bruzio describes the stained-glass images in the choir in detail (fol. 130*v*): in the middle window, according to the consecration of the church, the *Trinity* was depicted in the upper part and the *Miracle of Pentecost* below. The window on the left showed the three holy bishops of the diocese of Narbonne and above them the patrons of the cathedral of Narbonne and of Briçonnet's first diocese of Saint-Malo in Brittany. In the right window, the Apostle Princes Peter and Paul and Mary were portrayed, as well as the three popular Saints of Southern France: the penitent Mary Magdalene, Martha of Bethany and her brother Lazarus, whom Brizio calls, as legend has it, Bishop of Marseille. Briçonnet wearing the Cardi-

[38] Maps of Rome by Leonardo Bufalini 1551, Étienne du Pérac 1577. Cf. *Le piante di Roma*, a cura di A.P. Frutaz, Roma 1962, pianta 109, 127, fig. 196, 255; D'Onofrio, *Scalinate di Roma*... cit., pp. 279ff., fig. 210.

[39] The fact that Bruzio means with the "length of the apse" the extension of the church from the crossing to the east end, is confirmed by his indications for the length of the whole church and its remaining parts: length of the church outside = 201 *palmi*, inside = 188 *palmi*; length of one of the side chapels inside = 19 *palmi* (length of the nave: 6 × 19 *palmi* + 6 × wall thickness of approx. 2 *palmi* between the side chapels); width of the transept = depth of the crossing = 26 *palmi*; length to the choir accordingly = approx. 152 *palmi*.

[40] Günther, *Demonstration avantgardistischer Architektur*… cit., p. 199, fig. 8; Id., *Der ursprüngliche Chor der SS. Trinità dei Monti*... cit., p. 80, fig. 4.

[41] *Ibidem*.

[42] Günther, *Der ursprüngliche Chor der SS. Trinità dei Monti*... cit., pp. 76-83.

Fig. 7 *Church of SS. Trinità dei Monti, Rome. Reconstruction of the original appearance of the interior (by H. Günther, photomontage by B. Zuber).*

nal's robe was depicted kneeling in front of the three holy bishops of the diocese of Narbonne[43]. The stained glass must have been made between 1507 and 1511, because in 1507 Briçonnet became Archbishop of Narbonne and in 1511 he left Rome because Pope Julius II had excommunicated and deposed him.

The interior was decorated with frescoes during the sixteenth century, beginning immediately after the completion of its first parts (fig. 6). The original decoration in the southern arm of the transept and in some chapels is quite well preserved and has recently been restored[44]. The nave, except for the arch fronts of the arcades and spandrels between them, was whitewashed in the Baroque era. The transept frescos were painted from 1520-1522 onwards by a pupil of Raphael on behalf of the Minims (fig. 5). A pupil of Pietro Perugino created the frescoes in the first southern chapel (fig. 6) at the beginning of the period between 1513 and 1525. The dating results from the facts that Melchiorre Guerrieri assumed patronage of the chapel in 1513 and died in 1525. The spandrels above the arcade that opens from his chapel to the nave show the coats-of-arms of Guerrieri and of his wife Giustina Calandra, who died in 1520 (fig. 6). In the chapel there is an architectural articulation painted with Doric pilasters and Ionic Corinthian entablature. It is quite similar to the architectural articulation of the southern arm of the transept in shape and its painted decoration, although these are by different artists. This similarity conveys the impression that the Minims originally planned to paint the walls in a uniform Renaissance style.

Probably the vaults of the nave, crossing and choir were also originally painted, but not in a Renaissance style. The French fleur de lis with which Dom Edme saw the church "littered"

[43] The chronicle of Martin, *Histoire du couvent royal*... cit., pp. 564f. mentions the stained glass windows of the choir after its destruction: "Les trois grandes fenêtres qui l'eclairaient en bas (the choir), étaient tissues en dehors d'excellentes ferrates, et ramattes en fer, comme on en peut juger d'une qui est restée pour la montre du côté de la sacristie, et à une des fenêtres supérieures aux corniches de pierre dudit choeur, était peint à genoux aux pieds des saints Juste et Pasteur, le cardinal Briçonnet, archevêque de Narbonne, qui avait fait venir de ce pays les pierres toutes taillées pour bâtir cette église, l'an 1502, et jusques aux vitres peintes pour le choeur, qu'on conserva dans la construction du nouveau, en mémoire du bienfait et du bienfaiteur".

[44] Di Matteo, *L'église et le couvent de la Trinité-des-Monts*... cit.; *La chiesa e il convento della Trinità dei Monti*... cit.

Fig. 8 *Church of S. Salvatore al Monte, Florence. Interior (photo H. Günther).*

in 1520-1521 must have been painted there, as there was hardly any space left for them on the walls. The French coats-of-arms may have been attached to the intersections of the ribs, as is often the case with star vaults.

Figure 7 shows how I reconstruct the SS. Trinità. The illustration of the interior is intended to convey an overall idea of the original appearance with its combination of two styles which constitute opposites in classical Italian architectural theory. In order to achieve this, elements in the choir, whose form is not known in detail, have been added in accordance with the appropriate style. The high altar and choir stalls are missing because there is no indication of their original appearance. In order to avoid the creation of an abstract atmosphere in the illustration, despite this central gap, modern parts of the furnishings of the nave that are irrelevant to the construction have been retained or inserted.

Now the question arises as to what special feature of the SS. Trinità, the classification *a la mode françoise* relates. In order to prepare an answer, we first systematically place the original elements of the church in the context of art history[45].

The building type is certainly not addressed here as a French peculiarity. The aisleless church with its simple plan was already typical of mendicant orders in the Middle Ages and remained so during the Renaissance, but the side chapels were given a uniform layout. A transept was rare in this type of construction, but the eastern part could generally be designed very individually. Recently, the double-tower façade of the SS. Trinità has repeatedly evoked the memory of the French Gothic, since, despite its Renaissance elements, it seems alien to Rome (fig. 1)[46]. But Dom Edme has not yet seen it, and perhaps it was not even originally planned.

[45] Günther, *Demonstration avantgardistischer Architektur...* cit., pp. 202-207; Roberto, *La chiesa della Trinità dei Monti...* cit., adopted the reference to the relationship with S. Salvatore al Monte in Florence, but paid too little attention to the other relationships.

[46] T. Manfredi, *Il problema della facciata "gotica" della Santissima Trinità dei Monti a Roma*, in *Presenze Medievali nell'Architettura di Età Moderna e Contemporanea*, a cura di G. Simoncini, Milano 1997, pp. 126-135.

The balanced proportions of the interior, the Doric architectural articulation, the side chapels and their painting are all typical of the Italian Renaissance. The articulation even reflects the most advanced contemporary style in Italy. Like the disposition of the nave, it obviously adheres to S. Salvatore al Monte (also known as S. Salvatore e S. Francesco) in Florence, which was built by a branch of the Franciscan Observants, i.e. also a particularly severe mendicant order (fig. 8). S. Salvatore was largely completed in 1500, thus two years before the laying of the foundation stone for the SS. Trinità, and consecrated in 1504[47]. Cronaca planned the construction. Also S. Salvatore is a church without aisles. The eastern part is also clearly dissociated from the nave as in the SS. Trinità, but not with a pointed arch. The walls of the nave are articulated in the lower zone as in the SS. Trinità: with an architectural order and, framed by it, arcades which give access to the side chapels. The articulation also consists of pilasters with Doric capitals and a large Ionic-Corinthian entablature. Apart from a few exceptions, it is only towards the end of the fifteenth century that the order with Doric capitals appears in sacred buildings as prominently as it does here. Until then, orders similar to the Corinthian dominated almost exclusively. The churches without aisles that are close to S. Salvatore in time and disposition, like S. Maria Maddalena dei Pazzi by Giuliano da Sangallo, also have orders of Corinthian columns, as has Cronaca's plan for an aisleless church denominated S. Piero in Scrimio, but Cronaca had also planned a centralized building with a Doric articulation similar to the SS. Trinità[48]. The complete Vitruvian Dorica with a metopic triglyph frieze in the entablature had not been revived at the time when the SS. Trinità was planned. Bramante introduced it at the Tempietto only in 1502. With the Tempietto the new style of the High Renaissance began in architecture.

Although this has hardly been noticed so far, the SS. Trinità occupies an essential position in the development of Renaissance architecture in Rome: it is closer to Cronaca's new style than any other Roman building and forms the link between the Tuscan churches without aisles and their Roman successors, such as Antonio da Sangallo's S. Marcello al Corso and S. Spirito in Sassia. As an aisleless church with a vault and a transept that terminates on the periphery of the side chapels, it comes closer to the disposition of the Gesù than any other church built in Rome before the Gesù.

Usually, in keeping with their modesty, mendicant orders had aisleless churches covered with flat ceilings or even with exposed roof trusses. The clerestory therefore forms a separate tier of the elevation. This is also the case in S. Salvatore, S. Marcello al Corso and S. Spirito in Sassia. However, the insertion of vaults in the SS. Trinità, did not, on its own, necessarily have to appear as a French peculiarity to Dom Edme either. There were also several vaulted mendicant churches in Rome. The main churches of mendicant orders, as in Rome S. Maria sopra Minerva, had vaults as well as aisles. The same disposition had been given by Pope Sixtus IV and Cardinal d'Estouteville to S. Maria del Popolo and S. Agostino, as they were intended as burial places of the Della Rovere family and of the Cardinal himself, respectively. The vault manifests first and foremost the will to design the building in a representative manner, for vaults were considered the most noble form of roofing[49]. For S. Pietro in Montorio it is documented that the patron placed emphasis on a design that was appropriate to his dignity. In 1488, the King of Spain, Ferdinand of Aragon, who together with his wife Isabella of Castile financed the construction, wrote to his procurators in Rome that the church, as a settlement of the Observant Franciscans, should adhere to what was customary in

[47] On S. Salvatore, its building type and its succession, see A. Markschies, *Gebaute Armut. San Salvatore e San Francesco al Monte in Florenz (1418-1504)*, München 2001, which, however, does not consider SS. Trinità dei Monti.
[48] H. Günther, *Das Studium der antiken Architektur in den Zeichnungen der Hochrenaissance*, Tübingen 1988, pp. 89-97.
[49] L.B. Alberti, *De re aedificatoria*, 7.11.

this order, i.e. be modest rather than great, but, he added with concern, it should not appear so inconspicuous that it "is detrimental to the greatness of the person who has it made"[50]. S. Pietro in Montorio has, as is typical for normal churches of the mendicant orders, no aisles, but despite the Franciscan Observance, it is vaulted. The Gesù was vaulted at the request of the patron, Cardinal Alessandro Farnese, against the will of the Jesuits. As a peculiarity of the SS. Trinità, it had to be noticed in Rome, however, that the choir and the vault, including the clerestory, were Gothic, in contrast to the articulation of the nave, and that, as the eyewitness accounts testify, they gave the interior an overall Gothic appearance. The choice of style for the choir can be explained by the phenomenon mentioned at the beginning, which is that the Gothic style evoked associations with the sacred sphere; however, this explanation does not apply to the other parts of the church.

The clearly French element of the SS. Trinità is the star vault[51]. In contrast to the simple cross vaults common in Italy and or to the complex vault formations that were created in Central Europe during the late Gothic period and shaped new spatial forms, in France the vaults adhered to the patterns that had developed during the High Gothic period and respected the conventional elevation. The four-pointed rhombic star, which was installed in the SS. Trinità, appears at the Cathedral of Amiens (from about 1264). This formation is still quite close to the cross vault; later it was enriched by increasing the number of points to six or eight. Often in French churches, as in Amiens, only the crossing is marked by a star vault, while even in the late Gothic period the other bays of the nave are covered with cross vaults. In this case, the ground plan of the crossing is distinguished as a square and not, as in the SS. Trinità, as oblong as are the bays of the nave. However, in France, there is a whole series of late-Gothic churches that are covered throughout with star vaults from the west to the choir, with four-pointed rhombic stars, for example St. Nicolas-de-Port in Lorraine (1481/1495-1530) or the cathedral of Condom, Midi-Pyrénées (1496-1531), or in Paris considerably later still, the parish church of Saint-Eustache (from 1532). Also typical for France is the brick masonry of the Gothic vault of the SS. Trinità with layers that run parallel to the apex lines of the caps. This complicated way of laying bricks was already used in the star vault in Amiens[52].

In the main spaces of late Gothic churches, the ribs of the vaults are usually differentiated according to their position. Uniformly designed, as in the SS. Trinità, they are located rather in subordinate spaces (vestibules, side chapels etc.), or in separate chapels that were not part of a church (e.g. the chapel of the Hôtel de Cluny in Paris, 1485-1490). Similar remnants of the SS. Trinità type of vaulting, where the ribs overlap each other, can be observed in the Hubertus chapel of the royal residence of Amboise (1491-1496). Only for the short pieces of single vaulting shafts over which the ribs in the SS. Trinità start, there are no parallels. They were probably inserted in consideration of the pilaster articulation in the lower zone.

The painting of the vault reconstructed here was typical for France: by this point the vaults of the Sainte-Chapelle or some late-Gothic vaults of the fifteenth century, and even at the end of the sixteenth century, the barrel vault of the large hall in the Hôtel du Petit-Bourbon were "littered" with golden fleur de lis on a blue background (fig. 9)[53]. The magnificent fireplace that Cardinal Briçonnet had erected in the Archbishop's Palace in Reims is also covered with fleurs de lis and bears many coats-of-arms: those of the King of France, of the Archdiocese of Reims and of Briçonnet himself, four times.

[50] A. de la Torre, *Documentos sobre relaciones internacionales de los Reyes Católicos*, Barcelona 1947-1966, III, p. 143f., n. 152. H. Günther, *Bramantes Tempietto. Die Memorialanlage der Kreuzigung Petri in S. Pietro in Montorio, Rom*, Diss., Universität München 1973, pp. 202f., cat. doc. 10; F. Cantatore, *San Pietro in Montorio. La chiesa dei Re Cattolici a Roma*, Roma 2007, pp. 43-45. Incidentally, in 1482-83 King Louis XI of France also donated money (500 scudi) for the construction of S. Pietro in Montorio, but this was an episode that had no influence on the design of the church (ivi, pp. 42-43).

[51] N. Nussbaum, *Das gotische Gewölbe. Eine Geschichte seiner Form und Konstruktion*, Darmstadt 1999, pp. 273-293. I thank Stefan Bürger and Christian Freigang for their substantial support for art historical classification of the star vault of the SS. Trinità.

[52] Ivi, p. 176.

[53] See, for example, the representation in a window of the chapel of Jacques Coeur in the cathedral of Bourges, 1451. J.M. Leniaud, *La restauration du décor peint de la Sainte Chapelle haute par Duban, Lassus et Boeswillwald (1839-ca.1881)*, in *Die "Denkmalpflege" vor der Denkmalpflege*, Akten des Kongresses (Bern, 30. Juni-3. Juli 1999), herausgegeben von V. Hoffmann, J. Schweizer, W. Wolters, Bern 2005, pp. 333-360: 335f.; *Primitifs français. Découvertes et Redécouvertes*, catalogue d'exposition (Paris, Musée du Louvre, 27 février-17 mai 2004), éd. D. Thiébaut, P. Lorentz, F.R. Martin, Paris 2004, pp. 81, 83; B. Kurmann-Schwarz, *Vitraux commandités par la cour. Le vitrail et les autres arts; ressemblances et dissemblances*, in *Hofkultur in Frankreich und Europa im Spätmittelalter*, herausgegeben von C. Freigang, J.C. Schmitt, Berlin 2005, pp. 161-182, coloured fig. 1.

Fig. 9 *Cathedral of Bourges. Chapelle Jacques Coeur, window with representation of the Annunciation (photo H. Günther).*

Now we try to understand what *la mode françoise* should mean, as it is difficult to discern what terms like *mode* (Italian: *modo*, *uso*, etc.) or manner (Italian: *maniera*), style or fashion (Italian: *stile*, French: *façon*) and similar ones might indicate in the Renaissance in the modern sense of the terms *style*, or *building type* or *genus* or *kind of construction* or other criteria[54]. Before the record of the visit of Dom Edme de Saulieu to the SS. Trinità, architecture was rarely characterized as *la mode françoise* or by similar terms. During the Renaissance, the Italians referred to the style of medieval buildings, as indicated above, as *maniera tedesca* or as *maniera moderna*, without distinguishing between Gothic, Romanesque or other medieval styles, and opposed it to the style of antiquity which was considered to be authentic and exemplary for new architecture[55]. The French were hardly taken into account in this context, although it was well known that the "uso e modo" of medieval architecture, as Filarete says (1460-1464), was established "da' tramontani, cioè da Todeschi e da Francesi"[56]. In 1521 a Lombard architectural theorist writing about Milan Cathedral noted that the German architects ("Germanici Architecti") had made the equilateral triangle the basis of their planning, although an Italian, Gabriele Stornaloco, came up with the idea[57].

The term *mode* definitely refers to French style in the chronicle of a Bohemian monastery, which reports that King John of Bohemia of the House of Luxembourg (1296-1346) had artists from France come to build in "modo galli-

[54] Regarding the *mode Françoise*, see Frankl, *The Gothic*... cit., pp. 295-299; Hesse, *Von der Nachgotik zur Neugotik*... cit., pp. 33-36. Generally E. Panofsky, *Das Problem des Stils in der bildenden Kunst*, in *Aufsätze zu Grundfragen der Kunstwissenschaft*, herausgegeben von H. Oberer, E. Verheyen, Berlin 1980, pp. 19-27; M.E. Blanchard, *Stil und Kunstgeschichte*, in *Stil. Geschichten und Funktionen eines kulturwissenschaftlichen Diskurselements*, herausgegeben von H.U. Gumbrecht, K.L. Pfeifer, Frankfurt am Main 1986, pp. 559-573.

[55] Brandis, *"La maniera tedesca"*... cit.

[56] A. Averlino detto il Filarete, *Trattato di architettura*, a cura di A.M. Finoli, L. Grassi, Milano 1972, p. 382.

[57] Vitruvius, *De architectura libri decem*, translated and commented by C. Cesariano, Como 1521, fol. 13*v*.

co", and his son, King Charles IV (1346-1378), had the Prague Castle built "ad instar domus regis Franciae"[58]. Occasionally, terms such as *opus francigenum* or *ad modum franciae* were used in the Middle Ages to mark special work techniques for bricks or roof tiles[59]. This is also true for Italy, as has not been considered until now: in 1279 a certain "tegularius" Thomas received the order to supply roof tiles "ad modum franciae" for the abbey of S. Maria di Realvalle, which Charles of Anjou had founded for French Cistercians in 1277[60]. More often terms like *French* or *German* refer more to the builder than to the style. So it is in the examples I know. The Florentine chronicler Giovanni Villani (died 1348) writes about Charles of Anjou, who came to Italy in 1265:

> *E poco appresso al re non piacque di abitare nel castello di Capova, perch'era abitato al modo tedesco; ordinò che si facesse castello nuovo al modo francese, il quale è presso a san Piero in Castello dall'altra parte di Napoli*[61].

Paolo Cortesi writes in his treatise "On the Office of the Cardinal" (1510): following the train of time to abandon the "prisca ratio symmetriae" in order to introduce a "nova ratio" of architecture, Emperor Frederick II (1194-1250), a German, used the "germanica symmetria" in the planning of his Campanian house (perhaps the Castel Capuano in Naples), and Pope Martin IV (1281-1285), a Frenchman, was led by the same "ratio novitatis" when he built his Faliscan house "gallico genere" – "domum in phaliscis gallico genere aedificatam ferunt" (probably the Rocca of Montefiascone is meant here)[62]. In 1524, the Neapolitan humanist Pietro Summonte explains how the architecture of his homeland was degraded in the Middle Ages under the foreign rulers from the dynasties of the Staufer, Anjou and Aragon[63]: at that time only primitive, German, French and barbaric buildings were built there ("non si facevano se non cose piane, tedesche, francesche e barbare"), and the foreign rulers robbed spolia of ancient monuments in order to use them in a barbaric way for French and German buildings ("in uso barbarico di opere francese e tedesche"). The most important of the "barbaric" buildings in Naples, i.e. the Sala dei Baroni, which Alfonso of Aragon had built in the Castel Nuovo, is disparagingly called by Summonte a Catalan thing, far from ancient architecture ("pur grande opera; ma è cosa catalana, nihil omnino habens veteris architecturae"). Contrary to these statements, the expression *la mode françoise* and the indication of the many fleurs de lis and "armes de France" in the record of the visit of Dom Edme de Saulieu, really characterise the appearance of the SS. Trinità as made in the French manner and explain it by stating explicitly that the Church was intended for French monks. This understanding of the term is confirmed by the classical architectural treatise of the French Renaissance, Philibert de L'Orme's *Premier tome de l'architecture*, which appeared later, but refers to idiomatic expressions that had long been used in France (1567). De L'Orme writes that the buildings that were built before the invasion of the new Italian style in his nation were made in a French manner; literally, as in the record of Dom Edme's visit to the SS. Trinità, he says, that they are "faicts à la mode Françoise"[64]. He repeats this classification several times, specifically with reference to Gothic vaults or such vaults, as he writes, that were customary in France before the invasion of the Italian Renaissance, but meanwhile were no longer used[65]. Primarily, de L'Orme treats here the star vault with four points similar to those in the SS. Trinità, merely over a square ground plan (4.8). This "façon de voute" no longer in use was "appellée entre des ouvriers La mode Françoise". The linguistic parallel confirms that Dom Edme's travel companions with their phrase of the *mode françoise* referred, specifical-

[58] P. Deschamps, *Saint Louis et le rayonnement de l'art français*, in *Le siècle de Saint Louis*, éd. R. Pernoud, Paris 1970, pp. 143-152, note 13.

[59] Around 1280-1290 in Wimpfen there is mention of "opus francigenum", but its meaning remains controversial. Frankl, *The Gothic*... cit., pp. 55-57; G. Binding, *Opus Francigenum. Ein Beitrag zur Begriffsbestimmung*, "Archiv für Kulturgeschichte", LXXI, 1989, pp. 45-54; C. Freigang, *Zur Wahrnehmung regional spezifischer Architekturidiome in mittelalterlichen Diskursen*, in *Kunst & Region. Architektur und Kunst im Mittelalter*, herausgegeben von U.M. Bräuer, Utrecht 2005, pp. 14-33: 26f.; J.M. Pérouse de Montclos, *L'architecture à la française. Du milieu du XV^e siècle à la fin du XVIII^e siècle*, Paris 2001², pp. 28f.

[60] C.A. Bruzelius, *'ad modum franciae'. Charles of Anjou and Gothic Architecture in the Kingdom of Sicily*, "Journal of the Society of Architectural Historians", L, 1991, pp. 402-420: 403.

[61] G. Villani, *Cronica*, Firenze 1823, II, p. 156.

[62] K. Weil-Garris, J.F. D'Amico, *The Renaissance Cardinal's Ideal Palace. A Chapter from Cortesi's "De Cardinalatu"*, in *Studies in Italian Art and Architecture, 15th through 18th Centuries*, edited by H.A. Millon, Rome 1980, pp. 45-123: 77.

[63] Letter to Marcanton Michiel of 20 march 1524. R. Pane, *Il Rinascimento nell'Italia meridionale*, Milano 1975-1977, I, pp. 68-70. Not regarded by Brandis, *"La maniera tedesca"*... cit.

[64] Ph. De l'Orme, *Premier tome de l'architecture*... , Paris 1567, fol. 142*v* (5. 11). For de L'Orme cf. A. Blunt, *Philibert de L'Orme*, London 1958; J.M. Pérouse de Montclos, *Philibert De l'Orme*, Paris 2000; H. Günther, *Philibert de l'Orme zwischen italienischer Avantgarde und französischer Tradition*, in *KunstKritikGeschichte: Festschrift für Johann Konrad Eberlein*, herausgegeben von J. Aufreiter, Berlin 2013, pp. 229-254; *Philibert De l'Orme, un architecte dans l'histoire*, éd. F. Lemerle, Turnhout 2015.

[65] De l'Orme, *Premier tome de l'architecture*... cit., foll. 107*r*, 110*v*, 112*r* (4. 8, 10, 11).

ly, to the Gothic parts of the SS. Trinità, i.e. the choir and the vault, not only because they were Gothic, but also because they corresponded to what was especially common in France before the penetration of the forms of the Italian Renaissance.

But this is not the end of the matter. In the record of Dom Edme's journey, the entire church is assigned to the *mode françoise*. This classification also includes the articulation in Italian style and the balanced proportioning of the entire space. We are therefore faced with the question of what the connection between the two means, in the sense of the Italian Renaissance opposing styles in the SS. Trinità. De L'Orme also helps us to understand this connection when we consider the *Premier tome de l'architecture* as a whole.

De L'Orme proudly identifies himself as the person who had introduced the style of the Italian Renaissance into French architecture, and his treatise is intended to teach the new way of designing. He therefore takes Italian architectural theory as his point of departure and focuses on the hallmark of the *all'antica* style, i.e. the columnar orders. In this context, de L'Orme, as was standard practice in Italy at the time, denigrates the Gothic style: "Telle façon barbare" had been abandoned by builders after he, de L'Orme, had taught them the better way of building more than thirty years previously (fol. 142*v*).

But the *Premier tome* also has another focus, namely vaults. De L'Orme treats them in the context of stereotomy (stone cutting) and the complicated geometric basics necessary to form the individual stones, which are set in the vaults exactly according to the conditions of the spherical surfaces (livres 3-4). The title page of the treatise does not show the columnar orders or ancient monuments, but geometric constructions on which stereotomy is based (see the contribution of Yves Pauwels, fig. 2, in this volume). In the *Nouvelles inventions pour bien bastir* (1561), de L'Orme deals mainly with vaults. De L'Orme personally built highly complex vaults in ashlar, and such vaults became a characteristic element of subsequent French architecture. In French architectural theory, the treatment of stereotomy and vaults had a great following, and the later treatises emphasise that de L'Orme was the first to deal with the subject[66].

Concerning the vaults, de L'Orme does not teach the new Italian style. In Vitruvius and in Italian architectural theory, vaults, as far as they are considered at all, play at most a subordinate role. Sebastiano Serlio largely ignores them; Leon Battista Alberti dedicates only two chapters of his voluminous architectural treatise to them, and concentrates, according to the Italian way of construction, on rather simple modes of laying bricks[67]. In relation to the vaults, de L'Orme opposes Italian polemics against French architecture with a criticism of the Italian Renaissance from the perspective of a French avant-gardist (fol. 124*v*). In an almost schoolmasterly manner, he disciplines an incunabulum of the High Renaissance, the spiral ramp at the Cortile del Belvedere, and its architect Bramante, whom the Italians celebrated as an "illuminator and innovator of architecture". He says that the way in which the columns were inserted there, and the design of the vaulting, would demonstrate that the "craftsman" who had designed it – so disparagingly he addresses Bramante – did not comprehend what a real architect should actually understand. Then de L'Orme teaches such "ignoramuses" in detail how to design proper vaults and how to apply the columnar orders. In the first book of his treatise, de L'Orme opposes the idea of bringing craftsmen and ashlar from abroad to France, because France had enough of both; there would be no better ashlar than in France (foll. 27*r-v*). The same conviction probably prompted Cardinal Briçonnet to order that the stone for the SS. Trinità be carved in France.

Fig. 10 *Abbey church of Saint-Gilles. Remains of the spiral staircase of the destroyed Romanesque choir (photo H. Günther).*

[66] So first in the prefaces of M. Jousse, *Le secret d'architecture découvrant fidèlement les traits geometriques, couppes et derobemens necessaires dans les bastiments*, La Flèche 1642, and F. Derand, *L'architecture des voûtes, ou l'art des traits et coupes des voûtes*, Paris 1643.

[67] L.B. Alberti, *De re aedificatoria*, 3.14; 7.11.

Fig. 11 *Statue of an architect from the entrance to the east choir of Mainz Cathedral, Bischöfliches Dom und Diözesanmuseum Mainz (photo H. Günther).*

As de L'Orme points out, vaulting and stereotomy belong to the traditional way of building in France. In contrast to Italy, vaults made of perfectly bonded ashlars were already widespread in France in ancient times, for example in the so-called Temple of Diana in Nîmes or in the arcades and ambulatories of the arenas of Nîmes and Arles. In Italy, the ancient vaults are usually made of bricks or, as in the Pantheon, of concrete. However, de L'Orme does not mention the ancient precursors; he prefers to start in this field from the French tradition of the Middle Ages. His main focus is on the Romanesque period. In particular, he treats the spiral staircase in the choir of the abbey of Saint-Gilles as a real miracle of stereotomy (twelfth century) (fig. 10). It forms the paradigm for the genus[68]. Its vault is constructed of ashlars so large and long that they all had to be carved bent individually in three directions, depending on their position in the masonry: according to the helical turn, the inclined rise and the curvature of the barrel. The stones fit together exactly, without the use of mortar. Although the spiral staircase of Saint-Gilles was largely destroyed in the Huguenot Wars, it was still an attraction for stonemasons in the seventeenth century. The graffiti they left on its wall bear witness to this. De L'Orme (fol. 123*v*) states that the art of stonecutting in the manner of the spiral staircase of Saint-Gilles was still known during his lifetime and appreciated as a sign of supreme mastery[69].

The spiral staircase of Saint-Gilles had already aroused admiration in the Middle Ages. In my opinion, this is shown by the life-sized figure of a master craftsman carved around the middle of the thirteenth century, which was placed at the entrance to the east choir of Mainz Cathedral (fig. 11)[70]. From today's point of view it looks like the signature of an architect. What it meant in its time is an open question, because it is out of the ordinary, if not unique. It is as original as the figure of the Vitruvian measure-man, who used to stretch his limbs across the intersections of a groin vault in the western rood-screen of Mainz Cathedral (before 1239), or as the donor figures with their vivid individual characteristics in the western choir of Naumburg Cathedral. All of these figures are close in style to each other and to the sculptures of Reims Cathedral. The master craftsman at the entrance to the eastern choir of Mainz Cathedral wears the leather cap typical of members of his guild, and a noble cape. He is deeply bent under the burden of the responsibility of his important office and leans on a stick. This support has not the shape of timber, but is made in the form of a lengthened ashlar as a sign of his craft. An observer, standing in the middle before the east choir, would see the corner of the sculpture where the stone stick of the figure appears in the foreground, approximately as shown in figure 11. The stone is carefully carved and turns in a way similar to the stones in the vault of the spiral staircase of Saint-Gilles, only it is elongated in order to serve as a support for the master craftsman[71] (fig. 12). Any other kind of construction, in which a stone with such a formation could be inserted, besides the vault of a spiral staircase, is hardly imaginable. Since the master of the figure as well as the other masters of the Swabian sculptures of similar style (figures from the west rood-screen of Mainz cathedral, statues of the patrons of Naumburg Cathedral, etc.) was at least trained at a French mason's lodge, if not a native from France, he certainly would have known the famous spiral staircase of Saint-Gilles. Even in the Swabian architecture in southern Italy (Castel Maniace, Siracusa) the staircase of Saint-Gilles was imitated[72].

De L'Orme also treats Gothic vaults in detail, although they are usually not made of ashlar, but as in the SS. Trinità, of bricks (4.8-10). He ignores the complex forms that were common in Central Europe and on the Iberian Penin-

[68] Pérouse de Montclos, *L'architecture à la française*… cit., pp. 143-146; J.M. Pérouse de Montclos, *La vis de Saint-Gilles et l'escalier suspendu dans l'architecture française du XVI^e siècle*, in *L'escalier dans l'architecture de la Renaissance*, éd. A. Chastel, J. Guillaume, Paris 1985, pp. 83-89; A. Hartmann-Virnich, *L'escalier en vis voûté et la construction romane: exemples rhodainiens*, "Bulletin Monumental", 154, 1996, 2, pp. 113-128; Id., *La 'vis' de Saint-Gilles*, "Gard. Session/Congrès Archéologique de France. Société Française d'Archéologie", CLVII, 1999, pp. 293-299; F. Mielke, *Handbuch der Treppenkunde*, Hannover 1993, pp. 230-232.

[69] De l'Orme, *Premier tome de l'architecture*… cit., fol. 123*v*-125*r* (4.19).

[70] A. Peschlow-Kondermann, *Rekonstruktion des Westlettners und der Ostchoranlage des 13. Jahrhunders im Mainzer Dom*, Wiesbaden 1972, pp. 10-15; *Der Naumburger Meister Bildhauer und Architekt im Europa der Kathedralen*, Ausstellungkatalog (Naumburg, Dom, Schlösschen und Stadtmuseum Hohe Lilie, 29. Juni 2011-2. November 2011), herausgegeben von H. Krohm, Petersberg 2011, I, pp. 106f., n. I.3; H. Günther, *Philibert de L'Orme and the French Tradition of Vaulting*, in *Building Techniques in Architectural Treatises: Construction Practices versus Technical Writings*, éd. C. Cardamone, P. Martens, "Aedificare. Revue internationale d'histoire de la construction", 2017, 2, pp. 119-142.

[71] See the schematic representation of the stones in the vault of the spiral staircase of Saint-Gilles by Hartmann-Virnich, *L'escalier en vis voûté*… cit., p. 119, fig. 6.

[72] M.M. Bares, *La vis de Saint-Gilles del castello Maniace di Siracusa: un'audace sperimentazione di stereotomia*, "Lexicon. Storie e architettura in Sicilia", 2007, 4, pp. 15-23; A. Knaak, *Prolegomena zu einem Corpuswerk der Architektur Friedrichs II. von Hohenstauen im Königreich Sizilien (1220-1250)*, Marburg 2001, pp. 47-57; F. Maurici, *L'architettura federiciana in Sicilia e Castel Maniace*, "Tabulae del Centro Studi Federiciani", XX, 40, 2008, pp. 91-120; S. Zorner, *Nachtrag zu Reims und Naumburg. Die Kapitelle des Castello Maniace in Syrakus*, in *Der Naumburger Meister Bildhauer und Architekt im Europa der Kathedralen*, III (*Forschungen und Beiträge zum internationalen wissenschaftlichen Kolloquium in Naumburg vom 05. bis 08. Oktober 2011*), herausgegeben von H. Krohm, Petersberg 2012, pp. 528-539.

Fig. 12 *Schematic drawing of a stone in a screwed barrel vault in the manner of the spiral stair case of Saint-Gilles (by A. Hartmann-Virnich, 1996).*

sula and were studied in many pattern books[73]. Primarily, as already mentioned, he deals with stellar vaults. In connection with the vaults, de L'Orme assesses the Gothic with understanding. On behalf of the king of France, he personally closed the vaults of the Chapel of the Castle of Vincennes (1548-1552), which were commenced in 1379. Regarding the star vault, he admits that "ceste façon de voute, appellée entre des ouvriers La mode Françoise" was no longer in use, but that it was not to be despised; rather, it had very good sides (fol. 107*r*). Moreover, in contrast to what was customary in the Italian Renaissance, he allows Renaissance vaults to integrate elements from the Gothic ones, from the "voute de la mode Françoise", that were uncommon in the Italian Renaissance, especially ribs and jack arches (fol. 112*v*). Overall, the SS. Trinità dei Monti originally demonstrated how to build in the French avant-garde style: namely, by combining the columnar orders following the rules most advanced at the time, with the art of vaulting, which emanates from the high science of geometry. This demonstration was extraordinarily complicated, because in order to carry it out, artists from two different traditions had to work together. Central Italian artists could hardly create vaults in the French manner, and French artists could not design in the same way as Cronaca. However, the *mode françoise*, which was presented in the SS. Trinità did not correspond to what was customary in France at the time. The influence of the new Renaissance style on French architecture only became apparent some years after the construction of the SS. Trinità had started. The SS. Trinità demonstrated how the ideal *mode françoise* should be henceforth. This foresight was to be largely realised in the future. The design of the SS. Trinità still differs from the maxims set up by de L'Orme in that the pointed arch was inserted and that the vault had a Gothic shape and, as usual in French Gothic, was made of bricks. But it already had in common with de L'Orme the crucial idea that the ideal architecture should combine the architectural articulation *all'antica* with the classical, i.e. the French art of vaulting.

In his building works in France, Briçonnet did not adopt Italian forms any more than Cardinal d'Estouteville did, but adhered to the local Gothic fashion[74]. At the SS. Trinità, he addressed the demonstration of the *mode françoise* to the Italians and to the foreigners who gathered in Rome. On his journey through Central Europe (1517-1518), the Italian cleric Antonio de Beatis noticed, as unusual compared with Italy, that so many churches were vaulted[75]. From a French point of view, the construction of vaults caused difficulties for Italians still half a century after de L'Orme. During his visit to Italy in 1601-1603, the Parisian geographer Pierre Bergeron observed that there were only a few churches vaulted in Rome. He lists six examples: the three French churches of S. Agostino, SS. Trinità and S. Luigi dei Francesci, built by the French brotherhood from 1518-1589, followed by the two most prominent later ones that had adopted the disposition of the SS. Trinità: the Gesù and S. Maria in Vallicella, the main centres of the Counter-Reformation in Rome[76]. Only S. Giacomo degli Spagnoli does not correspond to the argument. According to Guarino Guarini, the audacity of Renaissance architects to place mighty domes on high pillars, as at the crossings of the Gesù and S. Maria in Vallicella, was adopted from Gothic architecture, too[77].

[73] P. Booz, *Der Baumeister der Gotik*, Berlin 1956; L.R. Shelby, R. Mark, *Late Gothic Structural Design in the 'Instructions' of Lorenz Lechler*, "Architectura", IX, 1979, 2, pp. 113-131; K. Hecht, *Maß und Zahl in der gotischen Baukunst*, Hildesheim-New York 1979; *The Art and Craft of Masonry Construction Design-Stereotomy-Conservation*, edited by J. Grech, Malta 2013; R. García Bano, J. Calvo Lopez, *About an Early 16th-Century Stonecutting Manuscript in the National Library of Spain and the Origins of Modern Stereotomy*, in *Proceedings of the Fifth International Congress on Construction History*, Acts of the International Congress (Chicago, 3-7 June 2015), edited by B. Bowen and others, Chicago 2015, II, pp. 135-142; *Tecniche costruttive nel Mediterraneo dalla stereotomia ai criteri antisismici*, a cura di M.R. Nobile, F. Scibilia, Palermo 2016; *Crociere e lunette in Sicilia e in Italia meridionale nel XVI secolo. Dalla costruzione gotica all'affermazione di un modello peninsulare*, a cura di E. Garofalo, Palermo 2016.

[74] B. Chevalier, *Guillaume Briçonnet (v. 1445-1514). Un cardinal-ministre au début de la Renaissance*, Rennes 2005, pp. 327-337; Bardati, *Hommes du roi*... cit., pp. 206-210, 312-316.

[75] A. de Beatis, *Die Reise des Kardinals Luigi d'Aragona durch Deutschland, die Niederlande, Frankreich und Oberitalien,1517-1518*, herausgegeben von L. Pastor, Freiburg im Breisgau 1905, p. 69.

[76] P. Bergeron, *Voyages en Italie (1603-1612)*, a cura di L. Monga, Moncalieri 2005, pp. 137f.

[77] G. Guarini, *Architettura civile*, a cura di B. Tavassi La Greca, Milano 1968, p. 209 (3.13.1).

Margarida Tavares da Conceição

HARD TO OBTAIN, HARD TO TRANSLATE: LIME AND EARTH CONSTRUCTION IN EARLY MODERN PORTUGUESE WRITINGS ON ARCHITECTURE AND FORTIFICATION

Lime masonry and earthwork construction are subjects treated in the earliest written sources related to fortification in the Portuguese empire. Although these texts are not in the form of an architectural treatise, they do evince a noteworthy concern with construction techniques. A group of administrative records related to Mazagan (1541) provide us with a first-hand account regarding new methods of building a fortress, and reveal that good lime, considered more reliable than earth filling for the new ramparts, was difficult to obtain. Another source is an anonymous manuscript from around 1579, written by a fortificateur *playing the role of the architect. Going beyond Vitruvian guidance, the author merges several sources with his own observations. A significant part of his text is devoted to construction techniques, including earthworks, and discusses new materials using new words that are sometimes hard to translate. Both cases show a pragmatic approach and a preference for time-tested knowledge and practical experimentation.*

First notes, first questions

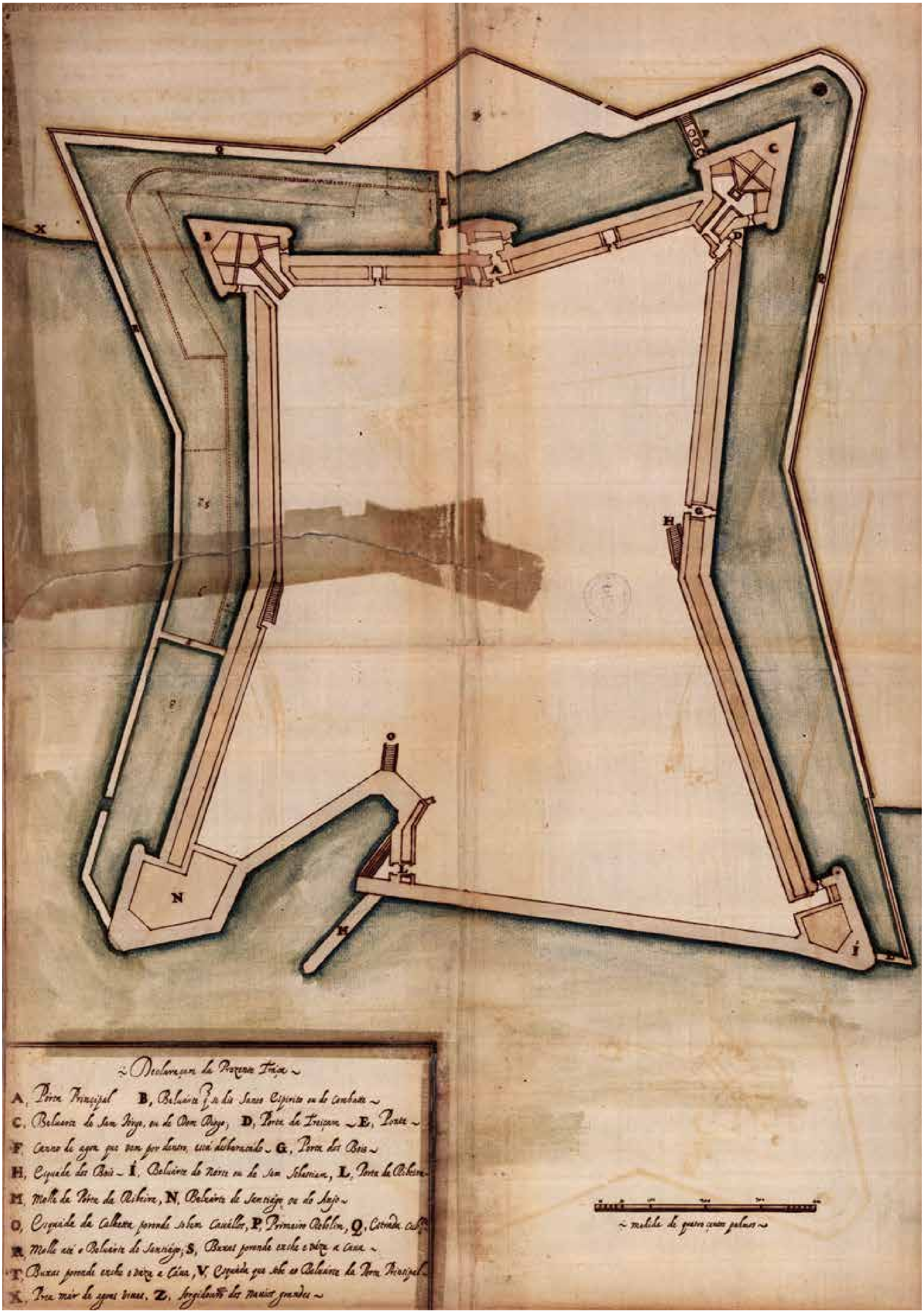
Early modern writings in Portuguese on architecture and fortification – whether theoretical or technical, treatises or notes, handwritten or printed – are not particularly easy to come by as sources, in striking contrast to the construction activity in all of the overseas territories at that time. In fact, the first architectural treatise was printed in Portugal only in 1680, and was a book restricted to matters relating to fortification[1]. Some manuscripts on military architecture may be found dating prior to that, but most of them relate to the same author, royal cosmographer and engineer, Luís Serrão Pimentel[2]. From the period before the 1640-1668 war (when the Portuguese crown was recovered from the Habsburgs), only an incomplete treatise on architecture remains, a manuscript presented as a "lesson read" in 1631 by a royal "master architect"[3]. In addition, no writings specifically focusing on military architecture have been identified before the 1630s[4]. Previously, in the sixteenth century, only fragmentary texts give us a hint as to how architectural writings were produced in Portugal, concurrent with the transformation of the builder into architect or engineer. The scope of this article is to inquire whether construction techniques were a topic included in these first scarce sources, and whether there was any particular concern with the building of military structures, a necessary condition for survival on a transcontinental imperial scale and at a time when fortification was quickly changing.

Construction history is a rather recent field of research in Portugal, but some general works and case studies provide a brief overview. A broad perspective is given by João Mascarenhas Mateus[5], who presents the subject over time and by type; however, the primary focus here is masonry techniques, rather than specifically military features. Nevertheless, some scholars who address the topic in early modern Portugal present other relevant features, especially those relating to the organisational procedures and royal representatives involved[6], mostly from the reign of King Manuel (1495-1521). At that time, a general procedure became mandatory: all royal building works had to be subordinated to an *empreitada* (literally, an undertaking), meaning both a type of contract and a building site management tool. The *empreitada* had to include a prior design (and related drawings) and a regulation document, called a *regimento*, which included a detailed description of the work to be done for a singular case. Other interesting studies[7] demonstrate the relevance of ordinances, regulations and all sorts of legal constraints on the organisation of the built urban environment, at least since medieval times, and underline elements that withstood the test of time. However, beyond a broad treatment of construction management, these studies do not go so far as to examine military building techniques. Still, the unseen face of the material reality points to the very existence of other textual sources besides (and in the absence of) theoretical writings, which must somehow have facilitated the learning of new construction features.

The overarching issue to be addressed is how Portuguese architectural writings actually evince the changes that we might expect in terms of experimentation with fortifications. Common sense would suggest that construction techniques would have been crucial to experimentation in early modern military architecture, and that it should be possible to discuss an equivalent stage of innovation to that which we find in the design of bastioned fortifications[8]. For instance, one of the most obvious cases would be the use of embankments, which required earthen and wooden materials to be mixed together, in a sense creating what could be thought of as new techniques, such as fascine and variations thereof.

In order to approach this topic, two different kinds of sources are explored. Firstly, there are the most direct sources – administrative documents relating to fortification building sites, in particular Magazan, the principal bastioned fortress overseas. Such documents mention technical problems when adapting construction methods to local circumstances. The (new) use of earth construction and the reliable (old) lime con-

Opus Incertum (2020) pp. 54-67 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12360 www.fupress.com/oi


Declaraçam da Prezente Traça
A, Porta Principal B, Baluarte do Santo Espirito ou do Combate
C, Baluarte de Sam Diogo, ou de Dom Diogo, D, Porta da Traiçam E, Ponte
F, Cano de agoa que vem por dentro, está desbaratado G, Porta dos Bois
H, Escada dos Bois I, Baluarte do Norte ou de Sam Sebastiam, L, Porta da Ribeira
M, Molle da Porta da Ribeira, N, Baluarte de Santiago ou do Anjo
O, Escada da Calheta, P, Primeiro Rebelim, Q,
R, Molle até o Baluarte de Santiago, S,
T, V, Escada que sobe ao Baluarte da Porta Principal
X, Z, Surgidouro dos navios grandes
medida de quatro centos palmos

pagina 55
Fig. 1 *Anonymous, Plan of Mazagan, sent by governor Henrique Correia da Silva to King Philip II of Portugal, 1611 (ANTT, Códice Cadaval, PP/TT/CCDV/29).*

*This work is supported by national funding from the Fundação para a Ciência e a Tecnologia (FCT) under the UID/PAM/00417/2019 project. Unless otherwise noted, all translations are my own. Margarida Tavares da Conceição, Institute of Art History, School of Social Sciences and Humanities, Universidade NOVA de Lisboa; Universidade Autónoma de Lisboa.

[1] L. Serrão Pimentel, *Methodo Lusitanico de Desenhar as Fortificaçoens das Praças Regulares, & Irregulares*, Lisbon 1680. The Lisbon editions (1541 and 1542) of Diego de Sagredo, *Medidas del Romano*, Toledo 1526 (R. Moreira, *Arquitectura*, in *Os Descobrimentos Portugueses e a Europa do Renascimento. As Descobertas e o Renascimento, Formas de Coincidências e de Cultura*, Lisbon 1983, p. 345; F. Marías, *Diego de Sagredo, entre Arquitectura y Escritura*, in *Medidas del Romano, Diego de Sagredo*, edición F. Marías, F. Pereda, Toledo 2000, p. 11) are not considered here. An overview of Portuguese early modern architectural writings can be found in M.T. Conceição, *Da cidade e fortificação em textos portugueses (1540-1640)*, Lisbon (2008) 2015, pp. 17-28, 99-118.

[2] Luís Serrão Pimentel trained several engineers in the royal fortification class in Lisbon and some of them left their course textbook manuscript (M. Soromenho, *Manuel Pinto de Vilalobos, da Engenharia Militar à Arquitectura*, Master's diss., Universidade Nova de Lisboa 1991, pp. 4-56; M.T. Conceição, *A Praça de Guerra, aprendizagens entre a Aula do Paço e a Aula de Fortificação*, "Oceanos", XLI, 2000, pp. 24-38).

[3] Mateus Do Couto, *Tractado de Architectura que leo o Mestre e Architecto Matheus do Couto o velho no Anno de 1631*, ms., Biblioteca Nacional de Portugal, Lisboa (henceforth cited as BNP), cod. 946. Details in Conceição, *Da cidade e fortificação...* cit., pp. 347-363. C. Rubão, *"O Eupalinos Moderno": teoria e prática da arquitectura religiosa em Portugal: 1550-1640*, PhD. thesis, Universidade de Coimbra 2006, pp. 281-299.

[4] For instance this first one, related to the Jesuit school: I. Stafford, *La Architectura Militar, in Varias obras mathematicas compuestas por el P. Ignacio Stafford mestre de mathematica en el collegio de S. Anton de la Compañia de Jesus y no acavadas por causa de la muerte del dicho padre*, Lisbon 1638 (BNP, cod. 240, ff. 505-642).

[5] J. Mascarenhas-Mateus, *Técnicas tradicionais de construção de alvenarias. A literatura técnica de 1750 a 1900 e o seu contributo para a conservação de edifícios históricos*, Lisbon 2002; *História da Construção em Portugal. Alinhamentos e fundações*, ed. J. Mascarenhas-Mateus, Coimbra 2011; *História da Construção em Portugal. Consolidação de uma disciplina*, ed. J. Mascarenhas-Mateus, Lisbon 2018; J. Mascarenhas-Mateus, *The Study of the History of Construction in Portugal: Between the Singular and the Universal*, in *L'Histoire de la Construction / Construction History*, éd. A. Becchi, R. Carvais, Paris 2018, pp. 325-356. Research on heritage conservation techniques usually covers the historical context: for example, C.C. Santiago, *Estudo dos materiais de construção de Vitrúvio até ao século XVIII: uma visão crítico-interpretativa à luz da ciência contemporânea*, PhD. thesis, Universidade de Évora 2001.

[6] H. Carita, *Empreitada, regimento e contrato de obras, nas estratégias de actuação da Provedoria das Obras Reais (séc. XVI-XVII)*, in *História da Construção em Portugal. Consolidação de uma disciplina...* cit., pp. 59-75; M. Soromenho, *A Administração da Arquitectura: o Provedor das Obras Reais em Portugal no século XVI e na 1ª metade do século XVII*, "Anuario del Departamento de Historia y Teoria de Arte", Madrid 1997-1998, IX-X, pp. 197-209.

[7] S.M.G. Pinto, *As interacções no sistema das operações urbanísticas nos espaços urbanos portugueses até meados de Oitocentos*, PhD. thesis, University of Coimbra 2012; *Building Regulations and Urban Form, 1200-1900*, edited by T.R. Slater, S. Pinto, London 2017; S.M.G. Pinto, *Behaviours and*

struction are underlined here. These rather administrative and legal texts, which are almost the complete opposite of a treatise, provide us with a manifestation of the real learning in the field and a first-hand reaction to new ways of building a fortress. In short, they tell us how it was achieved – knowledge that would otherwise have been lost. Secondly, we have architectural writings dating from around the 1570s, the first of their kind to be produced within a Portuguese context. We are able to examine these, looking for explanations of construction techniques. The main topics worth addressing here include the interest that this area held for the "architectural writer" and the way in which new materials and words were translated, including descriptions of earthworks. Going beyond the use of Vitruvian *topoi* (despite the fact that this point of reference was mediated to a high degree through contemporary Italian books), we should question whether modern authors were really updating ancient instructions[9] in addressing such building techniques. From at least the fifteenth century, Vitruvian influence in Portugal was disseminated within a broad cultural context[10], but we do not have any architectural text on this subject before the 1570s. Due to this context of an insufficiency of architectural writings, the necessity of exploring sources that fall somewhat outside the theoretical canon also makes it essential to discuss a secondary issue, namely the profile of the "writers". Who wrote about construction techniques and what difficulties arise when attempting to identify their backgrounds? They are variously described as masters of works, or *fortificateurs*, more often than architects or engineers. Coming from different backgrounds, writers use words and expressions that are sometimes hard to translate: words originally in Latin, Italian or French are adapted to Portuguese in different ways, and the use of old vernacular formulations may make the meaning of the text hard to understand and even harder to translate, as its use and meaning in craft practice are lost today.

Building site sources: materials for a new fortress

Certain documents relating to fortification building sites in the first decades of the sixteenth century, when architectural design was changing to resist gunpowder artillery[11], seem to provide the most promising path towards understanding how construction techniques were applied and how they were discussed at the time. In any case, the connection with the existence of a building is very specific. The documents may be signed by different actors, expressing their knowledge and their doubts, and deserve close attention as they state the difficulties being faced in a first-hand account.

One such case that brings together a range of preeminent, professional figures was the fortress of Mazagan (now El Jadida, in Morocco). Construction took place in two different stages: in 1514, when a quadrangular fortress was built (later transformed into a warehouse and cistern); and in 1541, when work began on the new bastioned fortress[12]. The first stage can be connected to two brothers, Diogo and Francisco de Arruda[13]. These royal master builders were at the forefront of important changes in Portuguese military architecture, creating some of the first new constructions to resist firearms. The Arruda brothers were sent to North Africa in 1514 and engaged in work on the fortifications of Azamor and Mazagan. From Azamor, the two wrote the king a long letter reporting construction problems[14] (fig. 2).

Like many similar letters exchanged between local agents and the king's circle, this document shows that the Arrudas' overriding preoccupation was the security of the wall structures in both places and the difficulty of finding supplies of good limestone. Indeed, this was a recurring

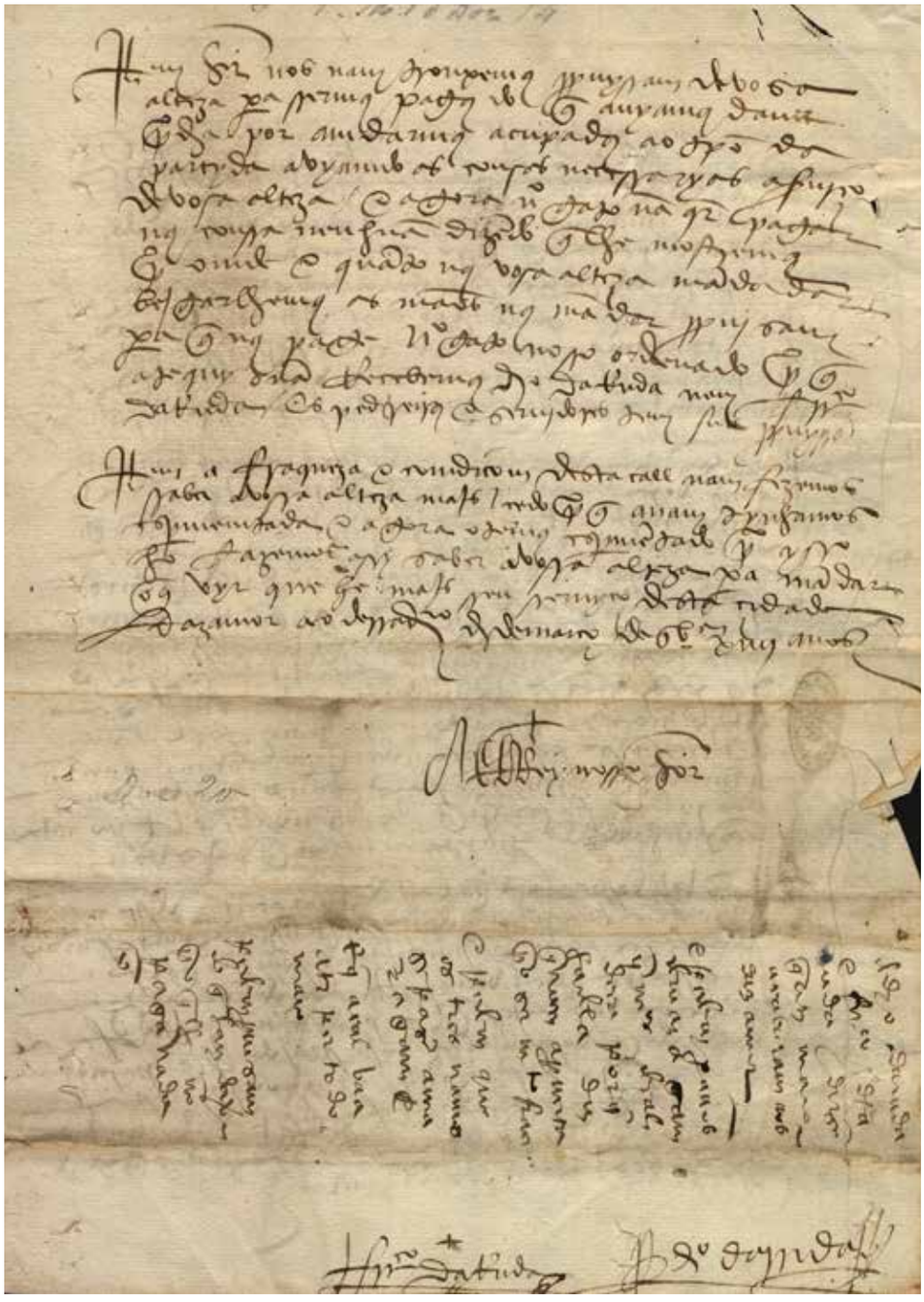


Fig. 2 *Letter addressed to King Manuel, signed by Diogo and Francisco de Arruda, dated from Azamor, 31 March 1514 (ANTT, CC, 1, 15, doc. 14).*

problem[15], as Portuguese limestone (particularly from Portimão on the Algarve coast and areas of the south, such as Évora)[16] was required to get good-quality lime mortar. The reported difficulty mainly related to the walls and bastion foundations facing the sea, which required stronger mortar. For that reason, they claimed to have reserved Portuguese lime for those structures only[17]. The builder-architects explain that they have built lime kilns and tried local limestone to no avail, and stress that they are sure about the lack of viability because they have carried out some experiments. They claim that the local lime they tried to use didn't melt in the same way Portuguese lime does, instead turning to an ashy substance and resulting in a weak, poor-quality material. They also assert this lime is so bad that Moorish builders themselves had to cover the walls with plaster in order "to hold lime inside the wall". This was described by the Arruda brothers, who discovered some points on the Moorish walls coated with less plaster[18]. Over time and across different areas, the production of lime (*cal*) as a binder material relied not only on the quality of the limestone but also on a proper heating, burning and cooling process for it, in accordance with the specific details and recipes later found in most textbooks[19].

Procedures used by Construction Agents of Ordinary Buildings in Portugal during the Late Middle Ages and Early Modern Period: Rules, Regulations and Controls, "Construction History, International Journal of the Construction History Society", XXX, 2018, 1, pp. 49-68. Pinto also studied the case of Valério Martins de Oliveira, a stonemason who also wrote a technical book that was printed in Lisbon in 1739; see S.M.G. Pinto, *As advertências de Valério Martins de Oliveira ou o manual dos mestres pedreiros e carpinteiros portugueses do período moderno*, in *História da Construção em Portugal. Consolidação de uma disciplina*... cit., pp. 77-102.

[8] On the building of fortifications and earthworks, see among others: J.R. Hale, *The Development of the Bastion, 1440-1534, an Italian Chronology*, in *Renaissance War Studies*, London 1983, pp. 1-31 (first edition 1965); S. Pepper, N. Adams, *Firearms and Fortifications. Military Architecture and Siege Warfare in Sixteenth Century Siena*, Chicago 1986; D. Lamberini, *Il Sanmarino. Giovan Battista Belluzzi, architetto militare e trattatista del Cinquecento*, Firenze 2007.

[9] The bibliography of interpretations of Vitruvius and early modern architectural theory and practice is extensive. To quote just the main general works: *Trattati d'Arte del Cinquecento fra Manierismo e Controriforma*, a cura di P. Barocchi, Bari 1960-1962; *Scritti Rinascimentali di Architettura*, a cura di A. Bruschi *et al.*, Milano 1978; *Le Projet de Vitruve. Object, destinataires et réception du De Architettura*, actes du colloque international (Rome, 26-27 mars 1993), éd. P. Gros, Roma 1994; P. Gros, *Vitruve et la tradition des traités d'architecture. Fabrica et ratiotinatio. Receuil d'études*, Rome 2013; M. Carpo, *Architecture in the Age of Printing. Orality, Writing, Typography, and Printed Images in the History of Architectural Theory*, Cambridge 2001; *Sebastiano Serlio à Lyon: architecture et imprimerie. Le traité d'architecture de Sebastiano Serlio, une grande enterprise éditorial au XVI^e siècle*, éd. S. Deswarte-Rosa, [Lyon] 2004; *Les traités d'architecture de la Renaissance*, actes du colloque (Tours, 1-11 juillet 1981), éd. J. Guillaume, Paris 1988; *Paper Palaces. The Rise of the Renaissance Architectural Treatise*, edited by V. Hart, P. Hicks, New Haven-London 1998; F. Lemerle, Y. Pauwels, *Architectures de papier. La France et l'Europe, suivi d'une bibliographie des livres d'architecture (XVI^e-XVII^e siècles)*, Turnout 2013; *Architectvra. Architecture, textes et images, XVI^e-XVII^e siècles*, éd. F. Lemerle, Y. Pauwels, http://architectura.cesr.univ-tours.fr/Traite/index.asp?param, last accessed on 24 February 2020; P.N. Pagliara, *Vitruvio da testo a canone*, in *La Memoria dell'Antico nell'Arte Italiana*, a cura di S. Settis, Torino 1986, III, pp. 5-85; A. Payne, *The Architectural Treatise in the Italian Renaissance. Architectural Invention, Ornament, and Literary Culture*, Cambridge 1999.

[10] Moreira, *Arquitectura*... cit., p. 342; R. Moreira, *A Arquitectura do Renascimento no Sul de Portugal, a Encomenda Régia entre o Moderno e o Romano*, PhD. thesis, Universidade Nova de Lisboa 1991, pp. 286-299. An attempt to translate *De Architectura*, by the mathematician Pedro Nunes, is documented in 1541 (see also M.T. Conceição, *Translating Vitruvius and Measuring the Sky: On Pedro Nunes and Architecture*, "Nexus Network Journal: Architecture and Mathematics", 13, 2011, 1, pp. 205-220).

[11] See Moreira, *A Arquitectura do Renascimento*... cit., pp. 126-195; *História das Fortificações Portuguesas no Mundo*, ed. R. Moreira, Lisbon 1989, pp. 126-195; P. Dias, *Arquitectura dos Portugueses em Marrocos. 1415-1769*, Lisbon 2000; M. Barroca, *Tempos de resistência e de inovação: a arquitectura militar portuguesa no reinado de D. Manuel I (1495-1521)*, "Portvgalia", 2 s., XXIV, 2003, pp. 95-118.

[12] P. Cenival, *Sources inédites pour l'Histoire du Maroc, Série Portugal*, Paris 1934-1953, I-IV; Dias, *Arquitectura dos Portugueses*... cit., pp. 135-153; R. Moreira, *A construção de Mazagão. Cartas inéditas 1451-1542*, Lisbon 2001; J. Correia, *Implantação da cidade portuguesa no Norte de África. Da tomada de Ceuta a meados do século XVI*, Porto 2008 pp. 336-349, 395-402; J.B. Matos, *Do mar contra terra. Mazagão, Ceuta e Diu, primeiras fortalezas abaluartadas da expansão portuguesa*, PhD. thesis, Universidad de Sevilla 2012, pp. 75-227.

Fig. 3 *Baluarte do Raio, Azamor (photo J. Correia).*

Fig. 4 *Torre da Cegonha, Mazagan (photo J. Correia).*

Some construction work took place between 1514 and 1530 both in Azamor and Magazan (figs. 3-4). Problems periodically arose, with Portuguese lime applied to the troublesome spots[20]. Afterwards, around 1540, King John III and his councillors decided to abandon the kingdom's fortifications in North Africa, with the exception of Mazagan, Tangier and Ceuta. In order to secure the Portuguese position, the monarch also decided to build a new bastioned fortress town in Mazagan. By June 1541, the head of the building site, João de Castilho – who was the most important architect in Portugal at the time and already over sixty years old[21] – was already in place when Miguel de Arruda (ca. 1500-1563, probably the son of Francisco Arruda and nephew of Diogo)[22] was sent there to accompany the Italian engineer Benedetto da Ravenna (ca. 1485-1556). At that time, Benedetto was working in Spain for the Emperor Charles V, brother-in-law to John III, and the Portuguese monarch requested the engineer's services via

[13] Diogo (active 1508-ca.1530) and Francisco de Arruda (active 1510-1547) were responsible for Lisbon's new fortifications, including the *baluarte* of the Ribeira palace (since 1508) and the *baluarte* in Restelo (1516-1517, now known as the Torre de Bélem); besides adapting medieval castles and building new fortifications in Alentejo, they both worked in several fortifications in North Africa. Moreover, Diogo de Arruda was appointed in 1521 as surveyor of the Royal Works. F.S. Viterbo, *Dicionário Histórico e Documental dos Arquitectos, Engenheiros e Construtores Portugueses*, Lisbon 1988, I, pp. 51, 60 (first ed. Lisbon 1899); N. Senos, *O Paço da Ribeira 1501-1581*, Lisboa 2002, pp. 54-62.

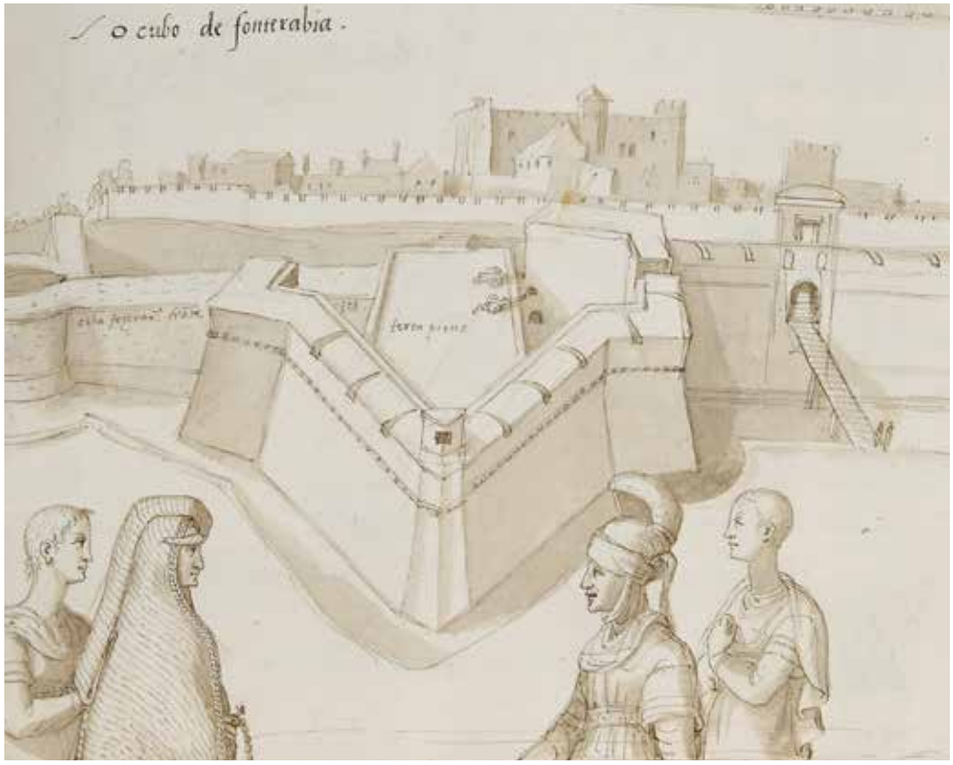
[14] Dated from Azamor, 31 March 1514, Arquivo Nacional da Torre do Tombo (henceforth cited as ANTT), Lisboa, *Corpo Cronológico* (henceforth cited as *CC*), 1, 15, doc. 14, published by Viterbo, *Dicionário...* cit., I, pp. 48-50.

[15] Sources largely published by Sousa Viterbo reveal this issue around the same period, for instance on the north-eastern Portuguese border during the renewal of the castle of Almeida in 1508 (ANTT, *CC*, 1, 17, doc. 46, Viterbo, *Dicionário...* cit., I, pp. 338-340).

[16] Viterbo, *Dicionário...*cit., I, p. 60, refers to Portimão; BNP, cod. 3675, ff. 17*v*-18*v*, refers to Évora. From a broad geological point of view, southern Portuguese regions feature a different kind of limestone.

[17] "[para] fazer obra durauell convem que seja ao menos os alicerces da call de Purtugall [...] como por que he a borda do mar que mais asynha a ade gastar" (Viterbo, *Dicionário...* cit., p. 48); translation: "to create work that lasts, it is important for the foundations, at least, to be made using lime from Portugal […] also because they are at the sea edge, so they are worn more easily".

[18] Longer transcription: "O ponto em que ora estaa o castello dazamor, saberra vosa alteza o que se fez na call que vosa alteza mandou que cá trabalhassemos por se fazer. Cozemos huum forno que nos lamçarya trezemtos cimquemta moyos, o quall forno, se a pedra fomdyra como fumde a de Portugall, ouueramos quinhentos moyos, assy que esta quebra nos parece que jaz na pedra nã ser muyto natural de call e a call em si he fraca [...]. [...] pera que a obra que se com ella fezesse fosse segura e durauel, o que com estoutra, por ser tã fraca como he, nam sera segura a obra com ella começada [...]; por que sabera vosa alteza que quanta obra antyga os mouros tem feyto nesta cidade toda he cuberta de jesso, pera que segure a call de dentro da parede e omde quer que o jesso mimgoa logo a agoa a desfaz como se fosse barro; [...] nem crea vosa alteza que se pode em Mazagão fazer call de que vosa alteza seja seruido, por que parece cimza; assy a faziam os mouros nesta cidade, e a que agora fazemos he de muita avamtagem da que os mouros faziam e comtudo não he boa, como já dizemos. [...] A fraqueza e condiçoens desta call nam fazemos saber a vossa alteza mais ceedo, por que a nam tynhamos esprimentado e agora o temos esprimentado, por yso ho fazermos assy saber a vossa alteza […]" (Viterbo, *Dicionário...* cit., p. 49); translation: "As the castle of Azamor is at this point in time, Your Highness knows what has been done in the lime your highness told us to work with. We burnt it in a kiln which would make three hundred and fifty *móios* [Portuguese old unit of volume measurement, equivalent approximately to 60 *alqueires*, with 1 *alqueire* equal to around 14 litres; the unit was subject to substantial large regional variation], which kiln, if the lime would burn as it does in Portugal, would give us fifty hundred *móios,* so this break that lies in the stone seems to us not to be very natural for lime, so that the lime itself is weak [...]. [...] for the work done with it would be safe and durable, such that for this other one, being as weak as it is, work started with it will not be safe [...]; because Your Highness should know that old work the Moors have done in this whole city is covered with plaster, so that you can hold the lime inside the wall, and wherever the plaster falls, the water



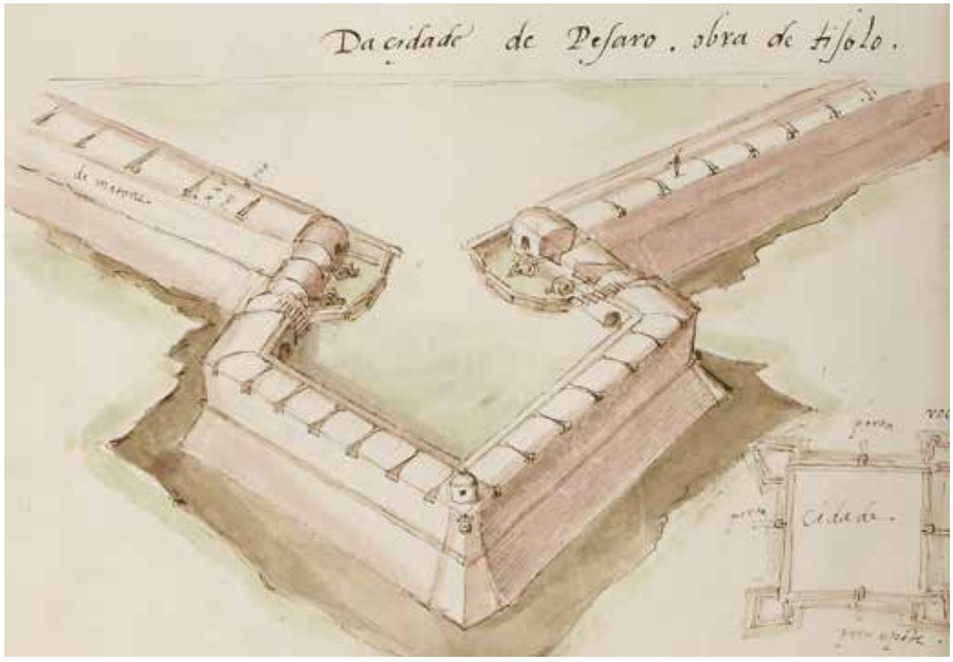


Fig. 5 *F. de Holanda, Detail of the bastion of Fuenterrabía (Real Biblioteca del Monasterio de San Lorenzo de El Escorial, ms. 28-I-20, f. 42r; © Patrimonio Nacional).*
Fig. 6 *F. de Holanda, Detail of the bastion at Pesaro, in brickwork (Real Biblioteca del Monasterio de San Lorenzo de El Escorial, ms. 28-I-20, f. 36v; © Patrimonio Nacional).*

diplomatic channels[23]. Benedetto's mission was to decide on the design of the bastions both in Ceuta and in Mazagan. Building work immediately began in Mazagan and the enceinte was closed by November 1542. Sources[24] relating to the site provide us with far more information than the authorship of the design, revealing the ongoing learning process and aspects under discussion. Such issues were resolved quite swiftly, as the king ordered the Italian's notes to be strictly followed.

These letters reveal new vocabulary in Portuguese, and several sentences are explicit about certain technical changes, such as the transformation of the round or squared *torre* (tower) into the (also round or angular) *baluarte* or *bastião*[25]. One of the most frequently mentioned issues relates to the new type of walls or ramparts: thicker, with embankments, but also with stone cladding shaping the curtains between the new angular bastions. This introduced a differentiation between *muros* (walls) and *reparos* (ram-

soon undoes it as if it were clay; [...] Nor should Your Highness believe that in Mazagan you can make lime so that Your Highness is served, because it looks like ash; that made by the Moors in this city, and that which we are making now are better than that made by the Moors, and yet it is not good, as we have already said. [...]. We did not inform Your Highness of the weakness and conditions of this lime because we had not experienced it, and now we have experienced it, we are letting Your Highness know [...]".

[19] For instance, in Mateus do Couto's lesson (Couto, *Tractado de Architectura...* cit., pp. 36-38, Book 2, Chapter 9, on building materials) or in Oliveira (V.M. Oliveira, *Advertencias aos modernos, que aprendem os officios de pedreiro, e carpinteiro*, Lisbon 1739, pp. 78-81), both following the building techniques outlined in Vitruvio, *De architectura*, a cura di P. Gros, Torino 1997, I, pp. 131-133 (II, V).

[20] Dias, *Arquitectura dos Portugueses...* cit., pp. 117-128; but the building works in Mazagan are documented only between 1514 and 1517; Moreira, *A construção de Mazagão...* cit., pp. 41-42.

[21] The extensive work of João de Castilho (active 1515-1552) is mainly connected to the royal protection of big monasteries; by 1541 he was the leading master-builder of the Convent of Christ in Tomar. See Viterbo, *Dicionário...* cit., pp. 183-184; Moreira, *A Arquitectura do Renascimento...* cit., pp. 406-570.

[22] Over the next two decades Miguel de Arruda, appointed as *Royal Master of the Fortification Works* ("mestre das obras [...] dos muros e fortalezas nos luguares de meus reinos e señorios": Viterbo, *Dicionário...* cit., pp. 72-73) in 1549, oversaw bastioned fortress design in Portugal and overseas (Lisbon, Bahia in Brazil, Diu in India and on Mozambique Island).

[23] Benedetto da Ravenna was a veteran who had worked around the Mediterranean for the Spanish crown since 1511. Around 1540 he was stationed in Cadiz, on the southern coast of Spain, not far from Ceuta; see J. Bury, *Francisco de Hollanda: A Little-Known Source on the History of Fortification in the 16th Century*, "Arquivos do Centro Cultural Português", 1979, pp. 190-198. Id., *Benedetto da Ravenna (c. 1485-1556)*, in *A Arquitectura Militar na Expansão Portuguesa*, ed. R. Moreira, Porto 1994, pp. 130-134; E. Kassler-Taub, *Building with Water: The Rise of the Island-City in the Early Modern Mediterranean*, "Journal of the Society of Architectural Historians", 78, 2019, 2, pp. 145-166.

[24] Moreira, *A construção de Mazagão...* cit. See more in Matos, *Do mar contra terra...* cit.; J.B. Matos, *First bastioned fortifications of Portugal's overseas expansion*, in *Heritages and Memories from the Sea*, conference proceedings (Évora, 14-16 January 2015), edited by F. Barata, J. Rocha, Évora 2015, pp. 208-213; W. Rossa, *1514 El Jadida 1541. Le vicende della fondazione di una città marocchina*, in *Il cantiere della città. Strumenti, maestranze e tecniche dal Medioevo al Novecento*, a cura di A. Casamento, Roma 2014, pp. 103-120.

[25] *Baluarte* or *bastião* are both common equivalents to bastion in English. See M.T. Conceição, *Le langage militaire des ingénieurs et des fortificateurs portugais (c. 1480-1580)*, in *Les mots de la guerre dans l'Europe de la Renaissance*, éd. M.M. Fontaine, J.L. Fournel, Genève 2015, pp. 144-152.

part embankments). It is no mere coincidence that in spring 1540, when the artist Francisco de Holanda (ca. 1517-1584) returned from his journey to Italy, bringing with him drawings of new fortresses, one of them had the subtitle *terrapieno*[26], which highlights this requirement (figs. 5-6).

Mazagan's sources contain several references to the problem of building ramparts in earth *(repairos de terra*), even though everyone recognized the usefulness of this new type of curtain wall against artillery fire[27]. As the king pointed out, building this kind of rampart required a larger area. Moreover, earth was also needed, but the settlement had only rocks:

> [...] you do not have space to make the ramparts nor, I believe, the earth to make them, because I have been told that they are located on rock slabs […][28].

In fact, the moat was tremendously difficult to open, which led to a few piteous complaints by Castilho[29] (fig. 7).

Following the construction of the ramparts, the drawing showing the plan of the fortress in 1611 (fig. 1), as pointed out by João Barros de Matos[30], shows the structure accurately. The perimeter and bastions were not all filled in with earth and rubble[31]: two bastions have stone masonry casemates and another two are filled in. However, on the seafront near the wharf, the rampart is thinner and entirely built using stone masonry (see fig. 7). It is worth looking closer at the discussion between the monarch and master-builder João de Castilho, who complained that he would send the drawings if he had proper sheets of paper. He then justified himself, arguing:

> […] as Your Highness did not send any message regarding what I wrote about the bastion that goes into the sea and the wharf, that I did not do it per your ordination. And believe me, Your Highness, that if we did not make a rampart with dry stonework or stone cladding, no boat or caravel would enter the northern part of the wharf during a storm […]. // I wrote to Your Highness about the wall facing the sea, and what should be ordered to do, because plain earth will cost as much as stone and lime. And to the captain, and João Ribeiro and myself, it seemed that it would be good for it to be made thirty-five palms thick, because with the rubble for the traverses and with the town's wall there will be no more expenses, and plain earth is not needed[32].

Besides the resistance to filling the walls facing the sea with earth and rubble, another issue worth highlighting is the finishing of the parapets, a more visible and vulnerable part of the fortress. The Infante Dom Luís, Duke of Beja[33], the king's brother and his main military adviser, who was also leading the Lisbon board of advisors for the Mazagan works, issued instructions. These detail materials and measures for the parapet on each bastion or front, stipulating the obligation to apply the measurements according to the design. He warned that the walls should not be made thicker than necessary to hold the fill, albeit allowing masonry to be used instead of earthen materials in some specific parts, such as a cavalier facing the sea. He also decreed that no *échauguettes* (or watch turrets) should be built using masonry, but only using tarred wood.

Finally, these instructions distinguish between the materials for the embrasures, with stonework for 'bombards'[34] and brick for harquebuses, and add an exotic touch by ordering that the artillery be covered with palm leaves to provide shelter from the rain. The debate regarding the use of brickwork or stonework against gunpowder impact is absent in these sources. Employing brickwork was indeed among the advice Francisco de Holanda claimed to have given for Mazagan, although it was not heeded[35]. The list of instructions issued by Dom Luís ends with an order to send a large quantity of lime, suggesting that it was still deemed more suitable than rubble and earth filling.

[26] This was the case of Fuenterrabía in the Basque region: F. Holanda, *Os Desenhos das Antigualhas*, ms. 28-1-20, f. 42, Real Biblioteca del Monasterio de San Lorenzo de El Escorial. See Bury, *Francisco de Hollanda*... cit., p. 189; F. Cobos, *Dessins de fortification dans "Os desenhos das antigualhas" du Portugais Francisco de Holanda (1538-1540)*, in *Atlas Militaires Manuscrits Européens (XVI[e]-XVIII[e] siècles)*, actes des journées d'étude (Paris, 18-19 avril 2002), éd. I. Warmoes, E. d'Orgeix, C. van den Heuvel, Paris 2003, pp. 117-132: 124.

[27] "[...] porque aimda que pera artelharia os repairos de terra sejam fortes aveis de ver se vos ficão essas estamçias muito baixas e a cava se he estreita e pouco funda [...]" (Letter from King John III to Luís Loureiro, captain of Mazagan, 13 April 1541, in Moreira, *A construção de Mazagão*... cit., p. 92.). "[...] because even if earth ramparts are strong for artillery, you need to make sure that those platforms are not too low and that the moat is not too narrow and not very deep [...]".

[28] "[...] não tendes espaço pera fazerdes repairos nem creo que terra pera os fazer porque me dizem que estaa sobre lagias [...]." Letter from King John III to Luís Loureiro, April 1541, in Moreira, *A construção de Mazagão*... cit., pp. 86-89: 88. The king also commanded careful checking of the site for making the lime mortar.

[29] Besides the lack of food provisions, João de Castilho, chief master of the building site, states he was working since dawn to sunset (letter from João de Castilho to King John III, 2 September 1542, in Moreira, *A construção de Mazagão*... cit., pp. 137-138).

[30] Matos, *Do mar contra terra*... cit., p. 160.

[31] João Barros de Matos had the opportunity to examine one bastion and confirm its filling materials: earth and small pieces of stone compacted in layers (Matos, *Do mar contra terra*... cit., pp. 147-148).

[32] "[...] posto que Vossa Alteza me não mandou recado do que lhe esprevi açerqua do baluarte que entra dentro do mar e desta entrada da calheta, que eu ho não fizera como estava na hordenaçao pelo que compria a seu serviço. E crea Vossa Alteza que se se não fizer hum reparo de pedra seca hou de chaparia da parte do Norte que na calheta não entrara nenhum batel com tromenta nem caravela [...]. // [...] Eu esprevi a Vossa Alteza açerqua do muro da parte do mar que me mandase o que nele avya de fazer porque terra plana a-de custar tanto como de pedra e cal. E ao capitão he a João Ribeiro he a mym nos pareçia beem que se fizesse de trinta y cynco palmos de grosso porque com hos travezes que levão os entulhos e com ho muro da parte da villa não se faz mais despesa, e escusa terra plana". Letter from João de Castilho to King John III, 2 September 1542, in Moreira, *Cartas*... cit., p. 138. The unit of measurement used here is the Portuguese *palmo* (equivalent to 22 cm), which I have translated here as "palm".

[33] Instructions by the Infante Dom Luís to be sent to Mazagan, undated (ca. 1542), in Moreira, *Cartas*... cit., pp. 155-156.

[34] Here (Instructions by the Infante Dom Luís… in Moreira, *Cartas*... cit., p. 156) and in other documents during this period, the Portuguese word is *bombardeiras*; it refers to the place where the artillery piece was positioned and not to the piece itself. We may suppose that despite this name the embrasures were meant for other, more modern types of cannon.

Fig. 7 *Mazagan, Eastern curtain of the fortress, near the wharf (photo J. Barros de Matos).*

The sources explored here reveal the initial technical reaction to the process of conceiving and building a new fortress with angular bastions according to a design by an Italian engineer, who left drawings and instructions to be strictly followed by the Portuguese. The repeated royal advice not to deviate from these instructions also reflects the reaction towards new procedures for building fortifications, in particular a certain rejection of the use of earth and rubble filling for the ramparts. The Portuguese architects (who in the sources are named as *masters of the royal works*, but who were well acquainted with design) and those who were in charge on the ground seem to have taken a pragmatic approach, insisting on the use of good lime to build strong and lasting walls. This was intended to make the construction viable in the first place, and reliable in the long run.

Hard to translate: architectural writings by a fortification builder

In the late 1570s a very different geopolitical situation emerged. At this time, angular bastioned fortifications were under construction in strategic areas of the Portuguese empire, which would subsequently be united under the same Iberian monarch, Philip II of Spain, son of Charles V and Isabel of Portugal, in 1580. By this time, writings relating to military architecture were being printed and read in Europe (and its colonies) in a much larger number than previously, having seen a particular increase from the 1550s onwards[36].

Roughly coinciding with the start of the reign of the young King Sebastian, grandson and successor of John III, the very first manuscript on architecture to be written by a Portuguese author, albeit anonymous and untitled, dates from around 1576. It appears to meet the standards of architectural treatises published elsewhere and gives building materials a prominent position. Often attributed to António Rodrigues (ca. 1525-1590), Miguel de Arruda's immediate successor as Master of Royal Works[37], it was never printed and remains unfinished, the contents somewhat haphazardly arranged[38]. The codex has 66 *folia*, of which 21 are entirely devoted to construction techniques and the properties of materials, drawing upon approaches by various other writ-

[35] F. Holanda, *Da Ciência do Desenho*… 1571, ms., Biblioteca do Palácio Nacional da Ajuda (BA, Lisbon), 52-XII-24, ff. 43-43*v*. Holanda also claimed that the fortress of Mazagan was made according to his idea and model, but this is not the matter under study here.

[36] J. Bury, P. Breman, *Writings on Architecture Civil and Military c. 1460 to 1640*, The Hague 2000.

[37] BNP, cod. 3675 [*Tratado de arquitectura*]. Attributed to António Rodrigues by Rafael Moreira, who first studied the manuscript in depth and considered it to be the first part of another codex (R. Moreira, *Um Tratado Português de Arquitectura do Séc. XVI*, MA thesis, Universidade Nova de Lisboa 1982; partially published as *Um Tratado Português de Arquitectura do Século XVI (1576-1579)*, in *Colectânea de estudos Universo Urbanístico Português 1415-1822*, Lisboa 1998, pp. 353-398). For more, see Conceição, *Da cidade e fortificação*... cit., pp. 289-338.

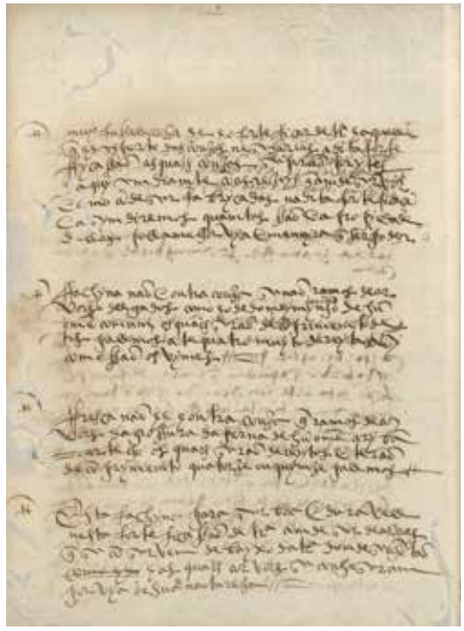


Fig. 8 *Anonymous, Tratado de arquitectura (BNP, cod. 3675, ff. 13v, 14).*

pagina successiva
Fig. 9 *Anonymous, Tratado de arquitectura (BNP, cod. 3675, f. 37v).*

Fig. 10 *Anonymous, Plan of a bastion, from Tratado de arquitectura (BNP, cod. 3675, f. 63).*

Fig. 11 *Anonymous, Plan of a bastion, from Tratado de arquitectura (BNP, cod. 3675, f. 67).*

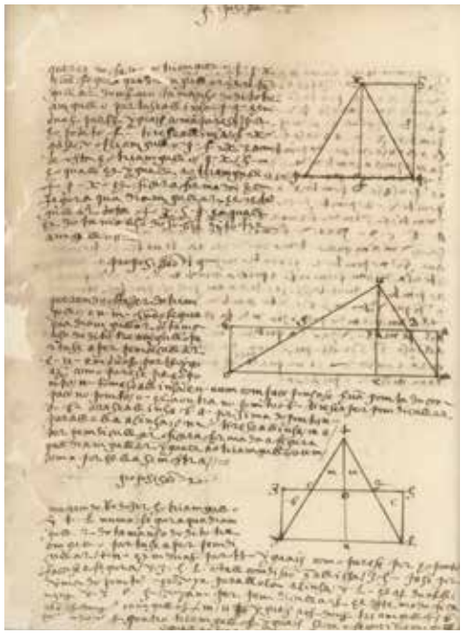
ers while sometimes incorporating the author's own statements. Without delving into the issue of authorship here, it must be said that the vocabulary employed in this work reflects a professional profile in transition: a *fortificateur* trying to play the role of architect, and striving to be seen as such. The manuscript repeatedly features the word *fortificador* struck through and replaced with the word *arquiteto*; in the same way, *fortaleza* is replaced with *edifício*. Although the word *arquitectura* does not occur anywhere and the text makes no reference to architectural orders, it often refers to the *profição de fabricar* (profession of building) or the *profição de quererem ser defemsores* (profession of those who wish to be defenders)[39]. We are, in fact, dealing with the complex metamorphosis from the older, medieval-style role of master builder into the newer, modern-style architect and engineer. These sorts of variations in vocabulary may also be detected in other European regions, such as the Low Countries, where some authors alternate between words such as *fortressaseur*, *ingeniaire* and *architecte*[40].

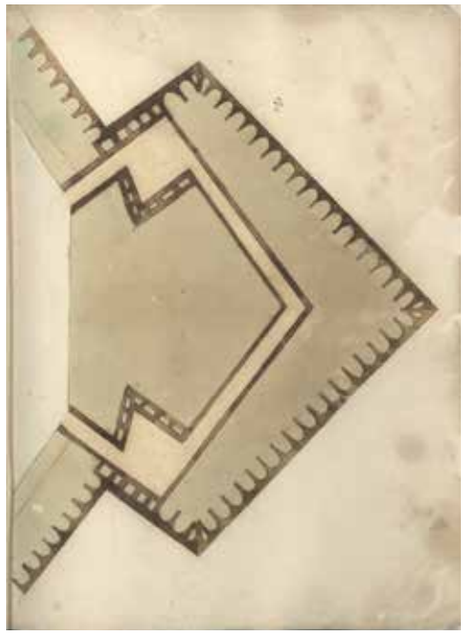
The fact that the aspiring Portuguese 'architectural writer' organised his own notes and started to write about fortifications of his own accord should not be underestimated in the light of other topics included in the manuscript, such as knowledge that architects were expected to acquire or the art of choosing an adequate site for building. To summarise the contents, the manuscript comprises three very different parts. The first section, which lacks drawings, covers various aspects of the art of building, deferring to Vitruvian authority, as is evident from chapters about the disciplines with which the architect should be familiar and the properties of water. The second part consists of a numbered sequence of definitions and propositions on geometry, surveying instruments and perspective, with drawings. The main reference here is Sebastiano Serlio's First and Second Books[41].The last, much shorter part only contains some studies of individual bastion plans (which are not mentioned in the text)[42] (figs. 8-11).

The first part starts with a kind of prologue and with five chapters (ff. 2-13) that may be considered a *résumé* of the initial sequence we find in the Vitruvius's *De architectura*, concerning the choice of a healthy site for the city, air and water quality, and the architect's education[43]. The second half of this first part (ff. 13-24) is mainly dedicated to construction materials, and has not attracted much scholarly attention. It includes two chapters on earthworks and lime production, and another six chapters on sand, clay for making bricks, and the most suitable weather or season for normal building works, earthworks and woodcutting. These chapters also reflect Vitruvius's influence, of course, but constitute a sort of organised compilation rather than direct translation[44].

Such technical writing indicates that the most direct influence was indeed Vitruvius's *De architectura* via the edition by Daniele Barba-

[38] Available since November 2019, but without a full critical edition and not available for direct purchase: *Primeiras Obras de Arquitectura*, ed. J.B. Pinho, J.V. Caldas, Lisboa 2019.
[39] See more in Conceição, *Da cidade e fortificação*... cit., pp. 324-329.
[40] See P. Martens, *Ingénieur (1540), citadelle (1543), bastion (1546): apparition et assimilation progressive de termes italiens dans le langage de l'architecture militaire aux Pays-Bas des Habsbourg*, in *Les mots de la guerre*... cit., pp. 105-140. For the Italian context, see E. Merrill, *The* Professione di Architetto *in Renaissance Italy*, "Journal of the Society of Architectural Historians", LXXVI, 2017, 1, pp. 13-35.
[41] The sequence of the definitions and propositions on geometry, perspective and surveying tools, as well as the drawings, are very similar to Serlio's First and Second Books, but are not a copy or close translation (S. Serlio, *Il primo [-quinto] libro d'architettura... di Sebastiano Serlio, Bolognese*, Venezia 1551; S. Serlio, *L'Architettura. I Libri I-VII e Extraordinario nelle prime edizioni*, a cura di F.P. Fiore, Milano 2001, I-II; or S. Serlio, *Sebastiano Serlio on Architecture. Books I-V of Tutte l'Opere d'Architettura et Prospetiva*, edited by V. Hart, P. Hicks, New Haven-London 1996). Rafael Moreira (*Um Tratado Português*... cit., pp. 168-169) pointed out this Serlio influence and also adds the probable use of Cosimo Bartoli's book (*Del modo di misurare le distantie, le superficie, i corpi, le piante, le provincie, le prospettive & tutte le altre cose terrene, che possono occorrere a gli huomini*, Venezia 1564). For more on the sources used in that part of the manuscript, see J.P. Xavier, *Sobre as origens da perspectiva em Portugal. O Liuro de Prespectiua do Códice 3675 da Biblioteca Nacional, um Tratado de Arquitectura do século XVI*, Porto 2006, pp. 211-242, 315.
[42] The plans of the bastions seem to be studies of different design possibilities for the same "ideal" or hypothetical bastion. As they are drawn on the last seven folios (six bastion plans, a section and half a schematic plan of a regular fortress) without any written explanation and as they are not referred to in the preceding chapters, they may have been produced by a different hand. Previous research on these drawings indicates that they are not copies (Conceição, *Da cidade e fortificação*... cit., pp. 321-324).
[43] Vitruvio, *De architectura*... cit., I, pp. 13-41 (I, 1-4); ivi, II, pp. 127-139 (II, 3-7); ivi, II, pp. 151-163 (II, 9-10).
[44] In Portuguese: *Capitolo dareia e de sua condisam, Capitolo da propiadade do baro pera teyolo, Capitolo do tempo em que se a de fazer o edefisio, Capitolo que trata do tempo convenyemte para se poder fabricar de tera, Capitolo da propiadade das arvores e quais sam boas pera os edefisios* (BNP, cod. 3350, ff. 18*v*-24*v*).
[45] Vitruvio, *I dieci libri dell'architettura di M. Vitruvio*... , a cura di D. Barbaro, Venezia 1556. Rafael Moreira (*Um Tratado Português*... cit., pp. 164-166) points to different passages where the words are very similar, revealing the source, for instance: BNP, cod. 3350, f. 2 refers to three important elements in warfare, "bataria, talhamento de mão e escala", a translation of "la batteria, il tagliamento che fa la man dell'uomo, & la scala" (Leonardi in Vitruvio, *I dieci libri*... cit., ed. 1556, p. 19); BNP, cod. 3350, f. 5 refers to the Vitruvian definition of architecture (without using the word), "portamto entendase ho que dis Vetruvio, que alem de hum omem ser syemtico tenha descurso, porque esta arte criouse da fabrica e do descurso", using a close translation of *fabrica et ratiocinatio*, like Barbaro, *fabrica* and *discorso* (Vitruvio, *I dieci libri*... cit., ed. 1556, pp. 8-9).
[46] P. Cataneo, *I quattro primi libri di Architettura*... , Venezia 1554; Id., *L'Architettura di Pietro Cataneo Senese. Alla quale oltre all'essere stati dall'istesso autore rivisti, meglio ordinati e di diversi disegni, e discorsi arricchiti i primi quattro libri*





ro[45] (1556) and Pietro Cataneo's First and Second books (1554, 1567)[46]. However, the Portuguese author does not go further into Cataneo's books, nor does he demonstrate a deep knowledge of the bastioned system, other than some basic features. As Rafael Moreira has studied, he mentions the "modern artillery" which has led to "new inventions"[47], as stated in the prologue, and later demonstrates that he clearly understands that the architect's main task is to design, to "show his concept through drawings"[48].

When listing the "sciences the architect needs to know", he adds artillery and the quality of gunpowder, lime, sand and how to make mortar, as well as woodcutting (ff. 12-12*v*), setting out some of the subjects he will later explain. When dealing with fortifications, the text provides no explanation of how to outline bastions or the perimeter. Nevertheless, it is curious that the author gives such prominence to earthworks, a type of construction method which (at least according to the current state of research) was barely used in Portuguese fortifications.

Although we cannot connect these *folia* to any specific building, we may try to trace the texts that informed the author. On four *folia*, he organises his notes into topics, explaining the earthworks in a very straightforward manner, listing materials and definitions. He describes fascine (brushwood bound together)[49] and *frasca* (using the Italian word, which today lacks any specialised Portuguese translation)[50], i.e. wooden materials to strengthen earthworks, average measurements and the best trees from which to get the branches (fig. 12). The technique of mixing earth with timber crosspieces is described as the next step in building a strong, lasting fort, making it clear that the explanation does not concern rampart filling. The author states that he is adding a drawing, but does not[51]. He also explains how to use the palisade as a complementary structure (again promising a drawing that does not materialise). This part of the so-called treatise also touches upon the type of earth to be used. The author states that the best type is loam (*greda*). Earth that is too stony, sandy or bumpy (*pedregoza, nem areoza, nem bechygoza*)[52] should be avoided, and he warns that the shape of the fortification, its final appearance[53], can only be realised by the *lota*. This is another word unfit for translation: indeed, the author feels the need to explain that this is a kind of grass[54], common in valleys and marshy fields, with entangled roots, which means it can be used to make sod bricks, the dimensions of which he provides[55]. It is a description that demands close knowledge of different types of grasses and bushes, and the appropriate level of humidity, to assure flexibility and resistance against fire.

Beyond the use of Italian words that do not have a Portuguese equivalent, the length of the explanatory text, when compared to other generally available materials, suggests that the author had access to other texts besides Barbaro's commentaries (and Leonardi's summary)[56] and the works of Pietro Cataneo[57]. Admittedly, the au-

per l'adietro stampati, sono aggiunti di più il Quinto, Sesto, Settimo e Ottavo libro... , Venezia 1567. Rafael Moreira (*Um Tratado Português...* cit., pp. 164-168) also points out different passages where the notes are very similar, despite not being a translation, strictly speaking; for instance: BNP, cod. 3350, f. 2 refers to Cain and Abel in an explanation of the beginning of the world (Cataneo, *I quattro primi libri...* cit., I-2, f. 2); BNP, cod. 3350, ff. 6-7, 9*v*, regarding the properties of the site and the water, like Cataneo (Cataneo, *I quattro primi libri...* cit., I-3, ff. 2-5); BNP, cod. 3350, f. 19, on the sand, follows Cataneo (Cataneo, *I quattro primi libri...* cit., II-4, f. 6*v*).

[47] As previously quoted in note 45, the "bateria, talhamento de mão e escada" was probably taken from G.G. Leonardi (via Vitruvio, *I dieci libri...* cit., ed. 1556, f. 39*v*) or Giovanni Tommaso da Venetia (via G. Ruscelli, *Della Militia moderna*, Venezia 1568, p. 40). For more, see Moreira, *Um Tratado...* cit., p.164.

[48] "É nesesario hao arquiteto saber debuxar porque por hele amostre ho seu cõseito [...]" (BNP, cod. 3350, f. 10*v*); on the evolution of drawing techniques see B. Bueno, *De quanto serve a Ciência do Desenho no serviço das obras de el-rei*, in *Universo Urbanístico Português 1415-1822*, actas do colóquio internacional (Coimbra, 2-6 março 1999), Lisbon 2001, pp. 267-281.

[49] The author writes *fachyna*, from the Italian (and Latin) *fascina*, and not the Portuguese *faxina*. "Fachyna não é outra couza senão ramos de arvores delgados como ho dedo meymynho da mão de hu ome comum, os quais serão de cõprimento de tres palmos ate quatro muyto dreyto, asy como são os vymes" (BNP, cod. 3675, f. 13). Translation: "Fascine is nothing more than tree branches, thin as a man's little finger, which should be three or four palms in length, and very straight, like wicker".

[50] *Frasca* in Italian means literally branch; "Frasca não he houtra couza que ramos de arvores de grossura da perna de hum home aryba do artelho, os quais são dereytos e terão cõprymento quatorze ou quymze palmos" (BNP, cod. 3675, f. 13*v*). Free translation: "*Frasca* is nothing more than tree branches with the width of a man's leg above the ankle, which are straight and shall be fourteen or fifteen palms in length". However, the Portuguese writer does not describe any other kind of branches, such as the *stipa* or the *frasca grossa* that we find in Italian books from that period.

[51] "[...] he nesesaryo que esta terra de que se este forte fas va lygada com grades de madeira emcruzadas huas com as houtras [...]. E a maneira destas grades de como am de ser feytas e asemtadas em seu lugar se [deve] amostrar em debuxo" (BNP, cod. 3675, f. 14*v*); translation: "[...] it is necessary that this earth for the ongoing fort is bound with *wooden railings crisscrossed together [...]. And how to make these grids and to lay them in its place [should] show up* in drawing". In Italian books it is usually called simply "gli alberi per le catene".

[52] BNP, cod. 3675, f. 14*v*.

[53] "A forteficassão de terra para ser boa e perfeita e pareser bem àqueles que a holharem não pode ser bem fabrycada para dar

Fig. 12 *Fascine, from an anonymous translation of G.B. della Valle, Tratado de Milícia, c. 1565-1566 (BNP, cod. 2107, f. 4r).*

thor did borrow his main considerations about the quality of earth from those sources[58]. Regarding the *lota* or sod, a passage from Vegetius (regarding military encampments) comes very close to our codex:

> They then throw up a slight parapet of turf and plant it with a row of palisades or caltrops of wood. The sods are cut using iron instruments. If the earth is held together strongly by the roots of the grass, they are cut in the form of a brick a foot and one half high, a foot broad and one half-foot long[59].

As widespread as readings of Vegetius and Vitruvius were, this consonance reminds us that embankments and earthworks in general were nothing new but were commonly used in earlier times; indeed the use of earthworks for the rapid construction of defences dates back to Antiquity. Sixteenth-century writers (and readers) were surely aware of this heritage. Yet the level of detail in the Portuguese author's text shows that he had read other material, including some Italian treatises on fortification printed before 1579. One of them, the *Duo Libri* by Giacomo Lanteri (1559)[60], essentially specialises in earthworks. This seems to have been used as a reference, although the Portuguese codex is much shorter than Lanteri's and presents only an outline of it. The treatise by Galasso Alghisi da Carpi (1570)[61] could also be a source, as one chapter relates to this topic, but it is somewhat different from the sequence in the manuscript under consideration.

Nevertheless, both of these sources, and Lanteri's text in particular, are in fact plagiarisms of the books by Giovanni Battista Belluzzi, known as "Il Sanmarino", as the comprehensive study by Daniela Lamberini has demonstrated[62]. Belluzzi's manuscripts, both originals and copies, were in circulation despite the fact that his work was only printed in 1598, in a posthumous, incomplete edition[63]. Belluzzi's *Fortificazioni di terra*, written in 1545 (and thus right before the various printed works on fortification), is considered the most accomplished work on the theory and practice of fortification sites[64], and in some ways the original source of many other writings (figs. 13-16).

Other renowned manuscripts, such as those by Francesco de Marchi (1540-1570, printed only in 1599)[65], include chapters about earth construction techniques, but with a less in-depth approach than Belluzzi. So far, however, it has not been possible to connect these treatises on fortification directly with Portuguese sources[66]. Lamberini also mentions that the famous treatise by Giacomo Castriotto, published posthumously by Girolamo Maggi in 1564, includes a rather short chapter – *Dell'ordine, che si debba tenire per fabricare opera di terra*[67] – which, interestingly, reveals that the ancestry of earthen and wooden works was already acknowledged as an *antichissima* invention in existence at least since the time of Homer's *Iliad*. Moreover, Castriotto and Maggi mention the little work by Giovanni Battista della Valle, best known as *Il Vallo Libro*[68], as the first to include earth and wood materials to *fortificare una terra*. Although the Portuguese manuscript does not mention gabions,

boa haparemssea de sy sem ser fabrycada com lota" (BNP, cod. 3675, f. 15); translation: "In order for fortification earthworks to be good and perfect and appear good to those who look at them, they must be made with *lota*".

[54] "Polos campos e vales e pauys nase hua sorte d'erva que em nosa lingoa se chama grama, a qual debayxo de terra crya muytas rayzes e estão tão lygadas huas cõ as outras que se não podem tirar hua que não venhão muytas ymtas. E a mylhor de todas é aquela que tem a folha e a sua folha é como carysso" (BNP, cod. 3675, f. 15*v*). *Cariço* is a Portuguese word for a material used in basketry. Translation: "In the fields and valleys and marshes grows a species of grass that in our language is called *grama*, which under the ground creates many roots that are so connected with each other that one cannot be removed without many coming up together. And the best of all is the one with the leaf, and its leaf is like a reed".

[55] "Esta lota sera cortada he postas nem mais nem menos que hu tijolo que tenha de cõprimento hu pe, e de largura meo pe, e de gorssura três dedos" (BNP, cod. 3675, f. 16); translation: "This *lota* should be cut into pieces, no more nor less than a brick one foot long and half a foot wide and three fingers thick". Lamberini clarifies that *lotta* or *lotte* was used in regions other than Tuscany, where the more common word was *piotte*; some authors present both words (Lamberini, *Il Sanmarino*... cit., I, p. 260-261, 307).

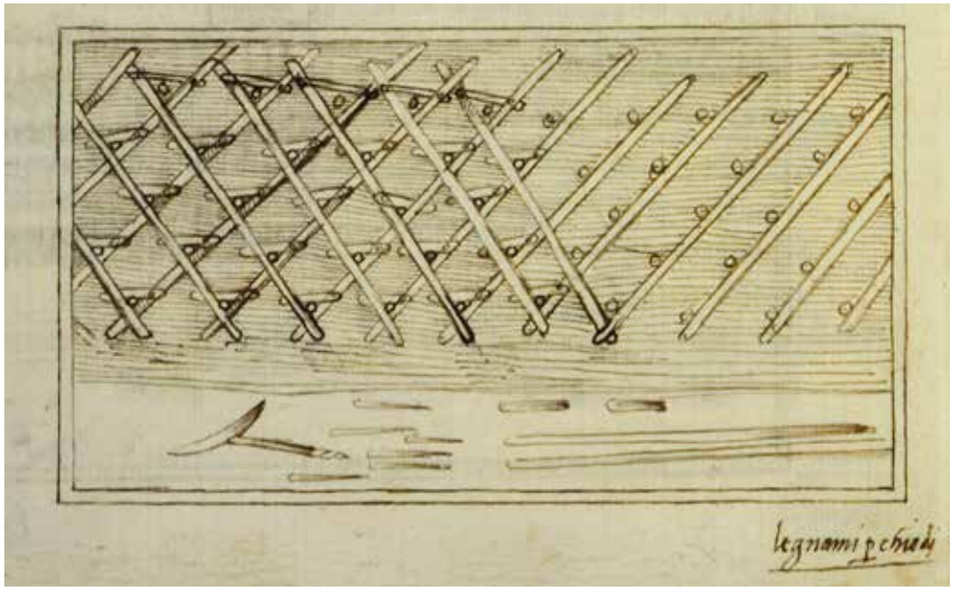
[56] Regarding fortifications, Barbaro includes some indications he gathered from Giovanni Giacomo Leonardi, thus updating Vitruvius's treatise contents; moreover, two drawings and a summary from the *Primo Libro delle Fortificatione del Signor Gianicopo Leonardi Conte de Montelabate* were added (Vitruvio, *I dieci libri*... cit., ed. 1556, pp. 30-31, 38-40). About the disclosure of the new architectural indications, as on Barbaro's edition of *De architectura* the bibliography is vast; see E. Concina, *La macchina territoriale. La progettazione della difesa nel Cinquecento veneto*, Roma-Bari 1983, pp. 135-155; L. Cellauro, *Daniele Barbaro and his Venetian editions of Vitruvius of 1556 and 1567*, "Studi Veneziani", n.s., XL, 2000, pp. 87-134; *Daniele Barbaro's Vitruvius of 1567*, edited by K. Williams, Basel 2019.

[57] Literature about Pietro Cataneo's treatise is scarce, besides references in more general works: G. Nudi, *Pietro Cataneo: trattatista d'architettura del Cinquecento*, Firenze 1968; Y. Pauwels, *Pietro Cataneo*, 2012, in *Architectvra. Architecture*... cit., http://architectura.cesr.univ-tours.fr/traite/Notice/Cataneo1567.asp?param=, last accessed on 24 February 2020.

[58] Vitruvius advises strengthening the walls with olive tree beams and embankments (Vitruvio, *I dieci libri*... cit., ed. 1556, f. 30). Cataneo (*L'Architettura*… cit., ff. 10, 15) also explains some of these construction techniques, how to fill in the ramparts (*terrapianare*) and the use of branches (*frasche*), but he did not dedicate any chapter to this topic in his *Second Book*.

[59] R.F. Vegetius, *Roman Military*, Philadelphia 2004, p. 118 (*Military Institutions of Vegetius*, edited by L.J. Clarke, London 1767). BNP, cod. 3675, f. 16: "Cortamdo desta lota nestes prados hou vales hou pauis a camtidade que for nesesarya pera esta forteficação, e a maneyra do cortar dela he ha seguinte: / Esta lota sera cortada he postas nem mais nem menos do que que hu tijolo que tenha de cõprimento hu pe, e de largura meo pe, e de gorssura três dedos".

[60] G. Lanteri, *Duo libri di M. Giacomo Lanteri di Paratico da Brescia. Del modo di fare le fortificationi di terra intorno alle Città, & alle Castella per fortificarle*, Venezia 1559. Book 1 includes chapters such as "Del modo di Fortificare di Terreno", "Della qualità della terra" (ch. 12), "Del maneggiare la terra" (ch. 13), or "Della qualità della lotta" (ch. 16), "Della stipa, e sue conditioni" (ch. 17), "Della frasca grossa" (ch. 18), "De gli alberi per le catene" (ch. 19). Meanwhile, Book 2 is titled "Del modo di fare I forti di terra intiorno alle città; et alle castella". Lanteri worked as an engineer for the Spanish King Philip II in Naples and the North African coast, which



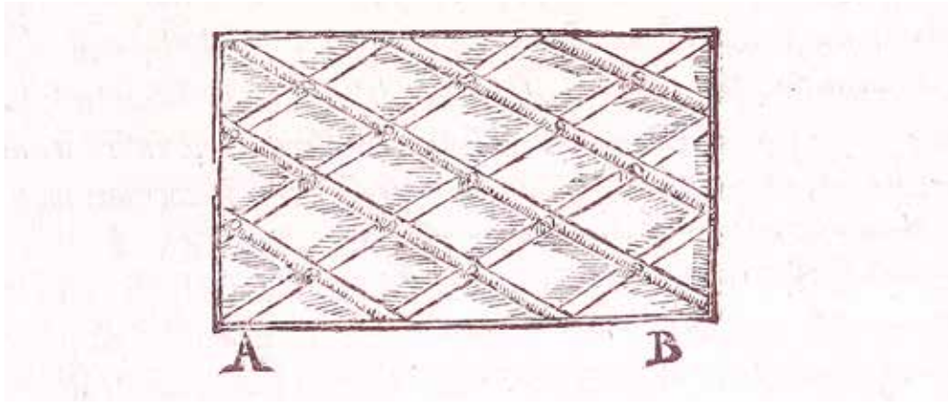


Fig. 13 *G.B. Belluzzi, Legnami per chiodi, from Trattato delle fortificazioni di terra, (Biblioteca Riccardiana, Firenze, Ricc. 2587, c. 19v; © Ministero per i beni e per le attività culturali e per il turismo).*

Fig. 14 *G. Lanteri, Catene, from Duo libri... Del modo di fare le fortificationi..., Vinegia 1559, p. 53 (Biblioteca Nazionale Centrale di Firenze, Magl. 12.5.27/b; © Ministero per i beni e le attività culturali e per il turismo).*

the main device underlined by Della Valle, the author is likely to have known the book, as it was widely publicised, with more than ten editions in thirty years[69], and was commonly found in Portuguese libraries[70].

In short, it is reasonable to assume that the Portuguese writer had direct contact with some or at least one of these treatises, most probably through the mediation of Lanteri's book[71]. He was obviously interested in earthworks and had familiarised himself with the subject, but he simplifies the available material and presents not a copy, but his own summary. When we look at descriptive details, such as techniques for the sod brick (*lotta*), the anonymous writer presents a slightly different version[72]. However, anyone studying his notes alone would have great difficulty in understanding how all the materials should be put together. This is probably why he intended to insert two drawings (for the crosspieces and palisade). The reason for the interest in earthworks in Portugal during that period remains unclear, besides intellectual curiosity in relation to an unusual procedure. In fact, he concludes by voicing doubts as to the actual usefulness of earth construction, suspecting that the Prince would accept this method for reasons of urgency rather than appropriateness[73].

The most noticeable aspect of the other chapters – regarding lime production, sand, clay to make bricks, and the most suitable weather or season for building works and woodcutting – is their brevity in comparison to the preceding chapters. Here the author presents little more than a summary of building materials and basic definitions. In doing so, he comes closer to the Vitruvian structure, which he could have found in both Barbaro and Cataneo, but still adds some personal and local details. For instance, picking up on the topic of lime again, he mentions his own experience in Évora – the source of the best limestone – and the trees most widely used in Portugal[74]. His line of argument seems to follow the sequence of the *De architectura*, explaining how to choose the best kind of stone according to its level of humidity and dryness, how to exer-

may have contributed to his book's dissemination in Iberian lands (M. Pollak, *Military Architecture, Cartography and the Representation of the Early Modern European City*, Chicago 1991, p. 58; Lamberini, *Il Sanmarino*… cit., p. 396 note 10).

[61] G. Alghisi, *Delle fortificazioni di M. Galasso Alghisi da Carpi architetto dell'eccellentiss. signor duca di Ferrara. Libri tre, all'invittissimo imperatore Massimiliano secondo Cesare Augusto*, Venezia 1570. Book 3 includes the chapter "Delle fortificazione di terra, che si fanno nel tempo de la guerra, ò sospetto di quella fatte per brevità di tempo". For an overview on fortification treatises see part of *Los Tratados de Arquitectura de Alberti a Ledoux*, edición D. Wiebenson, Madrid 1988; A. Fara, *Il sistema e la città. Architettura fortificata dell'Europa moderna dai trattati alle realizzazioni, 1464-1794*, Genova 1989.

[62] Lamberini, *Il Sanmarino*... cit., I, p. 288; D. Lamberini, *Il principe difeso: vita e opere di Bernardo Puccini*, Firenze 1990, p. 130. Lamberini underlines that Lanteri took materials from Belluzzi and his pupil and successor Puccini.

[63] G.B. Belluzzi [Belici], *Nuova inventione di fabricar fortezze*, Venezia 1598. From which Moreira (*Um Tratado*... cit., p. 168) mentions a possible source for the Portuguese manuscript, but in relation to another subject.

[64] Lamberini, *Il Sanmarino*… cit., pp. 302-309. The manuscript was presented by Lamberini before, as *Il trattato delle fortificazioni di terra*, in *Il Disegno interrotto. Trattati medicei d'architettura*, a cura di F. Borsi, C. Acidini Luchinat, Firenze 1980, I, pp. 375-401. Pepper, Adams (*Firearms and Fortifications*… cit., pp. 73-76) also mention that earthworks were commonly used in Italy and underline the role of Belluzzi as the author of the best description of building earthworks.

[65] F. De Marchi, *Della architettura militare*… , Brescia 1599. The First Book includes chapters such as "Modo di fortificare di terra" or "Della lotta, e ponerla in opera", and the Second Book includes military construction details. On F. De Marchi see D. Lamberini, *Francesco De Marchi. Ritratto di un cortigiano del Cinquecento, virtuoso e dilettante di architettura militare*, "Storia Architettura", X, 1987, 1-2, pp. 69-88; B. De Groof, G. Bertini, *Francesco di Marchi y la Monaquía Española*, in *Las Fortificaciones de Carlos V*, edición C.J. Hernando Sánchez, Madrid 2000, pp. 388-411; and M. Ng, *New Light on Francesco De Marchi (1504-1576) and His Treatise on Fortification*, "Mitteilungen des Kunsthistorischen Institut in Florenz", LVIII, 2016, 3, pp. 403-410.

[66] Nevertheless, a book on naval architecture, written by the royal chief cosmographer João Baptista Lavanha ca. 1600, contains an interesting quote: "A Architectura Militar he a que ensina a fabricar de tal modo que fortificados nos segura [...], cujos preceitos e regras ensinão em seus escritos Alberto Durero, Hieronimo Maggi, Carlo Theti, o Galarzo, Hieronimo Cataneo, Jacobo Lantero, Battista Zanchi, e outros modernos [...]" (J.B. Lavanha, *Livro Primeiro da Architectura Naval*, Lisboa 1996, p. 2; see F.C. Domingues, *João Baptista Lavanha e o ensino da náutica na Península Iberica*, in *As novidades do mundo do conhecimento e representação na Época Moderna*, actas das jornadas de História Ibero-americana (Portimão, 2002), ed. M.G.M. Ventura, S.J.S. Matos, Lisboa 2003, pp. 115-143; and Conceição, *Da cidade*... cit., p. 230.

[67] G. Maggi, J.F. Castriotto, *Della fortificazione delle città*… , Venezia 1564, Third Book, Chapter XXV, ff. 106*v*-108*v*; see G.E. Ferrari, *Le edizioni venete di architettura militare del Maggi e Castriotto*, in *L'architettura militare veneta del Cinquecento*, Milano 1988, pp. 179-194.

[68] G.B. Della Valle, *Vallo Libro continente appartenentie ad capitanij: retenere et fortificare una cita con bastioni...*, Venezia 1535, ff. 4*v*-8*v* (prima ed. Napoli 1521).

[69] Pollak, *Military Architecture*… cit., pp. 112-113. Bury, Breman, *Writings on Architecture* … cit., p.107.

[70] For instance, the Biblioteca Nacional de Portugal has two editions from the *Vallo Libro continente appartenentie ad capitanij*, Venezia 1531 (BNP, RES. 5973//1 P.), 1539 (BNP, SA 4150 P.), plus a handwritten translation done after 1565 (BNP, cod. 2107).

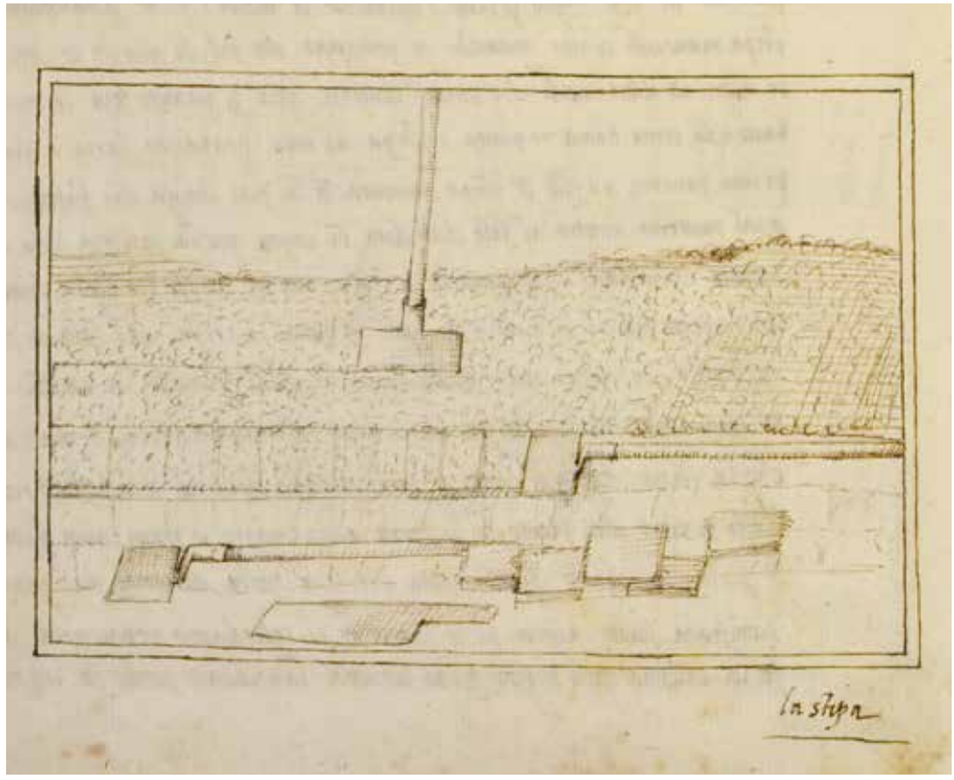


Fig. 15 *G.B. Belluzzi, La stipa, from Trattato delle fortificazioni di terra (Biblioteca Riccardiana, Firenze, Ricc. 2587, c. 17v; © Ministero per i beni e per le attività culturali e per il turismo).*

cise caution during the burning procedures and how much time is needed for the lime to slake[75]. Nevertheless, he also provides a special method for testing the lime. He stipulates that three baskets of sand should be mixed with two baskets of lime. Afterwards, the mason should knead just a small portion and test it; if the materials are not sufficiently intermingled (*bem traçada*), he should add more lime. These specifications do not match the contents or recipe prescribed by Vitruvius-Barbaro or Cataneo[76], who all state the simple rule of two parts sand to one part lime. Notwithstanding their concision, these notes do not evince the slightest hesitation, nor do they require translation (from Italian to Portuguese), and the terms used are fairly familiar. Likewise, the discussion about achieving a good level of humidity for the stone, which must not be too dry, leads him to issue a warning not to use the superficial stone, but to dig between fifteen and twenty palms, where the blueish stone is better than the whiter, as he experienced in Évora[77].

This short chapter ends with the recommendation to leave the lime to slake for at least six months, despite Vitruvius's advice to leave it for two years[78]. The writer concludes,

> But we say, as human life is brief and the appetite of the one ordering building works is big, we cannot wait for so long, and so we say that six months to slake it are enough[79].

Moreover, there is no reference to stonework. Was this topic considered too commonplace, or did the author just did not get around to writing about stonework, or was it perhaps included in a now lost part of the incomplete manuscript? Whatever the answer, this section regarding lime has fewer specifically military features and discusses instead common procedures for both civil and military building. In fact, it is ultimately unclear whether the author wanted to write about architecture or fortification, as the sequence of the chapters is not clearly apparent. In all likelihood, he was simply organising his own compilation of private notes. The chapters on earthworks, their thorny vocabulary issues and the advices on making good lime all to some extent reflect what might be expected of a fortification builder in order to claim architectural intelligence. The writer wishes to demonstrate that he is well read and proficient in basic Vitruvian building knowledge. He is aware that there are certain figures whom he needs to mention, but not without presenting some evidence of his own experience. However, these personal points of reference are not developed enough to support the idea of theoretical knowledge being adapted to local or real practice. Even the summary about earthworks in fortification is presented as an account that is not completely reliable as it relates to the practice at that time.

[71] The bastion drawings included in the Portuguese codex (BNP, cod. 3675 [ff. 62-67]) have a close affinity with one of Lanteri's plans (Lanteri, *Duo libri*... cit., II-15, pp. 100-101), although they are not exactly the same, namely in the design of the flanks and cavalier.

[72] BNP, cod. 3675, f. 16: one foot length, half foot width and three fingers height; Lanteri, *Duo libri*... cit., f. 45: half foot length, but could be more or less, depending on the quality of the earth, one ordinary palm width and four fingers height; Belluzzi (Lamberini, *Il Sanmarino*… cit., pp. 260-261): "mezzo braccio per lungo et larghi un quarto et gross'un ottavo". For the moment it is not clear why there are differences between the measurement units (foot, fingers, palm, and fathom).

[73] "Mas por quamto estes edefisyos de terra quamdo se mãodão fazer he per pura nesesydade do Primsepe que ho mãdar fazer, não se podera esperar este debyto tempo que sera nesessaryo para hele ficar em sua debyta rezão" (BNP, cod. 3675, f. 23); translation: "But as these earthen buildings were ordered to be built by pure necessity of the Prince's decree, it is not possible to wait the appropriate time for the building to take form by the appropriate method".

[74] The writer, presenting the best trees to use for the buildings, such as cedar, chestnut or larch, also points to the most common use (in Portugal) of the oak from Flanders (for doors and windows) and another species of oak, used in Portugal for beams (BNP, cod. 3675, ff. 23*v*-24*v*). For military fascines he recommends chestnut tree, elm, ash, willow, poplar and mulberry.

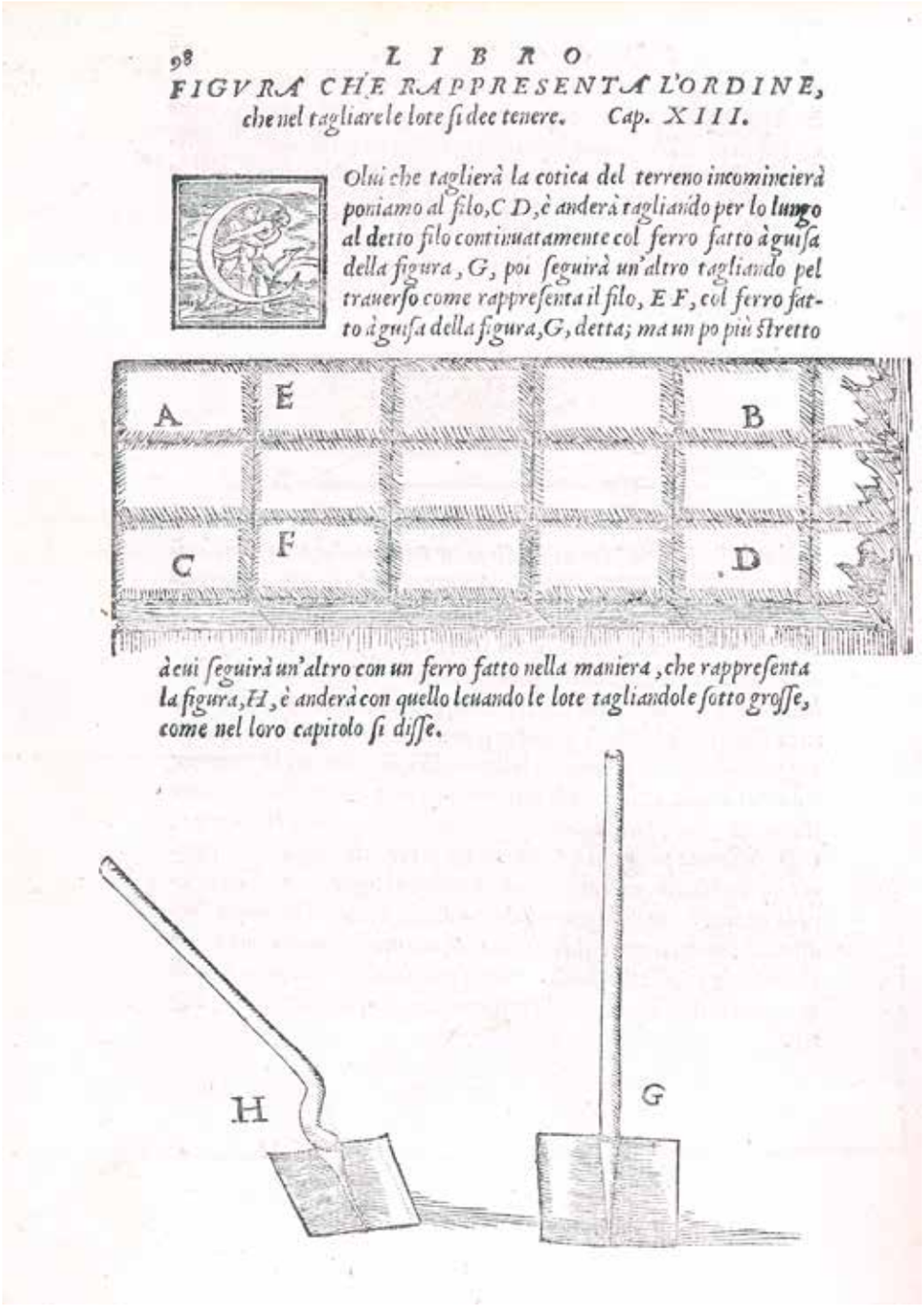
[75] "[...] comvem que declaremos tres couzas a, cõvem a saber: de que pedra a de ser ha boa cal; e quomo se conhesera quamdo he cozida; e depois de cozida quamto tempo avera myster pera se por em hobra" (BNP, cod. 3675, f. 16*v*); translation: "[...] we should state three things, as follows: which stone is needed for good lime; how do we know it when it is burnt; and after being burnt, how much time do we need [to wait before] using it in building work".

[76] Vitruvio, *I dieci libri*... cit., ed. 1556, p. 47; Cataneo, *I quattro primi libri*... cit., f. 29*v*.

[77] "[...] a pedra de que se houver de fazer boa cal não se a de tirar à soprefise da terra senão de quymze hou vimte palmos pelo semtro da terra [...] e quando a partirem paresa mais sobolo azulado que não sobre ho branco. E semdo esta fara boa cal, como se ve por ê por esperyemsy pela cal d'Evora, que por ser feita desta pedra é a mellhor do Reyno" (BNP, cod. 3675, f. 17*v*). "[...] to make good lime we cannot remove the stone from the earth's surface, but from fifteen or twenty palms into the earth [...] and when it breaks it seems more blueish than white. And being so it will make good lime, as I know from experience with the lime from Évora. As it is done with this stone, it is the best in the kingdom".

[78] BNP, cod. 3675, ff. 17*v*-18; the Vitruvian edition by Barbaro (Vitruvio, *I dieci libri*... cit., ed. 1556, II-5) doesn't give this indication and only Cataneo refers to the advice of the Ancients, which recommended leaving three years for the lime to slake (Cataneo, *L'Architettura*… cit., f. 29*v*).

[79] "Mas nós dezemos que por ser a vyda vmana breve e o apetite daquele que māda fabrycar gramde não podemos aguardar tamto tempo, e por yso dezemos que abastão hos seis mezes para se esfryar" (BNP, cod. 3675, f. 18).


98 LIBRO

FIGVRA CHE RAPPRESENTA L'ORDINE, che nel tagliare le lote si dee tenere. Cap. XIII.

Colui che taglierà la cotica del terreno incomincierà poniamo al filo, C D, è anderà tagliando per lo lungo al detto filo continuatamente col ferro fatto à guisa della figura, G, poi seguirà un'altro tagliando pel trauerso come rappresenta il filo, E F, col ferro fatto à guisa della figura, G, detta; ma un po più stretto

A E B C F D

à cui seguirà un'altro con un ferro fatto nella maniera, che rappresenta la figura, H, è anderà con quello leuando le lote tagliandole sotto grosse, come nel loro capitolo si disse.

H G

Fig. 16 *G. Lanteri, Lotte, from Duo libri... Del modo di fare le fortificationi..., Vinegia 1559, p. 98 (Biblioteca Nazionale Centrale di Firenze, Magl. 12.5.27/b; © Ministero per i beni e le attività culturali e per il turismo).*

Both these architectural notes written by a fortification builder and the letters sent from the building site at Mazagan evince a pragmatic approach. There is no trace of any discussion about the new fortress design; the debates they document relate instead to construction techniques and concern, to put it simply, the question of building either ramparts with earthen embankments or walls with stone and lime. One finds in these writings not so much the introduction of innovative architectural forms or new techniques, but rather a certain reluctance to apply new solutions without the necessary guarantees. The insistence on using reliable materials and previously tested techniques also shows that pursuing secure and immediate results was an integral part of the service to the crown.

Regardless of whether we understand this contact with new solutions as a learning process or not, it is worth observing that the contact existed and was followed by criticism when it came to achieving practical results. These architects or fortification builders were not indifferent to new expertise, but refused to apply it without discussion, even if the interlocutor was their king. They preferred to rely instead on practical experimentation and time-tested knowledge.

Yves Pauwels

LÉGITIMER LE TRAITÉ TECHNIQUE : LA RHÉTORIQUE DE PHILIBERT DE L'ORME DANS LES *NOUVELLES INVENTIONS* ET LE *PREMIER TOME*

Philibert de L'Orme's Nouvelles inventions pour bien bastir *(1561), on carpentry, and books III and IV in his* Premier tome de l'architecture *(1567), on stereotomy, are the first printed texts dealing with purely technical questions. By publishing them, de L'Orme broke with the traditional methods used in the corporations to transmit technical skills: he incorporated the old oral know-how in the field of printed humanist culture. To legitimate this approach, he needed to use rhetorical techniques in his text. A precise narration explains how he presented his project to the king, and how Henry II ordered him to write a book on this subject. So he justified the publication of the* Nouvelles inventions *by a royal order, which protected him from the craftsmen's criticisms. On the other hand, he presented an original allegory of the good architect in book III of the* Premier tome, *showing a new and prestigious aspect of the profession: the architect is no longer a mason, working in the field of the Aristotelian category of "art", but also a humanist concerned with "prudence": as such, he does not belong to the world of the corporations and may publish his works.*

Il n'est pas exagéré de voir dans les deux traités de Philibert De l'Orme, les *Nouvelles inventions pour bien bastir* (1561) (fig. 1) et le *Premier tome de l'architecture* (1567)[1] (fig. 2), les premières publications explicitement dédiées aux techniques de chantier : la première concerne la charpenterie, les livres III et IV de la seconde sont dédiés à la stéréotomie. Dès le début, De l'Orme a prévu d'intégrer dans un traité complet ces deux étapes de la construction, puisque les deux livres des *Nouvelles inventions* sont conçus pour constituer les deux dernières parties d'un ouvrage consacré à la réalisation d'un édifice en partant de ses fondations (et la taille des pierres intervient ici pour les voûtes de soutènement des fondations et des caves) pour se conclure avec sa couverture de charpente. De l'Orme est de ce fait le premier architecte à avoir délibérément conçu, écrit et publié un traité global, intégrant tous les aspects du projet, aussi bien techniques qu'esthétiques. Ce faisant, il se pose en héritier de Vitruve, d'Alberti et de Serlio, mais il prétend les dépasser puisqu'aucun de ses prédécesseurs romains ou italiens n'a su proposer une telle somme. La compétence technique propre aux bâtisseurs français liée à la capacité de la formaliser, de la « réduire en art », pour reprendre la formule chère au XVI[e] siècle[2], s'affirme ainsi comme un signe de la supériorité française et de sa prédisposition historique à reprendre le flambeau de la *translatio studiorum*.

Mais cela ne va pas de soi dans la mesure où, précisément, maîtrise des compétences constructives et maîtrise du nouveau langage esthétique – celui des ordres d'architecture, hérité de l'Italie du XVI[e] siècle et objet des livres 5 à 8 du *Premier tome* – relèvent de deux univers différents : celui de la pratique manuelle, dépendant en France du système des corporations, avec une transmission du savoir-faire strictement orale, au sein des ateliers, et celui de la pratique humaniste, qui se développe à la Renaissance grâce à la diffusion imprimée des textes et des images, dont la *trattatistica* italienne et en particulier l'entreprise de Serlio, commencée en 1537 avec les *Regole generali di architetura*, donnait le modèle et l'exemple. Fils d'un entrepreneur lyonnais, formé lui-même « sur le tas » avant d'acquérir une culture intellectuelle englobant naturellement la pratique de l'écrit et de l'imprimé, Philibert De l'Orme est à la jonction des deux univers, et se trouve particulièrement bien placé pour les réunir[3].

Il était nécessaire cependant de légitimer cette annexion du savoir-faire oral par la culture humaniste imprimée. Si l'on a souvent étudié le contenu de ces textes techniques[4], l'histoire de leur élaboration[5] et leur impact sur la pratique réelle[6], on ne s'est jamais vraiment intéressé à ce problème de légitimation de la « réduction en art » des savoir-faire. Il est certain que les corporations ne devaient pas voir d'un bon œil les « secrets » de fabrication exposés dans des livres devenir en théorie accessibles à n'importe quel public. On se souvient par exemple qu'à la fin du XVII[e] siècle encore, François Couperin, tout musicien du Roi qu'il était, connut quelques problèmes avec la ménestrandise, corporation très structurée des musiciens qui n'entendait pas que la pratique de la musique à la cour lui échappât totalement[7]. Inversement, il n'est pas évident d'intégrer un discours sur des pratiques « mécaniques » dans un contexte humaniste, *a priori* abstrait ou orienté vers des considérations plus élevées, fondées sur la géométrie comme la théorie des proportions ou la culture antique, comme l'exposé sur les ordres et le décor.

De sorte que De l'Orme – ou son éditeur – se trouve contraint à un certain nombre d'exercices rhétoriques visant à fondre arts mécaniques et arts libéraux en une production cohérente. D'abord, il s'agit d'anoblir l'art de la charpenterie et de lui conférer une légitimité qui égale celle de l'antique. C'est la mission confiée à Antoine Mizault, médecin célèbre en son temps, savant humaniste et éminent latiniste[8], qui rédige un poème introductif en distiques élégiaques, *In novam architectandi artem*, qui, compte tenu même de l'emphase laudative propre à ce genre d'exercice, apporte des éléments importants sur le statut qu'il convient de donner à la technique exposée dans le livre :

Opus Incertum (2020) pp. 68-75 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12361 www.fupress.com/oi

NOVVELLES

INVENTIONS POVR BIEN BASTIR ET A PETITS FRAIZ, TROVVEES n'agueres par Philibert de L'orme Lyonnois, Architecte, Conſeiller & Aulmonier ordinaire du feu Roy Henry, & Abbé de S. Eloy lez Noyon.

A PARIS,

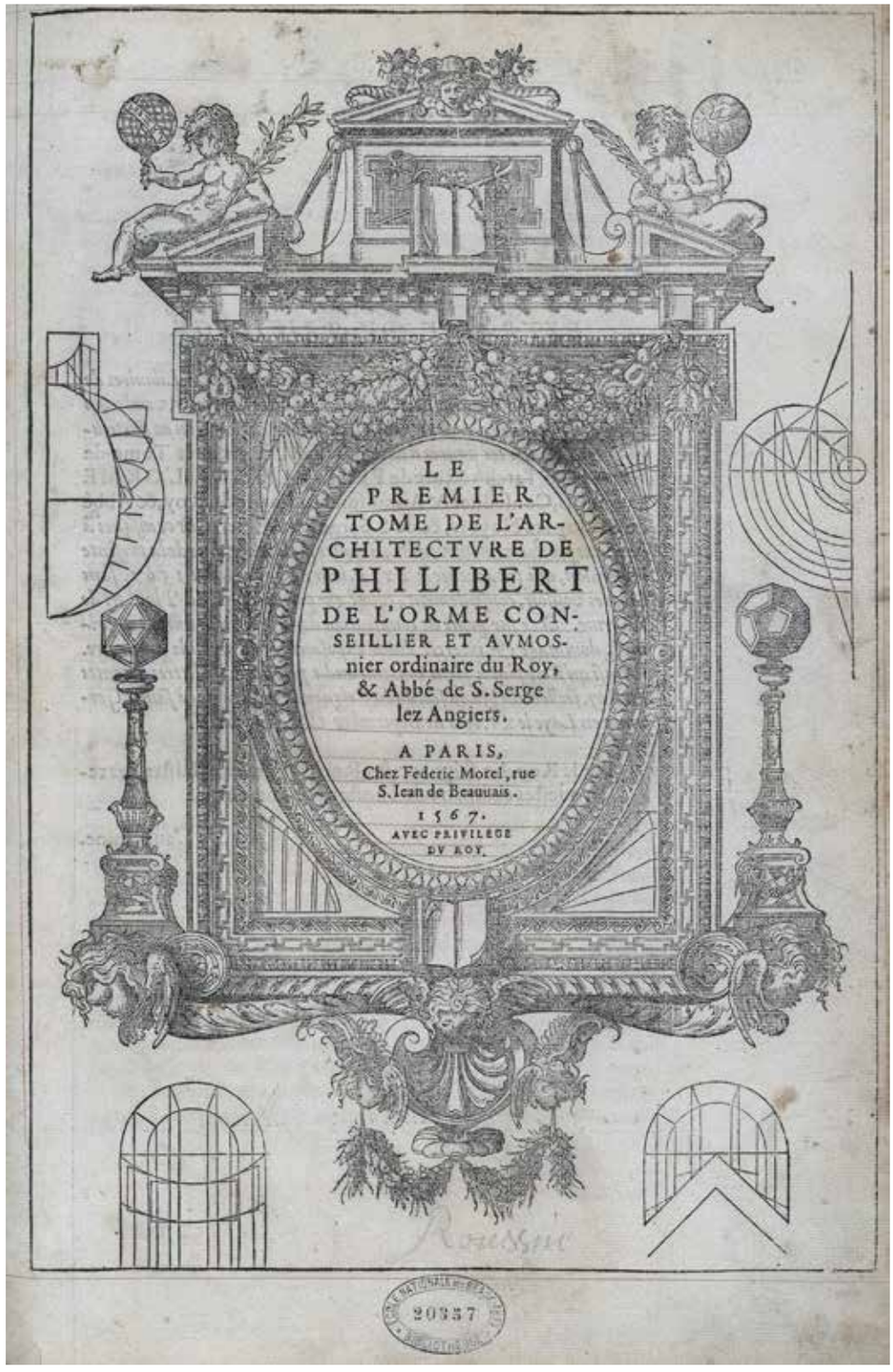
De l'Imprimerie de Federic Morel, rue S. Iean de Beauuais au franc Meurier.

M. D. LXI.

Auec priuilege du Roy.

pagina 69
Fig. 1 *Ph. De l'Orme, Page de titre des Nouvelles inventions pour bien bastir (© Architectura CESR).*

Fig. 2 *Ph. De l'Orme, Page de titre du Premier tome de l'architecture (© Architectura CESR).*



Suspicio et miror quod tectis sphærica forma
Aptetur, nullis cognita temporibus
[…]
Miror et admiror quam dat PHILIBERTUS AB ULMO
Structuram, antiquos sic latuisse viros.
Fœlix hoc partu nimium es, nimiumque superba
Gallia, nam nomen tollit ad astra tuum.
[…]
Hæc si Vitruvius scivisset nobilis ille,
Et quater excellens, an tacuisse putas ?

La leçon est claire : De l'Orme proposant des solutions ignorées des Anciens et de Vitruve en particulier, les surpasse, et ce faisant participe à l'exaltation de la France, portée aux nues comme héritière de la suprématie artistique dans le processus de *translatio studiorum* capital dans le conflit culturel qui agite les grandes puissances de la Renaissance… Voilà de quoi justifier l'intégration de la charpente dans un projet qui n'a plus grand chose à voir, ainsi présen-

[1] Ces traités, Ph. De l'Orme, *Nouvelles inventions pour bien bastir…*, Paris 1561 ; Ph. De l'Orme, *Le premier tome de l'architecture…*, Paris 1567, ainsi que tous les autres mentionnés dans cet essai, sont consultables en ligne sur le site « Architectura. Architecture, textes et images » du CESR (http://architectura.cesr.univ-tours.fr/index.asp; consulté 5 mai 2020).
[2] Voir sur ce sujet *Réduire en Art. La technologie de la Renaissance aux Lumières*, éd. P. Dubourg-Glatigny, H. Vérin, Paris 2008.
[3] Sur les compétences rhétoriques de Philibert, voir M. Hochon, *Philibert De l'Orme en architecte rhétoricien*, in *Philibert De l'Orme, un architecte dans l'histoire. Arts, sciences, techniques*, éd. F. Lemerle, Y. Pauwels, Turnhout 2016, p. 11-24.
[4] Par exemple P. Potié, *Philibert De L'Orme. Figures de la pensée constructive*, Marseille 1996 ; J. Sakarovitch, *Épures d'architecture, de la coupe des pierres à la géométrie descriptive, XVIe-XIXe siècles*, Bâle-Boston-Berlin 1998 ; S. Galletti, *From Stone to Paper : Philibert de L'Orme, the* Premier tome de l'architecture *(1567), and the Birth of Stereotomic Theory*, in *Building Techniques in Architectural Treatises: Construction Practices versus Technical Writings*, éd. C. Cardamone, P. Martens, "Aedificare. Revue internationale d'histoire de la construction", 2017, 2, p. 143-162.
[5] Récemment S. Galletti, *Philibert de L'Orme's Divine Proportions and the Composition of the* Premier tome de l'architecture, "Architectural Histories", 2, 1, 2014, 12, pp. 1-11.
[6] Voir entre autres V. Nègre, *La contribution des artisans au rétablissement de la charpente de Philibert De l'Orme au XVIIIe siècle*, et J. Calvo López, *Philibert de L'Orme and Spanish Stereotomy*, in *Philibert De l'Orme, un architecte dans l'histoire…* cit., p. 231-242, 199-214.
[7] W. Mellers, *François Couperin and the French Classical Tradition*, New York 2007 ; Couperin écrivit à cette occasion la pièce caricaturale intitulée *Les fastes de la grande et ancienne Mxnxstrxndxsx* (11ème ordre du second livre). La ménestrandise, qui avait atteint son apogée au XVIe siècle, tentait alors de mettre au pas organistes et clavecinistes de haut rang en interdisant à quiconque d'enseigner le clavecin, qui ne soit auparavant reçu « maître » par elle.
[8] Notons que Mizault publie en 1560 – l'année précédant la publication des *Nouvelles inventions* – son *De hortensium arborum insitione opusculum* chez le même éditeur Fédéric Morel, qui éditera dans les années 1570 plusieurs autres de ses ouvrages.

té, avec la nature manuelle et matérielle des arts mécaniques.

Il reste néanmoins à justifier l'entreprise humaniste de « réduction en art » vis-à-vis des artisans et des corporations. Et pour ce faire, De l'Orme n'en appelle pas à la poésie fleurie d'un ami latiniste, mais à ses propres talents de narrateur – la *narratio* étant comme chacun sait un autre moment privilégié du discours apologétique. L'adresse au lecteur des *Nouvelles inventions* contient ainsi le récit circonstancié de la genèse d'une œuvre que Philibert place délibérément sous l'aile protectrice de Henri II – la dédicace au jeune Charles IX ayant rappelé que le feu roi, « aimant le profit de son peuple et décoration de son royaume », lui avait commandé « de faire un livre, afin que chacun pût entendre les façons et moyens d'y procéder… ». Ainsi, raconte l'auteur, il lui arriva, alors qu'il assistait au repas du roi, de présenter devant la cour sa « nouvelle invention » de charpente à petit bois :

> Sur quoi il advint un jour d'en toucher quelque mot à la Majesté du feu roi Henri étant à table. Mais quoi ? Les auditeurs et assistants, pour n'avoir ouï parler de si nouvelles choses et si grande invention, tout à un coup me reculèrent de mon dire, comme si j'eusse voulu faire entendre à ce bon roi quelques menteries, lesquelles j'ai toujours eu en grandissime horreur et détestation, estimant que tout ainsi que le corps vaut peu sans l'âme, aussi fait la bouche sans vérité. Voyant donc faire un jugement si soudain de ce qui n'était encore entendu, et que la Majesté du roi pour lors ne disait mot, je délibérai ne plus rien mettre en avant de tels propos, commandant de procéder aux bâtiments comme l'on avait accoutumé[9].

Loin d'être déconcerté par le silence royal, De l'Orme fait mettre en œuvre sa charpente au château de la Muette à Saint-Germain (fig. 3) :

> Donc j'en fis l'épreuve au château de la Muette, ainsi que plusieurs ont vu, et en autres divers lieux selon la façon que j'écris en ce présent livre. Laquelle épreuve se trouva si belle, et de si grande utilité, que lors chacun délibéra en faire son profit et s'en aider ; voire ceux qui l'avaient contredite, moquée et débattue. Laquelle chose étant venue jusque aux oreilles de la Majesté dudit feu roi, qui avait vu et grandement loué ladite épreuve, il me commanda en faire un livre pour être imprimé, afin que la façon fût intelligible à tous, pour la décoration de son royaume. Auquel commandement je n'ai voulu faillir, aimant plutôt m'exposer au jugement des hommes, que désobéir à la Majesté d'un si grand prince et seigneur[10].

La narration, assez longue, aboutit à la confirmation de l'ordre royal : Philibert préfère risquer les critiques – il sait qu'elles ne manqueront pas – que de désobéir à ce qu'il présente comme un ordre. Dans cette fiction rhétorique, l'initiative ne vient pas de lui : il a fait son métier de constructeur, mais le passage à l'imprimerie est présenté comme une initiative de Henri II, prise non pas pour la gloire personnelle de l'architecte, mais pour le plus grand bien de son royaume. Cette présentation des faits est aussi une démarche de protection presque juridique : le statut royal de ce qui est présenté comme une commande du monarque met l'auteur à l'abri d'éventuels procès de la part de corporations qui pourraient s'estimer lésées par la publication. Et la protection royale est appelée à s'étendre à tout le traité à venir. Car les pages sur la charpenterie ne sont qu'un début. Seules, dit De l'Orme, elles n'auraient été que le bras d'une statue « d'or ou d'argent », un fragment d'« une chose imparfaite de tout le corps, lequel n'est beau sans l'harmonie entière de tous ses membres et parties »[11], entendons le traité encore à venir. Cette statue parfaite verra le jour six ans plus tard, avec le *Premier tome* de 1576.

C'est une stratégie différente qui est alors mise à l'œuvre pour légitimer l'irruption au sein d'un traité d'architecture d'une théorie de la stéréotomie (fig. 4). Là encore, c'est une première :

[9] De l'Orme, *Nouvelles Inventions*… cit., « Au lecteur… », f. 4*v*.
[10] *Ibidem*.
[11] De l'Orme, *Nouvelles inventions*… cit., f. 4*v*.

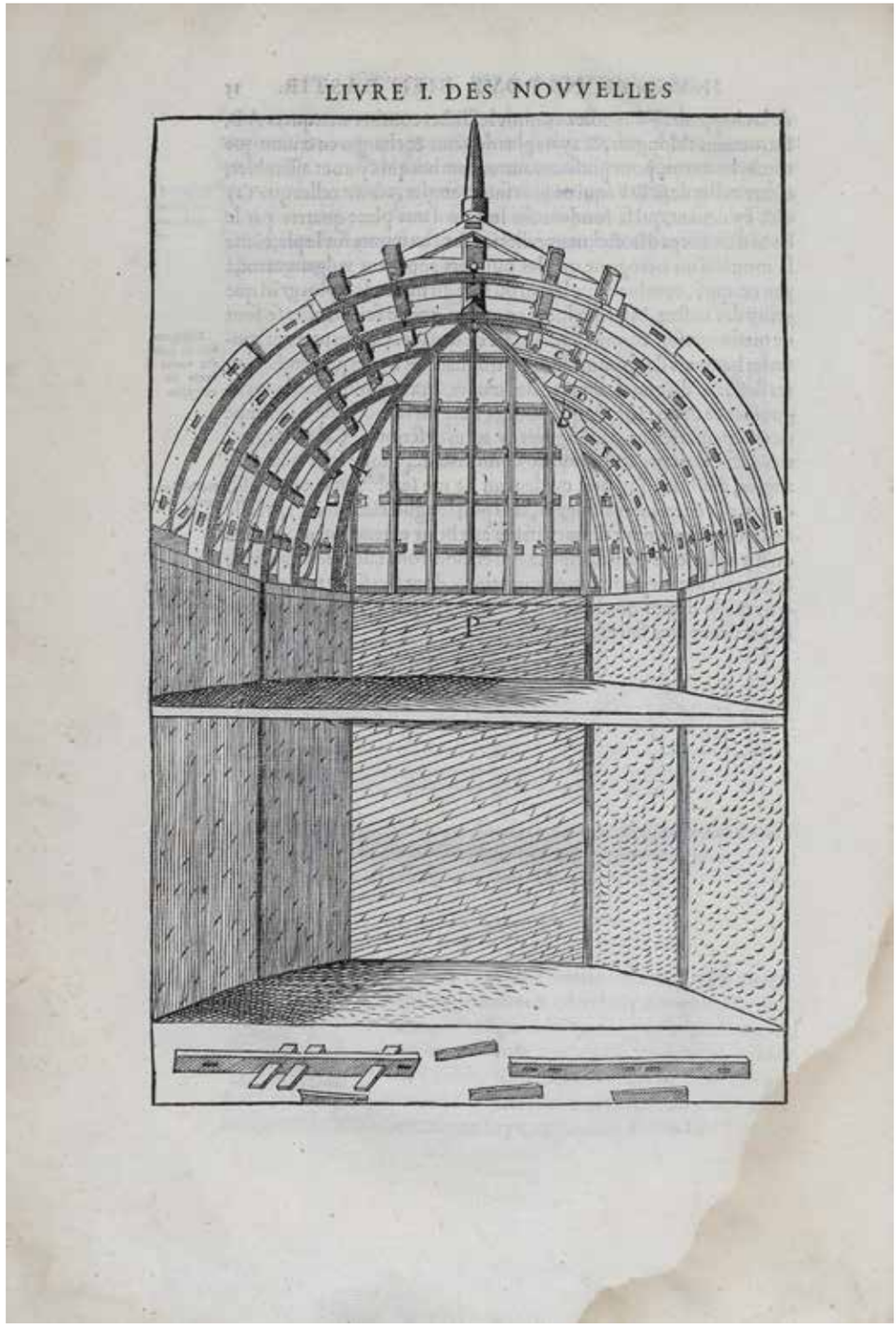


Fig. 3 *Ph. De l'Orme, Charpente pour La Muette (in* De l'Orme, *Nouvelles inventions pour bien bastir... cit., f. 15v ; © Architectura CESR).*

aucun architecte italien n'a songé à inclure de telles pages dans un écrit – comment l'auraient-ils fait du reste, puisqu'ils ne pratiquent pas l'« art du trait » où excellent les Français (et aussi les Espagnols, mais De l'Orme n'en dit mot, évidemment) ? Il s'agit donc de donner ses lettres de noblesse à une pratique dont l'apprentissage relevait alors uniquement des traditions du compagnonnage. Pour ce faire, Philibert ne met pas en avant la personne du roi, mais celle du nouvel architecte qu'il ambitionne d'être. Le « Prologue en forme d'avertissement » qui inaugure le livre III, consacré à « la déclaration et description de certains traits et lignes que nous appelons géométriques, fort nécessaires aux architectes, maîtres maçons, appareilleurs de pierres, tailleurs et autres »[12] est en fait une digression très humaniste destinée à définir les traits de l'« architecte prudent », représenté *in vivo* dans une vignette au folio 51*v*, habillé non pas en ouvrier mais en « homme docte et sage » sortant des ténèbres d'une caverne pour se diriger, en dépit des obstacles et des embûches, vers la palme de la gloire (fig. 5). Malgré les apparences, cette

[12] De l'Orme, *Premier tome*… cit., f. 50.

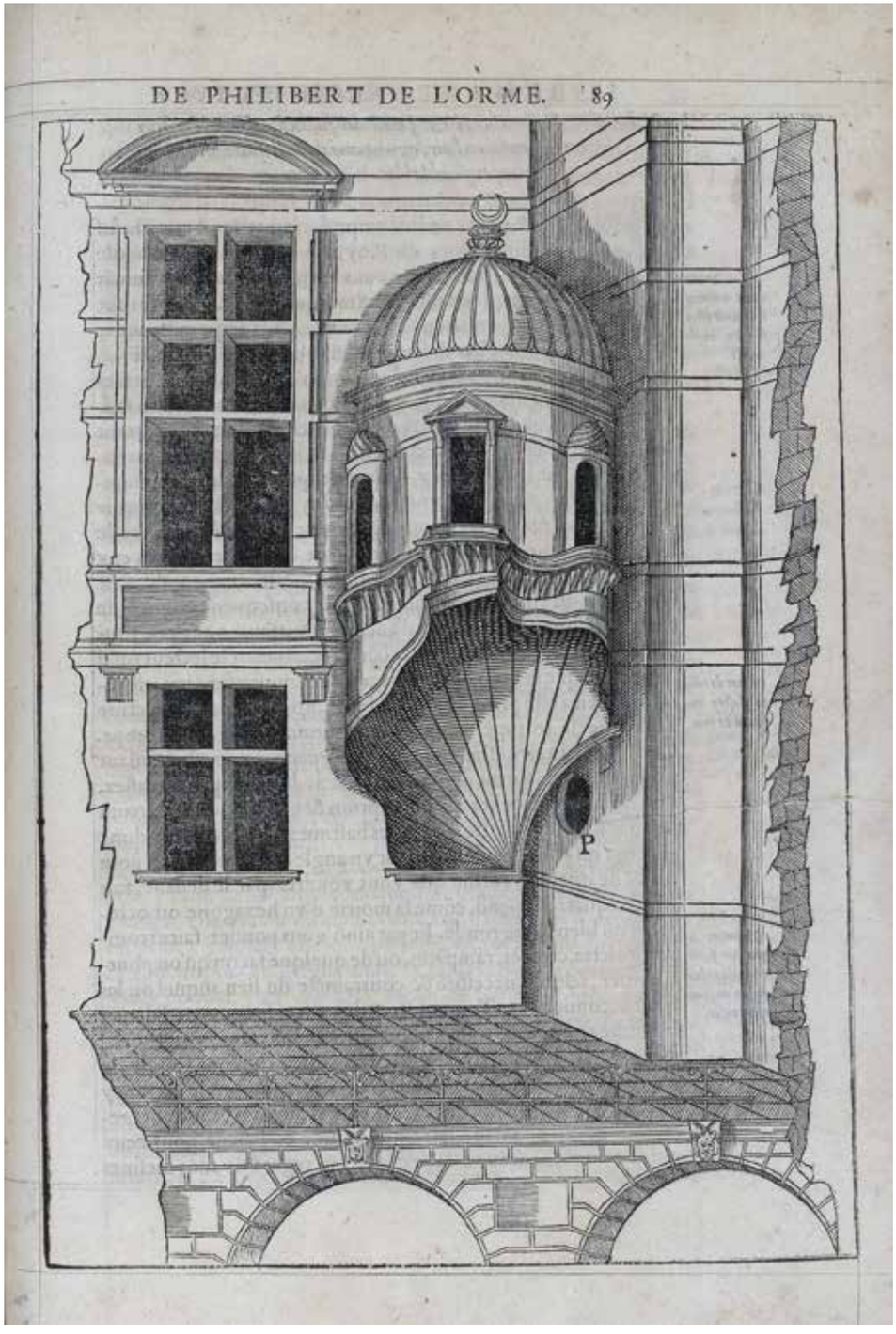
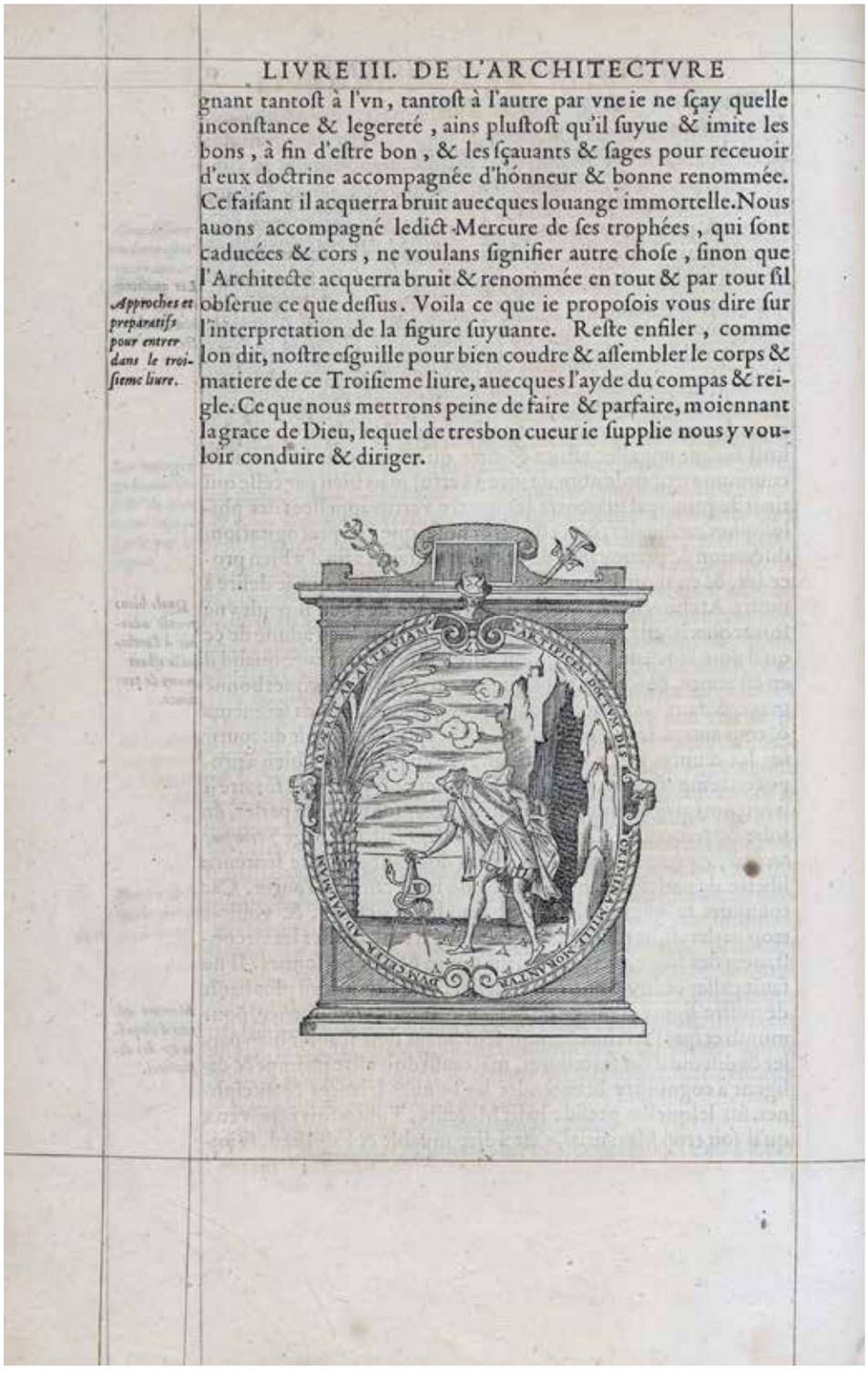


Fig. 4 *Ph. De l'Orme, Trompe du cabinet du Roi à Anet (in* De l'Orme, *Le premier tome de l'architecture… cit. ; f. 89 ; © Architectura CESR).*

caverne n'est nullement le lieu platonicien de l'illusion des sens : c'est au contraire lieu « de contemplation, solitude, et lieu d'étude ». Avant de sortir affronter la réalité, l'architecte a médité dans l'intimité de ce qui apparaît ainsi une préfiguration du « poêle » de Descartes. Et cette méditation préliminaire est axée sur une notion éminemment aristotélicienne sur la « prudence ». L'image est en effet glosée par un long discours sur la vertu de prudence, qui fait appel à une culture très étendue, à mille lieux de celle qu'on attendrait d'un tailleur de pierre : De l'Orme cite les Écritures, l'Évangile d'abord (*Estote prudentes sicut serpentes, et simplices sicut columbæ*, Matthieu 10, 16), mais aussi l'*Ecclésiaste*, 3 (*omnia tempus habent*), les *Psaumes* de David (*Super inimicos meos prudentem me fecisse*, Vulg. Ps. 118, 98) sans oublier saint Ambroise et saint Bernard de Clairvaux. Sa science n'est du reste pas forcément de première main, car la référence à l'Évangile participe en réalité d'une citation du « livre des mots dorés » de « Gavarre », en d'autres termes des *Epistres dorees et discours salutaires de don Antoine de Guevare*, traduction


LIVRE III. DE L'ARCHITECTVRE

gnant tantoſt à l'vn, tantoſt à l'autre par vne ie ne ſçay quelle inconſtance & legereté, ains pluſtoſt qu'il ſuyue & imite les bons, à fin d'eſtre bon, & les ſçauants & ſages pour receuoir d'eux doctrine accompagnée d'hónneur & bonne renommée. Ce faiſant il acquerra bruit auecques louange immortelle. Nous auons accompagné ledict Mercure de ſes trophées, qui ſont caducées & cors, ne voulans ſignifier autre choſe, ſinon que l'Architecte acquerra bruit & renommée en tout & par tout ſil obſerue ce que deſſus. Voila ce que ie propoſois vous dire ſur l'interpretation de la figure ſuyuante. Reſte enfiler, comme lon dit, noſtre eſguille pour bien coudre & aſſembler le corps & matiere de ce Troiſieme liure, auecques l'ayde du compas & reigle. Ce que nous mettrons peine de faire & parfaire, moiennant la grace de Dieu, lequel de tresbon cueur ie ſupplie nous y vouloir conduire & diriger.

Approches et preparatifs pour entrer dans le troiſieme liure.

Fig. 5 *Ph. De l'Orme, « l'architecte prudent » (in* De l'Orme, *Le premier tome de l'architecture… cit. ; f. 51v ; © Architectura CESR).*

des *Epistolas Familiares* de l'humaniste espagnol Antonio de Guevara, qui connut en France un succès certain dont témoignent plusieurs éditions à partir de 1558[13]. Il s'agit en l'occurrence d'un « Discours faict à l'empereur Charles V. en un Sermon de Quaresme : auquel est traité le pardon que Iesus Christ demanda à son Pere pour ses ennemis ». Cette référence apporte non seulement des arguments à la démonstration quasi philosophique de Philibert, mais elle place aussi le débat au plus haut niveau : celui des princes, où Charles Quint vient subrepticement épauler Henri II dans la démarche de légitimation du traité.

Pour mieux comprendre le sens de cette intrusion de la philosophie morale dans l'architecture, il faut revenir au concept de « prudence ». Chez Aristote comme chez saint Thomas, la

[13] *Les Epistres dorees et discours salutaires de don Antoine de Guevare, Evesque de Mondonedo, Prescheur & Croniqueur de l'Empereur Charles cinquiesme, Traduict d'Espagnol en François par le seigneur de Guterry, Docteur en Medecine*, Lyon 1558-1560. De l'Orme emprunte sa citation au tome second, p. 1.

prudence est liée à une autre vertu morale que l'un et l'autre nomment « art ». Prudence et art sont les deux « dispositions » de l'âme (*ethos* ou *habitus*) qui concernent la pratique ; mais à la différence de l'art, tourné vers la création, la prudence est tournée vers l'action ; en termes thomistes, l'art est *recta ratio factibilium* et la prudence *recta ratio agibilium*[14]. L'un concerne l'artisan et l'artiste (ce qui aux yeux d'un philosophe antique revient un peu au même), l'autre est propre au citoyen impliqué dans la vie de la cité, à l'homme politique au sens aristotélicien du terme ; à la Renaissance, essentiellement à l'homme de pouvoir, prince ou oligarque – celui auquel pense Machiavel. Aussi la démarche de De l'Orme consiste-t-elle à faire assimiler son statut d'architecte non plus seulement à la catégorie des « artistes », mais aussi à celle des hommes de pouvoir. Contrairement au maçon, il ne peut plus être uniquement un homme « de l'art » : il est aussi homme « de prudence », et son compas est irrémédiablement « entortillé d'un serpent ». La « sublime et héroïque vertu » est commune aux saints, aux monarques et enfin aux architectes qui utilisent le compas pour traiter de stéréotomie : à eux la palme qui représente « une constance et ferme propos de soutenir peine et travail en toutes ses charges et affaires, à fin de parvenir à gloire, honneur, et victoire ».

Il n'est donc pas surprenant que l'allégorie de l'architecte se place dans un cadre au sommet duquel apparaît Mercure, dieu « auteur d'éloquence »[15], qui préside aussi à la page du titre du *Premier tome* : la rhétorique sous toutes ses formes vient au secours de l'architecte pour justifier la nouveauté de son œuvre imprimée[16]. Reste à maîtriser la parole écrite dans un domaine où la main est souvent plus experte que la plume, et l'expérience plus claire que le discours. De l'Orme revient à plusieurs reprises sur la difficulté à écrire ce qui d'ordinaire se montre sur le terrain :

> Les façons ne se peuvent bien montrer, ni être bien entendues par écriture, si on ne les voit par effet et pratique. Toutefois il n'y a rien impossible à tout gentil et laborieux esprit. Ceux qui craindront y perdre trop de temps, et seront curieux de tout mieux entendre, ils en demanderont conseil et avis à ceux qu'ils connaîtront être bons maîtres[17].

De fait, l'écriture de Philibert ne parvient pas forcément à son but. Lorsqu'en 1642 Mathurin Jousse publie son *Secret d'architecture*, il commence par rappeler qu'aucun des grands traités d'architecture dont il fait la liste n'a parlé de l'art du trait, à l'exception de celui du *Premier tome*. Mais, ajoute-t-il, ses démonstrations, quoique n'étant pas fausses, sont « enveloppées sous tant de lignes et de paroles, que quoiqu'elles fussent bonnes pour les doctes, elles ne peuvent se comprendre aisément par beaucoup de ceux qui font profession de tailler et couper la pierre »[18]. Théorie *versus* pratique ? Dans le domaine de la taille des pierres, en particulier, le débat s'ouvre entre les artisans praticiens et les mathématiciens théoriciens. Il appartiendra au XVII[e] siècle de trancher ce débat[19].

[14] *Éthique à Nicomaque*, VI, III ; *Somme théologique*, 2a-2e, qu. 47, art. 5. Je reprends ici les analyses de F. Goyet, *La Prudence : entre sublime et raison d'État*, in *Devenir Roi. Essais sur la littérature adressée au Prince*, éd. I. Cogitore, Fr. Goyet, Grenoble 2001, p. 163-178.
[15] De l'Orme, *Premier tome*… cit., f. 51.
[16] Sur la prudence de l'architecte delormien, voir Y. Pauwels, *L'architecture au temps de la Pléiade*, Paris 2002, p. 109-117.
[17] De l'Orme, *Premier tome*… cit., f. 79. Voir aussi les folios 87*v*, 99, 112*v*, 124.
[18] M. Jousse, *Le secret d'architecture* …, La Flèche 1642, p. 2.
[19] Voir la contribution de Frédérique Lemerle dans le présent volume.

Sara Galletti

ÉPURES D'ARCHITECTURE: GEOMETRIC CONSTRUCTIONS FOR VAULT BUILDING IN PHILIBERT DE L'ORME'S *PREMIER TOME DE L'ARCHITECTURE* (1567)

This paper focuses on the representation of épures *—the 1:1-scale geometric drawings necessary for the production of stereotomic works— in Philibert de L'Orme's* Premier tome de l'architecture *(Paris 1567).* Épures *are technical drawings that medieval and early modern practitioners developed in order to solve the geometric challenges posed by stereotomy.* Épures *are traced on site and have functions similar to those of modern blueprints: they are produced by the* appareilleur *(setter) to communicate the geometry of the vault and its components (the voussoirs) to all the craftsmen involved in its making —those who prepare the templates, the carpenters who produce the centering, and the stonecutters who shape the voussoirs— and they are referred to throughout the execution process. Reading* épures *is a complex task for non-practitioners, and one that architectural historians have largely shunned, thus leaving a core aspect of de L'Orme's theory of architecture unexplored. In this paper, I use the case study of the entrance to a* descente de cave *(inclined barrel vault), the simplest of stereotomic works illustrated by de L'Orme, to demonstrate how* épures *are produced and read.*

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 (the 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, from the broader family of stone vaults, such as those covering the nave of the Church of Saint Séverin in Paris (figs. 2-3). In Granada, the large voussoirs (compared to the overall dimensions of the vault) 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' bays (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 shape and stability of the Granada vault result from the accurate carving of its voussoirs, while those of the Saint Séverin vaults result from the wedge-like shaping of its mortar fillings[1].

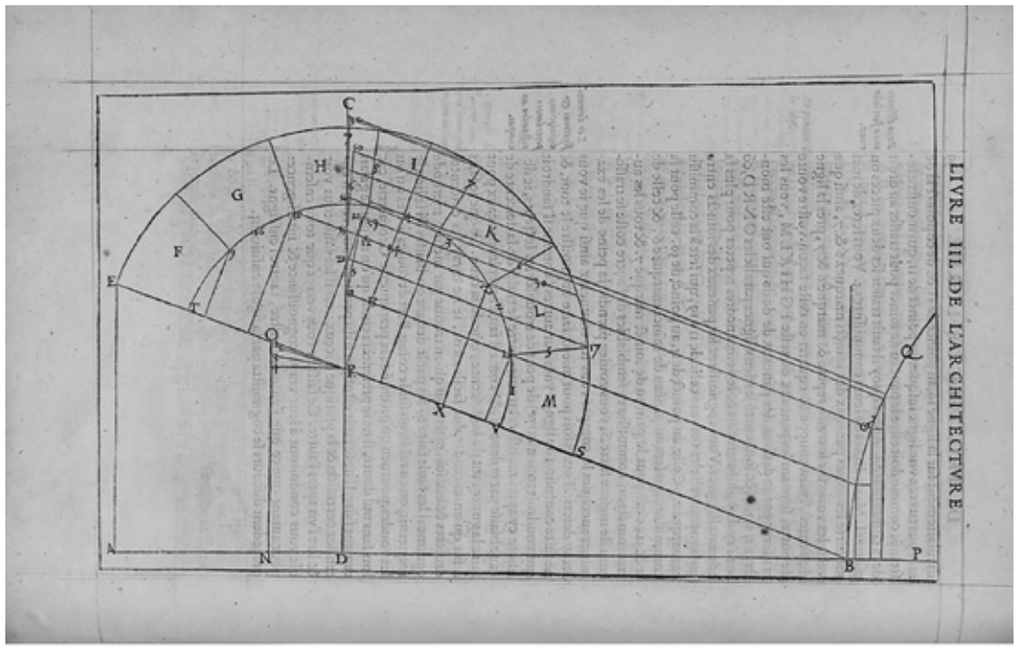
Geometric complexity further distinguishes stereotomic vaults from the category of *voûtes clavées*, vaults built with dressed stones. Such a distinction is evident, for instance, when comparing the stereotomic dome covering the caldarium of the West Bath in Jerash with the barrel *voûte clavée* of the Temple of Diana in Nîmes (figs. 4-5). In Nîmes, the plan and elevation of the vault provided the stonecutters with all the information necessary to shape its voussoirs because a barrel vault is, from the standpoint of geometry, the horizontal extrusion of a linear element, the arch. Stereotomic vaults, instead, are characterised by geometries complex enough that their defining orthographic views – plans, elevations, and cross-sections – do not fully describe the shape of their components. The Jerash dome features voussoirs whose faces lie neither on the vertical or the horizontal plane and, therefore, appear skewed in both plan and cross section. Thus, its production requires a further step in order to define the real shapes and sizes of the voussoirs, either through geometry and drawing – as in late medieval and early modern practice – or through empirical cutting techniques, as it was most likely the case at Jerash.

Stereotomy is an ancient art that has been practiced over a wide chronological span, from Hellenistic Greece to present-day Apulia, and across a broad geographical area, centered in the Mediterranean Basin but reaching far beyond – from Cairo to Gloucester, from Yerevan to Braga, and to colonial Latin America[2]. The art is best known for the variety of acrobatic masterpieces produced in early modern France and Spain, such as the composite vaults supporting the floating staircases of the Rohan Palace in Bordeaux and the Lonja de Mar in Barcelona (figs. 6-7)[3]. It is also known for a substantial body of theory that started with the books of architects such as Philibert de L'Orme (1514-1570) and Alonso de Vandelvira (1544-ca. 1625) and engaged practitioners and mathematicians alike in a heated debate that continued through the eighteenth century[4]. By focusing on the geometry of solids, this body of theory also crucially contributed to the definition of Gaspard Monge's 1798 theory of descriptive geometry, the branch of mathematics concerned with the two-dimensional representation of three-dimensional objects[5]. As historian of mathematics Joël Sakarovitch has shown, the modern theory of solid geometry derives from the practice of stereotomy and owes a substantial debt to the experiments in complex vaulting conducted by generations of architects, *appareilleurs* (setters), and stonecutters[6].

The execution of a stereotomic vault poses a fundamental geometric challenge which consists in the fact that a vault's defining orthographic views – the plans, elevations, and cross-sections that are the traditional instruments of architectural representation – do not provide all the information necessary to define the shapes of its voussoirs. To illustrate this problem, let us examine the case of the entrance to a *descente de cave*, the simplest of stereotomic works illustrated by de L'Orme[7].

A *descente de cave* (literally, a descent to a basement) is an inclined barrel vault that covers a flight of stairs or a ramp which provides access to a vaulted space, typically a basement. This work

Opus Incertum (2020) pp. 76-89 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12362 www.fupress.com/oi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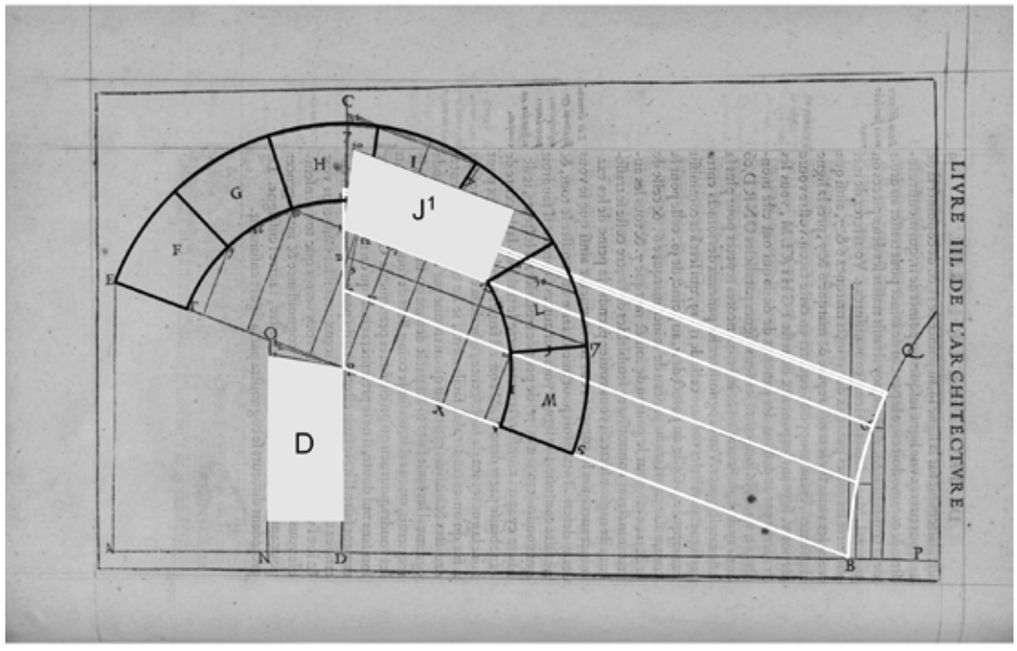
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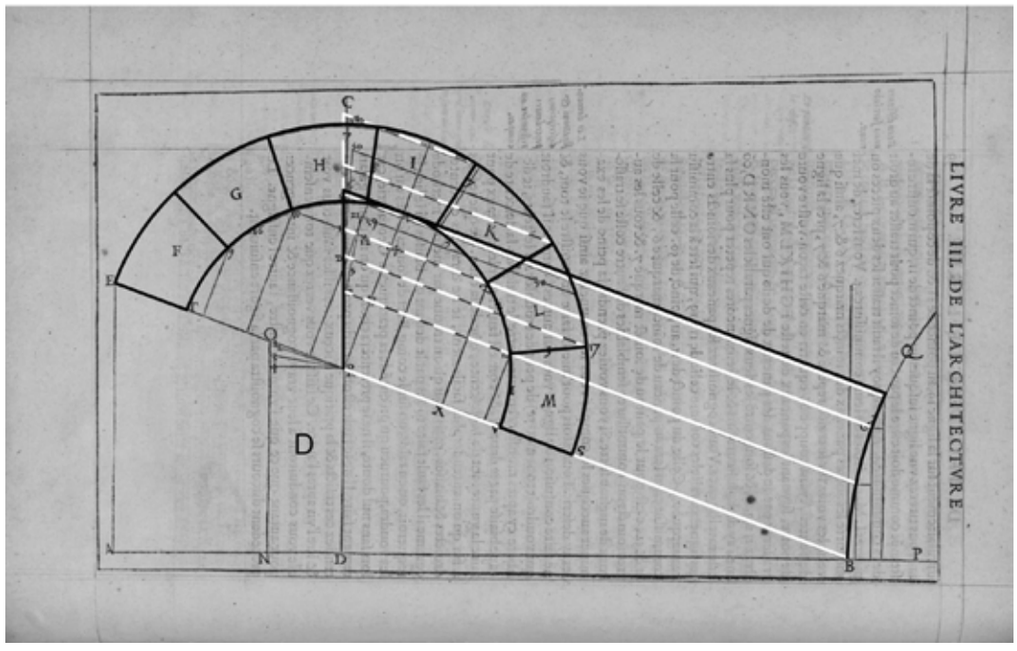
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* The title of this article is a homage to the work of Joël Sakarovitch (1949-2014), architect and historian of science, whose *Épures d'architecture: de la coupe des pierres à la géométrie descriptive, XVI^e-XIX^e siècles* (Basel 1998) is the most important modern contribution to the understanding of stereotomy and its history.

[1] Stereotomy is an ill-defined term which has been employed to signify a range of stonecutting practices many of which require no stereotomic expertise. I have attempted at establishing an operative definition of the term in S. Galletti, *Stereotomy and the Mediterranean: Notes Toward an Architectural History*, "Mediterranea: International Journal on the Transfer of Knowledge", II, 2017, pp. 73-120, https://doi.org/10.21071/mijtk.v0i2.6716, last accessed on 22 May 2019. In the interest of consistency, I repeat here that definition and use the same examples from Granada and Paris to highlight the difference between stereotomic and non-stereotomic works.

[2] Galletti, *Stereotomy and the Mediterranean*… cit.

[3] The most comprehensive works on the history of late medieval and early-modern stereotomy in France and Spain are J.M. Pérouse de Montclos, *L'architecture à la française: du milieu du XV^e à la fin du XVIII^e siècle*, Paris 1982 and J.C. Palacios, *Trazas y cortes de cantería en el Renacimiento español*, Madrid 1990. While there is no comprehensive work for the history of the practice in Italy, the works of Marco Rosario Nobile provide a rich panorama of case studies focused on Sicily, southern Italy, and the Mediterranean.

[4] Ph. De L'Orme, *Le Premier tome de l'architecture*… , Paris 1567; A. de Vandelvira, *Libro de traças de cortes de piedras compuesto par Alonso Van de Elvira, arquitecto Maestro de Cantería compônese de todo género de cartes, diferencias de capillas, escaleras, caracoles, templos y otras dificultades muy curiosas* [ca. 1585], ms R10, Biblioteca de la Escuela Técnica Superior de Arquitectura de Madrid, in *El tratado de ar-*

comprises two separate stereotomic problems: a solid-plane intersection on the upper end – where the semi-cylindrical inclined barrel vault meets the entrance vertical wall – and an interpenetration of solids on the lower end, where the barrel vault that covers the staircase/ramp meets a second vault covering the basement[8]. Here, the discussion will be limited to the entrance, upper end, of this vault (fig. 8). The geometric challenge in the execution of this work lies in the fact that the vertical plane of the entrance wall cuts the inclined semi-cylinder of the barrel vault at an angle, thus producing a semi-elliptical arch on the entrance front that is not defined by the vault's longitudinal and transversal cross-sections – the orthographic views that define the shape and size of this work (fig. 9, in which the transversal cross-section of the vault is highlighted in grey; the frontal voussoirs of the finished work are outlined with dashed lines; and F labels the frontal face of the voussoirs on the transversal cross-section). In fact, of the six faces that compose each of the front voussoirs of this work, only one is defined in its true shape and size by these drawings: the face *F* shown on the transversal cross-section. The remaining faces of these voussoirs – the frontal faces lying on the entrance wall, the intrados and extrados faces, and the lateral faces which will constitute joints once the vault mounted – are all inclined with respect to the planes of the vault's longitudinal and transversal cross-sections and, therefore, their true shapes and sizes are not provided by these orthographic views.

Stereotomic vaults like the entrance to a *descente de cave* can be executed with three different cutting methods which require varying degrees of geometric knowledge[9]. The first method, called *ravalement* (reduction), allows the stonecutter to circumvent altogether the geometric problem posed by this vault by cutting the voussoirs' faces after mounting them. When applying this

pagina 77

Fig. 1 *Philibert de L'Orme's épure of the entrance to a descente de cave (in* De L'Orme, *Premier tome… cit., f. 59v; drawing S. Galletti).*

Fig. 2 *Pedro and Luis Machuca, Palace of Charles V, Granada, 1562-1569. Annular stereotomic vault covering the portico (photo S. Galletti).*

Fig. 3 *Church of Saint Séverin, Paris, second half of the fifteenth century. Non-stereotomic vaults covering the nave of the church (photo Romanceor, Wikimedia Commons, CC BY-SA 3.0).*

Fig. 4 *West Bath, Jerash, second century CE. Stereotomic dome covering the caldarium (photo Erics, Wikimedia Commons, CC BY-SA 4.0).*

Fig. 5 *Temple of Diana, Nîmes, first century CE (photo Ji-Elle, Wikimedia Commons).*

method, the stonecutter shapes the front voussoirs of this work exactly as those of a regular barrel vault, then mounts them, and finally cuts off the excess material by following the vertical surface of the actual entrance wall (fig. 10, in the left column of which the voussoirs are shaped and mounted like those of regular barrel vault, whereas in the right column they are cut in situ following the vertical surface of the entrance wall). The procedure – which has been employed to build stereotomic vaults across the pre-modern world – requires no geometric constructions but implies a substantial loss of material. The loss of material also implies higher transportation costs – one of the items of highest expenditure in pre-modern building construction – since blocks much larger than those required by the final work need to be transported for on-site processing.

The second cutting method, called squaring (*taille par équarissement/dérobement* in French and *labra por robos* in Spanish), requires the stonecutter to transfer the orthographic projections of each voussoir as shown on the cross-sections of the vault onto the stone blocks for cut-

quitectura de Alonso de Vandelvira, edición G. Barbé-Coquelin, Madrid 1977.

[5] G. Monge, *Géométrie descriptive: leçons données aux Écoles normales l'an 3 de la République*, Paris 1798.

[6] Sakarovitch, *Épures d'architecture…* cit.

[7] The case study of the entrance to a *descente de cave* has been previously analyzed in Sakarovitch, *Épures d'architecture…* cit., pp. 149-170, and in A. Calandriello, *De l'Orme's Graphics Language: Between Stereotomy and Orthogonal Proto-Projection*, in *ICGG 2018. Proceedings of the 18th International Conference on Geometry and Graphics* (Milan, 3-7 August 2018), edited by L. Cocchiarella, Cham 2019, pp. 1859-1869. Both authors focus on the overall geometry of the vault and its representation and make no attempt at delving into the practical steps necessary for the development of the templates and the execution of the work on which I focus in the present paper. For a more general approach to stereotomy's graphic methods, see S.L. Sanabria, *From Gothic to Renaissance Stereotomy: The Design Methods of Philibert de l'Orme and Alonso de Vandelvira*, "Technology and Culture", XXX, 1989, pp. 266-299 and F. Camerota, *Renaissance Descriptive Geometry: The Codification of Drawing Methods*, in *Picturing Machines 1400-1700*, edited by W. Lefèvre, Cambridge 2004, pp. 175-208.

[8] A degree of confusion about this vault is generated by the fact that, in both early modern and modern literature, the term *descente de cave* is used interchangeably to indicate the upper end (entrance) or the lower end (basement) of the inclined barrel vault. For instance, de L'Orme applies the term to his discussion of the upper end of a *descente de cave* (De L'Orme, *Premier tome…* cit., ff. 58*r*-59*v*), whereas in the *Encyclopédie* published by the Association ouvrière des compagnons du devoir the term is only employed for the lunette on the lower end of the vault (*Encyclopédie des métiers. La maçonnerie et la taille de pierre*, Paris 1991-2010, III, pp. 248-256).

[9] For a detailed description of these methods, see Sakarovitch, *Épures d'architecture…* cit., pp. 111-121.

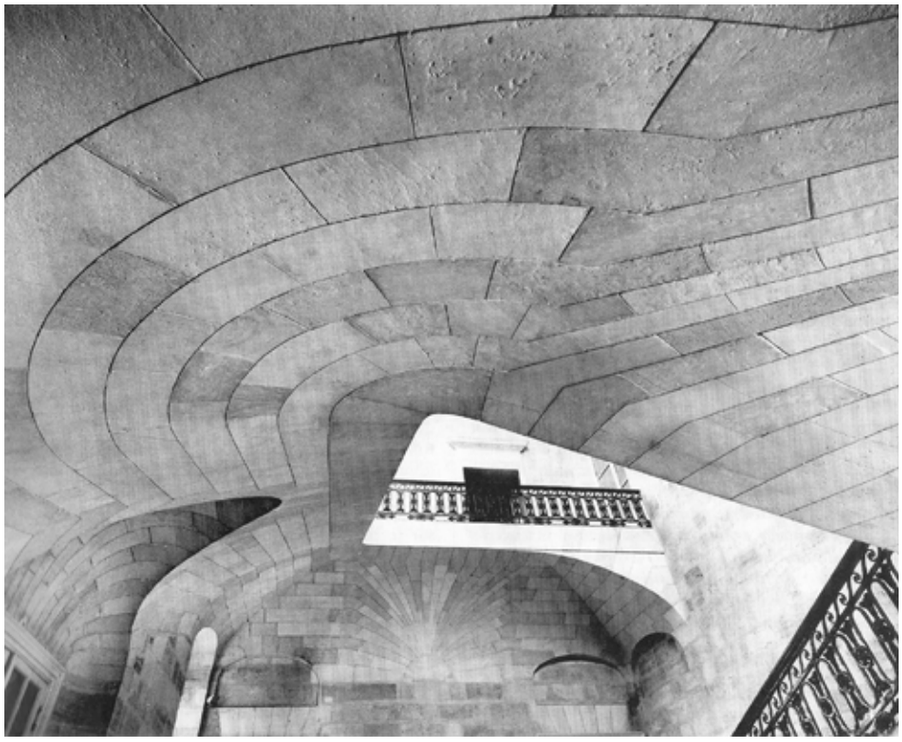


Fig. 6 *Joseph Étienne, Rohan Palace, Bordeaux, 1772-1778. Composite vault supporting the floating staircase (in* Pérouse De Montclos, *L'architecture à la française… cit.; photo M. Dubau).*

Fig. 7 *Joan Soler i Faneca, Lonja de Mar, Barcelona, 1774-1802. Composite vault supporting the floating staircase (photo Baldiri, Wikimedia Commons, CC BY-SA 3.0).*

ting. The voussoir's final shape is then progressively carved out of the stone block through a series of intermediate cuts and surfaces, "as if stripping the imagined figure of its clothing" in the words of eighteenth-century theoretician Amédée-François Frézier[10] (fig. 11, which illustrates how the orthographic projections of the chosen voussoir, shown at the top, are transferred to the sides of a stone block, shown at the bottom, which is then shaped through a series of intermediate cuts). The procedure requires the mastery of double orthographic projections but significantly reduces the loss of material when compared to the *ravalement* method – in order to obtain the same voussoir shown in figure 11, the *ravalement* method requires a stone block at least twenty percent larger in volume. On the other hand, cutting by squaring implies a significant waste of stonecutters' labor because a number of intermediary surfaces – i.e. surfaces that belong neither to the initial stone block nor to the final voussoir – need to be cut and then destroyed in the process of 'stripping' each block.

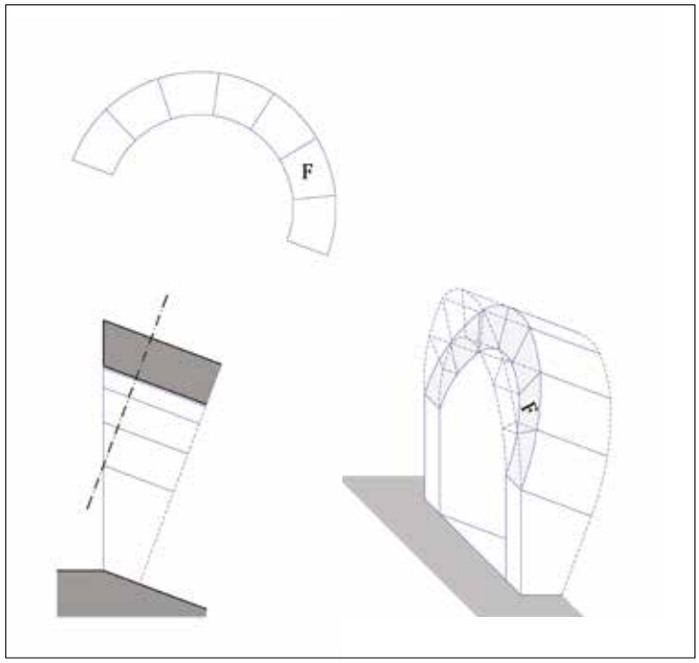
The third cutting method, called templates method (*taille par panneaux* in French and *labra por plantas* in Spanish), requires an *appareilleur* to produce paper or wooden models (templates) that replicate the true shapes and sizes of the voussoirs' faces, which the stonecutter will then apply to the blocks for carving (fig. 13). In the case of the entrance to a *descente de cave*, in which the template of the frontal face *F* is provided by the transversal cross-section, it will be sufficient for the *appareilleur* to produce either the template of the intrados face *D*, or *face de doile*, or those of the lateral (or joint) faces J^1 and J^2, for the stonecutters to be able to proceed with the shaping of the voussoirs (fig. 12, which shows two methods for obtaining the voussoir: via the templates of frontal face *F* and joint faces J^1 and J^2, at the top, and via the templates of frontal face *F* and intrados face *D*, at the bottom). The templates method is by far the most efficient of stereotomy's cutting methods from the standpoint of economy of labor and material supply and transportation – in order to produce the same voussoir shown in figure 12, the squaring method requires a stone block about twice as large in volume (cf. fig. 11). Yet, it is also the most challenging of them because it implies the mastery of solid geometry's fundamentals, such as plane rotations and surface developments. In order to obtain the true shapes and sizes of joint faces J^1 and J^2 shown above, for instance, the *appareilleur* needs to rotate the inclined planes onto which those faces lie onto the vertical plane of the vault's longitudinal cross-section (fig. 14). Similarly, in order to obtain the true shape and size of intrados face *D*, one needs to first translate horizontally and then rotate the inclined plane onto which D lies onto the vertical plane of the vault's lon-

[10] A.F. 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 1737-1739, II, p. 12.

Fig. 8 *Château d'Écouen, staircase, mid-sixteenth century. Entrance to a descente de cave (photo D. Lemel, http://www.lemel.gallery/; last accessed on 23 September 2020).*

gitudinal cross-section (fig. 15). The technical drawings generated by the *appareilleur* to obtain a vault's templates are called *épures* (see fig. 1). The choice of cutting method for a stereotomic vault depends on a variety of factors. Feasibility is the first. In most cases, the *ravalement*, squaring, and templates methods are interchangeable and can be applied to execute the same vault, as is the case with the entrance to a *descente de cave*. A few vaults constitute exceptions, such as cloister vaults, which cannot be executed with the templates method, and the helical barrel vault of the Vis de Saint Gilles type, which can be cut with the squaring and templates methods but not with the *ravalement* one[11]. In many instances, vaults are realized with hybrid methods that involve combinations of tools and approaches from the three categories described above. The rate of wages for specialized workmanship and the costs of material and transportation also play a crucial role in the choice of cutting method. For instance, while choosing the templates method may be wise for a building site located far from quarries and waterways because it allows for saving a substantial amount of material and lower transportation costs, squaring may be preferable in a building site located near the quarry even if this cutting method drives up the labor

[11] On the morphology of these vaults, and how it prevents from applying certain cutting methods to execute them, see *Encyclopédie des métiers…* cit., III, pp. 226-228 and 381-385.



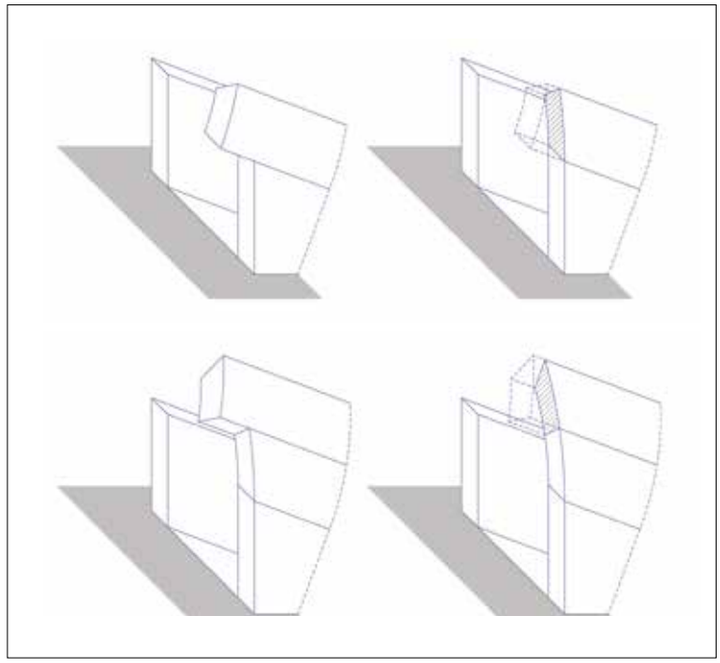


Fig. 9 *Longitudinal cross-section, transversal cross-section and axonometric view of the entrance to a descente de cave (drawing S. Galletti).*

Fig. 10 *Ravalement cutting method applied to the entrance to a descente de cave (drawing S. Galletti).*

costs by extending the cutting process. Depending on time, place, and the size of the building site, it may be a better choice to place the bulk of the workload on the stonecutters rather than on the highly specialized and high-earning *appareilleurs*, as one should keep in mind that, in the pre-modern world, expert *appareilleurs* were among the highest paid members of the building trades[12]. The type of contractual agreement between patron, designer(s), and workers also matters in this regard since, as Frézier explains, in cases where *appareilleurs* and stonecutters are paid a flat rate on the finished work but are not responsible for the provision of stone, they have no incentive in investing time in the production of *épures* and templates in order to avoid the waste of material[13]. Yet, costs and building site management do not account for what may be the most relevant factor in determining the cutting method for the execution of a stereotomic vault: the pride *appareilleurs* and stonecutters take in executing a vault with what they view as the most elegant – i.e. skillful, streamlined, and waste-less – of the methods they master. The choice of using *épures* and templates is often the way in which such pride manifests. Stereotomy is indeed a virtuoso art, first and foremost in the eyes of those who practice it.

Épures are a subset of technical drawings specifically produced to solve the geometric challenges posed by stereotomic vaults. They integrate a vault's defining orthographic views, the geometric constructions necessary to define the shape of its components, such as plane rotations and surface developments, and the templates that will be passed onto the stonecutters for the execution of the voussoirs. The combination of these elements – orthographic views, geometric constructions, and final templates – into a single graphic product distinguishes *épures* from other, less complex forms of technical drawings used in pre-modern building sites, such as *modani*. *Épures* are the direct predecessors of the drawings utilized in modern descriptive geometry, for they feature the plane rotations and surface developments that are at the very core of Monge's theory about the two-dimensional representation of three-dimensional objects.

Typically, *épures* are traced on site at full scale and have functions similar to those of modern blueprints: they are produced by the *appareilleur* to communicate the geometry of the vault and its voussoirs to all the craftsmen involved in its making – the stonecutters, the carpenters who produce the centering, and those who, where needed, prepare the templates – and they are used to control the shape of the vault and its components throughout the execution process. The *épures* that illustrate early modern stereotomy books such as de L'Orme's and Vandelvira's are small-scale renditions of the full-scale tracings used in building sites.

Vestiges of pre-modern *épures* are a rare find because they were often traced on provisional surfaces such as the wooden planks of a vault's scaffolding or the plaster beds covering the pave-

[12] Data on building-trade wages in fifteenth- and sixteenth-century France is found in C. Grodecki, *Documents du minutier central des notaires de Paris: histoire de l'art au XVI^e siècle* (1540-1600), Paris 1985 and É. Hamon, *Documents du minutier central des notaires de Paris: art et architecture avant 1515*, Paris 2008.

[13] Frézier, *La théorie et la pratique de la coupe des pierres*… cit., pp. 14-15.

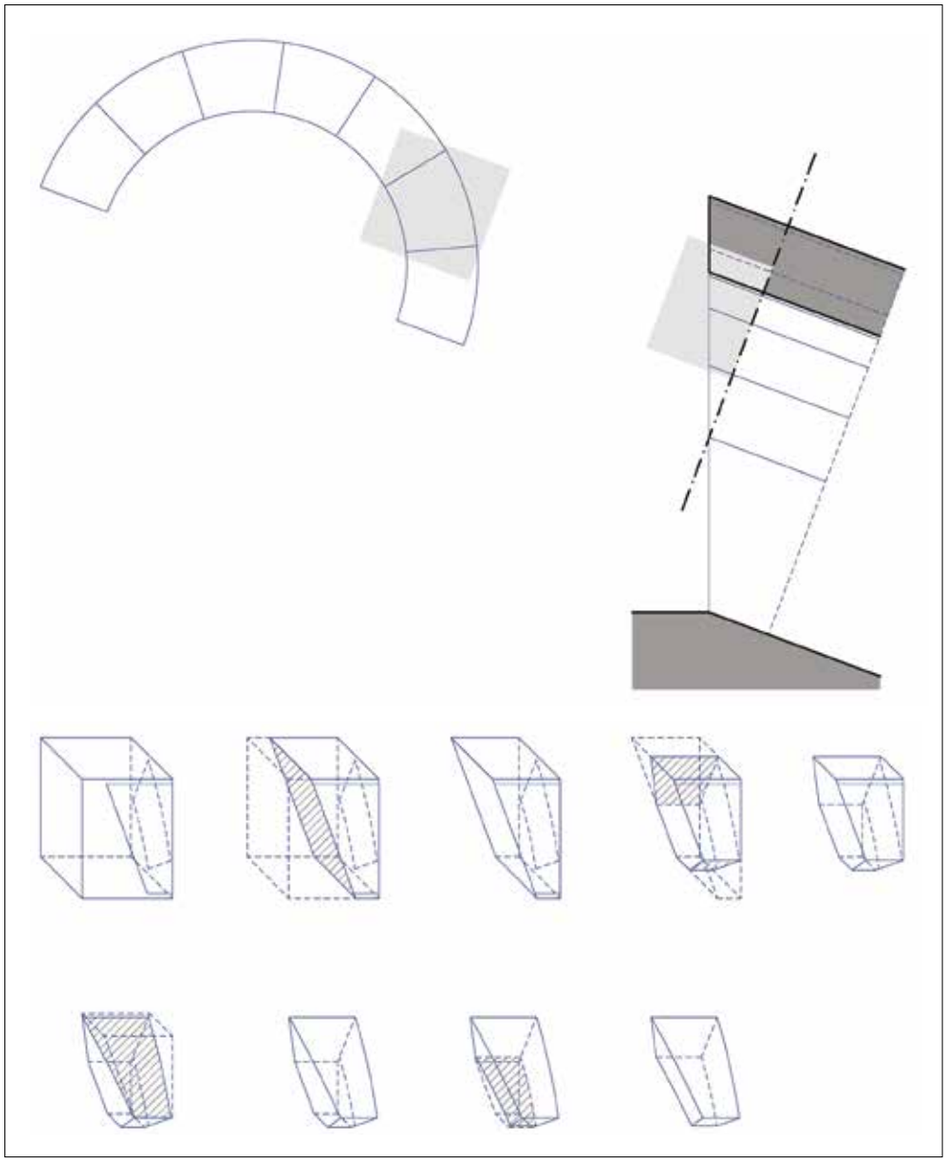


Fig. 11 *Squaring cutting method applied to the entrance to a descente de cave (drawing S. Galletti).*

ment of a tracing house[14]. Those that have been preserved are the *épures* that were drawn directly on the walls and floors of buildings, according to a practice of drawing on stone that dates back at least to ancient Egypt and which was still in use in early modern Europe[15]. With regard to stereotomy, an early example of *épure* traced on stone is found in the vestry of Murcia Cathedral[16]. Yet, the oldest stereotomic *épures* preserved are not full-scale, construction-site tracings but the small-scale renditions included in the thirteenth-century sketchbook of Villard de Honnecourt[17]. Villard's drawings show that the practice of transferring stereotomic knowledge through books – as opposed to oral transmission in the building site – largely predates the treatises of de L'Orme, Vandelvira, and their peers.

The emergence of *épures* in the medieval and early modern era is associated with a renewed interest in geometry and with the development of the templates cutting method, which, as mentioned above, requires a higher mastery of solid geometry compared to other cutting techniques in exchange for a reduction in material and transportation costs. Sixteenth-century authors of stereotomy books show a clear preference for the templates cutting method and, therefore, for the production of small-scale *épures* on paper. These circulated in manuscript form through the works of practitioners such as Pedro de Alviz (?-ca. 1545), Hernán Ruiz the Younger (ca. 1514-1569), and Vandelvira among others, as well as, starting with the publication of de L'Orme's *Premier tome* in 1567, in printed works whose intended audience was much wider than the circles of initiated professionals to whom earlier manuscripts were addressed[18]. The popularity of *épures* and templates at this point in

[14] On the various tracing techniques used in medieval and early modern construction sites, see especially R. Bechmann, *Villard de Honnecourt: la pensée technique au XIII^e siècle et sa communication*, Paris 1993, pp. 52-58; M.Á. Cajigal Vera *et al.*, *The Full-Scale Tracings of the Parish Church of Nogueira Do Miño*, in *I tracciati di cantiere: disegni esecutivi per la trasmissione e diffusione delle conoscenze tecniche*, a cura di A. Pizzo, C. Inglese, Roma 2016, pp. 108-117; and I. Camiruaga *et al.*, *Conservation of Early Modern Architectural Large-Scale Tracings: Challenges and Approaches*, ivi, pp. 118-126.

[15] For a history of tracings on stone in particular, see C. Inglese, *Progetti sulla pietra*, Roma 2000.

[16] J. 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," VII, 2013, 3, pp. 275-302. Further examples are found in M.J. Freire Tellado, *Los trazados de montea de factura renacentista del edificio de los escolapios de Monforte de Lemos (Lugo)*, in *Actas del Segundo Congreso Nacional de Historia de la Construcción* (A Coruña, 22-24 octubre 1998), edición F. Bores Gamundi, Madrid 1998, pp. 173-180; M. Taín Guzmán, *La utilización de monteas en la construcción en piedra: el caso gallego*, in *El arte de la piedra: teoría y práctica de la cantería*, edición J. Roldán Martín, Madrid 2009, pp. 173-204; and J. Calvo López *et al.*, *Métodos de documentación, análisis y conservación de trazados arquitectónicos a tamaño natural*, "Arqueología de la Arquitectura," XII, 2015, http://dx.doi.org/10.3989/arq.arqt.2015.024, last accessed on 22 May 2019.

[17] C. Lalbat, G. Marguerite, J. Martin, *De la stéréotomie médiévale: la coupe des pierres chez Villard de Honnecourt, I*, "Bulletin monumental", 145, 1987, pp. 387-406 and C. Lalbat, G. Marguerite, J. Martin, *De la stéréotomie médiévale: la coupe des pierres chez Villard de Honnecourt, II*, "Bulletin monumental", 147, 1989, pp. 11-34.

[18] P. de Alviz, *Dibujos de trazados arquitectónicos*, ms. 12686, Biblioteca Nacional de España, 12686; H. Ruiz el Joven, *El Libro de arquitectura*, ms R16, Biblioteca de la Escuela Técnica Superior de Arquitectura de Madrid, in *El Libro de arquitectura de Hernán Ruiz, el joven*, edición P. Navascués Palacio, Madrid 1974; De L'Orme, *Premier tome*… cit.; Vandelvira, *Libro de traças*… cit.

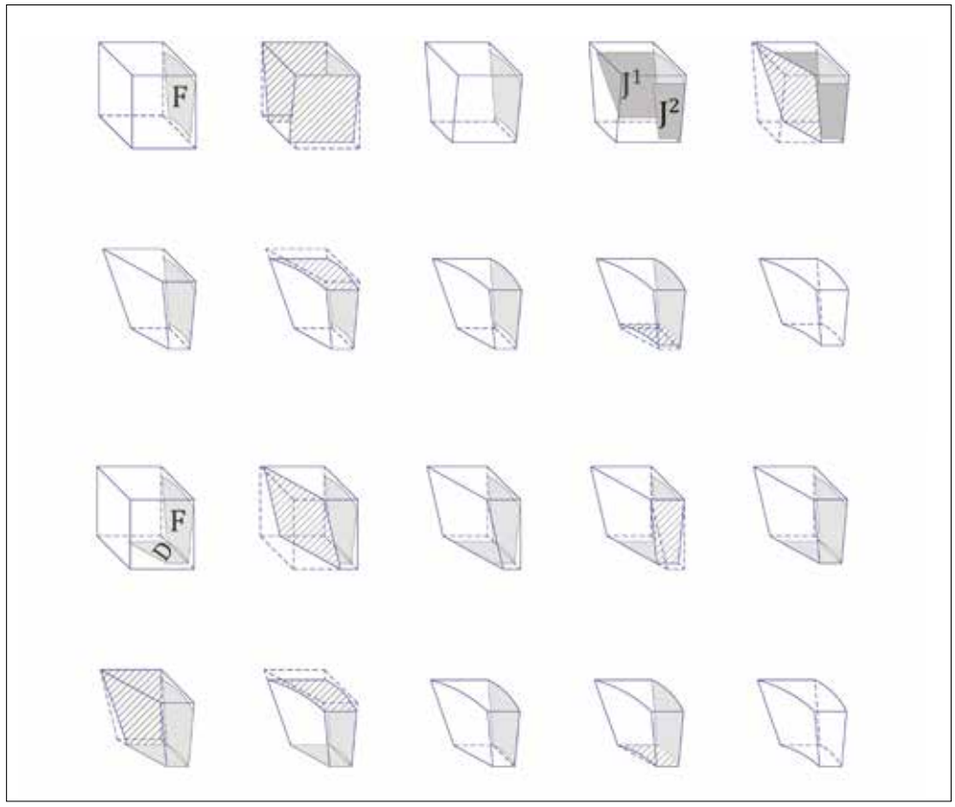


Fig. 12 *Templates cutting method applied to the entrance to a descente de cave (drawing S. Galletti).*

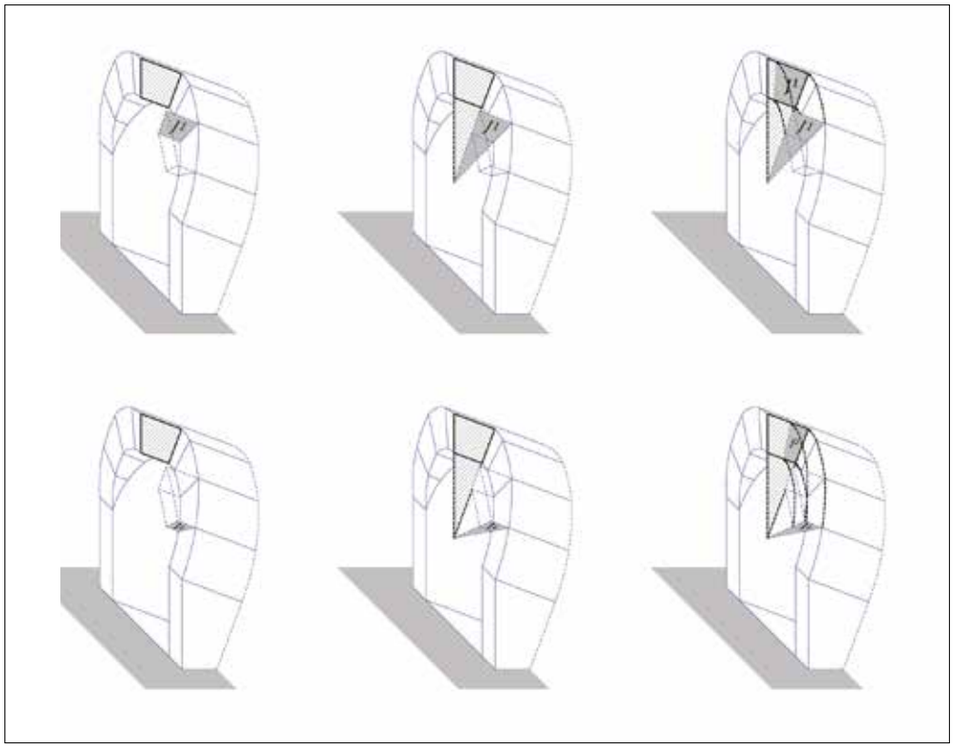
Fig. 13 *Paper template for stonecutting (photo Journal d'une formation de taille de pierre, in http://formationtailledepierre.blogspot.com/, last accessed on 22 May 2019).*

time was not due to practical reasons only but, for the most ambitious among stereotomy's theoreticians, to intellectual ones as well: because the use of the templates cutting method and the production of *épures* require the mastery of Euclidean geometry, they provide some latitude for claiming that stereotomy belongs with the mathematical sciences rather than the mechanical arts. Such a claim is especially central to de L'Orme's attempt, in the *Premier tome*, at defining the professional figure of the architect as "*docte*" (learned) – that is, conversant in both theoretical and practical matters. Indeed, it is unsurprising that de L'Orme's description of such *arteficem doctum* is found in the opening chapter of Book III, the first of two books he dedicates to stereotomy in his treatise[19].

Viewers are easily baffled by the *épures* of stereotomic vaults, which seem unintelligible to the non-initiated eye and, at times, even hardly recognizable as representations of architectural objects. The comparison between a trumpet vault and its *épure* is a case in point (figs. 16-17). The challenge these drawings pose is twofold: on the one hand, because they represent architectural objects at full scale, *épures* were codified in order to occupy the least possible space so that they can fit in the very same room where they will be used. This implies that a vault's defining orthographic views are not separated but superimposed in its *épure*, as are the geometric constructions derived from them in order to establish the true sizes and shapes of the vault's voussoirs. On the other hand, contours, section lines, and projection lines – which modern practitioners mark in their drawings by using regular, thick, and dashed lines respectively – are not graphically distinguished from each other in *épures*. This lack of graphic codification is due not only to the fact that the use of *épures* predates by several centuries the conventions introduced by descriptive geometry, but also to the fact that such conventions would have been hardly applicable anyway under the original conditions of production of *épures*, as it is virtually impossible to accurately define a line's thickness when tracing at full scale on a plaster bed or directly on stone.

Pre-modern stereotomy books that illustrate the reduced-scale renderings of full-scale *épures* do not simplify the readers' task. Quite to the contrary, the combined challenges of small-scale representation and of coordinating text and illustration add layers of visual barriers to the material. The sketchbook of Villard de Honnecourt is a case in point, for it was only in the late 1980s, and only thanks to a team of practitioners, that a number of its illustrations were recognized as small-scale *épures* of stereotomic arches

[19] De L'Orme, *Premier tome*… cit., ff. 50*r*-51*v*.



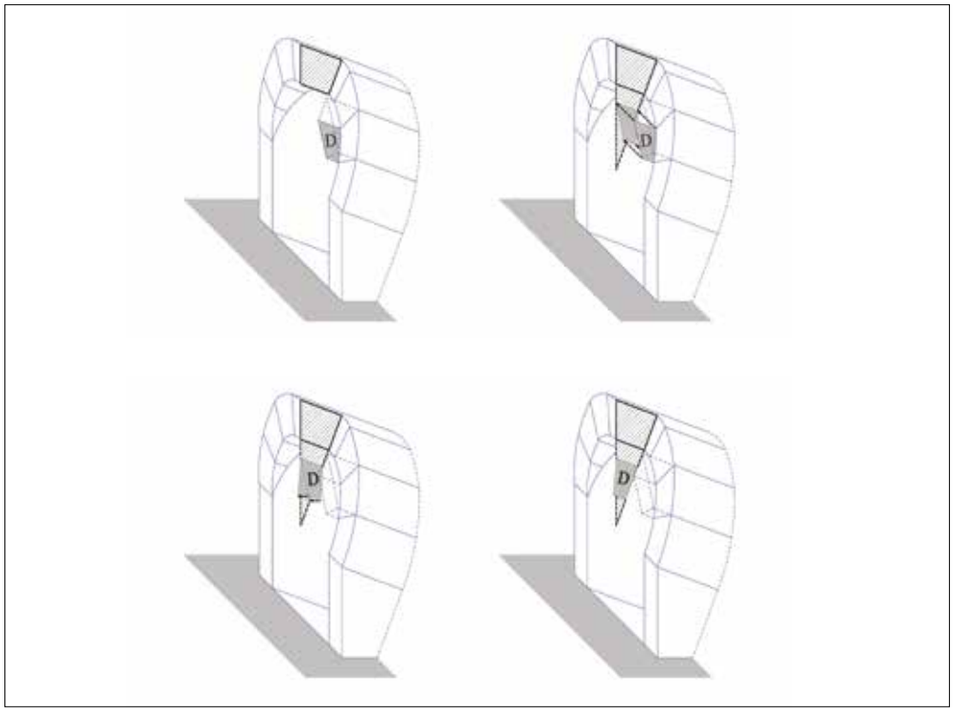


Fig.14 *Geometric constructions necessary to derive the templates of joint faces J^1 and J^2 from the orthographic views of the entrance to a descente de cave (drawing S. Galletti).*

Fig. 15 *Geometric constructions necessary to derive the template of intrados face D from the orthographic views of the entrance to a descente de cave (drawing S. Galletti).*

and vaults[20]. Unsurprisingly, the reduced-scale *épures* illustrated in the cohesive works of sixteenth-century theoreticians are far more readable than those found in Villard's sketchbook – if only because they are bigger in scale and accompanied by textual descriptions.

The layout of de L'Orme's Books III and IV dedicated to stereotomy is exceptionally well organized: the *épures* are arranged according to the level of difficulty of their execution, from the easiest to the most complex of stereotomic works; they are illustrated in the largest possible format allowed by the width of the page, often in full page format; and they are accompanied by textual descriptions that precede the drawings. Also, de L'Orme's illustrations are neatly and carefully executed, with minimal deformation of the geometries represented, i.e. the geometries described in the accompanying text are easily recognizable in the illustrations themselves.

[20] See works cited in note 17.

[21] M. Jousse, *Le secret d'architecture découvrant fidèlement les traits géométriques, couppes, et derobemens nécessaires dans les bastiments enrichi d'un grand nombre de figures, adioustées sur châque discours pour l'explication d'iceux*, La Flèche 1642; G. Martínez de Aranda, *Cerramientos y trazas de montea* [ca. 1600], Biblioteca Central Militar, ms 457, in *Cerramientos y trazas de montea: Ginés Martínez de Aranda*, edición A. Bonet Correa, Madrid 1986.

In some cases, the *épures* are marked by letters and/or numbers that are referenced in the body of text, to facilitate the identification of specific elements of the drawing. Yet, de L'Orme uses the same superimposition of plans, elevations, and cross-sections that characterizes the full-scale *épures* used in building sites and, again like in full-scale tracings, he does not distinguish graphically between contour, section, and projection lines or does so inconsistently, for instance by using interchangeably continuous and dashed lines for projections, as exemplified by his *épure* of the entrance to a *descente de cave* (fig. 1, in which the longitudinal and transversal cross-sections of the vault are shown in white and black, respectively, along with the joint and intrados faces of one of its voussoirs J^1 and D, at the center; at the bottom, the section, contour, and projection lines of the épure are shown in black, white, and dashed lines, respectively). The same is true of de L'Orme's sixteenth-century peers, including Pedro de Alviz, Hernán Ruiz the Younger, and Vandelvira. (It is only in the seventeenth century that a degree of consistency will be introduced in the use of continuous and dashed lines, for instance in the treatises of Martínez de Aranda and Mathurin Jousse)[21]. Indeed, one of the most striking features of early books dedicated to stereotomy is that their authors did not take full advantage of the medium onto which they translated their material. Books, both manuscript and printed, afforded the possibility of presenting *épures* in their building-site, synthetic form *as well as* including a series of separate images for orthographic projections and geometric constructions, each provided with distinctive graphic conventions; yet, the paper *épures* illustrated in early modern books remained conceptually identical to their stone predecessors. Moreover, because the *Premier tome* marks the first appearance of *épures* in printed form, the book testifies to the extra set of challenges raised by the technological advance of the printing press. It should be kept in mind that, at the time of publication of the *Premier tome*, in 1567, the illustrated printed book of architecture was still a novelty – the first of such publications, Fra' Giocondo's *Vitruvius*, had come out only in 1511. As a genre, these had a potential yet to be fully explored with technical glitches far from being solved. The diffusion of the printing press helped avoid the issues associated with unreliable manual copies of architectural illustrations differing from one manuscript to the next, but the possibility for images to be mechanically reproduced was no guarantee of either their accuracy or their fixity[22]. Indeed, the printing process introduced a number of intermediate steps in the transfer of architectural drawings onto paper: from an architect's originals, to the cutter's matrices (or plates), and from these to the printer's damp paper folios, the quality of which may vary from one ream to the next. Each of these steps had the potential to introduce elements of inaccuracy, especially in the case of reduced-scale geometric drawings like *épures*. Indeed, the printing press transferred the problem of illustration inaccuracy from the process of reproduction of a book to that of its production. De L'Orme warns his readers of precisely this type of issue in a passage illustrating the *épure* of a trumpet vault:

> I want nonetheless warn readers that my illustrations were not as accurately executed as I had drawn them because woodcutters dampen, and sometimes boil, the paper [of the original drawing] before fixing it on the woodblock for carving and, depending on the way they stretch said paper, it extends in one direction and shrinks on the opposite one, which is why, in many instances, my illustrations are not as accurate as I had drawn them, nor have they preserved their original proportions[23].

Discrepancies between letter and/or number references found in the illustrations and in the explanatory texts that accompany them are also a

[22] On the instability of early modern printed material, see A. Johns, *The Nature of the Book: Print and Knowledge in the Making*, Chicago 1998. Cf. with the exaggerated notion of fixity of early printed texts and images in E.L. Eisenstein, *The Printing Press as an Agent of Change*, Cambridge 1979, and M. Carpo, *L'architettura dell'età della stampa: oralità, scrittura, libro stampato e riproduzione meccanica dell'immagine nella storia delle teorie architettoniche*, Milano 1998.
[23] De L'Orme, *Premier tome*… cit., f. 106*v*. My translation.
[24] For example, in De L'Orme, *Premier tome*… cit., ff. 5*r* and 178*r*. In the *erratum* that closes the volume, de L'Orme provides corrections for some but not all of these discrepancies, several of which remained unaccounted for at the time of printing (ivi, f. 285*r*).

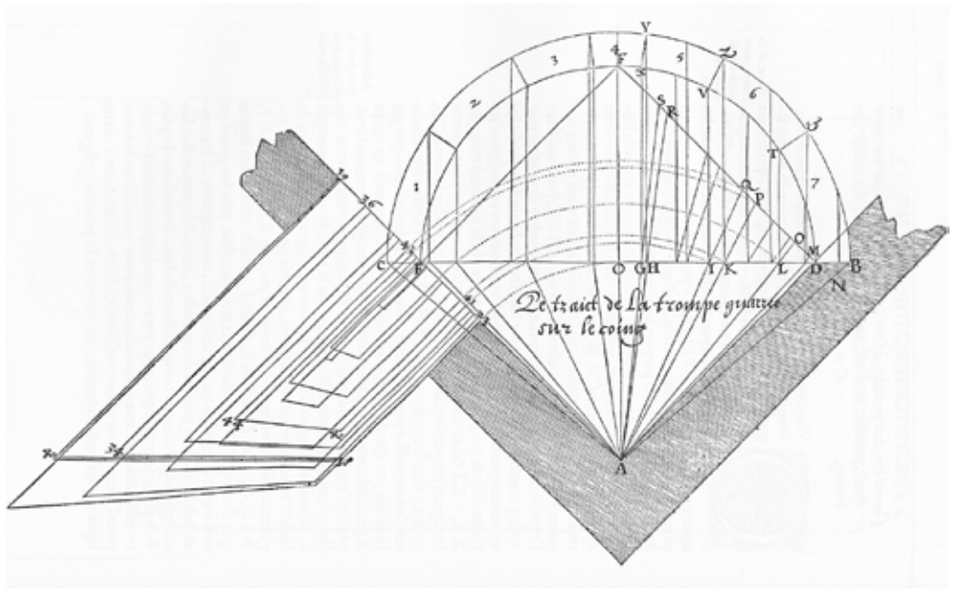


Fig.16 *Porte du Capitole, Toulouse, ca. 1620. Twin stereotomic trumpet vaults on square plan (photo C. Léna, Wikimedia Commons, CC BY-SA 4.0).*

Fig. 17 *Philibert de L'Orme's épure of a trumpet vault on square plan (in* De L'orme, *Premier tome… cit., f. 100v).*

common problem in sixteenth-century printed books, and one that de L'Orme mentions in several instances[24]. Of course, disagreements of this kind can be an annoying source of confusion for any image, but in the case of *épures*, where numbers and letters guide the reader step-by-step through the workings of combined orthogonal projections, plane rotations, and surface developments, they can easily invalidate the readability of an image and of the text that accompanies it. Reading *épures*, both full scale and on paper, is a complex task for non-practitioners, but not an impossible one. It requires a basic understanding of solid geometry, of the conventions that characterize stereotomic drawings, and of the production process of stereotomic vaults. Here, I use de L'Orme's *épure* for the entrance to a *descente de cave* to demonstrate how *épures* are produced and how they should be read.

As described earlier, the entrance to a *descente de cave* materializes the sectioning of an inclined semi-cylinder (the barrel vault covering the ramp or flight of stairs) by a vertical plane (the entrance wall) and its defining orthographic projections are the transversal and longitudinal cross-sections, which provide the shape and size of the barrel vault and the inclination at which it meets the vertical plane of the wall (see fig. 9). In his *épure*, de L'Orme draws the longitudinal and transversal cross-sections of the vault (highlighted in white and black, respectively, in figure 1); he then solves the stereotomic problem posed by this vault by finding the joint and intrados faces of its voussoirs (J^1 and D for the voussoir labeled L), which will allow cutting with the templates method. Figures 18 and 19 show, in a format that unpacks the synthetic representation that is characteristic of *épures*, the geometric constructions de L'Orme employs to find the true shapes and sizes of joint and intrados faces of voussoir L.

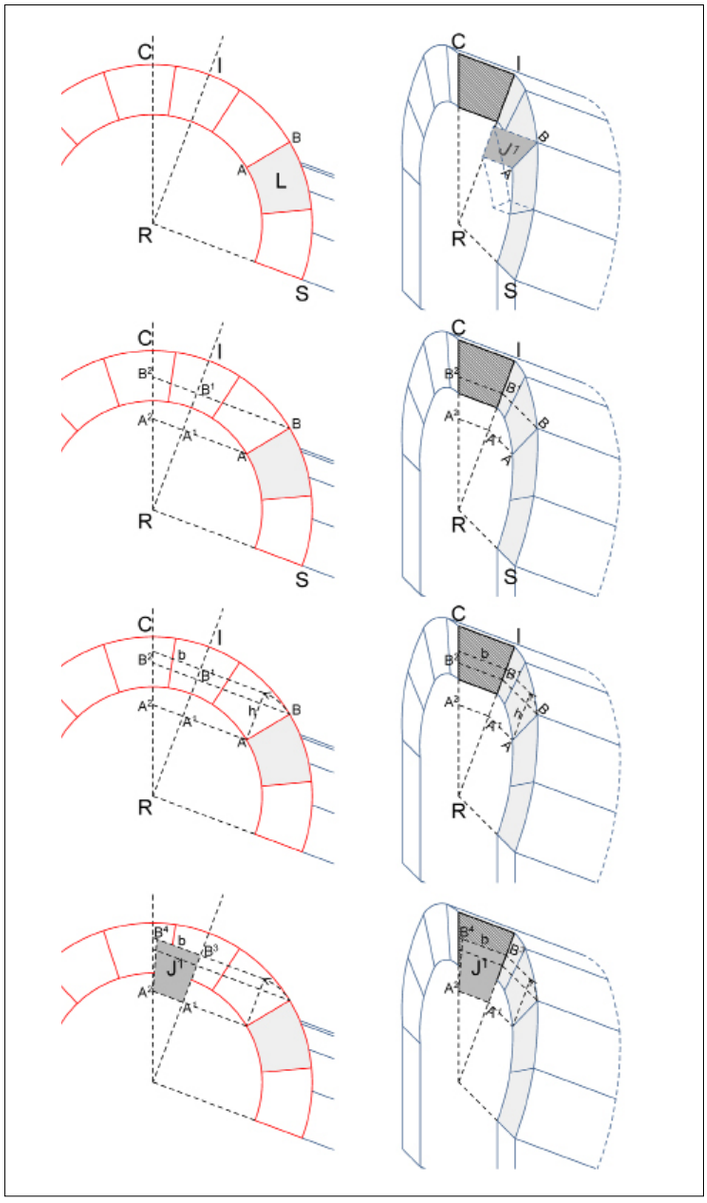
Figure 18 shows the subsequent steps necessary to find the joint face J^1, which are visualized as paired drawings illustrating, on the left column, a simplified version of de L'Orme's *épure* and, on the right column, the axonometric view of the vault. The first pair of drawings illustrates the geometric problem: the axonometric view on the right shows the joint face J^1 de L'Orme is looking for, and the simplified *épure* on the left shows the two-dimensional representation of de L'Orme's three-dimensional problem – note that in the *épure* the perpendicular planes IRS and CRI are represented as coplanar, i.e. the *épure* implies a 90° rotation of plane CRI along the axis $\overleftrightarrow{RI}$ to form plane CRS. Also note that the side of J^1 marked $\overline{AB}$ is the only one provided in true shape and size by the vault's defining orthographic views, for it is featured on the transversal cross-section. The second pair of drawings shows how de L'Orme first projects the segment $\overline{AB}$ onto the longitudinal cross-section plane CRI, finding points A^1 and B^1, and then projects A^1 and B^1 onto the vertical plane of the *descente*'s entrance, CRS, finding points A^2 and B^2. The trapezoid $A^1B^1B^2A^2$ thus obtained is the vertical orthographic view of the joint face J^1 – that is to say that its top and bottom sides, $\overline{B^1B^2}$

and $\overline{A^1 A^2}$, have the true lengths of the top and bottom sides of J^1, whereas its height is shorter than that of J^1, which is segment $\overline{AB}$. The third pair of drawings shows how, in order to find the true height of the trapezoid $A^1B^1B^2A^2$, de L'Orme transfers the length of segment $\overline{AB}$ onto plane *CRI* by rotating it to a position parallel to $\overleftrightarrow{RI}$, thus obtaining height *h* and tracing the projection line *b*. Finally, the fourth pair of drawings shows how de L'Orme transfers the length of segment $\overline{B^1 B^2}$ – the true length of the upper side of J^1 – onto line *b*, finding points B^3 and B^4. The trapezoid $A^1B^3B^4A^2$ thus obtained is the true shape and size of joint face J^1 de L'Orme was looking for (cf. fig. 1). The four steps illustrated in figure 18 are the equivalent of the rotation of the plane that contains J^1 onto the vertical plane of the vault's longitudinal cross-section illustrated in figure 14.

Figure 19 illustrates the same geometric constructions applied to the intrados face *D* of voussoir *L*. The first pair of drawings illustrates the geometric problem: the simplified *épure* on the left is the same as in the previous example, whereas the axonometric view on the right shows the intrados face *D* de L'Orme is looking for. The second pair of drawings shows how de L'Orme first projects the arc length $\widehat{AE}$ onto the longitudinal cross-section plane *CRI*, finding points A^1 and E^1, and then projects A^1 and E^1 onto the vertical plane of the *descente*'s entrance, *CRS*, finding points A^2 and E^2. The trapezoid $A^1A^2E^2E^1$ thus obtained is the vertical orthographic view of the intrados face *D* – that is to say that its top and bottom sides, $\overline{A^1 A^2}$ and $\overline{E^1 E^2}$, have the true lengths of the top and bottom sides of *D*, whereas its height $\overline{A^1 A^2}$ is shorter than that of *D*, which is arc $\widehat{AE}$. The third pair of drawings shows how, in order to find the true height of the trapezoid $A^1A^2E^2E^1$, de L'Orme transfers the length of arc $\widehat{AE}$ onto plane *CRI* by rotating it to a position parallel to $\overleftrightarrow{RI}$, thus obtaining height *h* and tracing the projection line *e*. Finally, the fourth pair of drawings shows how de L'Orme transfers the length of segment $\overline{E^1 E^2}$ – the true length of the lower side of *D* – onto line *e*, finding points E^3 and E^4. The trapezoid $A^1A^2E^4E^3$ thus obtained is the intrados face *D* de L'Orme was looking for (cf. fig. 1). Note that, in his *épure*, de L'Orme transfers the representation of the intrados faces, including *D*, to the bottom part of his illustration, under the sectioning line $\overleftrightarrow{RS}$, in order to avoid overlapping with the joint faces above it (see fig. 1). Also note that the curvature of *D* along the arc $\widehat{AE}$ is disregarded in this construction because the cutting of the voussoir will be executed in two phases: first, a template of the size and shape of trapezoid $A^1A^2E^4E^3$ will be used to define the intrados of the voussoir as a flat surface; then, a bevel square will be used to carve on such surface the curvature corresponding to the arc $\widehat{AE}$[25]. The four steps illustrated in figure 19 are the equivalent of the horizontal translation and rotation of the plane that contains *D* onto the vertical plane of the vault's longitudinal cross-section illustrated in figure 15.

The plane rotations shown here are key to the understanding of stereotomy and its graphic expression in *épures*. The geometric challenge posed by stereotomy is precisely about the definition of voussoirs' surfaces that lie on neither the vertical nor the horizontal plane and which, thus, need to be rotated or developed onto either one of the orthographic views in order to be graphically described in their true shape and size. The difficulty in the reading of *épures* is largely due to their nature as synthetic images in which the orthographic views of a given stereotomic work overlap with the geometric constructions required to derive the templates of its voussoirs from those same views, as well as with the final templates themselves. Yet, as shown in the case study of the entrance to a *descente de cave*, a ba-

[25] A bevel square (*biveau*) is a square with movable arms that has one straight arm and a second, curved arm that reproduces the curvature of the desired voussoir's face. An illustration is found in De L'Orme, *Premier tome*… cit., f. 56*r*, where the bevel square is labeled with the letter A.



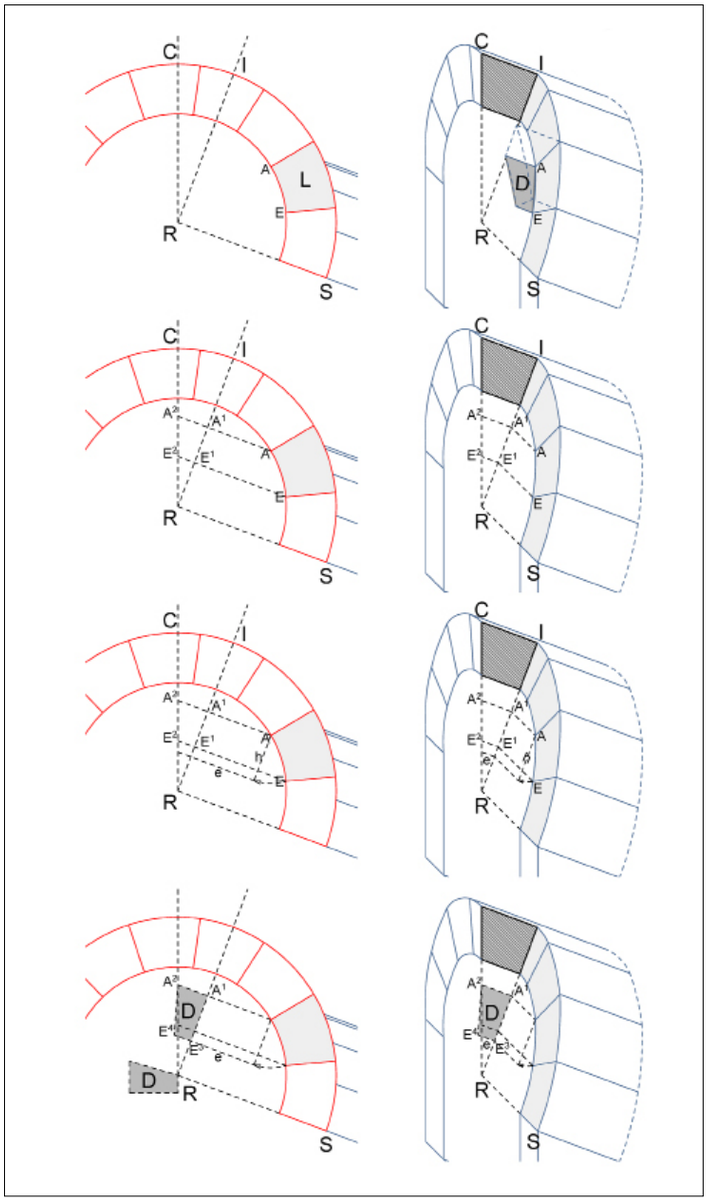


Fig.18 *Step-by-step geometric constructions used by de L'Orme in the épure for the entrance to a descente de cave in order to find the true shape and size of joint face J1 of voussoir L (drawing S. Galletti).*

Fig.19 *Step-by-step geometric constructions used by de L'Orme in the épure for the entrance to a descente de cave to find the true shape and size of intrados face D f voussoir L (drawing S. Galletti).*

sic understanding of solid geometry, of the conventions that characterize stereotomic drawings, and of the production process of stereotomic vaults are sufficient to unpack an *épure*'s multi-layered format and to access its geometric content. As also shown in this case study, *épures* are not only multi-layered drawings, but also drawings in which non-coplanar planes are represented as co-planar. As such, they are the direct precedent for descriptive geometry's convention of representing as co-planar (or unfolded) the horizontal, frontal, and profile planes containing the three defining orthographic views of a three-dimensional object. Indeed, the rotation of orthographic and auxiliary planes, and of the points, lines, and surfaces that they contain, is the defining element of *épures* as instruments of spatial representation, as well as the important legacy of pre-modern stereotomy to modern mathematics. Understanding how *épures* are produced and read allows assessing with precision the level of geometric knowledge possessed by their designers, for these drawings function as clear markers of the ability to conceive and control different sets of three-dimensional geometries and their two-dimensional renditions. Indeed, the case study of the entrance to a *descente de cave* illustrated in the *Premier tome* demonstrates that de L'Orme's mathematics skills were far more advanced than scholarship has traditionally recognized[26]. As such, it not only serves as a methodological key that allows accessing other, more complex *épures* illustrated in de L'Orme's treatise, but it also significantly improves our appreciation of the intellectual scope and ambition of the treatise as a whole.

[26] See, among others, J.P. Manceau, *La culture mathématique de Philibert De l'Orme*, in *Philibert De l'Orme, un architecte dans l'histoire. Arts, sciences, techniques*, éd. F. Lemerle, Y. Pauwels, Turnhout 2016, pp. 191-198.

Frédérique Lemerle

L'APPARITION DU TRAITÉ TECHNIQUE AU XVI[E] SIÈCLE EN FRANCE ET SA FORTUNE AU XVII[E] SIÈCLE DE MATHURIN JOUSSE À CLAUDE PERRAULT

The 17th century was a new era for architectural literature, in Europe and especially in France. Specialized technical writings, covering all branches of building, replaced general treatises. This new development was linked to the mass dissemination enabled by the printing press and to the mastery of engraving techniques, in particular intaglio printing. The renovation of Paris and some avant-garde construction sites in the provinces, and more generally the artistic policy of the French monarchy, stimulated an architectural production in which technical treatises feature prominently. Examples include those of Mathurin Jousse on carpentry and stereotomy (1627 and 1642), François Derand on stereotomy (1642), and Abraham Bosse, who published Girard Desargues' works (1643). All these books, as well as the composite ones which deal in detail with certain practical aspects of construction (Le Muet, 1623 and 1645), reveal the close relationship between theory and architectural practice, tradition and modernity, science and technique, as well as the occasional conflicts between architects and master builders.

Au XVII[e] siècle s'ouvre une ère nouvelle pour la littérature architecturale, en Europe et en particulier en France. Les traités généraux sont relayés par des ouvrages techniques spécialisés où tous les domaines sont représentés, de l'architecture militaire à la construction proprement dite et au second œuvre, traités de charpenterie et de stéréotomie, en passant par les recueils de modèles d'habitations et d'ornements, sans oublier les ouvrages des grands auteurs du siècle précédent : les deux traités de Philibert De l'Orme désormais réunis sous le titre d'*Architecture* (1626, 1648)[1], les publications des grands théoriciens italiens, Vignole[2] et Palladio[3] comme celle récente de Scamozzi[4], rééditées mais surtout traduites, abrégées, voire augmentées, et le traité fondateur de Vitruve qui, sans être un auteur moderne, demeure une référence incontournable. Ce nouvel essor est lié, entre autres, à la diffusion de masse due à l'imprimerie et à la maîtrise des techniques de gravure, en particulier celle de la taille-douce, que le savant graveur Abraham Bosse théorise en 1645 dans son *Traité des manieres de graver en taille-douce sur l'airain*. Surtout la rénovation de Paris et quelques chantiers d'avant-garde en province, plus généralement la politique artistique du pouvoir, ont favorisé l'essor d'une production architecturale où figurent en bonne place les traités techniques[5], tels que les écrits sur la charpenterie et la stéréotomie comme aussi les rééditions de Vitruve par Claude Perrault qui revendiquent une perspective critique contemporaine et nationaliste dans le domaine de la construction.

Les écrits sur la charpenterie

Mathurin Jousse (c. 1575-1645), maître-serrurier de son état a passé la majeure partie de sa vie à La Flèche, petite ville aux confins du Maine et de l'Anjou. Il est connu pour être l'auteur de trois traités rédigés entre 1627 et 1642, tous les trois publiés à La Flèche, dont deux d'entre eux figurent parmi les premiers du genre en France, l'un sur la serrurerie, *La fidelle ouverture de l'art de serrurier* (1627), un second sur la stéréotomie, *Le secret d'architecture* (1642). *Le theatre de l'art de charpentier*[6], publié en 1627 comme le traité de serrurerie, à défaut d'être le premier écrit de ce type est au moins le second, après les *Nouvelles inventions pour bien bastir* publiées par Philibert De l'Orme un demi-siècle plus tôt[7]. Jousse ne fait aucune allusion à l'invention de son prédécesseur, même si les conditions matérielles n'ont guère changé et que l'approvisionnement en bois de longue portée est toujours problématique, comme le rappelle volontiers De l'Orme[8]. Il n'est pas charpentier de métier : il a réalisé un certain nombre de travaux de grosse et de petite serrurerie au collège des Jésuites de la Flèche. L'édifice fondé en 1603 par Henri IV a vu sa construction se prolonger pendant toute la première moitié du XVII[e] siècle et a permis à Jousse d'entrer en contact avec les maîtres d'œuvre qui ont dirigé le chantier : Étienne Martellange, le principal architecte du collège, et François Derand qui après avoir fréquenté l'établissement comme élève (1613-1615), y enseigna par la suite les mathématiques (1618-1621). Témoin privilégié de la construction du collège royal qui a fait figure de chantier d'avant-garde, Jousse représente dans son traité une charpente d'église très proche, à quelques détails près, de la charpente de la chapelle, achevée en 1621 (fig. 2). *Le theatre de l'art de charpentier*, quoique de diffusion provinciale, eut du succès puisqu'il connut trois autres éditions posthumes à La Flèche (1650, 1659, 1664). Au XVIII[e] siècle il fit l'objet d'une édition revue et augmentée par l'astronome et mathématicien Gabriel-Philippe de La Hire car à cette époque il reste inégalé, comme l'affirme l'éditeur Thomas Moette, qui opte alors pour un titre plus encyclopédique, *L'art de charpenterie*, et il le restera pendant plus d'un demi-siècle encore[9]. De La Hire, proche du milieu académique – il succède à son père Philippe en 1718 à l'Académie royale des sciences – insère alors au début du traité cinq planches gravées en taille-douce, reprises d'ouvrages à succès de François Blondel, les *Principes de l'architecture* d'André Félibien (1676) et le *Cours d'architecture* d'Augustin-Charles d'Aviler[10]. De fait le traité de Jousse restera la principale référence en la matière au XVIII[e] siècle jusqu'à la publica-

Opus Incertum (2020) pp. 90-97 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12363 www.fupress.com/oi

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Fig. II.

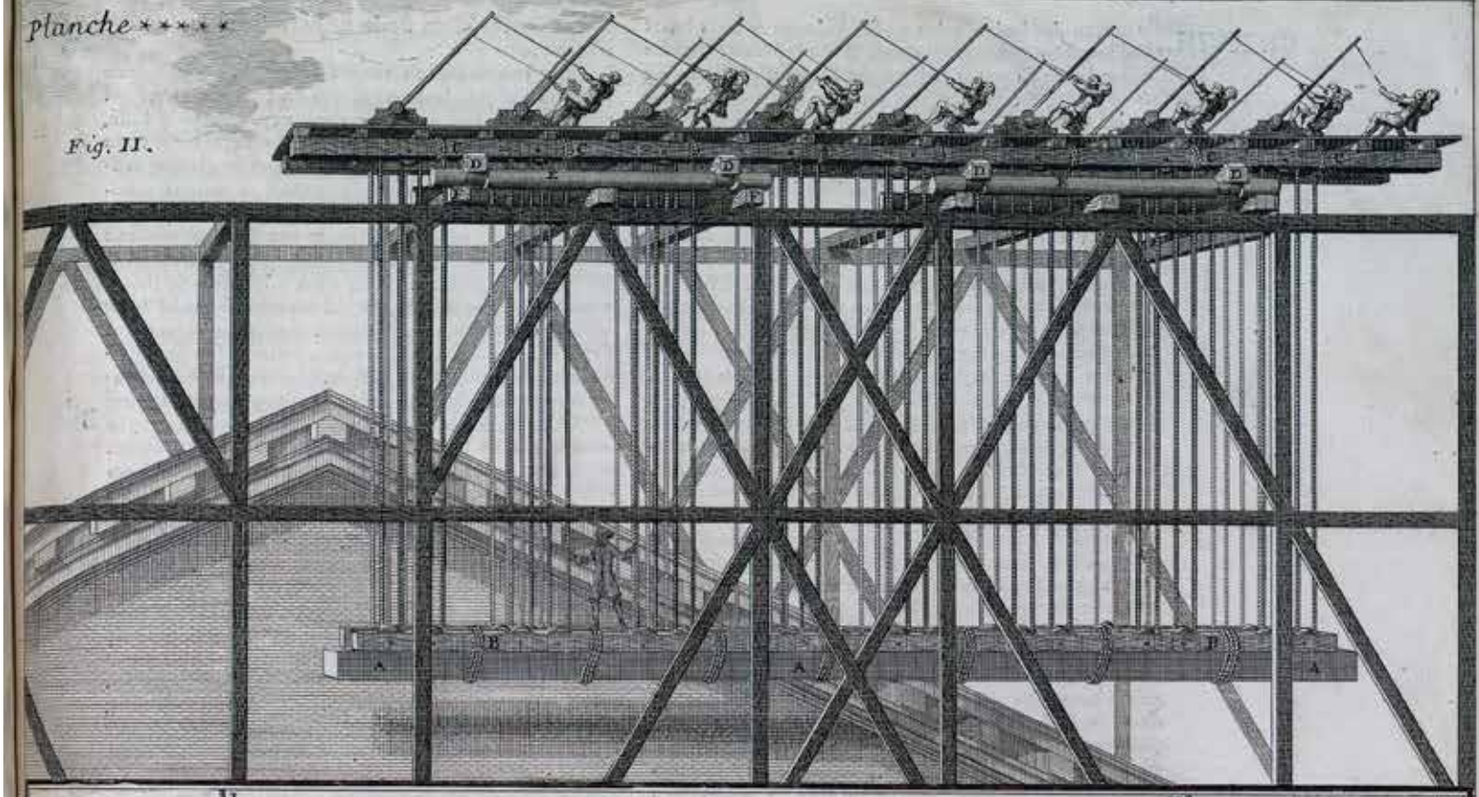


Fig. III

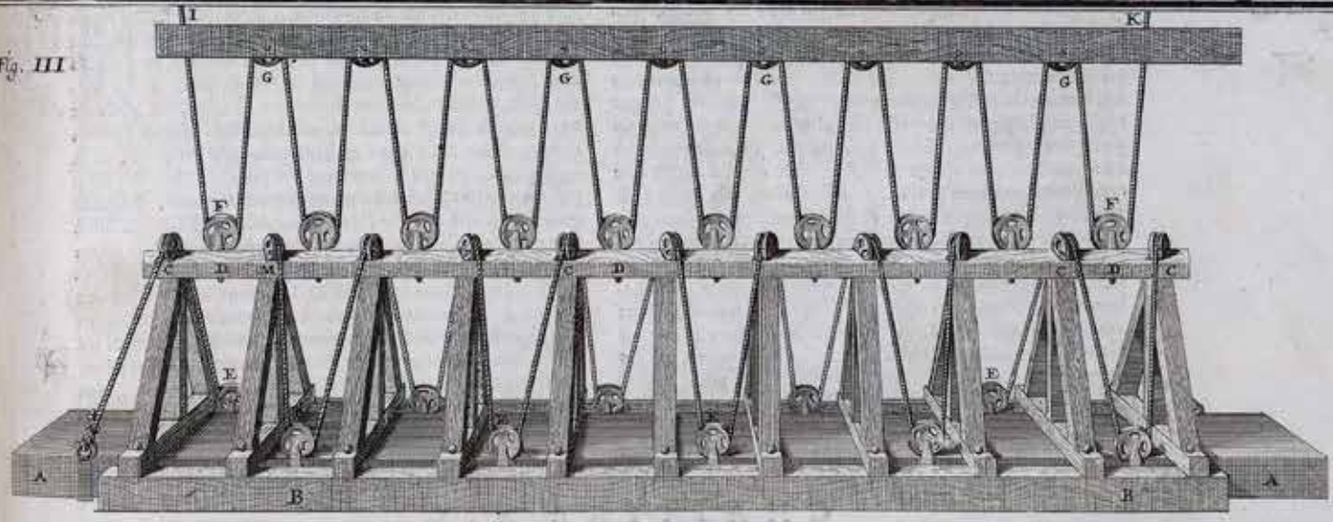
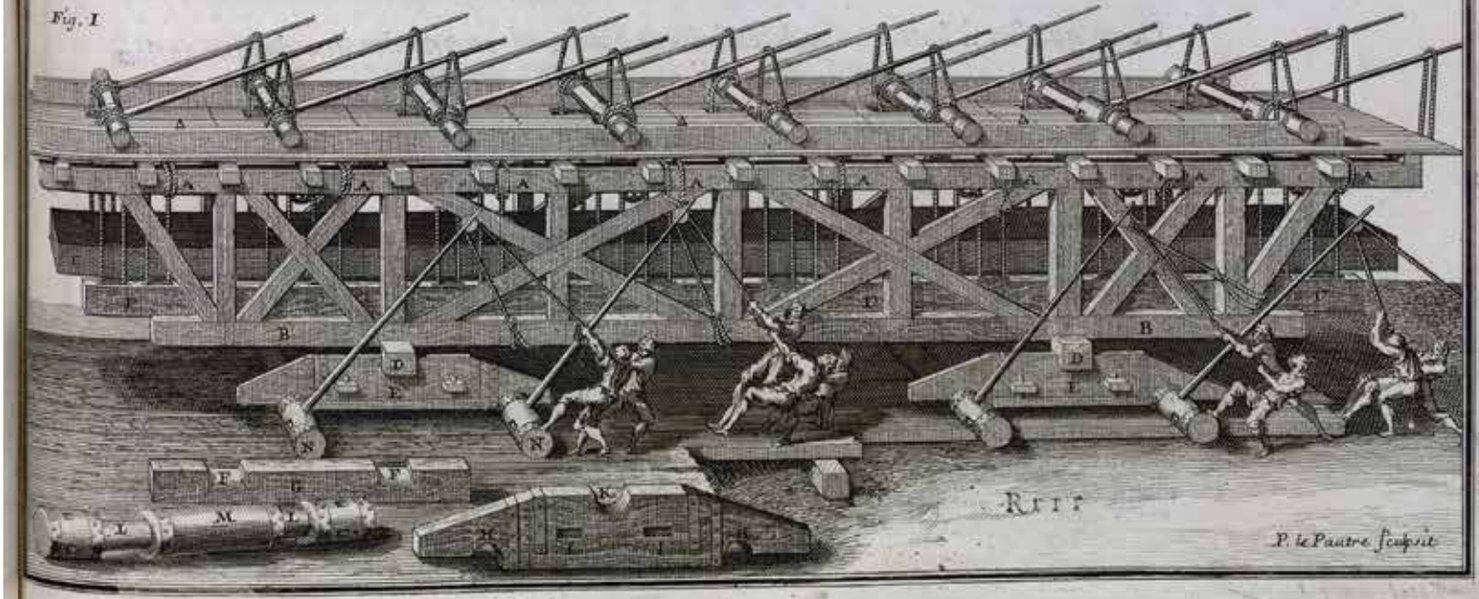


Fig. I



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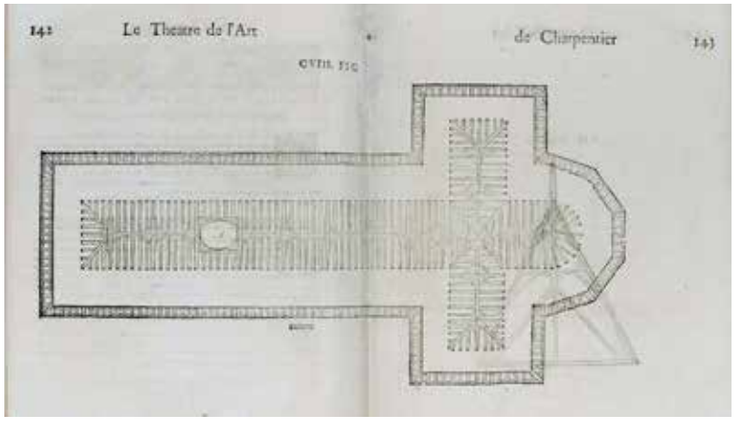
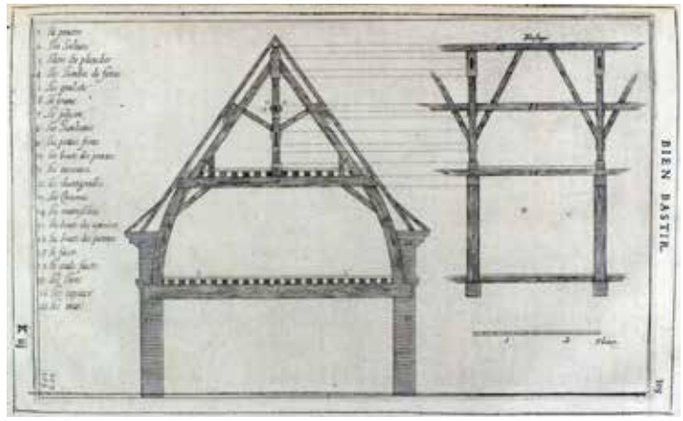




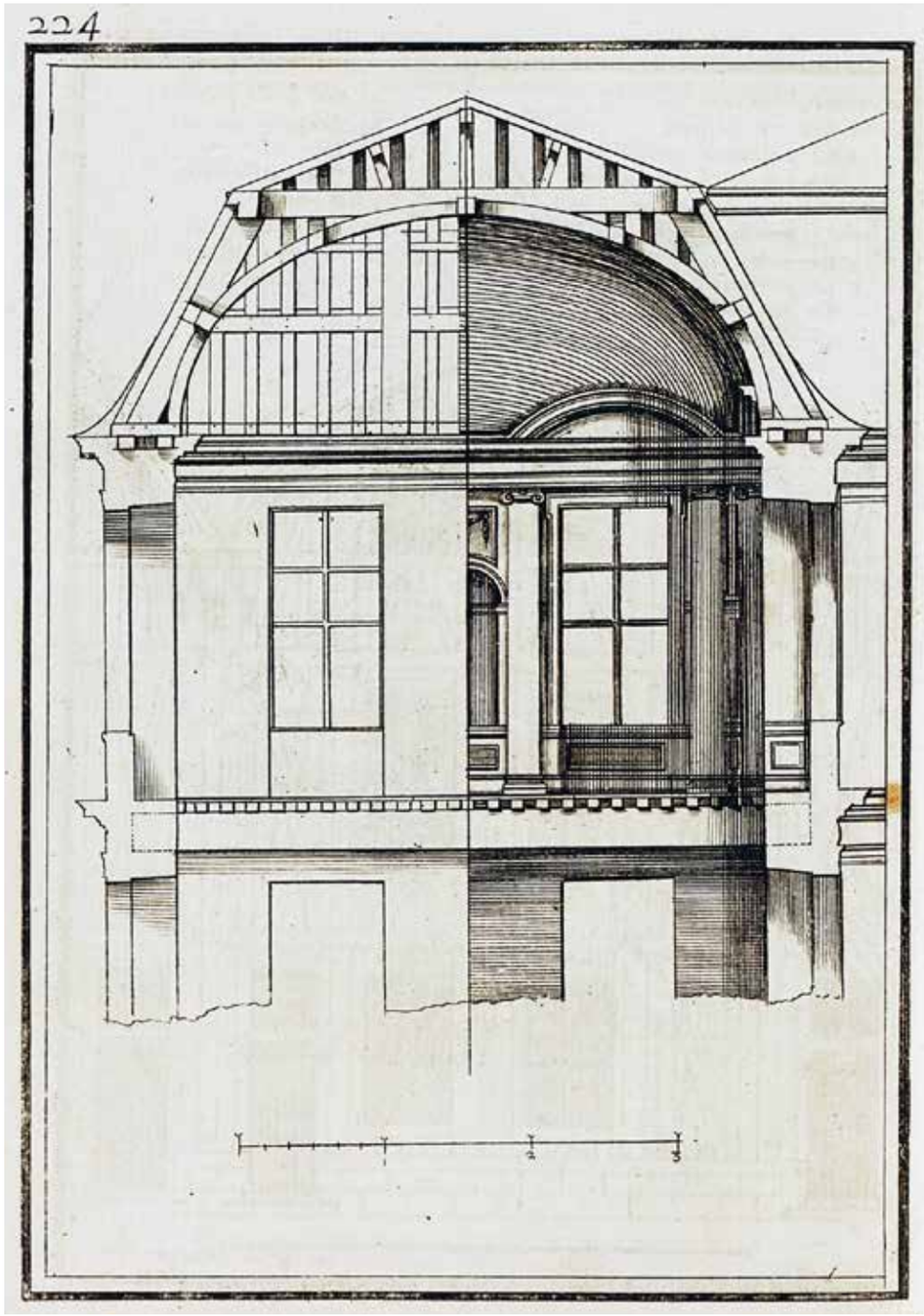
[1] J.M. Pérouse de Montclos, *Les éditions des traités de Philibert De L'Orme au XVII^e siècle*, in *Les traités d'architecture à la Renaissance*, éd. J. Guillaume, Paris 1988, p. 355-365.
[2] Sur la fortune éditoriale de Vignole, voir F. Lemerle, *Les versions françaises de la* Regola *de Vignole au XVII^e siècle*, "In Monte Artium", 2008, 1, p. 101-120.
[3] Voir *infra*, note 12.
[4] Sur le succès de Scamozzi en France, voir F. Lemerle, *Le XVII^e siècle français et l'*Idea dell'architettura universale *(1615) de Vincenzo Scamozzi*, "Revue de l'Art", 188, 2015, 2, p. 49-55.
[5] Voir F. Lemerle, *Vitruve, Vignole, Palladio et les autres : traductions, abrégés et augmentations au XVII^e siècle*, in *Architecture et théorie. L'héritage de la Renaissance*, actes de colloque international (Tours, Cesr, 3-5 juin, 2009, Paris, École d'architecture de Paris-Malaquais), éd. J.P. Garric, F. Lemerle, Y. Pauwels, Paris 2012, (http://inha.revues.org/3328 ; consulté 7 mai 2020) ; F. Lemerle, Y. Pauwels, *Architectures de papier. La France et l'Europe, suivi d'une bibliographie des livres d'architecture (XVI^e-XVII^e siècles)*, Turnhout 2013, p. 83-158.
[6] M. Jousse, *Le theatre de l'art de charpentier...* , La Flèche 1627. Ouvrage accessible en ligne avec la présentation de François Le Bœuf et Yves Pauwels sur le site du CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/ENSBA_LES1250.asp?param= ; consulté 7 mai 2020). Sur Jousse, voir F. Le Bœuf, *Mathurin Jousse, maître serrurier à La Flèche et théoricien d'architecture (vers 1575-1645)*, "In Situ", 2001, 1, (http://insitu.revues.org/1104 ; consulté 7 mai 2020) ; P. Le Bœuf, *La Bibliothèque de Mathurin Jousse : une tentative de reconstitution*, "In Situ", 2001, 1, (http://insitu.revues.org/1111 ; consulté 7 mai 2020) ; É. Pecquet, *Mathurin Jousse, architecte et ingénieur de la ville de La Flèche au XVII^e siècle*, "Cahiers Fléchois", 6, 1984, p. 28-41.
[7] Voir la contribution d'Yves Pauwels, *Légitimer le traité technique : la rhétorique de Philibert De l'Orme dans les* Nouvelles inventions *et le* Premier tome de l'architecture, dans ce volume.
[8] Ph. De l'Orme, *Nouvelles inventions pour bien bastir...* , Paris 1561, f. 4.
[9] G.Ph. De La Hire, *L'art de charpenterie de Mathurin Jousse, corrigé & augmenté de ce qu'il y a de plus curieux dans cet art, & des machines les plus nécessaires à un charpentier par Mr D.L.H.*, Paris 1702. Ouvrage accessible en ligne avec ma présentation sur le site du CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/CESR_IHA615.asp?param= ; consulté 7 mai 2020).
[10] Pour les combles de La Hire insère ainsi une planche de Félibien qu'il associe avec deux schémas détaillés de comble à la Mansart extraits du *Cours* de d'Aviler (De La Hire, *L'art de charpenterie...* cit., p. 133).
[11] P. Le Muet, *Maniere de bastir pour touttes sortes de personnes...* , Paris 1623, p. 101.
[12] Ouvrage accessible en ligne avec la présentation de Claude Mignot sur le site du CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/Folko5.asp?param= ; consulté 7 mai 2020).
[13] R. Fréart de Chambray, *Les quatre livres de l'architecture d'André Palladio...* , Paris 1650. Ouvrage accessible en ligne avec ma présentation sur le site du CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/CESR_4045.asp?param= ; consulté 7 mai 2020).
[14] Voir Lemerle, Pauwels, *Architectures de papier...* cit., p. 116 ; F. Lemerle, *À l'origine du palladianisme européen : Pierre Le Muet et Roland Fréart de Chambray*, "Revue de l'Art", 178, 2012, 4, p. 43-47.

tion par le maître charpentier Nicolas Fourneau de *L'art du trait de charpenterie* (Rouen, 1767-1770), véritable somme sur l'art de la coupe des bois.

Sans rédiger pour autant un traité spécifique, d'autres auteurs se sont intéressé à la charpenterie et ont abordé le domaine dans leurs ouvrages. Dans la *Maniere de bastir pour touttes sortes de personnes* (Paris, 1623), recueil de modèles de demeures sur de petites parcelles urbaines selon la manière pratiquée « à Paris et ès environs », depuis la plus petite maison jusqu'à de petits hôtels particuliers – dans la lignée du sixième livre de Serlio –, l'architecte Pierre Le Muet consacre les dernières planches de l'ouvrage à la charpenterie avec un modèle de maison en pan de bois[11] et cinq modèles de charpente de combles (fig. 3)[12]. De façon plus étonnante il en traite dans l'adaptation qu'il donne du livre I du traité de Palladio, *Traicté des cinq ordres... Traduit du Palladio, augmenté de nouvelles inventions pour l'art de bien bastir...* (Paris, 1645), contrairement à Roland Fréart de Chambray qui publie une traduction intégrale du traité de l'Italien (*Les quatre livres de l'architecture d'André Palladio...*, Paris, 1650)[13]. Comme la traduction de Vignole qu'il a publiée quelques années auparavant en 1632, ce manuel commode de format in-8° est avant tout destiné aux praticiens. Puisque les demeures et les usages de construction ne sont pas les mêmes en France qu'en Italie, Le Muet a pris le parti de supprimer tous les chapitres sur les matériaux et dans un second volet, avec une page de titre spécifique, il a habillé « à la française » les chapitres 21 à 29 des *Quattro libri dell'architettura*, qui traitent des galeries, entrées, salles, chambres, baies, cheminées, etc. Le Muet illustre ainsi le comble couvert en tuiles mais surtout en ardoise. Les planches extrêmement détaillées qu'il donne représentent des combles, dans différentes versions, à surcroît ou non, qui sont reprises de sa *Maniere de bastir* publiée en 1623. En 1645 Le Muet y ajoute des modèles plus modernes de combles brisés dits plus tard « à la Mansart », qu'il avait lui-même adoptés quelques années auparavant dans ses propres réalisations (fig. 4). On sait le succès de ce Palladio à la française, avec trois contrefaçons hollandaises publiées à Amsterdam successivement en 1646, 1679 et 1682. Cette version originale, moins révisée que développée, ne pouvait que séduire les éditeurs hollandais dans la mesure où les praticiens et les commanditaires y trouvaient des modèles de distribution et de couvertures adaptés à leur pays et à la dernière mode, au moment où Paris commence à s'imposer comme capitale artistique. Aussi dès 1646 l'ouvrage fut-il traduit en néerlandais. En Angleterre Godfrey Richards en proposa une adaptation anglaise en 1663 qui connut à son tour de nombreux tirages (1668, 1676, 1683, 1693, etc.). Ce succès éditorial s'explique par la particularité même de cette version, qui répondait aux attentes des praticiens et à la forte demande anglaise après le grand incendie de Londres en 1666[14]. En revanche le Palladio de Le Muet ne fut jamais traduit en Allemagne où l'on disposait de nombreux traités techniques.

Les traités de stéréotomie

Depuis toujours les Français ont revendiqué une compétence dans l'art du trait ou de la coupe des pierres qui leur permet de mettre en valeur les voûtes nues, les trompes virtuoses et les escaliers. Or ce savoir incomparable fut longtemps détenu par les maîtres d'œuvre. Philibert De l'Orme est le premier à l'avoir théorisé dans les livres III et IX du *Premier tome de l'architec-*



pagina 91

Fig. 1 *C. Perrault, Machines pour transporter, élever et positionner les pierres (in C. Perrault, Les dix livres d'Architecture de Vitruve... Seconde edition reveuë, corrigée, & augmentée, Paris 1684, p. 339 ; © Architectura CESR).*

Fig. 2 *M. Jousse, Charpente d'église (in Jousse, Le theatre de l'art de charpentier... cit., pl. 108, p. 142-143 ; © Architectura CESR).*

Fig. 3 *P. Le Muet, Charpentes de combles (in Le Muet, Maniere de bastir… cit., p. 105 (éd. 1647) ; © Architectura CESR).*

Fig. 4 *P. Le Muet, Combles « à la Mansart » (in P. Le Muet, Traicté des cinq ordres... Traduit du Palladio, augmenté de nouvelles inventions pour l'art de bien bastir... , Paris 1645, p. 224 ; © Architectura CESR).*

ture (1567), expliquant notamment ses propres réalisations comme la fameuse trompe du château d'Anet. Mais le *Secret d'architecture*, le dernier ouvrage publié par Mathurin Jousse est de fait le premier traité entièrement dédié à la stéréotomie[15]. Si l'on en croit le privilège octroyé en 1635, l'auteur en avait déjà rédigé à cette date la plus grande partie, soit bien avant l'*Architecture des voûtes, ou l'art des traits et coupes des voûtes* de son rival François Derand parue en 1642[16] et *La pratique du trait à preuve pour la coupe des pierres* d'Abraham Bosse et de Girard Desargues, ouvrages tous deux publiés en 1643[17]. Cette floraison d'ouvrages édités en quelques années démontre l'intérêt porté alors à la maîtrise théorique et technique de la coupe des pierres, spécificité de l'« architecture à la française » pour reprendre l'expression de Jean-Marie Pérouse de Montclos. La stéréotomie, il faut le rappeler, est l'art de produire des structures complexes de pierre de taille, notamment des surplombs et des couvrements dans lesquels, par l'artifice du clavage, la pesanteur travaille contre elle-même. Le terme « secret » révèle l'ambition de Jousse qui entendait définir scientifiquement ce qui appartenait auparavant à la pratique des chantiers, et ce malgré les avancées dues à Philibert qui n'avait abordé le sujet qu'en praticien virtuose,

[15] M. Jousse, *Le secret d'architecture*… , La Flèche 1642. Ouvrage accessible en ligne avec la présentation de Jean-Pierre Babelon sur le site du CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/ENSBA_LES1251.asp?param= ; consulté 7 mai 2020). Sur Jousse voir *supra*, note 6.

[16] F. Derand, *Architecture des voûtes, ou l'art des traits et coupes des voûtes*… , Paris 1643. Ouvrage accessible en ligne avec la présentation de Jean-Marie Pérouse de Montclos sur le site du CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/B250566101_11598.asp?param= ; consulté 7 mai 2020). Sur F. Derand, voir P. Moisy, *Les églises des Jésuites de l'ancienne assistance de France*, Rome 1958, tome 2 et J.M. Pérouse de Montclos, *L'architecture à la française. Du milieu du XV[e] siècle à la fin du XVIII[e] siècle*, Paris 2001[2], p. 99.

[17] A. Bosse, *La pratique du trait à preuve pour la coupe des pierres*, Paris 1643. Ouvrage accessible en ligne avec la présentation de Jean-Pierre Manceau sur le site du CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/MBAT1950-7-1.asp?param= ; consulté 7 mai 2020). Sur A. Bosse, voir C. Assegond, *Socialisation du savoir, socialisation du regard. Les usages techniques et sociaux du savoir géométrique et de la stéréotomie chez les compagnons tailleurs de pierre*, thèse de doctorat en sociologie, Université François Rabelais, Tours 2002 ; *Desargues en son temps*, éd. J. Dhombres, J. Sakarovitch, Paris 1994 ; M. Le Blanc, *D'acide et d'encre. Abraham Bosse (1604?- 1676) et son siècle en perspective*, Paris 2004 ; J.P. Manceau, *Abraham Bosse, un cartésien dans les milieux artistiques et scientifiques du XVII[e] siècle*, in *Abraham Bosse savant graveur, Tours, vers 1604-1676, Paris*, catalogue des expositions (Paris, Bibliothèque Nationale de France, 20 avil-11 juillet 2004 ; Tours, Musée des Beaux-Arts, 20 avril-11 juillet 2004), éd. S. Join-Lambert, M. Préaud, Paris-Tours 2004, p. 53-63.

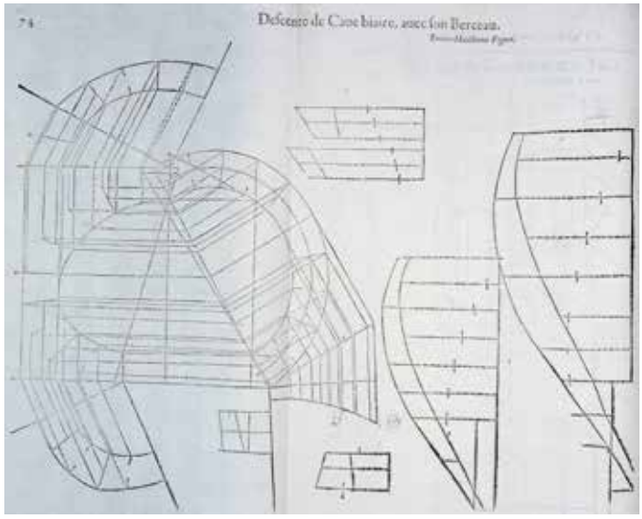


Fig. 5 *M. Jousse, « Descente de cave biaise avec son berceau » (in* Jousse, *Le secret d'architecture... cit., p. 74 ; © Architectura CESR).*

Fig. 6 *J. Nadreau, La Flèche, Collège royal. Tribune d'orgues de la chapelle, 1637-1640 (photo Y. Pauwels).*

reconnaissant parfois qu'il lui était plus facile de faire que de dire[18]. De fait Jousse est parvenu à se rendre intelligible aux ouvriers (fig. 5). Demeure la question de savoir comment le maître serrurier, si cultivé fût-il, a pu concevoir et rédiger pareil ouvrage. Il semble qu'il a tiré grand parti de sa rencontre avec François Derand. Tous deux furent de toute évidence très impliqués dans la construction de la tribune d'orgues du collège de La Flèche, véritable chef-d'œuvre stéréotomique, même s'ils n'en étaient pas les concepteurs. Adossée au mur occidental de la chapelle, la tribune est en effet portée par trois voûtes qui prennent elles-mêmes appui sur deux piliers ornés d'atlantes, une trompe centrale en berceau et deux trompes coniques latérales, toutes trois en tour ronde (fig. 6). Son exécution supposait une maîtrise consommée de la taille des pierres, encore envisagée de manière expérimentale à cette époque. Les commanditaires jésuites avaient eux-mêmes conscience du caractère hardi de ce voûtement, pour avoir exigé de son concepteur, le maître tailleur de pierre Jacques Nadreau, une garantie décennale, du jamais vu en la matière. Il se trouve que l'achèvement de la tribune a été suivi de peu par la parution de l'ouvrage de Jousse en 1642, qui devance d'une année ceux de Derand et de Bosse en 1643. Jousse, nourri des enseignements de Derand et des compagnons, apparaît avoir volé à ce dernier l'avantage de publier le premier ouvrage entièrement consacré à la stéréotomie.

Dans son *Architecture des voûtes* qui parut un an avant sa mort, Derand n'eut de cesse de proclamer « fautive » la publication de Jousse, ce qui en soi n'est guère surprenant[19]. Le Père jésuite est avant tout un mathématicien, qui clarifie l'analyse de ceux qui ont écrit avant lui, De l'Orme, Jousse, et aussi son collègue, l'éminent mathématicien Girard Desargues dont il cite le *Brouillon projet d'exemples d'une manière universelle... touchant la practique du trait à preuve pour la coupe des pierres* paru trois ans plus tôt, en 1640 (préface). Car l'opuscule de Desargues, d'accès difficile comme tous ses écrits, ne proposait pas un recueil de modèles mais entendait résoudre sur le plan mathématique tous les problèmes particuliers de la stéréotomie par une sorte de règle, la « manière universelle ». Derand sans être un professionnel de l'architecture, même s'il fut appelé à Paris (en 1629) pour achever l'église de la maison professe des Jésuites (aujourd'hui Saint-Paul-Saint-Louis), était suffisamment pragmatique pour rédiger un ouvrage où était conservée une place à la technique et à la pratique des tailleurs de pierre (fig. 7). D'où le succès incontestable de *L'architecture des voûtes* aussi bien auprès des ouvriers qui y trouvèrent tous les éclaircissements nécessaires dans le texte comme dans les figures qu'auprès des architectes qui n'eurent de cesse d'acquérir l'ouvrage comme en témoignent leurs bibliothèques[20]. Il n'est point étonnant que l'ouvrage ait connu deux rééditions au XVIII^e siècle à Paris en 1743 et 1755.

La même année que Derand, Bosse publia *La pratique du trait a preuves de Mr Desargues Lyonnois*[21]. Celui qui fut l'un des meilleurs graveurs en taille-douce de son temps avait rencontré à Paris dans les années 1640 Girard Desargues et cette rencontre avait été le début d'une collaboration fructueuse. Le don exceptionnel de Bosse pour les mathématiques lui donna en effet la possibilité de vulgariser les travaux de

[18] « La chose est telle qu'on la peut beaucoup mieux montrer manuellement, que verbalement, quasi ainsi que nous avons écrit par ci-devant des traits et pratique de géométrie, pour savoir couper les pierres, afin de les faire servir à toutes sortes de portes, voûtes, trompes, et autres. Vrai est que j'ai bien enseigné comme il le faut faire, et comme l'on se doit aider des panneaux des moules, des buveaux et cherche rallongée, mais je n'ai pas pu montrer par écriture comme les pierres se doivent tracer par leurs lits et parements, et autour, pour les couper, selon l'œuvre qu'on aurait à faire. Véritablement cela ne se peut décrire, mais bien montrer visiblement et manuellement, en exécutant l'œuvre de fait » (Ph. De l'Orme, *Le premier tome de l'architecture...* , Paris 1567, f. 195). Malgré une réelle compétence en arithmétique et géométrie, la connaissance que Philibert a de l'art du trait est profondément liée aux recettes d'atelier et aux hommes de métier, d'où sa difficulté à expliquer parfois le détail de mise en œuvre. Voir J.P. Manceau, *La culture mathématique de Philibert De l'Orme*, in *Philibert De l'Orme, un architecte dans l'histoire. Arts, sciences, techniques*, éd. F. Lemerle, Y. Pauwels, Turnhout 2016, p. 191-198.

[19] Voir la présentation de l'ouvrage par Jean-Marie Pérouse de Montclos (http://architectura.cesr.univ-tours.fr/Traite/Notice/B250566101_11598.asp?param= ; consulté 7 mai 2020).

[20] Perouse de Montclos, *L'architecture à la française...* cit. (note 16), p. 99.

[21] Voir la présentation de l'ouvrage par Jean-Pierre Manceau (http://architectura.cesr.univ-tours.fr/Traite/Notice/MBAT1950-7-1.asp?param= ; consulté 7 mai 2020).

[22] A. Bosse, *La maniere universelle de M^r Desargues Lyonnois, pour poser l'essieu…* , Paris 1643 (http://architectura.cesr.univ-tours.fr/Traite/Notice/ENSBA_LES108.asp?param= ; consulté 7 mai 2020). Voir Perouse de Montclos, *L'architecture à la française...* cit., p. 98-99.

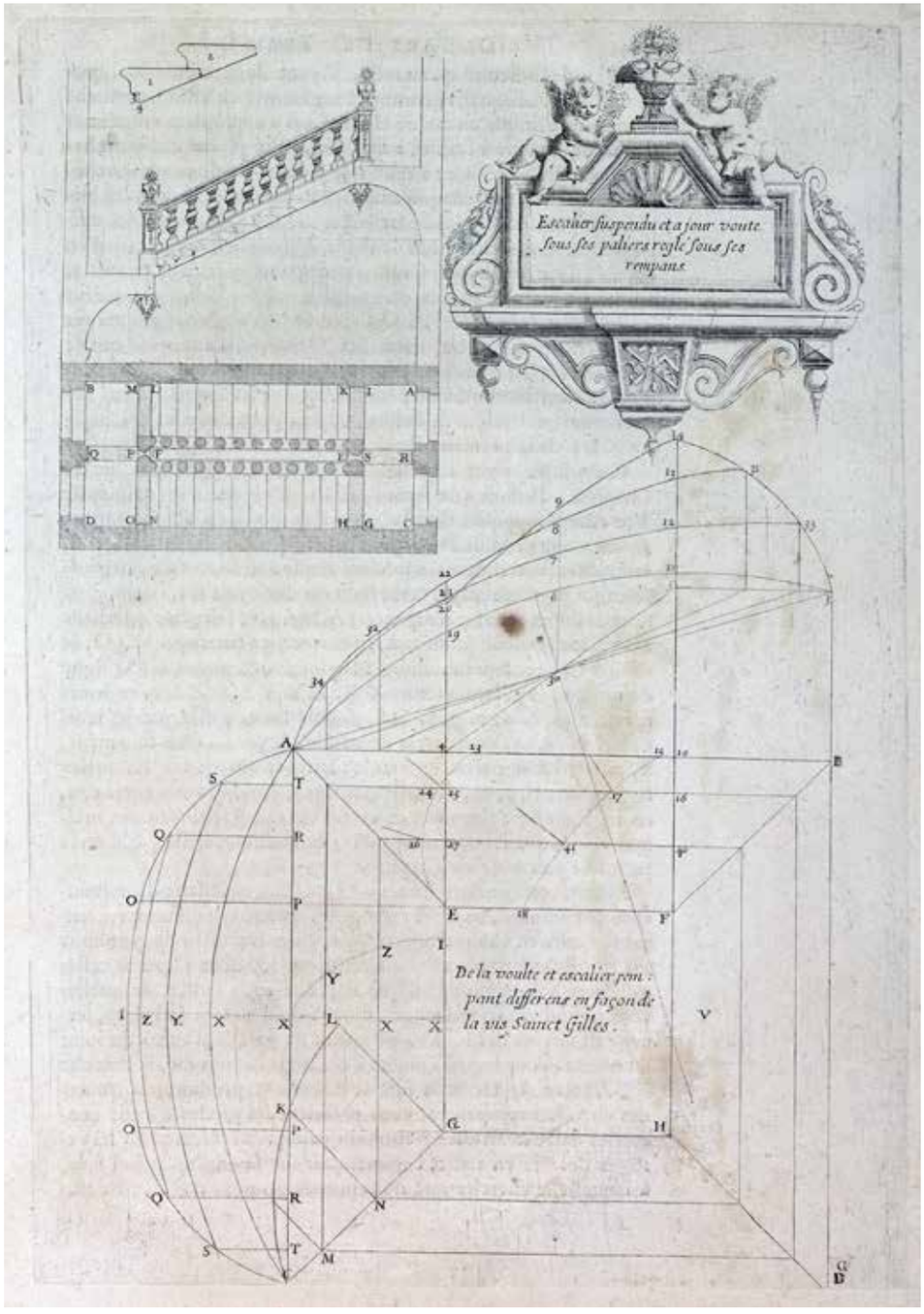


Fig. 7 *F. Derand, Escalier suspendu (in* Derand, *L'architecture des voutes... cit., p. 447 ; © Architectura CESR).*

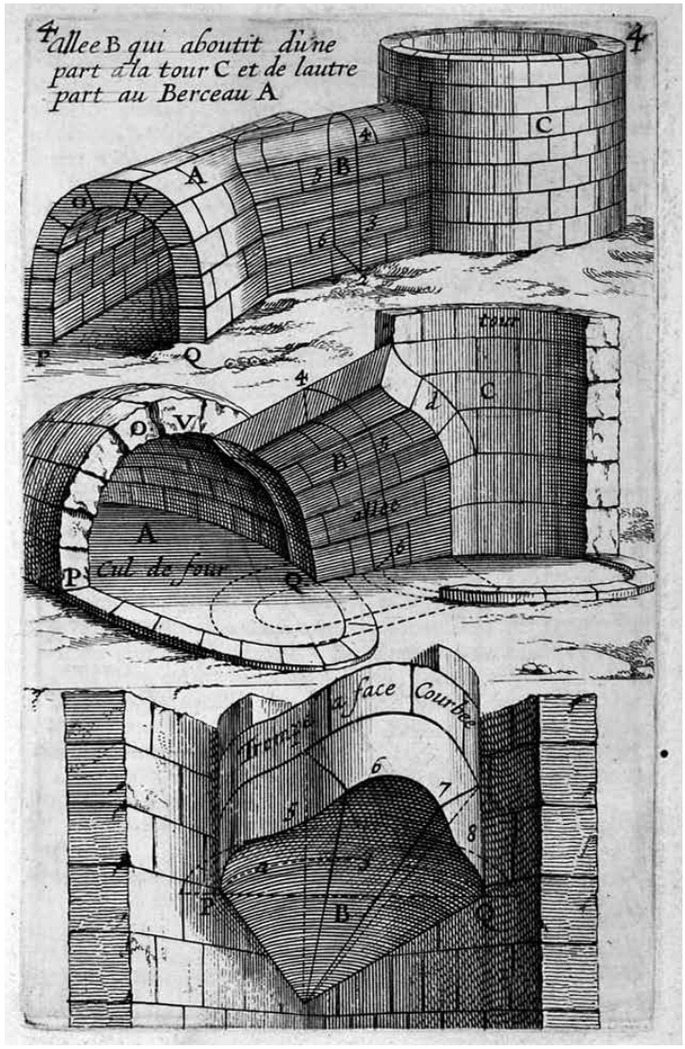
Desargues dans trois ouvrages qui illustrent la théorie développée par le savant en 1636 pour construire la perspective (*Exemple de l'une des manieres universelles... touchant la pratique de la perspective sans emploier aucun tiers point...*), de la stéréotomie (1643) et la gnomonique (1643)[22] à la perspective (1647-1648)[23]. Persuadé que la méthode de Desargues apporte aux praticiens une plus grande rapidité d'exécution, il a rédigé un traité qui leur soit accessible, en utilisant une pédagogie efficace. Partant des connaissances de base des appareilleurs, il élève ainsi progressivement son lecteur vers des savoirs plus compliqués en divisant chacune des difficultés rencontrées et en résolvant chaque problème élémentaire : en un mot, il décompose en étapes successives ce que Desargues avait présenté globalement. Surtout il traduit le vocabulaire mathématique en termes de métier (fig. 8). Malgré cet effort pédagogique, la réception de l'ouvrage auprès des praticiens fut assez médiocre[24]. Quelques années plus tard, Bosse qui depuis les années 1650 s'occupe presque exclusivement d'architecture, en dehors de ses cours à l'Académie Royale de peinture et de sculpture, appliqua ces principes dans le *Traité des manières de dessiner les ordres*, premier volet du diptyque sur les ordres publié en 1664-1665, où il aborde aussi le sujet des escaliers et des voûtes, citant les exemples d'escaliers contemporains les plus fameux, celui de la porte Saint-Antoine à Paris (détruite), l'escalier suspendu de l'Hôtel de ville de Lyon, l'escalier du château de Vizille (1653), l'extraordinaire trompe de la maison Saint-Oyen à Lyon (disparue au XIX[e] siècle), ces trois dernières réalisations étant dues à Desargues lui-même[25]. Car le sujet est tout à fait d'actualité : c'est l'époque où dans la capitale parisienne comme dans les grands châteaux se sont multipliés de vertigineux escaliers suspendus grâce aux prouesses stéréotomiques, tel celui du château du René de Longueil à Maisons (François Mansart, 1641-1650) ou celui de l'hôtel de Pierre Aubert de Fontenay, dit hôtel Salé (Gaspard et Balthazar Marsy, Martin Desjardins, 1656-1659)[26] – aujourd'hui musée Picasso. Bosse critique ainsi les « extraordinaires erreurs » d'escaliers aussi prestigieux que celui du palais du Luxembourg, du Palais Cardinal et d'autres grandes demeures parisiennes, dont les mains courantes ne s'ajustent pas correctement

[23] A. Bosse, *Maniere universelle de Mr Desargues, pour pratiquer la perspective par petit-pied, comme le geometral...*, Paris 1648, ouvrage accessible en ligne avec la présentation de Jean-Pierre Manceau (http://architectura.cesr.univ-tours.fr/Traite/Notice/CESR_7159.asp?param= ; consulté 7 mai 2020).

[24] Voir la présentation en ligne de l'ouvrage (Bosse, *La pratique du trait a preuves...* cit.) par Jean-Pierre Manceau, sur le site du CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/MBAT1950-7-1.asp?param=en ; consulté 7 mai 2020).

[25] A. Bosse, *Traité des manières de dessiner les ordres...* , Paris 1664-1665. Ouvrage accessible en ligne avec ma présentation sur le site du CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/ENSBA188A7TMDO.asp?param= ; consulté 7 mai 2020). Voir F. Lemerle, *Les livres d'architecture du graveur Abraham Bosse*, in *Le livre et l'architecte*, éd. J.Ph. Garric, É. d'Orgeix, E. Thibault Wavre 2011, p. 172-179.

[26] En raison de l'activité de P. Aubert de Fontenay qui était fermier des Gabelles.



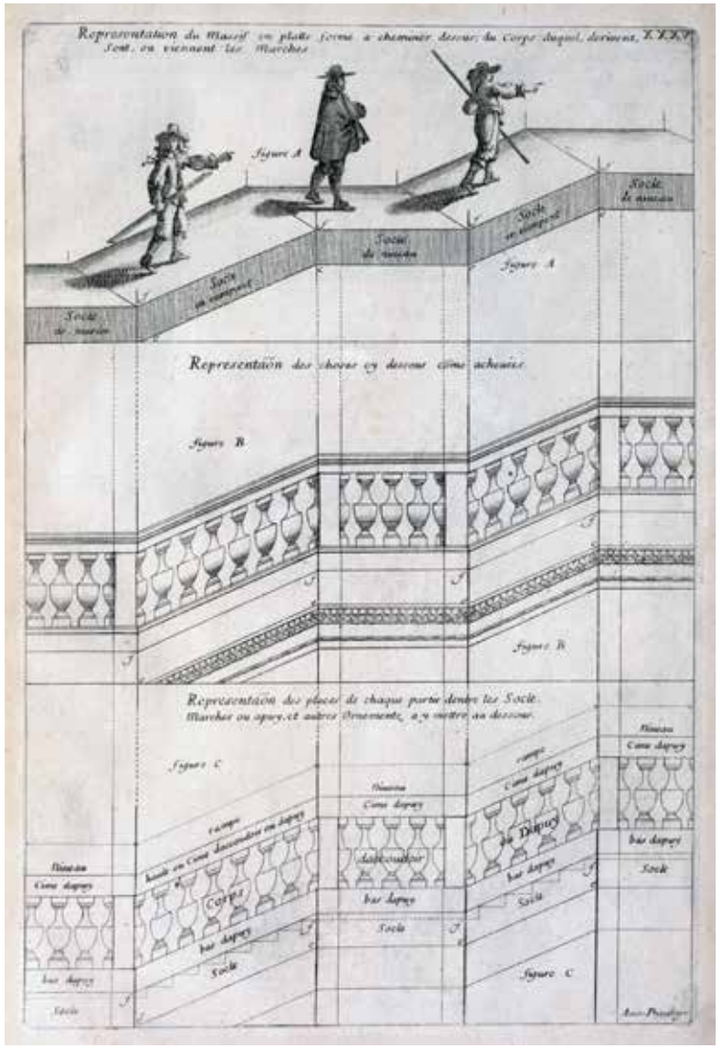


Fig. 8 *A. Bosse, Exemples de voûtes et trompe (in* Bosse, Desargues, *La pratique du trait à preuves... cit., pl. 4 ; © Architectura CESR).*

Fig. 9 *A. Bosse, Balustrades d'escaliers (in A.* Bosse, *Traité des manieres de dessiner les ordres... , Paris 1664-1665, pl. 9 ; © Architectura CESR).*

aux retours (fig. 9). Or ce défaut peut être aisément corrigé si l'on suit Desargues, le premier à proposer un tracé qui élimine les ruptures de pente disgracieuses aux retours et permet ainsi d'ajuster parfaitement les balustres ou tout autre élément décoratif des différentes volées[27].

Les Vitruve de Claude Perrault

On ne peut terminer ce panorama de la littérature technique en France sans évoquer l'édition critique du traité vitruvien par Claude Perrault et l'*Abrégé* très personnel qu'il en a donné. L'édition de Vitruve s'inscrit dans une politique globale qui vise à concrétiser la *translatio imperii et studii* voulue par Louis XIV menée à bien par son ministre et surintendant des Bâtiments Jean-Baptiste Colbert[28]. Pourtant, dans les années 1670, Vitruve n'est plus d'actualité mais, en dehors des monuments antiques, il est l'indispensable caution pour fonder une architecture d'État à valeur universelle. L'ouvrage est donc une commande et obéit à un cahier des charges précis : traduire la somme antique mais aussi et surtout la commenter et l'illustrer en modernisant le propos pour qu'il soit accessible en particulier aux divers corps de métier. La publication de 1673 est du reste un peu postérieure à la création de l'Académie d'architecture (1671) qui s'était donné pour premier travail précisément la lecture du traité antique[29]. Dans le cas présent c'est moins la traduction que le métadiscours auquel elle donne lieu dans les volumineuses notes qui importe. L'une des exigences du ministre était l'actualisation des sciences dans le domaine de l'architecture et celui de l'hydraulique. Les techniques antiques, toujours applicables, ont donc été illustrées et largement expliquées dans les notes ; mais les applications modernes et les ingénieux perfectionnements qui ont été opérés depuis l'Antiquité, y sont également développés. La traduction de Vitruve est le prétexte pour fonder un autre discours où le commentateur accorde une place privilégiée aux réalisations architecturales ou techniques

[27] Lemerle, Pauwels, *Architectures de papier...* cit., p. 156-158.
[28] Vitruvius, *Les dix livres d'Architecture de Vitruve...* , éd. C. Perrault, Paris 1673, p. 149-150.
[29] Ouvrage accessible en ligne avec la présentation de Pierre Gros sur le site du CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/ENSBA_01665A0013.asp?param= ; consulté 7 mai 2020). Sur C. Perrault, voir A. Picon, *Claude Perrault, 1613-1688, ou la curiosité d'un classique*, Paris 1988.

contemporaines. Et c'est précisément cette perspective moderne et l'abondante iconographie qui ont assuré le succès de l'ouvrage. C'est la science de la stéréotomie, parvenue sous Louis XIV à une telle perfection qui a permis de doter la Colonnade du Louvre (1667-1668) d'une architrave clavée portée par des colonnes jumelées. C'est grâce à la supériorité des Modernes dans le domaine technologique : si les Anciens savaient parfaitement appareiller à sec, ils n'avaient pas les moyens techniques pour mettre en œuvre les architraves de longue portée. D'extraordinaires engins ont en effet acheminé depuis Meudon les pierres sans les briser, les ont élevées sur le chantier du Louvre et les ont positionnées sans les rompre : Perrault les illustre dans son édition augmentée de 1684 (fig. 1)[30]. Les Français disposent aussi de machines performantes pour élever l'eau sans aide extérieure comme celle qui a été utilisée dans le jardin de la Bibliothèque du Roi[31].

Le pseudo *Abrégé* de Vitruve que Perrault publia un an après la première édition de sa traduction annotée du *De architectura*, est uniquement destiné aux apprentis et maîtres. L'ouvrage, publié dans un petit format (in-12°) chez Jean-Baptiste Coignard comme le *Vitruve*, malgré son titre, n'est pas un *compendium* : comme Le Muet l'avait fait avant lui pour Palladio, Perrault refond le texte vitruvien tout en l'actualisant. Il le divise en deux parties, la première regroupant tout ce qui est commun avec les Anciens (solidité, matériaux, planchers, murs, situation, exposition des bâtiments, ordres), la seconde isolant l'architecture spécifique aux Anciens (temples, places publiques, demeures privées...). Il l'illustre à la fin de onze planches. Ce faisant, il ajoute au texte antique tout ce qui lui manque pour définir les règles de ce qu'il appelle la « beauté positive », signalant ses ajouts en marge par des guillemets. Perrault fait ainsi de son *Abrégé* un Vitruve moderne de poche. Et ce sont précisément les libertés prises avec le traité antique qui assurent le succès international de l'ouvrage, avec une édition hollandaise en 1681, une traduction anglaise souvent rééditée (1692, 1703....) et une traduction italienne (1711...)[32].

Les traités techniques ainsi que les ouvrages composites qui abordent dans le détail certains aspects pratiques de la construction soulèvent l'ampleur de la problématique posée par ce type de littérature : la relation étroite entre théorie et pratique architecturale – la théorie anticipant ou concrétisant souvent l'expérience –, tradition et modernité, science et technique, avec les rapports parfois conflictuels entre architectes et maîtres d'œuvre. De vives querelles ont opposé Girard Desargues et Abraham Bosse aux appareilleurs et maîtres-maçons parisiens et notamment à Jacques Curabelle, « le meilleur appareilleur de son temps » selon Pierre-Jean Mariette (1694-1774)[33]. Curabelle semble le premier à avoir utilisé le terme de stéréotomie, savoir longtemps dit « art du trait »[34]. Du point de vue de la production éditoriale, force est de reconnaître que les auteurs se sont adaptés à l'offre et à la demande, voire à la commande royale. Ils ont innové ou traduit en adaptant les auteurs du siècle passé à leur pays d'accueil (Palladio, Vignole) ou Vitruve lui-même. Ce faisant, ils ont assuré à ces ouvrages une diffusion internationale, par le biais des contrefaçons ou de traductions de traductions. Aussi la production des traités techniques ne peut-elle être appréhendée qu'à l'échelle européenne et selon la culture de chaque pays.

[30] C. Perrault, *Les dix livres d'Architecture de Vitruve... Seconde edition reveuë, corrigée, & augmentée*, Paris 1684, p. 339, note 4. En 1673 Perrault ne décrivait qu'une seule machine (Vitruvius, *Les dix livres*… cit. (1673), p. 280, note 1). L'édition de 1684 est accessible en ligne avec ma présentation sur le site du CESR (http://architectura.cesr.univ-tours.fr/Traite/Notice/B250566101_11604.asp?param= ; consulté 7 mai 2020).

[31] Vitruvius, *Les dix livres*… cit. (1673), p. 292-293, note 3 ; (1684), p. 318-319, note 8.

[32] C. Perrault, *Abregé des dix livres d'Architecture De Vitruve*, Paris 1674 : l'ouvrage est accessible en ligne avec ma présentation sur le site du CESR (*http://architectura.cesr.univ-tours.fr/Traite/Notice/PerraultCl1674.asp?param=* ; consulté 7 mai 2020). Sur les éditions de Vitruve et l'*Abrégé* de Perrault, voir Lemerle, *Vitruve, Vignole, Palladio et les autres*… cit. ; ead., *D'un* Parallèle *à l'autre. L'architecture antique : une affaire d'État*, «Revue de l'Art», 170, 2010, 4, p. 31-39 et ead., *La face cachée du Vitruve de Claude Perrault (1673, 1684)*, in *La cause en est cachée*, éd. M. Chaufour, S. Taussig, Turnhout 2020, p. 447-455 (http://www.brepols.net/Pages/FCTitles.aspx ; consulté 7 mai 2020) ; Lemerle, Pauwels, *Architectures de papier*... cit., p. 93-94, 116-118.

[33] P.J. Mariette, *Abecedario*... , Paris 1851-1862, notice « Curabelle ». Curabelle a travaillé notamment avec Jacques Lemercier à la chapelle de la Sorbonne, à Paris.

[34] J. Curabelle, *Examen des Œuvres du S^r Desargues*, Paris 1644. Curabelle y présente l'esquisse de ce qui devait constituer le tome 1 d'un cours d'architecture resté inédit (Perouse de Montclos, *L'architecture à la française*... cit., p. 98).

Claire Ollagnier, Hélène Rousteau-Chambon

LA VALEUR DE L'EXEMPLE DANS LE *TRAITÉ D'ARCHITECTURE* (v. 1714) DE PHILIPPE DE LA HIRE

Even in his own time, Philippe de La Hire (1640–1718) was known as a prolific and accomplished mathematician and scientist with an insatiable curiosity. A member of the Académie des sciences (since 1678) and professor at the Collège Royal (since 1682), in 1687 he became the second professor (after François Blondel) at the Académie royale d'architecture, even though he never built anything. In this academy, he was very active and presented several contributions on the architectural orders, shared his own translation of Scamozzi's L'idea della architettura universale*, and held several courses for the future architects of the king on geometry, optics, stereotomy and architecture. He presented his course on architecture three times (1698–1699, 1705–1706, 1714–1715); it is preserved in three manuscript versions (in Paris, London, and Einsiedeln), covers construction, hydraulics, orders, interior distribution, etc., and can be considered the first general manual on architecture in France. La Hire developed his own propositions on construction. He commented on theoretical texts, studied buildings from antiquity and of his own time, and always and more than other theoreticians, gave great importance to arithmetic and geometry.*

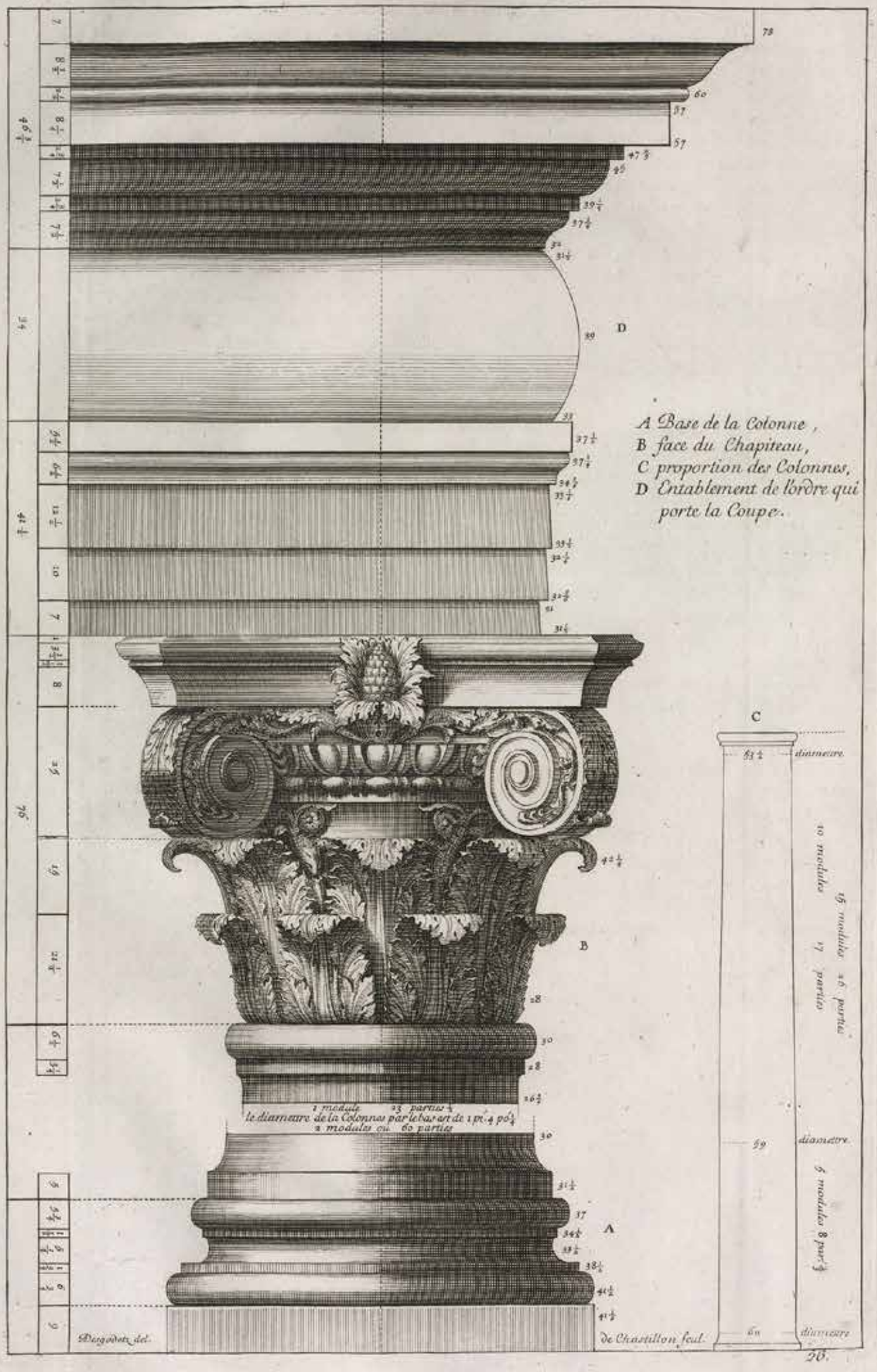
En son temps, Philippe de La Hire (1640-1718)[1] passe pour être non seulement un très grand travailleur mais aussi un homme à la curiosité insatiable[2]. Passionné de géométrie, il est reçu à l'Académie des sciences en 1678 et il y diversifie ses compétences (cartographie, hydraulique, gnomonique, physiologie, botanique, astronomie…). Il ne tarde pas non plus à être reconnu en dehors de cette institution : d'abord nommé professeur au Collège royal (1682 ; actuel Collège de France), il est désigné pour être professeur de l'Académie royale d'architecture en 1687, sans avoir rien construit ni écrit d'ouvrage théorique sur ce sujet[3]. Il marche alors sur les pas de François Blondel (1618-1686), lecteur de mathématiques au Collège royal (1656), membre de l'Académie des sciences (1669) et membre fondateur de l'Académie d'architecture en 1671, mais qui, lui, était déjà l'auteur du pont de Saintes (1665) et de la corderie Rochefort (1666)[4]. Ce choix confirme néanmoins le souci de faire de la connaissance des sciences un enjeu primordial pour les jeunes gens qui sont formés dans cette dernière institution. Cette désignation est aussi peut-être liée à la grande connaissance du dessin de ce nouveau professeur : fils du peintre Laurent de La Hyre (1606-1656) – l'orthographe diffère –, un des membres fondateurs de l'Académie royale de peinture et de sculpture, il a appris le dessin, la perspective et la musique, le latin et le grec dans le petit atelier familial[5]. Tout au long de sa carrière, il conserve d'ailleurs un goût pour le dessin ; son premier historiographe, le secrétaire perpétuel de l'Académie des sciences, Bernard Le Bouyier de Fontenelle (1657-1757)[6], souligna que La Hire était « un bon dessinateur & un habile peintre de paysage, car il réussissait mieux en ce genre de peinture peut-être parce il y a plus de rapport à la perspective, & à la disposition simple & naturelle des objets, telle que la voit un physicien qui observe »[7]. Le dessin de l'autruche, exécuté pour les *Mémoires pour servir à l'histoire naturelle des animaux* de Claude Perrault (Paris 1676)[8] est un dessin attesté de la production de Philippe de La Hire (fig. 2). Aucune représentation d'architecture n'est en revanche conservée, si ce n'est quelques dessins italiens qui lui sont attribués (fig. 3) ainsi que de rares croquis explicitant les mémoires qu'il présentait aux membres de l'Académie d'architecture[9] (fig. 4).

Cet homme de sciences, qui est donc aussi un bon dessinateur, est choisi pour être le second professeur à l'Académie royale d'architecture, institution fondée en 1671 qui avait pour but d'établir des normes architecturales pour la France et de former les architectes du roi. Il va y développer des propositions très personnelles quant au bâti qui a, selon lui, valeur d'exemple. Cette exemplarité prend des formes diverses pour lui. Ainsi ponctue-t-il régulièrement son propos de références concrètes qu'il convient de mettre en lumière et d'analyser dans le cadre de cet article. Comme la plupart de ses contemporains, La Hire appuie ses propos sur les textes théoriques ; mais il sait aussi s'en émanciper et, dans certains cas, mettre à profit son passé de géomètre. De plus, il ne se contente pas de références théoriques mais, à la suite de Vitruve et de Scamozzi, il mêle théorie et pratique. Il examine ainsi également les édifices, que ceux-ci datent de l'époque romaine ou qu'il s'agisse de réalisations contemporaines : s'il accorde beaucoup de crédit aux textes, ce professeur semble également développer un rapport distancié avec leur mise en œuvre pratique ; c'est alors bien souvent sur des calculs mathématiques qu'il fonde son étude, une spécificité pour cette époque. Cette méthode *a priori* inédite dans le contexte de la production pédagogique contemporaine gagne en outre à être comparée aux écrits théoriques contemporains.

Un professeur très actif

Dès sa nomination à l'Académie royale d'architecture, La Hire intervient régulièrement dans les débats, non seulement sur les aspects « mathématiques » (comme le toisé), mais aussi sur l'Antiquité et les ordres[10] ; il fait notam-

Opus Incertum (2020) pp. 98-113 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12364 www.fupress.com/oi

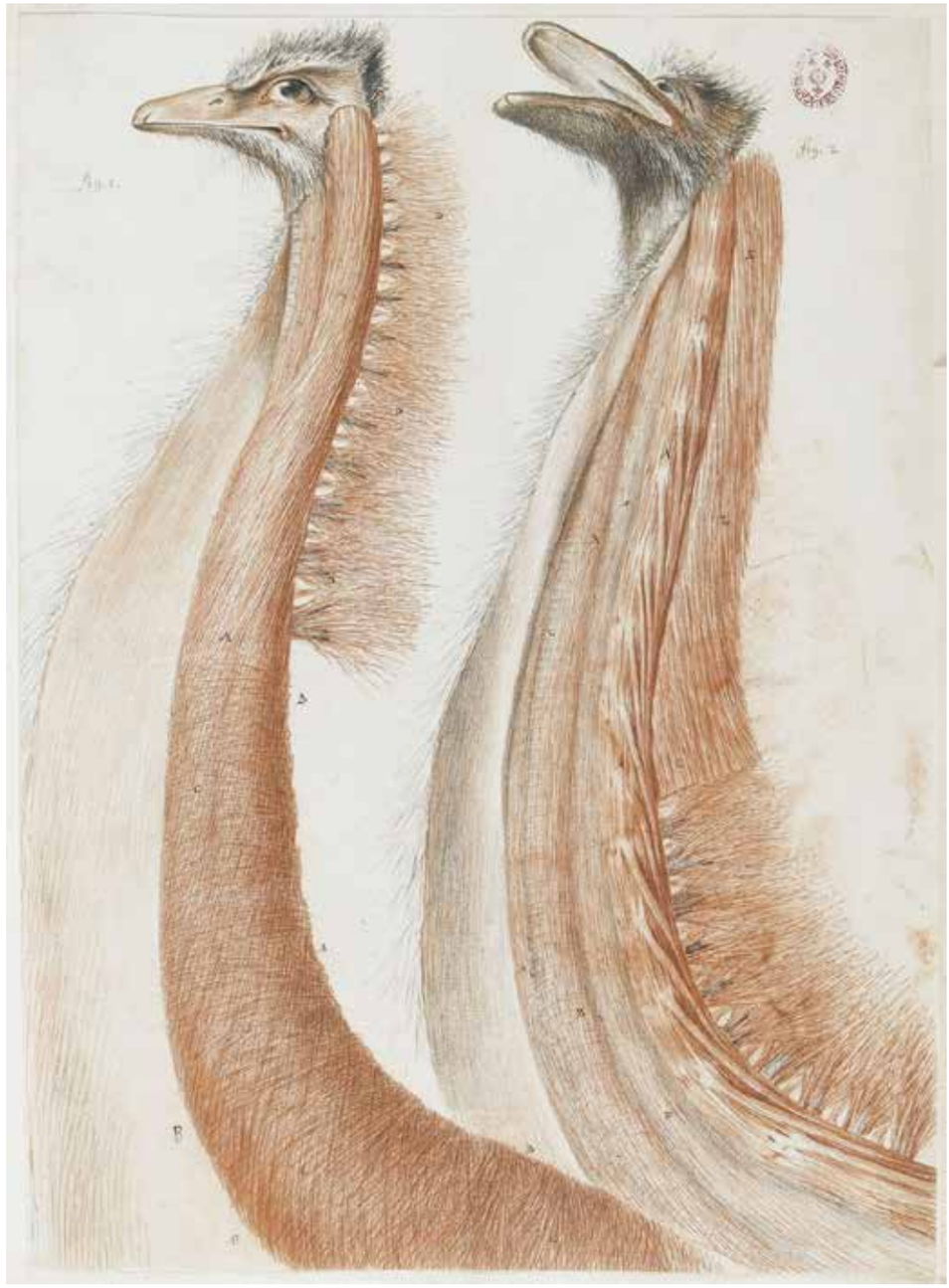

A Base de la Colonne,
B face du Chapiteau,
C proportion des Colonnes,
D Entablement de l'ordre qui porte la Coupe.
1 module 23 parties
le diametre de la Colonne par le bas est de 1 pi. 4 po.
2 modules ou 60 parties
C
diametre
15 modules 26 parties
diametre
5 modules 8 parties
diametre
Desgodets del.
de Chastillon fecit
20.

pagina 99
Fig. 1 *A. Desgodets, Temple de Bacchus (in* Desgodets, *Edifices antiques de Rome… cit. ; © INHA).*

Fig. 2 *Ph. de la Hire, Dessin de l'autruche (in Mémoires pour servir à l'histoire naturelle des animaux, dressé par M. Perrault, Paris 1676 [ed. 1731] ; © RMN).*

Fig. 3 *Ph. de La Hire (attribué), Monastère en Italie (Paris, Ecole Nationale Supérieure des Beaux-Arts, fonds Masson, Mas 1003 ; © ENSBA).*

Fig. 4 *Ph. de la Hire, Dessin de roue (in Mémoire sur les mécaniques, où il explique les efforts différents que l'homme peut faire pour élever des fardeaux et les pousser, 4 décembre 1702 ; Paris, Bibliothèque de l'Institut de France, section Beaux-Arts, carton B9 ; photo H. Rousteau-Chambon).*



[1] L.G. Michaud, *Biographie universelle ancienne et moderne, ouvrage entièrement neuf rédigé par une société de gens de lettres et de savants*, Paris 1819, t. 23, p. 196-198 ; J.M. Quérard, *La France littéraire ou Dictionnaire biographique des savants historiens et gens de lettres de la France*, Paris 1830, IV, p. 445-447 ; F. Hoefer, *Nouvelle biographie générale depuis les temps les plus reculés jusqu'à nos jours*, Paris 1861, XXVIII, p. 191-193 ; H. Blémont, *La Hire (Philippe de La Hyre dit)*, in *Dictionnaire de biographie française*, Paris 1933-2015, 19, col. 329 ; R. Taton, *La Hire, Philippe de*, in *Dictionary of Scientific Biography*, New York 1973, VII, p. 576-579 ; *Index biographique de l'Académie des sciences du 22 décembre 1666 au 1er octobre 1878*, Paris 1979, p. 321 ; D.J. Sturdy, *Hire, Philippe de la*, in *The Biographical Encyclopedia of Astronomers*, edited by T. Hockey, New York 2007, I, p. 513-515 ; F. Chareix, *La Hire, Philippe (1640-1718)*, in *The Dictionary of Seventeenth-Century French Philosophers*, edited by L. Foisneau, London-New York 2008, II, p. 662-664 ; A. Becchi, H. Rousteau-Chambon, J. Sakarovitch, *Philippe de La Hire 1640-1718. Entre architecture et science*, Paris 2013 ; M. Pinault Sørensen, *Philippe de La Hire et ses fils, dessinateurs et savants*, "Bulletin de la société de l'histoire de l'art français", 2010, p. 31-84 ; W. Oechslin, *Ratio und Vorstellungsvermögen, Geometrie! Philippe de La Hire, die wissenschaftliche Grundlage der Architektur in ihrer Ausrichtung auf die Praxis*, "Scholion Bulletin", 7, 2012, p. 73-132 ; H. Rousteau-Chambon, *L'Enseignement à l'Académie Royale d'Architecture*, Rennes 2016 ; *Cours d'architecture que j'ay transcrit au Louvre sur les leçons publiques de M. de la Hyre, Professeur royal*, éd. H. Rousteau-Chambon, à paraître chez Fondation W. Oechslin ; W. Oechslin, *Avant-propos*, ivi ; C. Ollagnier, H. Rousteau-Chambon, *Introduction*, ivi.

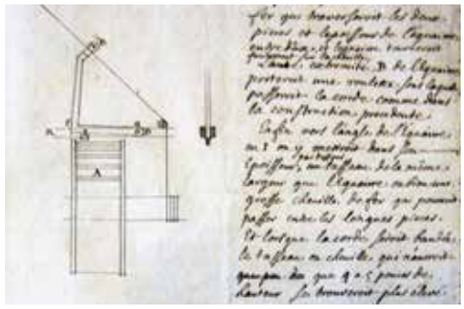
[2] J.P. Niceron, *Mémoire pour servir à l'histoire des hommes illustres dans la république des lettres*, Genève 1971 (première éd. Paris 1729-45), V, p. 335-346 : « Le grand nombre des ouvrages qu'il a donnés au public & les occupations des charges de professeur du Collège royal & de l'Académie d'architecture, que son mérite lui avait procurées doivent donner l'idée non seulement d'une grande assiduité au travail mais encore d'une santé forte & vigoureuse […] Toutes ses journées étaient occupées par l'étude & ses nuits très souvent interrompues par ses observations astronomiques ».

[3] La Hire est en revanche l'auteur de très nombreux ouvrages scientifiques. Ph. de La Hire, *Nouvelle méthode en géométrie pour les sections des superficies coniques et cylindriques*, Paris 1673 ; Id., *Nouveaux éléments de sections coniques. Les lieux géométriques, la construction ou effection des équations*, Paris 1679 ; Id., *La Gnomonique ou l'art de tracer des cadrans solaires sur toutes sortes de surfaces par différentes pratiques*, Paris 1682 ; Id., *Sectiones conicae in novem libros…*, Paris 1685 ; Id., *Tabularum astronomicarum pars prior, de motibus solis et lunae, nec non de positione fixarum ex ipsis observationibus deducta…*, Paris 1687 ; Id., *L'Ecole des arpenteurs où l'on enseigne toutes les pratiques de géométrie qui sont nécessaires à un arpenteur*, Paris 1689 ; Id., *Veterum mathematicorum Athenai, Apollodori, Philonis, Bitonis, Heronis, et aliorum opera. Graece et latine pleraque nunc primum edita. Ex manuscriptis codicibus Bibliothecae regiae*, Paris, 1693 ; Id., *Traité de Mecanique*, Paris 1695 ; Id., *Tabulae astromicae ludovici magni jussu et munificentia exaratae et in lucem editae…*, Paris 1702.

ment lecture d'ouvrages de référence comme ceux d'Andrea Palladio (1508-1580), de Jacopo Barozzi dit Vignole (1548-1516) ou de Philibert De l'Orme (1514-1570) et de Jean Bullant (1515-1578). Surtout, La Hire traduit l'ouvrage de Vincenzo Scamozzi[11], commenté pendant près de deux ans à l'Académie (6 décembre 1694-25 janvier 1697) et apporte le *Traité de l'Architecture harmonique* de René Ouvrard (1624-1694)[12] en 1690[13]. Il présente encore des mémoires sur le chapiteau du pilastre corinthien, sur la « grandeur des figures qui doivent accompagner les ordres des colonnes », ou sur la « manière de les former » et revient sur les différentes formes de voûtes : en cul de four, elliptiques, tronquées, sans arêtes, surbaissées[14], ou sur les « grandes voutes » à propos desquels il prend pour exemple les thermes de Dioclétien.

> *30 juin 1705.* M. de La Hire a présenté et lu à la Compagnie un nouveau mémoire sur la question qui a esté proposée au sujet des grandes voûtes. Ce mémoire contient des observations sur la proportion de la voûte des Thermes de Dioclétien, que M. de La Hire démontre n'estre pas éliptique par le calcul qu'il en a fait sur les mesures que M. Desgodets en a rapportés[15].

Effectivement, dans le « 3e mémoire sur l'exhaussement des voutes circulaires pour les faire paroitre en plein cintre », La Hire explique notamment :



> J'ai aussi remarqué que ces arcs des thermes de Dioclétien ne sont pas elliptiques comme je les ay proposés [d'autres exemples ont été cités précédemment] mais qu'ils sont beaucoup plus larges par leur partie superieure qu'ils ne devroient être, car suivant les mesures exactes que Mr Desgodets nous en a communiquées, je trouve que dans le grand arc, sa hauteur du milieu de l'arc dans les croisées des côtés est de 141 pieds[16].

La Hire rectifie les mesures précédemment indiquées par Antoine Desgodets, qui avait été envoyé à Rome par Colbert pour établir un relevé des édifices antiques ; Desgodets était resté seize mois, à partir de 1676[17]. Il est vrai que déjà en 1696, Oppenord, alors pensionnaire de l'Académie de France à Rome, avait été chargé de vérifier les mesures données par Desgodets[18]. La précision des chiffres reste d'autant plus importante pour La Hire que la forme des voûtes, leur dessin et la coupe des pierres, autre thème de prédilection de La Hire, découle de ces calculs[19]. La Hire s'implique donc dans les débats sur des sujets très variés, le plus souvent à partir d'exemples concrets, et se fonde sur des calculs précis permettant de remettre en cause des observations faites à l'œil nu qui étaient, jusque-là, acceptées par tous. Les calculs mathématiques permettent de regarder autrement l'architecture. Cette conception de l'architecture est encore plus évidente dans ses cours.

En effet, parallèlement à ses interventions dans les conférences hebdomadaires qui visent à établir des normes architecturales[20], La Hire, à l'aune de ce qu'organise son prédécesseur François Blondel, a la responsabilité de deux heures de cours chaque semaine : le premier doit porter sur l'architecture (fig. 5) et le second sur les « mathématiques appliquées à l'architecture »[21]. C'est ainsi qu'il dispense des cours diversifiés d'une part sur l'architecture et d'autre part sur la géométrie, l'optique, la mécanique, ou encore sur la coupe des pierres. À l'occasion de l'une de ces leçons hebdomadaires, il assure, à trois reprises (1698-1699, 1705-1706, 1714-1715) – comme il est fait mention dans les procès-verbaux de l'Académie –, un cours d'architecture, conservé à l'état de manuscrit en trois exemplaires[22] ; les trois versions sont presque identiques tant pour le plan suivi que pour les propos, mais aucun n'est autographe[23]. Le cours est constitué de trois parties, précédées d'un avant-propos. Dans la première partie, intitulée « Architecture civile », La Hire aborde à la fois les questions générales sur l'architecture (précaution qu'il faut prendre avant de bâtir), et des aspects plus scientifiques (nivellement). La deuxième section, intitulée « de l'architecture » est composée de questions relatives à la distribution et aux ordres, et la dernière, « de l'exécution », est constituée d'une étude des matériaux et de la mise en œuvre concrète de l'architecture. Ce projet, très complet, montre d'emblée combien La Hire se distingue de François Blondel, qui certes a annoncé des thèmes de cours très variés, mais finalement n'en a publié qu'un sur les ordres (*Cours d'architecture enseigné dans l'Académie royale d'architecture*, Paris, 1675-1683), les manuscrits des autres leçons n'ayant, par ailleurs, pas été retrouvés. Le plan et le contenu du cours de La Hire montrent un certain pragmatisme dans la manière d'aborder l'architecture et reflètent une démarche logique, si l'on excepte certaines digressions. En effet, un chapitre sur le nivellement apparaît curieusement en première partie ; d'autres, consacrés aux « citernes et canaux » et aux « ponts et quais » prennent place au cœur du développement sur la structure des maisons particulières[24]. L'intérêt que La Hire porte aux sciences, et la reconnaissance que lui accordent ses pairs en ce domaine peuvent expliquer ce parti pris. D'ailleurs, La Hire n'a de cesse d'établir des liens

[4] P. Mauclaire, C. Vigoureux, *Nicolas-François de Blondel, ingénieur et architecte du roi (1618-1686)*, Paris 1938 ; A. Gerbino, *François Blondel: Architecture, Erudition, and the Scientific Revolution*, London-New York 2010.

[5] *Laurent de la Hyre, 1606-1656, L'homme et l'œuvre*, catalogue d'exposition (Grenoble, 14 janvier-10 avril 1989 ; Rennes, 9 mai-31 août 1989 ; Bordeaux, 6 octobre 1989-6 janvier 1990), éd. P. Rosenberg, J. Thuillier, Paris 1988, p. 67-68 ; Pinault Sørensen, *Philippe de La Hire et ses fils*… cit., p. 31.

[6] M.S. Seguin, *Fontenelle et l'Histoire de l'Académie royale des sciences*, "Dix-huitième siècle", 44, 2012, 1, p. 365-379.

[7] B. Le Bouyer de Fontenelle, *Eloge de Monsieur de La Hire*, in *Histoire de l'Académie royale des Sciences. Année M. DCCXVIII. Avec les Mémoires de Mathématiques & de Physique, pour la même année. Tirés des Registres de cette Académie*, Paris 1719, 20, p. 76-89 (rééd. Becchi, Rousteau-Chambon, Sakarovitch, *Philippe de La Hire*… cit., p. 243-250) ; *Dessin et sciences XVII^e-XVIII^e siècles*, catalogue d'exposition (Paris, 22 juin-24 septembre 1984), éd. M. Pinault, Paris 1984.

[8] Sur Claude Perrault voir notamment A. Picon, *Claude Perrault, 1613-1688 ou la curiosité d'un classique*, Paris 1988.

[9] Les mémoires sont conservés dans les archives de l'Institut de France (Paris, Bibliothèque de l'Institut de France, section Beaux-Arts, carton B9).

[10] 19 décembre 1687, *Procès-verbaux de l'Académie royale d'architecture (1671-1793)*, éd. H. Lemonnier, Paris 1911-1929, II, p. 153. Pour une liste complète des mémoires présentés par La Hire à l'Académie royale d'architecture, voir Becchi, Rousteau-Chambon, Sakarovitch, *Philippe de La Hire*… cit., p. 307-309.

[11] V. Scamozzi, *L'Idea dell'Architettura Universale*, Venezia 1615.

[12] René Ouvrard est un prêtre et compositeur français auteur de divers ouvrages sur la musique. Son *Architecture Harmonique ou application de la doctrine des proportions de la musique à l'architecture* a fait l'objet d'une édition critique par Vasco Zara (R. Ouvrard, *Architecture Harmonique ou application de la doctrine des proportions de la musique à l'architecture*, éd. V. Zara, Paris 2017).

[13] *Procès-verbaux de l'Académie*… cit., II, p. 203-204.

[14] 24 novembre 1692, mémoire en appendice, *Procès-verbaux de l'Académie*… cit., II, p. 350-351 ; 15 et 29 octobre 1688, ivi, II, p. 168-169 ; 19 novembre 1688, ivi, II, p. 170 ; 23 février 1693, ivi, II, p. 352-353 ; 11 janvier 1694, ivi, II, p. 354-357 ; 15 juin 1705, ivi, III, p. 220 ; 2 juillet 1708, ivi, III, p. 297 ; 6 mars 1713, ivi, IV, p. 19-20.

[15] 30 juin 1705, ivi, III, p. 221.

[16] Paris, Bibliothèque de l'Institut de France, section Beaux-Arts, carton B9.

[17] A. Desgodets, *Les Édifices antiques de Rome*, Paris 1682. Sur la conception de cet ouvrage et ses apports, voir l'introduction de H. Rousteau-Chambon, à la réédition du fac simile (Paris 2008).

[18] A. de Montaiglon, *Correspondance des directeurs de l'Académie de France à Rome*, Paris 1887-1912, II, p. 239, 26 juin 1696. Ces mesures sont à nouveau vérifiées par Pierre-Adrien Pâris en 1779, comme l'indique le manuscrit conservé à la bibliothèque de l'Institut de France : Paris, Bibliothèque de l'Institut de France, ms. 1906, *Notes et lavis de Pierre-Adrien Paris, intercalés par lui, avec différentes estampes, dans «Les édifices antiques de Rome, dessinés et mesurés très exactement par feu M. Desgodetz», Nouvelle édition, Paris, C.A. Jombert, 1779.*

entre les deux académies dont il relève, l'Académie des sciences et l'Académie d'architecture[25]. Mais viennent aussi d'autres questions – pourquoi un chapitre sur les portes de ville dans la distribution des maisons particulières, et cette redondante question du bois dans la troisième partie ? – face auxquelles nous ne pouvons qu'élaborer des pistes de réflexions. Est-ce la destruction progressive des enceintes de ville[26], remplacées par quelques édifices emblématiques, comme la porte du Peyrou à Montpellier réalisée sur les dessins de François d'Orbay (1691-1693)[27] sur le modèle de la porte Saint-Denis à Paris de Blondel (1672), qui conduit La Hire à les évoquer ? Est-ce parce que son fils Gabriel Philippe – et Philippe de La Hire n'a de cesse d'inscrire ses fils dans les institutions dont il relève[28] – prépare alors la réédition d'un ouvrage sur la charpenterie[29] ? Il est difficile de le savoir, mais c'est aussi précisément dans ses imperfections et ses lacunes que réside l'intérêt d'un tel document.

Comme ses contemporains, La Hire indique clairement sa volonté de trouver une solution conciliant un idéal normatif et les impératifs nouveaux de la construction, mais, dans son discours, on ne sent pas, pour autant, l'ambition de prouver l'hégémonie du Siècle de Louis XIV. Ainsi, pour la construction en plâtre, qu'il est le seul à étudier véritablement pendant deux folios, écrit-il, mêlant étude du matériau et pragmatisme :

> La pierre du platre est d'une nature toute particulière et il y en a en peu d'endroits, encore est elle fort differente dans la qualité car il y en a qui demande dans la cuisson un feu de longue durée au lieu qu'il s'en trouve qui serait en tres peu de temps. L'on le garde trop de tems après qu'il est cuit, il perd sa force et enfin, il ne se prend plus avec l'eau. Il faut donc l'employer le plus promptement qu'il sera possible apres etre cuit. Les ouvriers savent fort bien que celuy qui est réduit en poussiere tres fine ne fait jamais une aussi grande fermeté que celuy qui n'est que mediocrement ecrasé[30].

La Hire se fonde ici sur les propos de Vitruve ou de Scamozzi, qu'il adapte à la situation française des premières années du XVIII[e] siècle. Cependant, n'étant pas architecte, il façonne son cours avec plus de distance et beaucoup de rigueur, mais n'envisage pas systématiquement tous les aspects des sujets étudiés contrairement à ses contemporains qui présentent les ordres par exemple[31]. En revanche, La Hire embrasse un nombre varié de sujets, ce qui conduit à considérer ce cours comme un véritable manuel général d'architecture, encyclopédique, aussi bien théorique que pratique, à destination des élèves architectes, plus d'un demi-siècle avant le *Cours d'architecture* de Jacques François Blondel (1771-1777)[32]. Ces caractères essentiels peuvent cependant paraître d'autant plus surprenants que La Hire n'a jamais rien construit. Pour pallier ce manque certain, La Hire nourrit son texte de références variées et explicites.

Des références théoriques citées et discutées

Dans un esprit de synthèse assumé, La Hire se réfère à des auteurs divers. Le premier d'entre eux est sans aucun doute Vitruve dont l'œuvre reste fondamentale pour lui comme pour ses contemporains[33]. Au-delà de la célèbre traduction qu'en livre Claude Perrault en 1673[34], l'auteur et son ouvrage de référence – *De architectura* – sont continuellement cités par les membres de l'Académie royale d'architecture. Cet intérêt n'est d'ailleurs pas étonnant puisque les approches des deux hommes sont similaires et qu'ils sont, l'un et l'autre, intéressés par les aspects scientifiques et techniques de l'architecture. La Hire se fonde régulièrement sur les propos de Vitruve, notamment dans sa présentation des ordres et dans le domaine de la construction. Ainsi, quant à la manière de construire en bois, La Hire explique :

> Les anciens ont aussy mis quelques fois des pieces de bois qui traversaient toute l'épaisseur du mur et qui seraient à en rendre la construction plus solide

[19] Sur la coupe des pierres, voir notamment L. Tamborero, *De Delorme à de La Hire, La recherche d'une méthode universelle dans les traités de stéréotomie. Opérations géométriques et emprunts*, thèse du diplôme, Ecole des Hautes Études en Sciences Sociales, 2008 ; Id., *Le Traité de la coupe des pierres*, in Becchi, Rousteau-Chambon, Sakarovitch, *Philippe de La Hire*… cit., p. 191-202.

[20] Voir sur l'organisation et le but de l'Académie : W. Schöller, *Die « académie royale d'architecture » 1671-1793, Anatomie einer Institution*, Köln 1993 ; B. Baudez, *Architecture et tradition académique au temps des Lumières*, Rennes 2012.

[21] Ce sont les termes employés par Blondel : F. Blondel, *Cours d'architecture enseigné dans l'Académie Royale d'Architecture*, Paris 1675-1683, préface, non paginée.

[22] Londres, Riba, ms. 725 : *Architecture civile par Mr de La Hire de l'académie des sciences et professeur royal d'architecture* ; Paris, Bibliothèque de l'Institut de France, ms. 8125 : *Cours d'architecture enseigné au Louvre dans l'académie royalle par Monsieur de La Hire, professeur de matématiques du college royal à Paris* ; Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture que j'ay transcrit au Louvre sur les leçons publiques de M. de la Hyre, professeur royal*. C'est ce manuscrit qui sert de référence. Le texte a fait l'objet de très peu d'études jusqu'à ces dernières années. Henry Lemonnier ne le connaissait pas et c'est Françoise Hamon qui l'a cité pour la première fois : F. Hamon, *Le château dans le discours sur architecture XVI[e]-XVIII[e] siècle*, "Arts de l'ouest, Etudes et documents", 1978, 1, p. 5-20. Depuis, il a été présenté dans le colloque consacré à Philippe de La Hire (H. Rousteau-Chambon, *Le Traité d'architecture*, in Becchi, Rousteau-Chambon, Sakarovitch, *Philippe de La Hire*… cit., p. 203-216) et comparé aux autres cours dispensé à l'Académie (Rousteau-Chambon, *L'Enseignement à l'Académie*… cit.).

[23] Voir sur ce sujet, *Cours d'architecture*… cit., éd. H. Rousteau-Chambon.

[24] Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture*… cit., 3[e] partie « chapitre 6, De la construction des ponts et des quays », f. 187*v*-198*v* ; ivi, « chapitre 12, Des citernes et des puits », f. 213*v*-214*v*.

[25] H. Rousteau-Chambon, *Un savant chez les hommes de l'art*, in Becchi, Rousteau-Chambon, Sakarovitch, *Philippe de La Hire*… cit., p. 107-109.

[26] Sur l'histoire de l'urbanisme voir P. Lavedan, J. Hugueney, Ph. Henrat, *Histoire de l'urbanisme à l'époque moderne, XVI[e]-XVIII[e] siècles*, Genève 1982 ; *De l'esprit des villes : Nancy et l'Europe urbaine au siècle des Lumières : 1720-1770*, catalogue d'exposition (Nancy, Musée des Beaux-Arts, 7 mai-22 août 2005), éd. A. Gady, J.M. Pérouse de Montclos, Versailles 2005.

[27] Sur cet architecte voir A. Laprade, *François d'Orbay, architecte de Louis XIV*, Bar-sur-Aube 1960.

[28] Pinault Sørensen, *Philippe de La Hire et ses fils*… cit., p. 32-84.

[29] G.Ph. de La Hire, *L'art de charpenterie de Mathurin Jousse, corrigé & augmenté de ce qu'il y a de plus curieux dans cet art, & des machines les plus nécessaires à un charpentier par Mr D.L.H.*, Paris 1702.

[30] Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture*… cit., f. 170*v*.

[31] Nous pouvons citer notamment F. Blondel, *Cours d'architecture enseigné dans l'Académie royale d'architecture*, Paris 1675-1683 ; A. Bosse, *Des ordres de colonnes en l'architecture antique et plusieurs autres dépendances d'icelle*, Paris 1664 ; A.C. D'Aviler, *Cours d'architecture (…) avec une ample explication des termes d'architecture*, Paris 1691 (2[e] éd. revue et augmentée par J.B.A. Le Blond, Paris 1710).

[32] J.F. Blondel, *Cours d'architecture civile ou Traité de la décoration, distribution et construction des bâtiments contenant les leçons données en 1750 et les années suivantes*, I-VI, Paris 1771-1777.

> en liant les paremens les uns aux autres comme l'enseigne Vitruve dans ses murs de villes. Mais ils choisissaient des bois d'ollivier [sic] qui ne se corrompt pas dans la maçonnerie. On n'ozeroit [sic] y mettre les bois dont on se sert ordinairement dans les bastimens comme le chesne, le chasteignier et le sapin à cause que la chaux de mortier les brule et les corrompt en tres peu de temps[35].

Le cours de La Hire laisse, par ailleurs, entrevoir une référence sous-jacente à Scamozzi[36]. Bien que peu cité, l'auteur italien semble avoir profondément marqué le professeur. Il faut dire que la traduction du Livre III de *L'idea dell'architettura universale* qui traite des édifices privés, l'occupe dès son arrivée à l'Académie :

> 31 *Janvier 1687*. M. de la Hire a proposé à la Compagnie que, si elle jugerait à propos, il traduira le troisième livre de Scamozzi, afin d'en faire la lecture dans les conférences et y faire des remarques, à mesure qu'il traduira cet auteur, dont, ensuite, il pourra se servir dans les leçons qu'il donnera aux élèves, et à quoi on l'a exhorté[37].

Cette traduction – dont on comprend qu'elle se fait à son initiative – commence à être exposée et discutée dès l'année 1687, aboutissant à d'importants débats[38]. S'il n'en reste aucune trace manuscrite, il est fort probable que La Hire ait été le plus à même de sa génération à comprendre les propos complexes du théoricien de la fin de la Renaissance, très attaché à considérer l'architecture au regard de la science[39]. Outre Vitruve et Scamozzi, La Hire se réfère également, au gré des sujets abordés, tantôt à Philibert De l'Orme (*Premier tome de l'architecture*, Paris 1567), Andrea Palladio (*I Quattro libri dell'architettura*, Venetia 1570, éd. fr. Paris 1650) ou Pierre Bullet (*Architecture pratique*, Paris 1691) qui citent eux-mêmes certaines de leurs réalisations. Il renvoie aussi, essentiellement sur les questions de salubrité, aux propos du médecin Louis Savot (*Architecture françoise des bâtiments particuliers*, Paris 1624)[40], à ceux de l'historiographe du roi, André Félibien, pour les aspects constructifs (*Des principes de l'Architecture, de la Sculpture, de la Peinture, et des autres Arts qui en dépendent*, Paris 1676)[41], ou encore, pour les mesures des édifices romains à Antoine Desgodets et ses *Edifices antiques de Rome* (Paris 1682). Ces ouvrages restent les références clefs, plus ou moins explicites, de son exposé. Dans certains cas, l'auteur va même jusqu'à indiquer la page de l'ouvrage dont il est question. À propos de la porte antique de l'église Sainte-Sabine, située sur l'Aventin à Rome, on lit notamment : « Mais M. Desgodets qui l'a mesurée avec un tres grand soin dit dans son livre des bastiments de Rome page 18 qu'elle est aussy large par le haut que par le bas »[42]. Ou encore, dans le chapitre consacré aux arcs de triomphe (II[e] partie, chapitre 3) : « Philibert de Lorme page 233 donne la distribution d'une grande porte ornée de deux colonnes de chaque côté, mais il n'y a point d'attique au-dessus de leurs entablements »[43].

Mais La Hire ne se contente pas de se nourrir de ces textes, il cherche aussi à les compléter pour fournir un manuel général de l'architecture. Ainsi, l'auteur est-il probablement le premier théoricien français à écrire une synthèse sur certains matériaux (brique et plâtre) et sur quelques constructions (quais, canaux, écluses). La brique est un sujet évidemment abordé par Vitruve mais La Hire se montre beaucoup plus précis et organisé que l'auteur romain : il évoque les raisons de son emploi, la composition des briques, leur cuisson et leurs avantages. Ce sujet lui tient d'ailleurs particulièrement à cœur puisque le 14 septembre 1699, il lit aux académiciens un mémoire quant au projet de la nouvelle construction de murs de brique et de pierre de taille[44], et le 27 juin 1707, il propose un autre mémoire sur ce thème, qui fait l'objet de commentaires. De même, le plâtre reste « d'un très grand usage dans les batimens à cause de sa promptitude avec laquelle il se prend »[45]. La Hire se fait

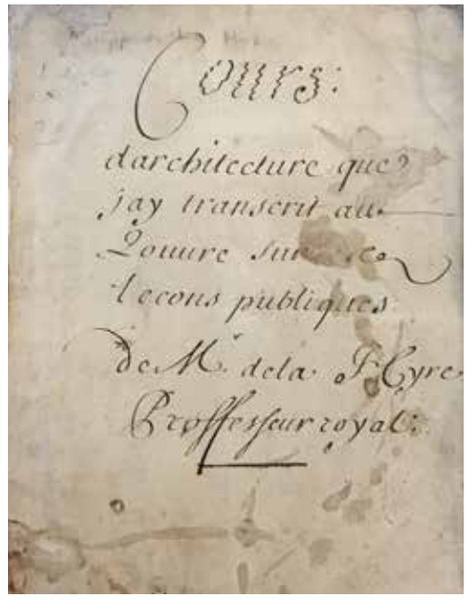


Fig. 5 *Premier page du Cours d'architecture que j'ay transcrit au Louvre sur les leçons publiques de M. de la Hyre, professeur royal (Einsiedeln, Bibliothek Werner Oechslin ; photo H. Rousteau-Chambon).*

[33] Voir A. Payne, *The Architectural Treatise in the Italian Renaissance: Architectural Invention, Ornament, and Literary Culture*, Cambridge 1999.
[34] C. Perrault, *Les dix livres d'Architecture de Vitruve…* , Paris 1673.
[35] Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture*… cit., f. 178*v*-179.
[36] Sur Scamozzi voir Payne,*The Architectural Treatise in the Italian Renaissance*… cit., p. 214-236 ; *Vincenzo Scamozzi teorico europeo*, a cura di F. Barbieri, M.E. Avagnina, P. Sanvito, Vicenza 2016.
[37] *Procès-verbaux de l'Académie*… cit., II, p. 137.
[38] La traduction est exposée aux Académiciens à partir de 1687 et s'achève le 5 septembre 1695, après quoi l'Académie poursuit la lecture du sixième livre, traduit et abrégé par A.C. D'Aviler (*Les cinq ordres d'architecture de Vincent Scamozzi, vicentin*, Paris 1685), jusqu'au 25 juin 1696.
[39] De manière plus générale, La Hire se situe dans la lignée des architectes de la Renaissance pour lesquels chaque partie d'un édifice doit correspondre à un système unique de rapport mathématique (R. Wittkower, *Les principes de l'architecture de la Renaissance*, éd. fr. Paris 1996 [première éd. Londres 1949] ; sur Scamozzi et la science voir W. Oechslin, *L'architettura come scienza speculativa*, in *Vincenzo Scamozzi, 1548-1616*, catalogo della mostra (Vicenza, 7 settembre 2003-11 gennaio 2004), a cura di F. Barbieri, G. Beltramini, Vicenza 2003, p. 23-32 ; sur La Hire et la science : Oechslin, *Ratio und Vorstellungsvermögen*… cit. ; W. Oechslin, *Avant propos*, in *Cours d'architecture*… cit., éd. H. Rousteau-Chambon.
[40] Il se réfère à Savot quant à l'exposition des maisons, pour le choix du lieu où l'on doit bâtir ou quant à la nature des eaux par exemple.
[41] Félibien (A. Félibien, *Des principes de l'Architecture, de la Sculpture, de la Peinture, et des autres Arts qui en dépendent*, Paris 1676) constitue une référence fondamentale pour La Hire dans son chapitre sur les matériaux de construction (3[e] partie, chapitre II). Il suit l'historiographe quant à la pierre, à la brique, au ciment notamment, se montrant moins systématique que son prédécesseur, mais il évoque aussi le fer et le plâtre dans la construction, non abordés réellement par Félibien. Sur cet auteur voir S. Germer, *Art-pouvoir-discours : la carrière intellectuelle d'André Félibien dans la France de Louis XIV*, Paris 2016.
[42] Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture*… cit., f. 48.
[43] Ivi, f. 48*v*.
[44] Le mémoire est publié in extenso dans les *Procès-verbaux de l'Académie*… cit., III, p. 379-381.
[45] Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture*… cit., f. 170*v*.

donc un devoir d'en parler, alors que ni Vitruve, ni Félibien ne l'évoquent et que Bullet ne lui accorde que quelques lignes. Mais, le professeur insiste surtout sur les difficultés de sa mise en œuvre (cuisson difficile, emploi qui ne s'acquiert que par une longue pratique, non résistance à l'eau) et par là même, il révèle sa connaissance générale du sujet, peut-être fondée sur la lecture de Scamozzi qu'il ne reprend pas explicitement cependant, l'usage constructif en France étant différent de la pratique ultramontaine, et assez rare. Il livre toujours les recettes de fabrication de ces matériaux et insiste sur leurs spécificités chimiques (composition) et physiques (résistance), autant de connaissances personnelles qu'il peut vérifier, si nécessaire, auprès des autres membres de l'Académie des sciences.

Les matériaux ne constituent pas les seuls éléments constructifs présentés largement par La Hire qui se passionne aussi beaucoup pour les fortifications. Ce sujet est abondamment traité par des ingénieurs depuis le XVI[e] siècle, et La Hire semble synthétiser les propos de Jean Errard (*La fortification démonstrée et réduicte en art*, Paris 1600) sur les murailles (Livre I, chapitre V) et les terrasses (chapitre VI). Cette référence implicite n'est pas étonnante puisque le traité d'Errard reste alors un des ouvrages les plus importants sur ce sujet et que le même ingénieur était, comme La Hire, un mathématicien[46]. Cependant, une fois encore, cet intérêt de la part de La Hire reste exceptionnel. Certes, François Blondel a mené une étude précise sur la balistique alors qu'il était professeur à l'Académie royale d'architecture (*L'art de jetter les bombes*, Paris 1683), mais cet ouvrage ne concerne que peu l'architecture. En revanche, La Hire se focalise sur la manière de construire des « murs des fortifications et ceux des terrasses [qui] doivent etre faits d'une manière particuliere à cause des terres qu'ils doivent soutenir et qu'il les pousse toujours au centre »[47]. Nous retrouvons là un intérêt constant pour la poussée des voûtes sur lequel il se penche déjà dans son *Traité de mécanique* (Paris 1685). La construction des voûtes, d'ailleurs, l'intéresse continuellement comme l'indique son mémoire sur ce sujet présenté à l'Académie des sciences en 1712, reflet les débats qui se sont tenus à l'Académie d'architecture[48].

La Hire est encore le premier professeur de l'Académie à dispenser un cours général d'architecture sur la commodité. Ce sujet est, à l'époque, abordé de deux manières par les théoriciens : soit par le biais de modèles prêts à bâtir, c'est le cas des ouvrages d'Androuet du Cerceau (*Livre d'architecture*, Paris 1582)[49] ou de Pierre Le Muet (*Manière de bâtir pour toutes sortes de personnes*, Paris 1623)[50], soit en livrant quelques principes dans le domaine de la distribution, comme le font Philibert De l'Orme et Louis Savot dans leurs traités. La Hire choisit de traiter les questions de commodité avant les ordres et accorde ainsi une importance nouvelle à la distribution. Il développe le principe de « convenance », déjà évoqué par Scamozzi et Félibien. Pour ce dernier « Les palais se font selon la grandeur & la magnificence du Prince & des grands seigneurs ; et les Maisons des particuliers aussi selon leurs emplois & leurs moyens »[51]. Outre ce principe général, La Hire explique que « Les salles doivent être grandes à proportion de la dignité du maitre de logis. Elles seront carées ou tout au plus d'un double carré car au dela de cette mesure, elles doivent plustost passer pour des galleries que pour des salles »[52].

Il ne s'intéresse en revanche ni aux circulations, ni aux dispositions des pièces les unes par rapport aux autres et ne fournit aucun dessin pour illustrer les propos de ce chapitre. Dans l'ensemble, La Hire fait montre d'une vision pragmatique dans les détails distributifs – emplacement du lit, de la cheminée, des portes et fenêtres, etc. Cependant bien qu'il accorde une

[46] Outre son ouvrage sur les fortifications, on doit à Jean Errard : J. Errard, *Premier livre des instruments mathématiques*, Nancy 1584 ; Id., *La géométrie et practique générale d'icelle*, Paris 1594 ; Id., *Réfutation de quelques propositions du livre de M. de l'Escale de la quadrature du cercle par luy intitulé : Cyclometrica elementa duo*, Paris 1594 ; Id., *Les neuf premiers livres des élémens d'Euclide*, Paris 1605.

[47] Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture*… cit., f. 184*v*.

[48] Sur ce sujet voir A. Becchi, *Idées manuscrites, théories imprimées : la mécanique architecturale de Philippe de La Hire*, in Becchi, Rousteau-Chambon, Sakarovitch, *Philippe de La Hire*… cit., p. 177-190.

[49] Sur cet auteur, voir *Jacques Androuet du Cerceau : « Un des plus grands architectes qui se soient jamais trouvés en France »*, catalogue d'exposition (Paris, Musée des monuments français, 10 février-9 mai 2010), éd. J. Guillaume, Paris 2010.

[50] Sur cet auteur voir P. Le Muet, *Manière de bien bastir pour toutes sortes de personnes*, éd. C. Mignot, Paris 1981 ; C. Mignot, *Pierre Le Muet, architecte (1591-1669)*, thèse de doctorat, Paris-Sorbonne, 1991.

[51] Félibien, *Des principes de l'Architecture*… cit., p. 43.

[52] Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture*… cit., f. 43.

certaine importance à ce sujet, deux traits caractéristiques apparaissent dans ce discours : s'il est disert sur quelques pièces spécialisées (galerie) ou éléments architecturaux (escaliers), seules les proportions l'intéressent véritablement – on retrouve bien là son esprit mathématique – et surtout, il ne livre aucun exemple précis en ce domaine. Ainsi, pour les perrons mêle-t-il esprit pratique et prescriptions chiffrées.

> Il y a quelques endroits dans des jardins ou sur des costeaux où l'on est obligé de faire des marches qui ayent de grands girons pour descendre doucement, mais il faut bien prendre garde dans ces sortes de marches qu'on ne soit pas obligé de descendre toujours d'un même pied car on seroit extremement fatigué dans ces sortes de descentes, ce qui feroit le mesme effet que si en descendant dans les escaliers ordinaires, on mettoit sur chaque marche les 2 pieds à fois, comme font les enfans.
> Pour éviter ce deffaut, il faut que le giron de ces marches qui sont comme autant de palliez aient 3 pieds ½ au moins ou 4 pieds pour pouvoir faire deux pas entiers sur le pallier, et s'il est plus étroit et qu'il n'ait par exemple que 3 pieds, on tombera dans une grande incommodité car cette largeur estant trop grande pour ny faire qu'un pas on sera contraint d'en faire 2 qui seront trop petits. Il faut donc en général pouvoir faire 2 ou 4 pas entiers sur ces sortes des paliers et jamais 1 ou 3[53].

La Hire revient d'ailleurs largement sur ce sujet dans son cours sur la coupe des pierres, dispensé régulièrement de 1688 à 1712. Mais alors que pour toutes les autres parties du cours, il cite des ouvrages du passé ou du présent, La Hire n'explicite ses propos par aucun édifice dans cette partie. Est-ce parce qu'il n'est pas architecte et qu'il ne souhaite pas se commettre en ce domaine ? Est-ce parce que les élèves peuvent acquérir ces connaissances dans les ateliers d'architectes dans lesquels ils se forment nécessairement parallèlement, puisqu'il n'y a que quatre heures de cours hebdomadaires ? La Hire a fait le choix d'un cours elliptique sur certains points. Il n'en est pas de même pour les autres thématiques.

Des édifices antiques examinés précisément

La Hire livre donc sa propre conception de l'architecture en s'appuyant sur ses lectures mais aussi, voire surtout, sur les édifices antiques qu'il a pu observer directement à Rome, même s'il pouvait le faire plus alors en tant que dessinateur voire de mathématicien[54]. Après sa formation initiale à la peinture par son père, il séjourne en effet pendant quatre années en Italie (1660-1664), à Rome et en Vénétie, comme l'écrit son contemporain Fontenelle dans sa rubrique nécrologique. Sensibilisé à l'art, il ne peut, comme ses contemporains qui font ce voyage[55], qu'être sensible aux productions contemporaines et à celles du passé romain (fig. 2). Tout au long de son traité mais particulièrement lorsqu'il étudie les différentes parties des colonnes dans son chapitre sur les ordres (2e partie, chapitre 4), La Hire cite de nombreux édifices antiques : le Panthéon, le théâtre de Marcellus, et les arcs de triomphe – ici celui de Septime Sévère et de Constantin –, mais aussi les thermes de Dioclétien, le temple d'Antonin et Faustine, les trois colonnes du Campo Vaccino – assimilées au temple de Jupiter Stator et qui est en fait le temple de Castor et Pollux –, le frontispice de Néron – aujourd'hui plutôt temple d'Hercule et Dionysos – et le temple d'Albane. Tous ces édifices constituent des références récurrentes pour tous les théoriciens de l'architecture[56], mais La Hire ne semble cependant pas avoir fait de relevés des édifices antiques lors de son séjour romain. Il ne se contente cependant pas de se référer voire de comparer les propos de ses prédécesseurs, comme a pu le faire Fréart de Chambray par exemple dans son *Parallèle de l'architecture antique et de la moderne* (Paris 1650). Surtout, il observe les édifices antiques précisément et donne son opinion sur les proportions des différentes parties des colonnes antiques. Quant aux formes des différentes parties de colonnes, il explique ainsi à propos de celles du forum (Campo Vaccino) :

[53] Ivi, f. 50*v*-51.
[54] Sur le séjour en Italie de La Hire, voir T. Verdier, *Les années romaines, 1660-1664. La naissance d'une culture scientifique*, in Becchi, Rousteau-Chambon, Sakarovitch, *Philippe de La Hire*… cit., p. 25-40.
[55] G. Bertrand, *Bibliographie des études sur le voyage en Italie, voyage en Europe, XVIe-XXe siècle*, Grenoble 2000 ; V. Meyer, M.L. Pujalte-Frayssse, *Voyage d'artistes : en Italie du nord, XVIe-XIXe siècle*, journées d'études (Université de Poitiers, 2009), Rennes 2010 ; L. Bolard, *Le voyage des peintres en Italie au XVIIe siècle*, Paris 2012.
[56] J. Ackerman, *Imitation*, in *Antiquity and its Interpreters*, conference proceedings (Toronto, March 1994), edited by A. Payne, A. Kuttner, R. Smick, Cambridge 1999, p. 9-16.

> Entre tous les chapiteaux corinthiens qui nous restent de l'antique, on peut avec raison donner premier rang à celui des trois colonnes de Campo vacino [sic] dans Rome qui font le reste du temple de Jupiter Stator. Car quand même on retrancheroit de ce chapiteau une partie des ornemens dont il est enrichy, il ne laisseroit pas encore d'avoir une grace et une elegance qui le feroit admirer[57].

Outre cette appréciation, somme toute subjective, La Hire défend sa conception de l'architecture. Examiner l'antique pour livrer des mesures exactes semble avoir été son *leitmotiv* et de fait, La Hire adopte un regard neuf sur l'architecture et ne s'interdit aucune remise en question, reformulant chaque calcul mathématique, afin de livrer le modèle le plus abouti et le plus juste possible. Ainsi explique-t-il la manière de dessiner géométriquement la volute du chapiteau ionique :

> J'ay deja dit que le centre de l'œil de la volutte qui forme la petite rose que l'on met au milieu devoit estre à la hauteur du bas du chapiteau, ou à celle du dessus de l'astragale, et à plomb au dessus du bord d'en bas ou interieur du tailloir ou abaque […] On divise la hauteur CA depuis le centre C de l'œil de la volutte jusqu'au dessous du tailloir en A, laquelle est de 13 minuttes, et en 9 parties égalles entr'elles, et d'une de ces parties comme CD, on en fait le demy diamettre de l'œil CBD de la volutte. On aura donc 8 parties de reste depuis B jusqu'en A dont le point E soit le milieu. On prend aussy 6 de ces parties depuis D jusqu'en F et l'on a par ce moyen la grandeur AF pour toute la hauteur de la volutte, laquelle contient 16 parties ou 8 diametres de l'œil de la volute BD. Ensuite on divise BD en 6 parties egales entr'elles et l'on marque les points de division dans l'ordre où ils sont dans la figure en mettant le chiffre I au point D, le chiffre 2 au point D et les autres ensuitte sur les divisions. Ces points sont les centres de demy cercles qui forment la courbure de la volutte[58].

Les références aux édifices antiques visent à servir son propos. Il remet ainsi en cause une unicité de l'antiquité, insistant sur les exemples diversifiés de l'architecture romaine, tout en s'appuyant sur les dessins qui illustraient ses propos, notamment dans la répartition des moulures des entablements :

> Dans les 3 exemples antiques que nous avons de cette corniche, les denticules sont au milieu des 3 membres qui sont sous le larmier comme on le voit cy dessus. Mais au temple de la fortune virile et aux thermes de Diocletien, le 1[er] membre sous le larmier est un quart de rond, lequel on a taillé des oves, et celui qui est au dessous des denticules est un talon qui est orné de feuilles de refend. Au contraire au theatre de Marcellus, le talon est au dessus des denticules et les oves sont au dessous[59].

De même, il rappelle que les édifices antiques ne sont que des exemples qui ne peuvent, en aucun cas, être pris pour des modèles absolus puisque leurs moulures et proportions diffèrent. Ainsi, les profils des impostes ioniques des arcs de Titus et de Septime Sévère ne sont pas identiques (*Des arcades ou des arcs avec leurs impostes, archivoltes ou bandeaux*)[60]. Il est vrai que La Hire, comme ses contemporains, ne tient pas compte des deux cents ans d'écart qu'il y a entre les deux édifices[61].

Si l'observation précise et personnelle des édifices antiques lui permet d'insister sur la variété intrinsèque de l'architecture des Romains, La Hire, esprit rigoureux qui peut s'appuyer sur son savoir géométrique, souligne les erreurs de reports des architectes contemporains. Il relève ainsi à propos de l'entablement corinthien, tout en montrant sans doute aux élèves un dessin qu'il a pu réaliser de cette partie de l'architecture[62] (fig. 6) :

> Les architectes modernes se sont imposés une loy pour la distribution des modillons, ce qui demande quelques précautions dans le plan general car ils veulent qu'il y ait toujours un modillon qui reponde exactement au milieu de la colonne ou du pilastre. Cependant au Pantheon tant au portique qu'au dedans, cette regle n'est pas observée. Ils veulent encore que la place des roses qui

[57] Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture*… cit., f. 71.
[58] Ivi, f. 69*r-v*.
[59] Ivi, f. 79.
[60] Ivi, f. 112*v*-113 : « L'imposte et le bandeau de l'ordre composite n'ont point de mesure ni de regle bien certaine car on les peut faire, comme on le jugera à propos, en les composant de l'ionique et du corinthien. On peut voir les Arcs de Titus, de Severe et d'autres où les antiques [Anciens] s'en sont servis et où ils ont mis des ornements sur toutes les moulures. »
[61] L'arc de Titus est édifié par Domitien en 81 après J.-C., celui de Septime Sévère est bâti en 203 après J.-C.
[62] Les cours conservés de La Hire ne sont pas autographes ; les dessins de ses cours non plus donc. Cependant tous les cours conservés dispensés par les professeurs de l'Académie font référence à des dessins. Sur ce sujet, voir Rousteau-Chambon, *L'Enseignement à l'Académie*… cit., p. 54-63.

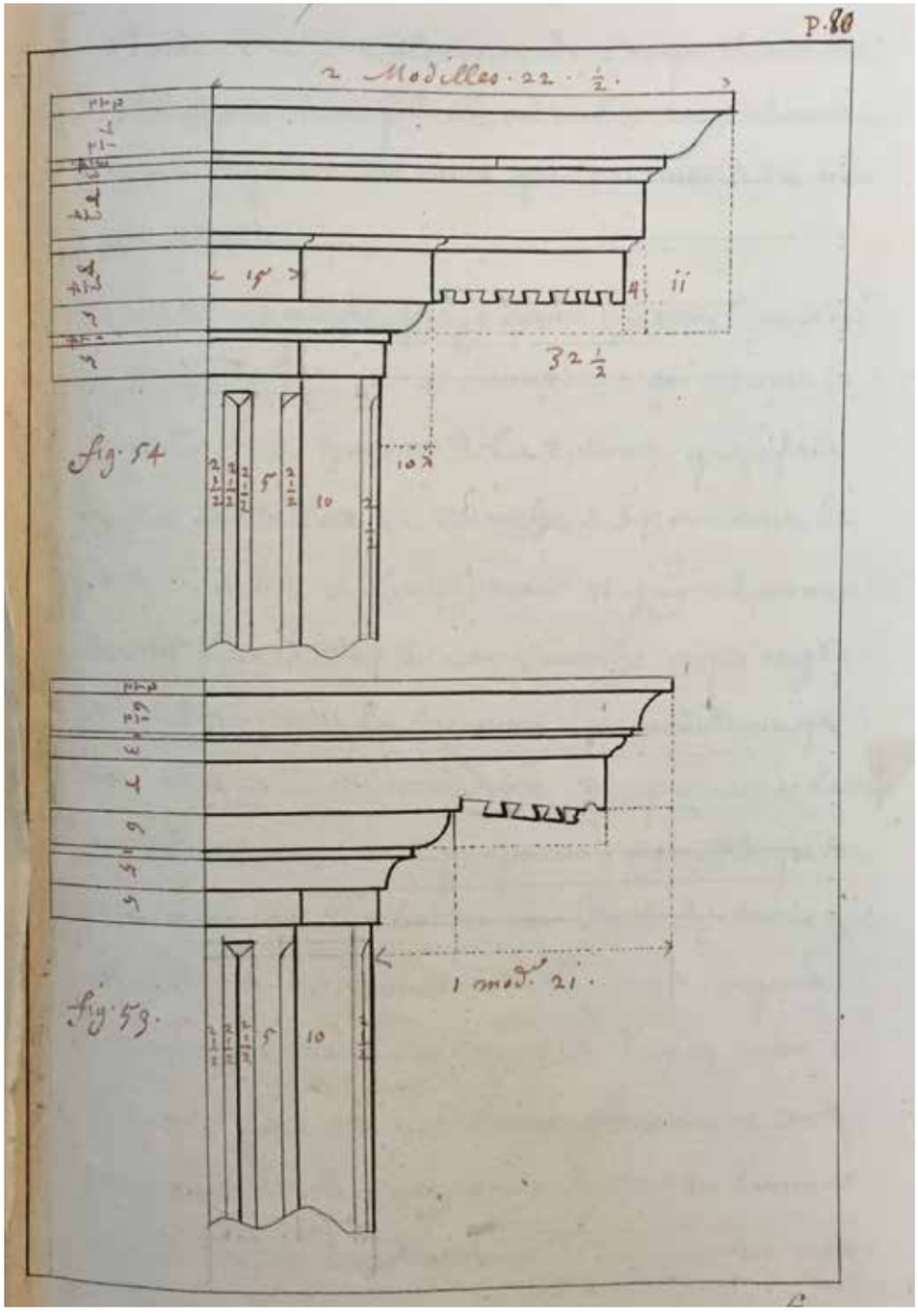


Fig. 6 *D'après Ph. de La Hire, Proportions de l'entablement corinthien (in Cours d'architecture… cit. ; Einsiedeln, Bibliothek Werner Oechslin ; © Bibliothek Werner Oechslin).*

> sont entre les modillons soit quarrée. Mais il est assez difficile de faire accorder exactement ces deux choses quand on a une figure determinée pour la forme du modillon[63].

De même, le professeur dénonce, de manière souvent sous-jacente, le manque d'observation et l'absence de rigueur des théoriciens de la Renaissance qui peuvent, pour un même édifice, trouver des mesures fort différentes et fonder leurs propos sur des proportions erronées. Il n'a ainsi de cesse d'insister sur les opinions divergentes des théoriciens de référence et rappelle notamment :

> Vignolle donne deux modeles de chapiteau dorique. Il dit que le 1er est tiré du theatre de Marcellus à Rome et le second qu'il l'a pris de divers fragments antiques dont il a fait un composé qui réussit fort bien en execution comme il l'a connu par son experience. Philibert de Lorme rapporte pour exemple le chapiteau dorique du theatre de Marcellus et il dit qu'il l'a mesuré fort exactement avec le palme romain, ce qui paroist fort vrayssemblable puisque ses mesures conviennent avec celles de M. Desgodets mais elles ne sont point d'accord avec celles de Vignolle. Dans le 1er des deux chapiteaux qu'il donne, le tailloir de celui de Marcellus est bien plus fort que le tiers, mais je crois qu'il vaut mieux suivre la proportion que donne Vignolle

[63] Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture…* cit., f. 79*v*.

> que toutes les autres. Les mesures du chapiteau de Palladio s'approchent un peu de celles du theatre de Marcellus car il fait le gorgerin de neuf minutes seulement et il donne au tailloir 11 minutes et ⅙[64].

Outre son commentaire précis, il apparaît que La Hire ne fait pas personnellement les mesures des édifices romains – difficiles à relever, il faut en convenir –, mais qu'il se fonde sur celles de Desgodets reconnues notamment par les membres de l'Académie royale d'architecture. Cependant, La Hire va plus loin que Desgodets : pour lui, les références aux édifices antiques passent par une vérification mathématique des mesures. Il reste donc fondamental de reformuler les calculs des auteurs les plus respectés, de les mettre à l'épreuve voire de les corriger. Cette préoccupation semble continuelle pour lui. Il en parle à propos du théâtre de Marcellus[65] et revient sur cette question pour le frontispice de Néron qu'il a pu examiner et mesurer précisément. En effet, les quelques morceaux du « frontispice de Néron » sont conservés, à même le sol, dans les jardins du palais Colonna et il peut en tirer un certain nombre de conclusions personnelles :

> La corniche corinthienne que l'on voit au frontispice de Néron est d'une manière toute particulière. Elle est estimée d'un grand goust par les plus habiles architectes mais ils en composent ordinairement la corniche de l'ordre composite. C'est aussi celle la que je finiray icy en y faisant quelques petits changements dont je rendray raison ensuitte. L'entablement du frontispice de Néron est du ¼ de la hauteur de la colonne, à deux minuttes et demy près, mais je l'ay reduitte entre le ¼ et le ⅓ pour en faire l'entablement de l'ordre composite comme j'ay fait dans l'ordre corinthien[66].

La Hire ne se place donc pas ici dans la continuité de son prédécesseur François Blondel. En effet, à la différence de ce dernier, La Hire semble considérer que la comparaison intelligente des auteurs les plus respectés ne suffit pas : encore faut-il reformuler leurs calculs, les mettre à l'épreuve et, pourquoi pas, les corriger. Par ailleurs, l'ambition générale de son cours – un manuel général, rappelons-le – conduit La Hire à une certaine économie concernant les ordres d'architecture. Considérant que l'essentiel du *Cours* de Blondel est d'ores et déjà à la portée de chacun de ses élèves, La Hire aborde d'emblée ce qui pose question, ce qui suscite le débat et le détaille alors longuement. L'examen des édifices contemporains participe aussi directement de sa démonstration.

Des édifices contemporains pour modèles

Comme pour les édifices antiques, La Hire pour les édifices contemporains – à savoir ceux construits à partir de la Renaissance –, fonde ses propos sur les textes théoriques mais surtout examine par lui-même les constructions parisiennes et livre ainsi sa propre vision de ce que doit être l'architecture. À ce titre, il n'hésite d'ailleurs pas à placer sur un pied d'égalité un édifice antique et des édifices contemporains :

> Pour les colonnes et pilastres rustiques ou par tambour ou bossage, les anciens s'en sont servis en quelques endroits comme à l'amphiteatre de Veronne. Mr Brosse [Salomon de Brosse], excellent architecte françois qui a fait le portail de St. Gervais à Paris a orné de ces sortes de colonnes les deux ordres du palais du Luxembourg[67].

Surtout, il développe de nombreux exemples français lorsqu'il présente les techniques constructives. Il expose aussi bien la structure des colonnes du château d'Ecouen de Bullant (f. 120*v*) que les fondations du château de Saint-Maur de De l'Orme (chapitre 4, f. 176) ou la construction du pont de Cismone expliquée par Palladio et sur laquelle La Hire revient longuement (f. 194-198). Le professeur en rappelle notamment les défauts :

> Ce pont a six travées qui n'ont chacune que 12 pieds ½ y compris les poutres. Palladio représente

[64] Ivi, f. 66.
[65] Ivi, f. 66*r-v* : à propos du chapiteau dorique : « Philbert Delorme raporte pour exemple le chapiteau dorique du theatre de Marcellus et il dit qu'il l'a mesuré fort exactement avec le palme romain, ce qui paroist fort vrayssemblable puisque ses mesures conviennent avec celles de M. Desgodets, mais elles ne sont point d'accord avec celle de Vignolle. Dans le premier des 2 chapiteaux qu'il donne, le tailloir de celuy du théatre de Marcellus est bien plus fort que le tiers, mais je crois qu'il vaut mieux suivre la proportion que donne Vignolle que toutes autres. Les mesures du chapiteau de Palladio aprochent un peu de celuy du theatre de Marcellus car il fait le gorgerin de 9 minuttes seulement et il donne au tailloir 11 minutes et un 6[e] ».
[66] Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture*… cit., f. 83*r-v*.
[67] Ivi, f. 120*v*.

> la partie du milieu du plancher de ce pont un peu plus elevée que les extremitez en sorte que le dessus est un peu en arc. Mais cete construction n'est pas bonne quoy qu'elle parroisse d'abord fort solide car il est facile à voir que si l'assemblage des pieux ABA vient un peu à lacher, le plancher du pont descendra, à moins que les deux pieces qui portent sur les culées ne soient appuyées contre un massif tres solide, ce qui n'arrive pas si le plancher du pont étoit en ligne droite car comme elle est la plus courte distance entre les points extremes, elle ne sçauroit descendre dans son milieu sans faire changer de figure à la forme et faire remonter la piece du milieu qui releveroit par ce moyen les poinçons C, ce qui feroit un effet tout contraire à celuy du plancher du pont qui la tire en bas[68].

Dans ce dernier exemple, La Hire se situe dans l'exacte continuité des académiciens qui, notamment en 1673, ont souligné leurs différences vis à vis de l'architecte vicentin. Il est alors reproché à Palladio d'insister sur la beauté, la commodité et la durée de l'ouvrage, alors que les académiciens préfèrent se pencher sur le choix de l'emplacement du pont, la conception de sa structure ou ses proportions (11 décembre 1673)[69]. La Hire reprend donc le point de vue des académiciens du XVII[e] siècle tout en livrant des propositions mathématiques et physiques.

D'ailleurs, si La Hire évoque certaines recommandations de ses devanciers, il ne manque pas de pointer leurs erreurs. Il critique ainsi explicitement Alberti qui affirmait la nécessité de construire une voûte en deux temps, ou encore partiellement De l'Orme dans sa méthode de construction des voûtes[70]. En revanche, il ne cite jamais les inexactitudes de son contemporain André Félibien (1619-1695). Il est vrai que ce dernier étant secrétaire de l'Académie royale d'architecture depuis sa fondation et ayant déjà écrit une œuvre théorique importante dans des domaines variés, La Hire ne souhaite sans doute pas le critiquer trop ouvertement ; il amende simplement ses propositions. Pour Félibien en effet, par exemple, il ne convient pas de mélanger de l'eau de mer au mortier[71]. Or La Hire qui peut se fonder sur les propos de Vitruve et qui a pu voir des constructions faites en bord de mer, à Brest notamment lorsqu'il a été chargé d'établir la cartographie du royaume avec l'abbé Picard (juillet 1679), a sans doute vu des constructions pérennes de ce type. Il affirme donc que « l'eau de mer est fort bonne contre le sentiment de quelques ouvriers, ce que l'on a reconnu par experience car le mortier prend bien plus de consistance quand on y mêle de l'eau de mer que lorsqu'on le fait avec de l'eau douce »[72]. La Hire se réfère d'ailleurs assez souvent aux constructions maritimes dans son étude sur les matériaux (sable de mer, utilisation de la coquille d'huître pour la fabrication de la chaux...). Une fois encore son observation personnelle prime, même s'il ne fait pas explicitement référence à un édifice, mais plutôt à une pratique constructive généralisée.

La Hire mentionne aussi des édifices qu'il a pu examiner à loisir. Ainsi, La Hire évoque-t-il quelques édifices italiens – Saint-Marc de Venise (pour la construction des murs qui peuvent supporter les tremblements de terre, f. 179) et le baldaquin de Saint-Pierre de Rome.

> Les colonnes de bronze dont Michel Ange [Le Bernin] fit le grand autel de l'église St Pierre à Rome ont receu une approbation si généralle que dans tous les autels qu'on veut orner extraordinairement, on tasche de les imiter. Elles ont cela de propre qu'elles peuvent facilement recevoir plusieurs et différents enrichissements étant contournées de telle manière qu'il semble que leur forme les demande, car si on les faisait toutes unies, elles perdroient la plus grande partie de leur beauté. On en voit quelques petites de marbre qui sont antiques et c'est peut être sur leur modèle [que] Michel Ange [Le Bernin] a fait celles de St Pierre de Rome.
>
> Il est facille de voir que l'idée de ces sortes de colonnes est venüe de branches d'arbres qui ayant esté forcées et entortillées par quelques arbrisseaux comme le chevrefeüille et autres de meme nature ont creusé dans cette contrainte et ont formé une

[68] Ivi, f. 195*r-v*.
[69] *Procès-verbaux de l'Académie*… cit., I, p. 53.
[70] De l'Orme consacre un livre entier (4[e] livre) à la construction des voûtes. Sur ce sujet, voir H. Günther, *Philibert de L'Orme and the French Tradition of Vaulting*, in *Building Techniques in Architectural Treatises: Construction Practices versus Technical Writings*, éd. C. Cardamone, P. Martens, "Aedificare. Revue internationale d'histoire de la construction", 2017, 2, p. 119-142. Alberti quant à lui évoque les voutes dans un chapitre court du *De re aedificatoria* (Livre III, chap.14). Sur ce sujet voir P.N. Pagliara, *L'esperienza costruttiva nel De re aedificatoria di Leon Battista Alberti*, in *Building Techniques in Architectural Treatises: Construction Practices versus Technical Writings*, éd. C. Cardamone, P. Martens, "Aedificare. Revue internationale d'histoire de la construction", 2017, 2, p. 37-65.
[71] Félibien, *Des principes de l'Architecture*… cit., p. 46.
[72] Einsiedeln, Bibliothek Werner Oechslin, *Cours d'architecture*… cit., f. 168*v*.

> branche à peu pres comme on fait ces sortes de colonnes[73].

Dans ce dernier exemple, il évoque plus particulièrement les colonnes torses – attribuées ici à Michel-Ange –, et insiste sur le fait que cet exemple a été largement imité, mais il s'intéresse surtout à leur origine naturelle, se fondant sur une histoire vitruvienne de l'architecture.

La Hire s'arrête plus longuement sur les édifices français, notamment royaux. Il fait ainsi référence au Louvre à plusieurs reprises : au pavillon de l'horloge de Lemercier dont les ordres ont été dessinés dans le respect de l'architecture de Pierre Lescot (f. 129*v*) ou encore à la construction – pierres scellées par du plomb de la nouvelle façade du Louvre de Perrault (f. 198) et à son comble dont l'invention est attribuée à François Mansart.

> Nos architectes modernes considérant que des combles sy elevez ne pouvoient faire un couronnement sur la façade d'un bastiment décoré d'un ou de 2 ordres d'architecture se sont retirés autant qu'ils ont pu de cette ancienne maniere comme on peut le voir dans le bastiment du Louvre qui a été fait du tems de Henry 2, et Mr Mansard l'un des plus excellents architectes qui ayent été, a mis en usage un espece de comble brisé dont la partie superieure est tres platte en sorte qu'elle ne paroist pas ordinairement au dedans du logis ny à la distance dont on doit voir le bastiment.
>
> Par ce moyen, il a baissé la hauteur de nos anciens combles de plus de la ½ et […] on est delivré des combles qui accablent nos anciens bastiments[74].

Dans cet exemple, La Hire loue la pratique des architectes français, et plus particulièrement celle du grand-oncle du Premier architecte du roi et surintendant des bâtiments, Jules Hardouin-Mansart (1646-1708), commettant aussi des erreurs d'attribution : le comble brisé est de la main de Pierre Lescot, tandis que Lemercier reste l'architecte qui, avec le pavillon de l'Horloge, a assuré une jonction entre la partie du XVI[e] siècle et celle du XVII[e] siècle. François Mansart, quant à lui, a beaucoup utilisé le comble brisé, mais dans des hôtels particuliers et non dans un édifice royal. La Hire, tout en célébrant la famille Mansart, entend sans doute insister sur le rôle des architectes du roi pour l'évolution architecturale, et par conséquent indirectement, sur le rôle que peut avoir le professeur de l'Académie royale d'architecture en ce domaine. Pour parfaire cette vision, d'autres édifices royaux sont cités : la porte Saint-Antoine qui célèbre la puissance louis-quatorzienne, comme les deux autres arcs parisiens dus au dessein de son prédécesseur à l'Académie, François Blondel (f. 180*v*), les Tuileries de Philibert De l'Orme pour les colonnes torses (f. 119*v*), qui reste la résidence parisienne du roi, ou encore le palais du Luxembourg – pour les pilastres dans l'angle – de Salomon de Brosse voulu par Marie de Médicis et qui est alors une résidence de la famille royale. En revanche, La Hire ne cite Versailles, pourtant en cours de construction, que pour les voûtes de son orangerie (f. 114*v*). Cette omission n'est en fait pas étonnante : le château dans lequel vit Louis XIV rompt avec les principes défendus par les académiciens et ne peut donc en aucun cas servir d'exemple[75]. Par conséquent, La Hire préfère se référer à des édifices royaux moins polémiques au niveau de leur forme. Il cite ainsi longuement un édifice dont la construction s'achève alors : l'église du dôme des Invalides du dessin de Jules Hardouin-Mansart[76]. Il l'évoque pour ses fondations (f. 177) et surtout, il décrit longuement – pendant quatre folios (f. 14-18) – la manière de lever son plan ; il s'agit du seul bâtiment sur lequel il appuie aussi longuement sa démonstration. C'est en outre un édifice construit par le Premier architecte et surintendant des bâtiments du roi.

Des démonstrations pour le dessin

L'église du dôme reste emblématique du règne de Louis XIV. Son plan est aussi très complexe

[73] Ivi, f. 114*v*.
[74] Ivi, f. 52.
[75] Sur les discours tenus par les académiciens, outre les introductions de H. Lemonnier (*Procès-verbaux de l'Académie*… cit.), voir Schöller, *Die « académie royale d'architecture »*… cit. ; Baudez, *Architecture et tradition académique*… cit.
[76] B. Jestaz, *L'Hôtel et l'église des Invalides*, Paris 1990 ; *L'hôtel des Invalides*, éd. A. Gady, B. Bouget, Paris 2016.

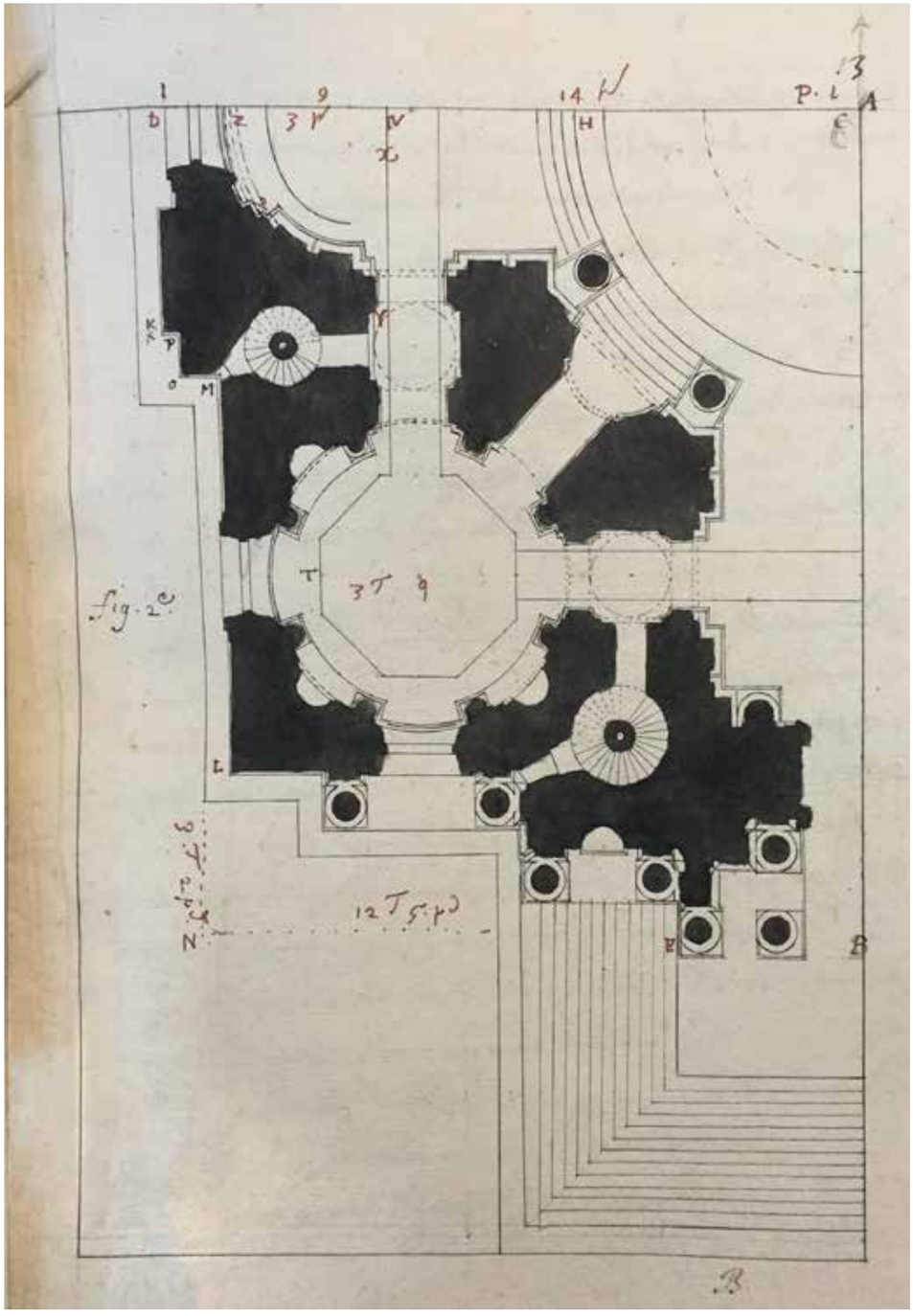


Fig. 7 *D'après Ph. de La Hire, Méthode de relevé du plan d'une chapelle de l'église royale des Invalides (in Cours d'architecture… cit. ; Einsiedeln, Bibliothek Werner Oechslin ; © Bibliothek Werner Oechslin).*

à lever mais La Hire entend se servir de cet exemple difficile pour expliquer ses propos à ses élèves (fig. 7). En prenant un modèle à partir duquel il pourra faire une extrapolation, La Hire inculque la méthode propre aux ouvrages scientifiques de cette époque pour établir des preuves mathématiques : énonciation du théorème, démonstration élément par élément, résultat ; c'est ce qu'il met en œuvre dans ses propres ouvrages scientifiques. De même, tout en employant des instruments simples d'utilisation, il explique deux manières de pratiquer – avec une équerre ou un compas –, la seconde méthode permettant de vérifier la première ; la démarche reste géométrique une nouvelle fois. Enfin, il s'intéresse essentiellement aux masses et non aux détails : il n'indique pas la manière de lever les différentes parties de l'église – ses contreforts, l'ébrasement des baies ou l'épaisseur des murs par exemple. Ce sont en effet les volumes qui sont les plus difficiles à lever, ce sont eux aussi qui vont permettre de donner une harmonie générale à l'édifice. Il a donc une démarche radicalement différente de celle adoptée par Bullet, lui aussi un dessinateur reconnu – il a donné des cours de dessins aux élèves de l'Académie du

temps de François Blondel –, qui, dans son *Architecture pratique* (Paris 1691) se penche essentiellement sur les détails architecturaux ; le but de ce dernier est, il est vrai, d'insister sur le toisé et l'économie de la construction[77]. Il n'empêche que La Hire se montre très didactique et explique sa démarche toujours de manière progressive. Ainsi, explique-t-il pas à pas comment lever un plan « je passe ensuite aux parties intérieures... » (f. 16*v*), « je prends ensuite le diametre du cercle des chapelles... » (f. 16*v*). Il va même jusqu'à noter où placer les cotes ainsi relevées. Tous ces éléments peuvent être repris par les élèves puisque les manuscrits des cours doivent être laissés à l'Académie. C'est tout du moins ce qui est prévu dans les lettres patentes de 1717 dont La Hire a sans doute été l'un des inspirateurs[78].

Ce souci de la pédagogie se retrouve dans son exposé sur la façon de dessiner une volute ionique, caractéristique de l'architecture en France comme en Italie, encore à la fin du XVII[e] siècle (fig. 8). Il a d'ailleurs pu en apprécier la variété à Rome dans les édifices récents romains : volute ionique à balustre sur la façade de Santa Bibiana de Bernin (1620-1624), ou angulaire, à chute et cornes sur le Palais Neuf dessiné par Michel-Ange par exemple (1571-1654). Cette disparité se retrouve aussi en France : si la volute à balustre est utilisée dans la façade de Saint-Gervais-Saint-Protais, celle à chute est de plus en plus souvent employée, notamment dans le château de Versailles. Mais La Hire ne cite aucun exemple cette fois. D'ailleurs, s'il avoue sa préférence pour la volute ionique scamozzienne – à cornes –, il reste très modéré dans ses propos. Aussi préfère-t-il s'appesantir sur la manière de dessiner une volute ionique, sujet sur lequel achoppent tous les théoriciens, Vitruve n'ayant pas exposé clairement la manière de procéder[79]. Il explique ainsi pour l'œil de la volute :

> La différence qu'il y a entre le chapiteau ionique de Palladio et celluy de Vignolle n'est que dans l'œil de la volute, les antiques font le centre de cet œil à la hauteur du dessus de l'astragale du haut de la colonne, ce que Vignole a imité, mais la plupart des architectes ont suivy Palladio qui fait tout l'œil de la volute compris dans la largeur de l'astragale. Ainsi il est obligé de donner à ce chapiteau moins de hauteur que 2/3 de modules ce qui est pourtant une proportion fort agréable car sans cela la volute seroit trop grande et pendroit trop bas[80].

Cette partie de la volute reste donc fondamentale pour lui car le dessin qu'il réalise parallèlement à ses explications – conservé de sa main dans le mémoire qu'il présente à ce sujet[81] – peut tout expliquer. Mais le dessin ne peut suffire : une nouvelle fois, ce sont les mathématiques, et plus précisément ici, la géométrie qui permettent de renouveler la perception et le discours sur l'architecture. C'est d'ailleurs aussi l'idée centrale qu'il développe lorsque, dès le premier chapitre de la deuxième partie de son cours, il explique la manière de concevoir un projet architectural : l'invention ne peut seule suffire selon lui, il faut y ajouter l'autocritique. En effet, à la suite de la conception du premier projet, La Hire conseille aux jeunes architectes d'en concevoir un deuxième, voire un troisième, afin d'arriver à la version la plus satisfaisante possible. Ces projets devaient alors être comparés et soumis si possible à l'examen d'un confrère. À la suite de cette période de recul, l'architecte doit être à même de concevoir un dernier projet ayant les avantages de tous les autres, et de s'y tenir. Ainsi l'auteur développe-t-il d'emblée une méthode de projet concrète, pratique, de conception de l'édifice mais qui, une fois encore, s'apparente à la recherche de la preuve que l'on retrouve dans le domaine scientifique ; on ne constate d'ailleurs aucun équivalent de cette démarche dans les ouvrages d'architectes contemporains. Cet intérêt pour la conception du dessin n'est pas, aussi, sans rappeler la formation première qu'il a pu acquérir auprès de son père, le peintre Laurent de La Hyre.

[77] Sur Pierre Bullet voir : E. Langenskiöld, *Pierre Bullet, The Royal Architect*, Stockholm 1959 ; J. Hernu-Bélaud, *De la planche à la page, Pierre Bullet et l'architecture en France sous Louis XIV*, thèse de doctorat, Paris-Sorbonne, 2015.
[78] Rousteau-Chambon, *L'Enseignement à l'Académie*… cit., p. 43-49.
[79] *Procès-verbaux de l'Académie*… cit., II, p. 245 ; F. Benelli, *Antonio da Sangallo the Younger and the Making of the Ionic Capital*, in *Building Techniques in Architectural Treatises: Construction Practices versus Technical Writings*, éd. C. Cardamone, P. Martens, "Aedificare. Revue internationale d'histoire de la construction", 2017, 2, p. 95-117.
[80] Paris, Bibliothèque de l'Institut de France, ms. 8125, f. 89.
[81] Paris, Bibliothèque de l'Institut de France, section Beaux-Arts, carton B9, 30 septembre 1692.

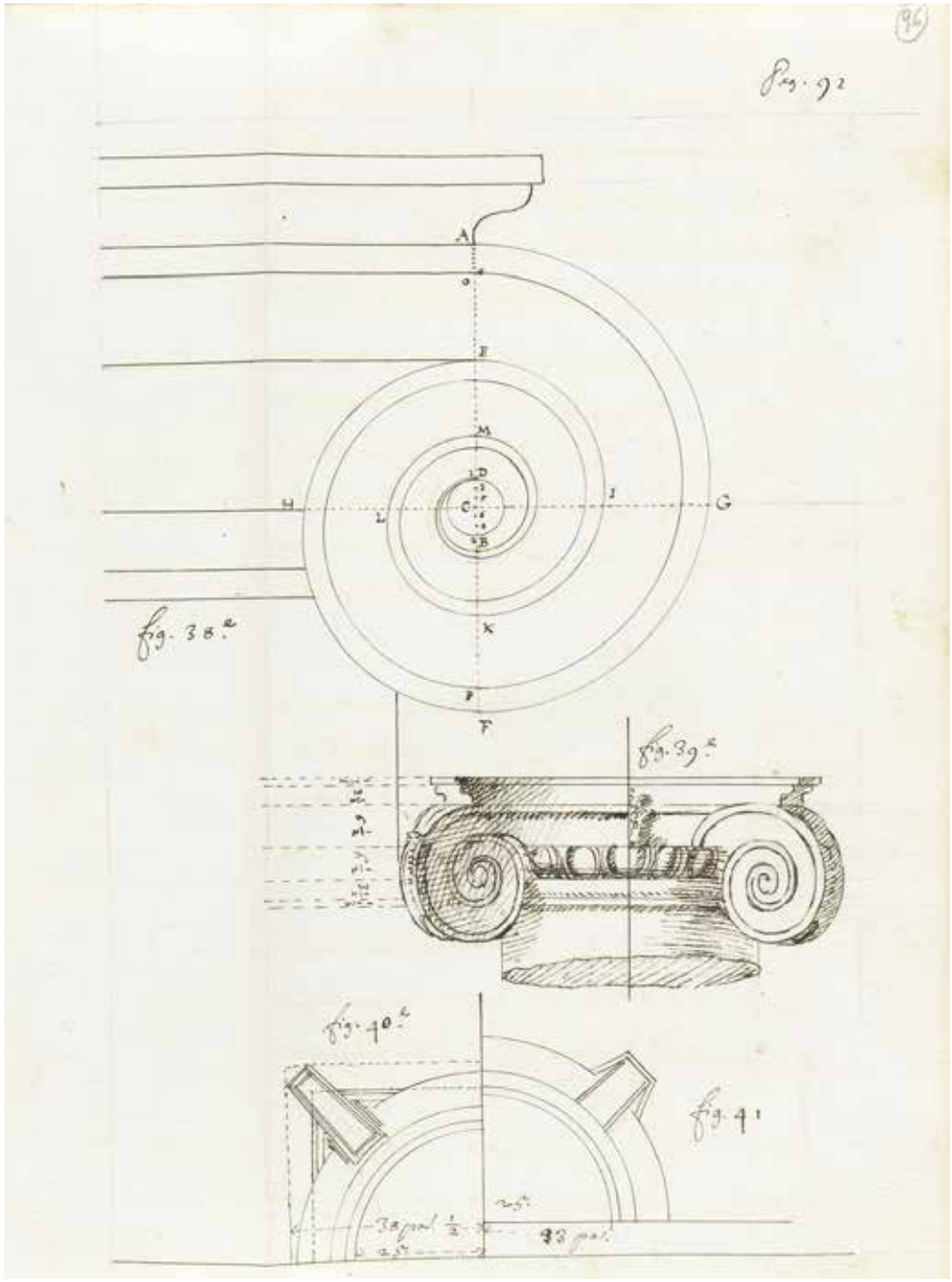


Fig. 8 *D'après Ph. de La Hire, Dessin de la volute ionique (in Cours d'architecture enseigné au Louvre dans l'académie royalle par Monsieur de la Hire, professeur de matématiques du college royal à Paris ; Paris, Bibliothèque de l'Institut de France, ms. 8125 ; © RMN).*

Conclusion

Philippe de La Hire reste une figure atypique parmi les théoriciens de l'architecture. S'il demeure sans aucun doute un incontestable vitruvien tant pour les thématiques sur lesquelles il fonde son propos – les ordres, la commodité, la solidité –, que pour son intérêt pour les sciences, il se démarque nettement des autres théoriciens qui clament pourtant leur filiation avec l'ingénieur romain. En effet, alors que la majorité des théoriciens semblent davantage attachés à l'autorité des textes qu'aux pratiques établies, La Hire adopte un regard neuf sur l'architecture. Il se fonde certes sur des références établies mais sait examiner précisément les exemples construits. Il ne s'interdit aucune remise en question, et n'hésite pas non plus à reformuler chaque calcul mathématique. Son but reste de livrer le modèle le plus abouti, le plus juste possible, et de le prouver par la géométrie. Il adopte un regard distancié tant sur les exemples puisés dans les textes de référence que sur ceux sur lesquels il fonde son propos. Faut-il y voir de sa part une volonté de normaliser tous les savoirs de l'architecte ? De fait, sa démarche résolument moderne ne sera pas poursuivie immédiatement, même si l'un de ses successeurs immédiats fut Antoine Desgodets (fig. 1), qui avait justement levé des mesures sur lesquels se fondait La Hire dans ses démonstrations sur la relativité de l'exemplarité antique, et indirectement moderne.

Jeroen Goudeau

SPARKLES UNDER THE NORTHERN SUN: THE DANCKERTS PRESS AND THE SLOW INTRODUCTION OF WRITING ON BUILDING TECHNIQUE IN THE DUTCH REPUBLIC

Between 1630 and 1727 the rich catalogue of the Danckerts press covered a wide span of subjects in contemporary architecture. This case-study makes clear that in the Dutch Republic the interest in autonomous information on building techniques arose relatively late. Publishers mostly looked to Italy, France and, as is demonstrated here, also to Germany. In the genres discussed, actual building techniques can only be traced to a very limited extent. It is more precise to speak of technical details in the communication of architecture. Only in 1680 the first book with exclusively technical illustrations appeared, Architectura chivilis, *based on a German source. Danckerts proved to be a pioneer in what would become an independent technical book genre. Around 1700, books on elements of civil architecture, such as roofs and stairs, were accompanied by publications on mills, sluices, and bridges. It was only then that building techniques in the strict sense found their way into books.*

Although a wealth of high-quality books on architecture was published in the Dutch Republic during the sixteenth and seventeenth centuries, some crucial topics remained remarkably underexposed. Technical, material and constructional issues that were faced in actual building practice, for instance, rarely found their way into treatises or engravings. In this article it will be argued that in the Italian-, French-, and Vitruvius-oriented architectural publishing in the Netherlands, technical knowledge remained almost entirely absent until the last quarter of the seventeenth century[1]. Although this situation was no different from that in neighbouring countries, this slow introduction of writings on building techniques does contrast with the then lively building practice, showing the interest in these matters among Dutch craftsmen, architects, engineers, and amateurs.

This article sketches the milieu in which descriptions of building techniques, if any, appeared as isolated sparkles in the broad spectrum of architectural books of this era in the flourishing Northern Netherlands[2]. In order to draw some conclusions from the large body of material, the focus will be on the architectural publications of the Danckerts press[3]. This publishing house was responsible for some of the most important, as well as the majority of architectural books in the Northern Netherlands during the seventeenth century[4]. Moreover, Danckerts' architectural books cover the span of subjects in contemporary architectural writing in which technical knowledge gradually found its way to print. It will become clear that, when speaking about technical knowledge in architectural books in the sixteenth and seventeenth centuries, the term technique itself will have to be interpreted in a broad sense. Knowledge of building technique is seldom explicitly dealt with and can only be discovered indirectly and in altered forms. Technical knowledge is reflected in the use of technical terminology, in the summing up of building materials, and is most manifest in visual representation, that is, in illustrations displaying technical operations or containing technical or constructional details without these being the main subject. The illustrations can occur in unexpected places. The Danckerts press can function here as a marker in a still undefined field. All in all, it was Danckerts who would publish only in 1680 the first book in the Dutch Republic with almost exclusively technical illustrations: *Architectura chivilis*. To get there the road had been long and winding, prudently moving through the varied genres of the architecture book.

The Danckerts architectural press

The founding father of the renowned Amsterdam family enterprise was Cornelis Danckerts (1604-1656), who operated as an engraver, art dealer, bookseller and publisher of prints and books[5]. Of his ten children the oldest two sons, Dancker and Justus, followed in his footsteps, while his daughter Anna married Hieronymus Sweerts, another print publisher[6]. In the third generation, Justus' two oldest sons, Theodorus and Cornelis, took over the family business. With respect to the architectural publications of the firm, it is noteworthy that before they entered the printing business the family had prospered in the building trade[7]. Two generations before the first mentioned Cornelis Danckerts, halfway through the sixteenth century, progenitor Cornelis Danckertsz (1536-1595) had held the position of master bricklayer of the city of Amsterdam. The latter's oldest son Cornelis Danckerts de Rij also became master bricklayer of the city, as well as an independent stone mason and architect. The second son, Danckert Cornelisz, specialized in the stone trade and the third son, Hendrick Cornelisz, was bricklayer, stone merchant and clerk of works. Being the son of Danckert Cornelisz, and with a cousin in building who also was called Cornelis Danckerts de Rij, the founder of the publishing house thus came from a milieu that was tried and tested at all levels of the architectural business. He also knew what counted in the then booming city of Amsterdam, both for the architects and builders, and for the wealthy clientele who commissioned their classicist houses along the new canals. He and his relatives knew about construction, ma-

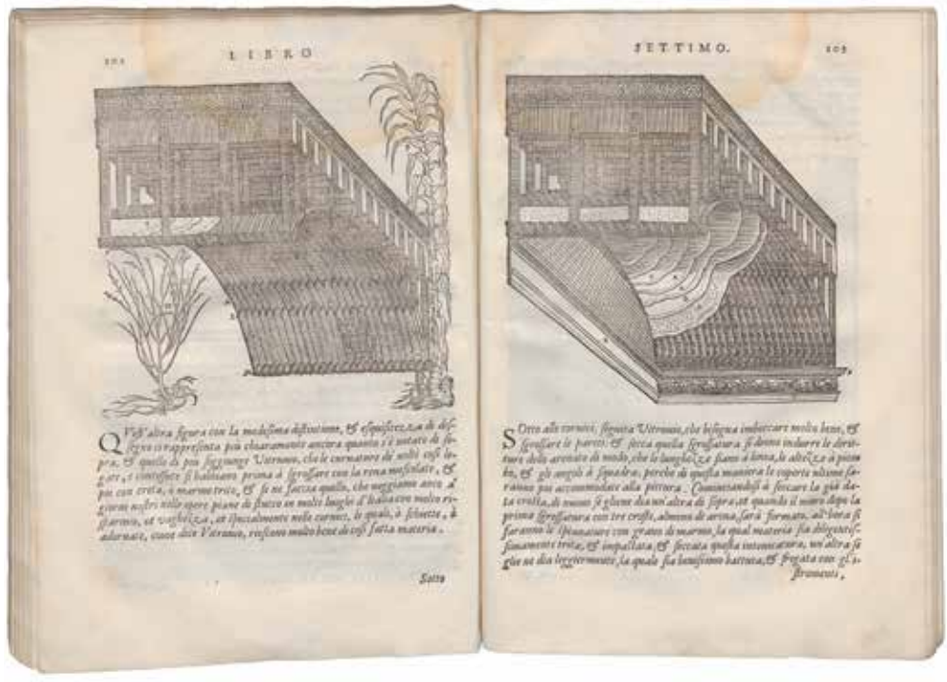
Opus Incertum (2020) pp. 114-129 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12365 www.fupress.com/oi

ARCHITECTURA
CHIVILIS
Vertoonende verſchey de Treffelijcke
CAPPEN
Soo van TOORENS, KERCKE, *als mede veelderhande voorname* HUYSEN, *etc*
en eenige
WENTELTRAPPE
Dienſtigh voor alle Lief-hebbers en Leerlingen van de Bouw-konſt.
uyt gegeven
Door
JUSTUS DANCKERS.

T'AMSTERDAM,
Gedruckt by Juſtus Danckers Conſt en Boeck-verkooper inde Calver-ſtraet by den Dam werden deſe Boecken verkoft als mede de Architectuer Boecken van Schamotſi, Vinjola Simon Bosboom, en andere

pagina 115
Fig. 1 *Architectura chivilis vertoonende verscheyde treffelijcke cappen... cit., engraved title page (Nijmegen, Radboud University, Coll. University Library, shelf mark OD 9 b 30).*

Fig. 2 *Rusconi, Della architettura… cit., pp. 102-103 (Nijmegen, Radboud University, Coll. University Library, shelf mark OD 408 b 22).*



sonry and timberwork, but also about Italian and French taste that brought new aesthetics into building. Architecture was in the genes of the Danckerts family.

The three successive generations of the Danckerts family as printmakers and book publishers would become responsible for a series of highly influential publications on architecture over the course of the seventeenth century. Their publisher's list covers both theory and practice, with authors ranging from one of the first Dutch classicist architects, Salomon de Bray, to the Italian architect and theorist Vincenzo Scamozzi, up to the Swedish engineer Pieter Linperch, bridging a period from about 1630 to 1727[8]. With over thirty different titles, many of them issued in successive editions, Danckerts operated in the heartlands of architectural publishing. If any publisher was to have come up with treatises of a technical character, it should have been Danckerts[9].

Filling a gap

In the preface to the anonymous *Architectura chivilis* (1680), the editor Justus Danckerts (1635-1701) crisply summarized for his 'benevolent reader' the position of architectural books prior to 1680:

> It has to be realized that, for a long time, many outstanding Buildings and Constructions have been erected, of which many significant and praiseworthy books in different languages have appeared for the instruction of the Amateurs of Architecture; however, to my knowledge, I have never seen until now any printed books on Roofs and Roof construction in our Dutch language [...][10].

Apart from the fact that in its preface almost every early modern publication recommends itself as new or unique, in this case the prosperous Amsterdam printmaker, publisher, art seller and bookseller had a point. In fact, Danckerts could have been even more precise. The large body of books on architecture had for the most part focussed on the theory of the column orders alone. And it was not only the specific topic of roof construction that was absent in Dutch architectural books: knowledge of building materials and techniques had been almost totally neglected. It is telling in this respect that notwithstanding their fine commercial sense for what would become successful, the Danckerts press itself had until that point also passed over technical treatises and manuals. It is hard to say whether there was no demand at all, or whether the publishers did not dare to take the risk and missed an opportunity here.

This could imply that there was no demand for books on building practice. Traditionally, technical knowledge was communicated orally or in manuscripts. It was handed down by the craftsman to his apprentice, a tradition hard to verify[11]. Just as in other European countries, in the Northern Netherlands of the late sixteenth and seventeenth centuries, the building trade was confronted with 'new', classical ornaments and with new standards for representative architecture.

[1] In this article the Netherlands refer to the Southern and Northern Netherlands jointly. Northern Netherlands is used interchangeably with the designation Dutch Republic.
[2] The interest in the architectural book as an object of study is growing. General surveys include: *The Mark J. Millard Architectural Collection*, I-IV, New York-Washington 1993-2000; A. Tavares, *The Anatomy of the Architectural Book*, Zurich 2016. On Great Britain, see E. Harris, N. Savage, *British Architectural Books and Writers 1556-1785*, Cambridge 1990; on France: F. Lemerle, Y. Pauwels, *Architectures de papier. La France et l'Europe, suivi d'une bibliographie des livres d'architecture (XVI[e]-XVII[e] siècles)*, Turnhout 2013; on Germany: W. Oechslin *et al.*, *Architekturtheorie im deutschsprachigen Kulturraum 1486-1648*, Basel 2018; on the Netherlands: J. Goudeau, *Denken in steen, bouwen op papier*, Nijmegen 2016.
[3] On Dutch book culture in general, see O.S. Lankhorst, P.G. Hoftijzer, *Drukkers, boekverkopers en lezers in Nederland tijdens de Republiek*, Den Haag 1995; *Bibliopolis*, red. J.A. Bots *et al.*, Zwolle-Den Haag 2003; P.G. Hoftijzer, *The Dutch Republic. Centre of the European Book Trade in the 17th Century*, *European History Online (EGO)*, Mainz, 2015-11-23 (http://www.ieg-ego.eu/hoftijzerp-2015-en, last accessed on 8 August 2020); A. Pettegree, A. der Weduwen, *The Bookshop of the World. Making and Trading Books in the Dutch Golden Age*, New Haven-London 2019.
[4] Other renowned seventeenth-century publishers on architecture include the Elzevier house and Pieter van der Aa. See *Boekverkopers van Europa*, red. B.P.M. Dongelmans *et al.*, Zutphen 2000; P.G. Hoftijzer, *Pieter van der Aa (1659-1733)*, Hilversum 1999.
[5] A more detailed study on the Danckerts press as a whole is desired. Although this article attempts to present the publisher's catalogue on architecture, a definitive list still has to be drawn up. The best account of the publishing house is J. van der Veen, *Danckerts en Zonen. Prentuitgevers, plaatsnijders en kunstverkopers te Amsterdam, c. 1625-1700*, in *Gedrukt tot Amsterdam*, red. E. Kolfin, J. van der Veen, Zwolle-Amsterdam 2011, pp. 59-119. Archival information in I.H. van Eeghen, *De Amsterdamse boekhandel 1680-1725*, I-III, Amsterdam 1965, passim. On Danckerts as map makers, see G. Danku, Z. Sümeghy, *The Danckerts Atlas. The Production and Chronology of its Maps*, "Imago Mundi", 59, 2007, 1, pp. 43-77.
[6] I: Cornelis Danckertsz (1536-1595), II: Cornelis Danckerts de Rij (1561-1634), Danckert Cornelisz (c. 1580-1618/19), Hendrick Cornelisz (c. 1576-1646/50), III: Cornelis Danckerts (1604-1656), IV: Dancker Danckerts (1634-1666), Justus Danckerts (1635-1701), Anna Danckerts (1641-1672), V: Theodorus Danckerts (1660-1727), Cornelis Danckerts (1664-1717). H.L. Kruimel, *Proeve eener genealogie van het uitgestorven geslacht Danckerts (Danckerts de Ry)*, "Nederlandsch Archief voor Genealogie en Heraldiek", 2, 1940, pp. 97-100, 131-136, 145-148, 176-180, 204-209, 250-254, 282, 284; Van der Veen, *Danckerts en Zonen*... cit., p. 60.
[7] For the Danckerts family and contemporary building, see J.E. Abrahamse, *De grote uitleg van Amsterdam*, Bussum 2010, passim; G. van Essen, *Het stadsfabrieksambt*, diss., Utrecht University 2011, passim.
[8] At his death in 1727 Theodorus was declared insolvent and probably that meant also the end of the company. Kruimel, *Proeve eener genealogie*... cit., p. 254.
[9] These publications are referred to below. Though incomplete, the inventory at the death of Dancker Danckerts in 1667 offers an insight into the publisher's catalogue: Stadsarchief Amsterdam, *SA*, notaris D. Danckerts, NA 2852, pp. 691-708, d.d. 2 February and 20 May 1667. Partial transcription in Van der Veen, *Danckerts en Zonen*... cit., pp. 111-115, without the part with (architecture) books (pp. 699-708). With thanks to Jaap van der Veen for sharing information and the exchange of thoughts.

With this came an increasingly codified theoretical apparatus that had spread from Italy since the early fifteenth century. For this classical language new theoretical foundations were needed. However, this new *all'antica* architecture did not immediately require a revolutionary new way of construction. Compared to a good many highly complex late-Gothic experiments in construction, in a way the classical building idiom probably curbed the development of building techniques. In any case, the radical changes in taste and design did not require immediate technical innovation in the Netherlands[12].

Almost simultaneously with the rise of classical architectural theory from the south, the sixteenth century met with another, even more revolutionary, invention from the north: the printing press[13]. The interaction between, on the one hand, printing as a vehicle for the transmission of knowledge and ideas and, on the other, the dissemination of the systematic rules of classical architecture seems by now obvious, but is in fact a highly felicitous concurrence of circumstances – a new *medium* for the dissemination of new *ideas* and *classical* texts. Limiting oneself to architectural books, in this emergence of the unseen and unread and the classification of existing theoretical knowledge, building methods and techniques seem to have been disregarded – in publishing then as well as in historiography now.

The non-technical classical standard: Vitruvius and the column orders

In the Netherlands, the trend for architectural books was established in the southern provinces by Pieter Coecke van Aelst (1502-1550), who presented Sebastiano Serlio's fourth book on the use of the classical column orders in an astonishingly beautiful Dutch translation[14]. After the first compact volume on the orders in 1539, the two larger Antwerp editions of 1539 and 1549 already show the divergence of theory and practice that would later pertain to books on architecture. The first of these bore the title *Generale reglen der architecturen* (i.e. general principles of architecture), and the successive edition spoke of *De reglen van metselrijen* (i.e. principles of masonry), thus shifting the emphasis from architecture to masonry, and implicitly from the humanist architectural amateur into the domain of craftsmen[15]. Coecke's real source was in fact not Vitruvius but Serlio, who had comprised the whole of classical theory: its compelling modular system as a basic design principle for entire buildings, its new idiom and its infinite ornamental possibilities. However, the reference in the extended title to Vitruvius, and with him to his authoritative treatise *De architectura libri decem* from the first century B.C.E., was maintained. In his books Vitruvius had combined theory, construction and material considerations. Nevertheless, it was particularly for his theoretical chapters and theory of the orders and typology that he was referred to[16]. That Vitruvius was also valued by some early modern authors for his technical information is proven by Giovanni Antonio Rusconi's *Della architettura* of 1590, in which the fine woodcuts show above all an unrestrained love for *technical and material detail* – a fascinating exception in this genre (fig. 2). This book was known in the Netherlands[17]. In this respect the influence on architectural knowledge in the north as a whole of the German translation *Vitruvius Teutsch*, published in Nuremberg in 1548 by the physician Walther Ryff (c. 1500-1548) cannot be overestimated. For the first time, Ryff provided building with a rather sophisticated and permanent terminology that would knit together new theoretical knowledge and building practice. Ryff introduced a professional vocabulary and herewith accomplished for architecture what Georg Agricola (1494-1555) had done for mining and met-

[10] 'Staet dan te betrachten, dat van over langh tot nu toe, seer veel voortreffelijcke Gebouwen en Timmeragien sijn gemaeckt, waer van veel sinrijcke en zeer dienstige Boecken in verscheyde talen sijn gedruckt en in 't licht gebracht, tot oeffeningh van de Liefhebbers der Boukonst; en ick, mijnes wetens noch noyt gesien heb in onse Hollantsche tael, eenige boecken van Kap of Dack-werck gedruckt sijn [...]'. *Architectura chivilis*, Amsterdam [1680], "Aen den Discreten Leser", p. [3].

[11] J. Rykwert, *On the Oral Transmission of Architectural Theory*, in *Les traités d'architecture de la Renaissance*, actes du colloque (Tours, 1-11 juillet 1981), éd. J. Guillaume, Paris 1988, pp. 31-48.

[12] This remarkable aspect of seventeenth-century building is still underexposed. On the medieval tradition see: R. Meischke, *Het architectonisch ontwerp in de Nederlanden gedurende de late middeleeuwen en de zestiende eeuw* (1952), in Id., *De gotische bouwtraditie*, Amersfoort 1988, pp. 127-207; M. Hurx, *Architecture as Profession. The Origins of Architectural Practice in The Low Countries in the Fifteenth Century*, Turnhout 2017. On the close relationship between technique and the trading of building materials: G. van Tussenbroek, *The Architectural Network of the Van Neurenberg Family in the Low Countries (1480-1640)*, Turnhout 2006.

[13] M. Carpo, *Architecture in the Age of Printing: Orality, Writing, Typography, and Printed Images in the History of Architectural Theory*, Cambridge 2001.

[14] On Coecke and further documentation see more recently *Unity and Discontinuity: Architectural Relationships between the Southern and Northern Low Countries (1530-1700)*, edited by K. De Jonge, K. Ottenheym, Turnhout 2007, pp. 41-53.

[15] *Die inventie der colommen met haren coronementen ende maten*, Antwerp 1539; *Generale reglen der architecturen op de vyve manieren van edificien*, Antwerp 1539; *Reglen van metselrijen, op de vijve manieren van edificien*, Antwerp 1549.

[16] See, among others, S. Holzer, *Vitruvianismus und Bautechnik. Zur neuzeitlichen Geschichte abgespannter Krankonstruktionen*, "Architectura", 44, 2014, 1, pp. 17-35.

[17] A copy in the Nijmegen University Library: *Della architettura di Gio. Antonio Rusconi*, Venezia 1590; shelf mark OD 408 b 22. Publisher and antiquarian Willem Goeree referred several times to Rusconi in his treatise: *D'Algemeene bouwkunde* [1681], Amsterdam 1705², "Voorbericht"; pp. 23, 103, 119, and 123; 12 and 29.

allurgy[18]. It was the orders that would dominate the architectural books, presumably at the cost of the interest in building technique.

Almost a century after Coecke's Serlio excerpt, the situation had not altered much. In 1640 Cornelis Danckerts also looked to Italy for his material. He had noticed the Dutch taste for the work of Vincenzo Scamozzi (1548-1616), the most recent and most comprehensive of Italian treatises[19]. With *Grontregulen der bow-const*, Danckerts established Scamozzi's column system as the standard for Dutch classicist architecture. The popularity of Scamozzi in the Netherlands equalled that of Giacomo Barozzi da Vignola (1507-1573) in France and that of Andrea Palladio (1508-1580) in England. In 1658, Cornelis's son Dancker Danckerts managed to purchase in Venice the original woodblocks of Scamozzi's sixth book on the orders. With an eye on the large Amsterdam city expansions, Dancker Danckerts boosted the popularity of Scamozzi by including the third book on private housing in his 1658 edition in two volumes. The work became an instant success. By 1661, another six different editions had appeared, including a German translation. That these books were widely used in building becomes clear from the fact that the Danckerts editions were adapted and simplified successively by architect Joachem Schuym (fl. 1658-1677), stone mason of the city of Amsterdam Symon Bosboom (1614-1662) and master bricklayer Joost Vermaarsch (fl. 1656-1664) from Leiden. They hired themselves out to Danckerts and to his competitive publishers, resulting in a vying miscellany of more or less analogous Scamozzi editions, each with their own character and adaptations[20]. These booklets were in fact a hands-on 'technical' application of theory. It was Danckerts, however, who added four new plates to his 1661 edition indicating and listing in Italian and Dutch all the parts of the column orders. With this important list the architectural terms were codified. The architect Salomon de Bray (1597-1664), who was responsible for this list, changed the still-unsettled Dutch vocabulary into a professional one, just as Ryff had done in German. Danckerts must have tried to capture the market as much as he could by also editing the only Dutch version of Palladio (i.e. the orders from the first book) as well as at least three editions of Vignola, who was especially esteemed by craftsmen for simplifying the correlation between the different orders[21].

Built examples on paper: topography, buildings, interiors

In 1631, in *Architectura moderna ofte bouwinge van onsen tyt*[22] Cornelis Danckerts initiated a tradition of publications on buildings by leading Dutch architects, with an overview of works by the practically-trained master mason of the city of Amsterdam, Hendrick de Keyser (1565-1621). With this book, one of the great craftsmen of its time was embedded in an intellectual narrative. The large format of the engravings and the scholarly introduction by the classicist architect Salomon de Bray set a standard that was only met by Danckerts himself, for example with a second and third reissue of *Gronden en afbeeldsels der voornaamste gebouwen* on the work of the celebrated Amsterdam architect Philips Vingboons (1607-1678)[23]. There were representations of important buildings after completion, such as the fine series on the Amsterdam city hall, or the Trippenhuis, the ultimate classicist city palace[24]. Without there being emphasis on construction or material features or accompanying text, the specialist nevertheless could see on these engravings – mostly consisting of plans, orthogonal elevations and sections – the *constructional details* he wanted to know about. The exact and technical reproduction of the walls, vaults, and roofs was almost casually subsumed in these tantalizingly rich engravings.

[18] W.H. Ryff, *Vitruvius Teutsch […]*, Nuremberg 1548; G. Agricola, *De Re Metallica Libri XII […]*, Basle 1556.
[19] First noticed by J. Terwen, *Mag de bouwkunst van het Hollands Classicisme "Palladiaans" genoemd worden?*, "Nederlands Kunsthistorisch Jaarboek", 33, 1982, pp. 169-189.
[20] For the relationship between these editions, see W. Kuyper, *Dutch Classicist Architecture*, Delft 1980, pp. 225-227; A. Hopkins, A. Witte, *Van luxe architectuurtraktaat tot praktische handleiding. De Nederlandse uitgaven van Scamozzi's* L'Idea della Architettura Universale, "Bulletin KNOB", 96, 1997, 5, pp. 137-153; P. Fuhring, *Ornament Prints in the Rijksmuseum II. The Seventeenth Century*, I-III, Amsterdam-Rotterdam 2004, passim; V. Scamozzi, *De grondgedachte van de universele bouwkunst. Klassieke zuilenorden*, red. M. Dicke *et al.*, Amsterdam 2008, pp. 26-39.
[21] On Vignola editions in the Netherlands, see R. Stenvert, *Constructing the Past*, diss., Utrecht University 1991, pp. 194-198, 455-460.
[22] H. de Keyser, *Architectura Moderna ofte Bouwinge van onsen tyt […]*, Amsterdam 1631. Reprint and context in K. Ottenheym, P. Rosenberg, N. Smit, *Hendrick de Keyser, Architectura Moderna. Moderne bouwkunst in Amsterdam 1600-1625*, Amsterdam 2008.
[23] *Editio princeps* Amsterdam: Joan Blaeu, 1648. The Danckerts editions: Amsterdam: Justus Danckerts, 1680 and 1688, made after the reprint of 1665 of Vingboons' first book.
[24] The Amsterdam city hall was designed by architect Jacob Van Campen and built between 1648-1655, only to be finished in 1665. Print series: *Afbeelding van 't Stadt Huys van Amsterdam. In dartigh coopere plaaten, geordineert door Jacob van Campen, en geteeckent door Iacob Vennekool*, Amsterdam 1661. Reprints, all in Amsterdam, by Frederik de Wit [1666-1706], David Mortier 1718, Gerard Valck 1719, Covens & Mortier & Covens Jr [1774-1783]. Architect Justus Vingboons' Trippenhuis in Amsterdam of 1660-1662 was published as: *Het huys van de heeren Louys en Hendrick Trip*, Amsterdam 1664; and reprinted by Justus Danckerts in 1699.

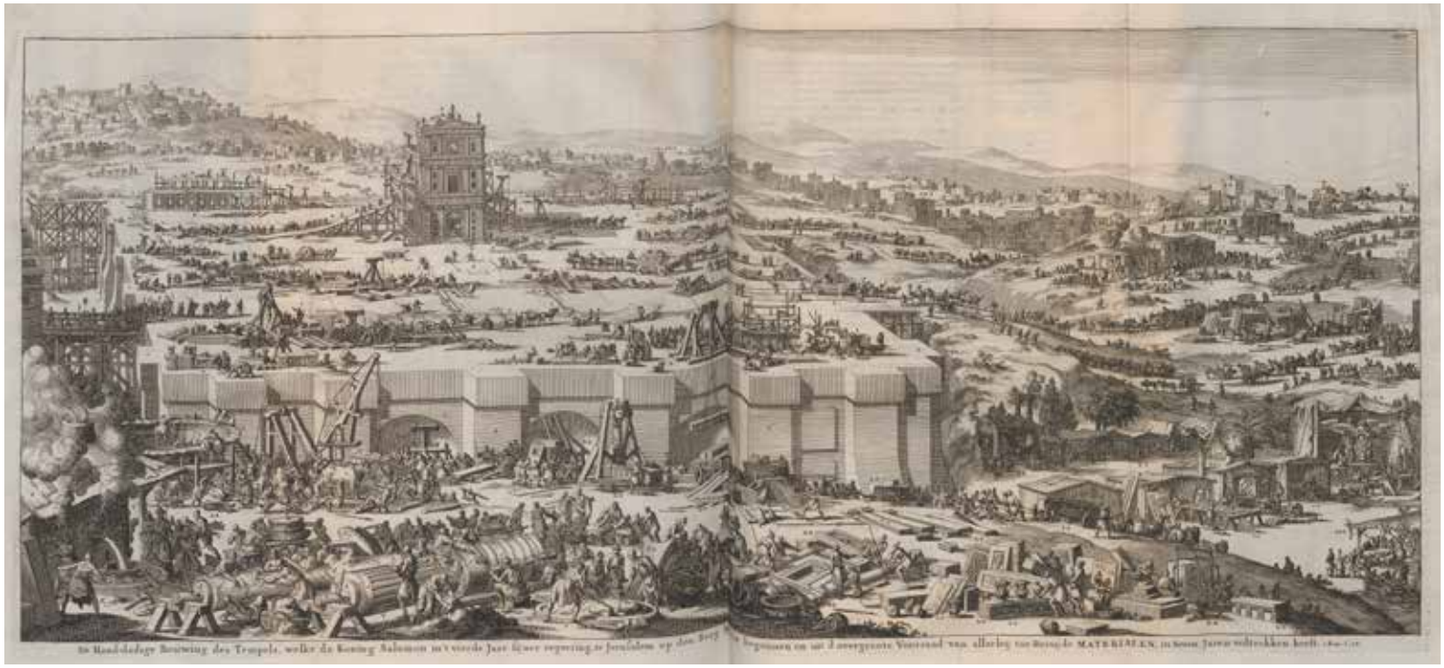


Fig. 3 Goeree, *Voor-bereidselen tot de bybelsche wysheid... cit., p. 1594 (Nijmegen, Radboud University, Coll. University Library, shelf mark OD 268 B 58).*

Sometimes, technical information occurs in unlooked-for places. An interesting example, although not by Danckerts, is the two-volume book on biblical 'wisdom' titled *Voor-bereidselen tot de bybelsche wysheid […]* (Amsterdam 1690). Its publisher and author was bookseller, architectural theorist and biblical antiquarian Willem Goeree (1635-1711)[25]. In the large engravings of the building of the Temple of Solomon, Goeree incorporates a goldmine of information about building practice (fig. 3). All over this Solomonic building site craftsmen are at work, busy with carpentry, stonecutting, brickmaking, erecting columns, hoisting loads and building elements, roofing, and casting bronze and iron objects. One learns about the ins and outs of work on the construction site, where various trades are involved. In one engraving only, Goeree is able to summarize the whole process of handling raw materials, applying construction techniques, and the use of tools and devices. The ancient setting in fact reflects contemporary building practice, thus providing us in this unexpected context with one of the most comprehensive *visual 'catalogues'* on building techniques in the Dutch Republic[26]. The rather isolated example of Goeree in the Dutch Republic would in fact only be complemented by a unique manuscript on practical engineering somewhat later, known as the 'testament' of engineer Adriaan Bommenee, who worked in the province of Zeeland[27].

In the meantime, the newest domestic classicist architecture, and the private houses along the canals of Amsterdam in particular, were drawing the attention of the market. Cornelis II Danckerts served its clientele by publishing around 1696-1706 a rare booklet on the canal houses in the new extensions of Amsterdam: twelve plates with rows of house facades, particularly of the Herengracht and Keizersgracht[28]. Here, architecture was reduced to representative fronts, without indication of its dimensions, ground plans, building material or interiors. There was a hunger for prints of luxurious houses. Danckerts' firm pictured with equal ease villas elsewhere in the country, such as the princely palace at Honselaarsdijk near The Hague. Again, though sometimes very accurate, these prints had more to do with status and court culture than with documenting architecture as such.

The Italian taste came 'filtered' to the market. In 1630, in Cornelis Dankerts' first architectural publication, *Architecture van verscheidene nieuwe poorten; of deuren van huisen*, an unknown author H.K. presented a series of classicist Italian entrance gates, adapted to the more sober Dutch taste, without any ornament or sculpture[29]. A later seventeenth-century less direct route was through French domestic architecture, which matched the taste and needs of the nobility around the stadtholder (Frederik Henry, William III) and the new mercantile elite in the Republic. The designs of chimneypieces made up the largest part of the publications, reprints from works by the French designer and engraver Jean and his son and ar-

[25] Ch. van den Heuvel, *Willem Goeree (1635-1711) en de ontwikkeling van een algemene architectuurtheorie in de Nederlanden*, "Bulletin KNOB", 96, 1997, 5, pp. 154-176.

[26] In a way, the materials and tooling displayed on this engraving are complemented by the passages on building materials in his later architectural treatise W. Goeree, *D'Algemeene bouwkunde*, Amsterdam 1681.

[27] *Het 'testament' van Adriaan Bommenee. Praktijkervaringen van een Veerse bouw- en waterbouwkundige uit de 18de eeuw*, Middelburg 1988.

[28] *Een Amsterdams grachtenboekje uit de zeventiende eeuw*, red. I.H. van Eeghen, Amsterdam 1963.

[29] The initials 'H.K.' probably are of Hendrick Cramer (Kramer). See Kuyper, *Dutch Classicist Architecture*… cit., pp. 227, 326.

chitect Pierre Le Pautre, such as *Nouveaux desseins de chéminées a l'italienne* and *Nouveau livre d' porte d' la chambre* (Amsterdam 1700, resp. 1751) and by the architect Pierre Bullet, e.g. *Verschyde schoorsteen mantels […]* (Amsterdam 1675-1686). When the focus of his clientele shifted to the home interior, Danckerts capitalized on this tendency in 1646 with *Verhandeling van galderyen, voor-huisen, zaelen […]*, an adaptation of the famous *Manière de bâtir* (Paris 1623) by Pierre Le Muet, who in his turn had been inspired by Sebastiano Serlio. The constructional and material specifications of all this architecture, however, remained implicit, if not completely absent, as before. These examples seem to indicate that seventeenth-century building techniques were favourably communicated without words and only *visually* through illustrations – sometimes isolated and in all types of publications.

The ultimate early technical treatise: military architecture

With its publishing policy the Danckerts press must have aimed at both the educated architect and the wealthy citizenry and aristocracy. Yet, there was one large field in the publishing of books on building that was more exclusively the arena of the engineer: fortification. The many treatises on fortification are the most technical of all publications on architecture, dealing with *mathematical operations*, land surveying, the construction of fortifications and the tactics of siege warfare, presented as a matter of calculation and geometry. The practical tricks of the trade, however, such as drainage, earth moving and examining geographical conditions remained mostly outside the scope of these treatises. In this case the Danckerts press made no attempt to gain a foothold in this book genre and most likely left it for specialized publishers such as Elsevier (Leiden and Amsterdam), who were in close contact with the engineers. Nonetheless, Danckerts did try to take some advantage of the wide interest in fortification. Around 1696 the house published a series of sheets called *Fortesse van […]*, displaying fortified cities all over Europe and the Mediterranean. Examples from Sicily, Lombardy, the Rhine region, the Spanish Netherlands or the Peloponnesian peninsula served purely illustrative purposes in the wake of the many evocative siege accounts that were published[30]. With hindsight it is curious that all these books on fortification with their *technical character* had no effect on the writings on civil architecture. Yet the multitalented Simon Stevin (1548-1620) had by the early seventeenth century tried to cover both fields with an equal practical attention[31]. His pioneering approach remained an exception throughout the seventeenth century.

Mechanical vistas: gardens and perspective

The expertise of the engineer and land surveyor stretched far beyond fortification alone. Wherever these men were recruited, they were also acquired for all sorts of civil engineering, as city planners, experts in hydraulics, fireworks, and, in the distant colonies, for house building too. Some of them specialized in landscape and garden architecture. Strangely enough, in books on garden ornaments, significantly more attention was given to technical *realization* than in books on civil architecture. One of the first was Salomon de Caus in his fantastic *Les raisons des forces mouvantes […]* (3 vols., Frankfurt: Jan Norton, 1615). In the case of garden design, the Dutch fascination for gardens had its origin in the French formal garden. The fabulous fable fountains by Charles Perrault in the labyrinth of Versailles became popular all over Europe, particularly thanks to a modest Dutch reprint of the original French publication, this time expanded with texts in French, English, Ger-

[30] See M. Pollak, *Cities at War in Early Modern Europe*, Cambridge 2010; J. Goudeau, *Safe Strongholds. Mathematical Fortification and the Fortress of Mathematics*, in *Festungsbau. Geometrie – Technologie – Sublimierung*, herausgegeben von B. Marten, U. Reinisch, M. Korey, Berlin 2012, pp. 219-235.

[31] Ch. van den Heuvel, *'De Huysbou'. A Reconstruction of an Unfinished Treatise on Architecture, Town Planning and Civil Engineering by Simon Stevin*, Amsterdam 2005.

man and Dutch[32]. The specifications of the advanced technique behind these colourful fountains that 'spoke' with their water jets remained untold. Here in the books and prints of garden architecture it was not the, sometimes remarkable, technique that played a role, but the ornamental function of the gardens or compact narrative of the symbolic universe that was displayed in them. At the turn of the century, Justus Danckerts added to his catalogue a series of French garden trellises by Jean and Pierre Le Pautre[33]. Of course, there were exceptions where technique did play the main role, such as the small book *Berigt om konstige lugt en waterwerken te maaken […]* by an anonymous author indicated as D.R. Ph.Dr. (Utrecht: Joannes Evelt, 1735)[34]. This booklet contains a compilation of fanciful fountains with their *pneumatics and hydraulics*, comparable with De Caus's earlier fascination.

Frequently the attractiveness of the luxurious country estates in prints is largely determined by the use of enhanced perspective. Books on the working and correct construction of perspective became popular, both for the education of the professional artist and architect and for the instruction of amateurs. Perspective was a standard part of books on mathematics. Danckerts contributed with two key publications on 'doorsicht-kunde' ('the art of viewing'), Dutch translations of books by Abraham Bosse, who in turn had borrowed the method from Girard Desargues[35]. Technique here was *drawing technique*.

Early traces: the roofs and stairs of *Architectura chivilis* (c. 1680)

In an attempt to find out when building technique first appeared in Dutch architectural books, the above brief overview has shown how new architectural knowledge entered the Republic directly or indirectly. It becomes clear that these publications contributed only to a very limited extent to the spread of knowledge on building technique. The technical aspect of architectural theory in the Netherlands was limited to mathematics. What was called *mechanics*, was in fact statics, followed by analytic mathematics. In France and England techniques were taught at the Académie and the Royal Society respectively, whereas the Netherlands lacked such permanent institutions[36]. A typical architectural problem since the late sixteenth century had been the advancement of stereotomy or stonecutting, which affected both the design of stone staircases and vaulting. Building in the Northern Netherlands meant mostly masonry, with mature techniques that had already developed in the Gothic period[37]. Although stereotomy was not unknown in the Republic, it is not reflected in Dutch architectural books.

The subject of building in wood, however, did abound in the print medium. A key publication in this respect was brought to the market around 1680 by Justus Danckerts: *Architectura chivilis, Vertoonende verscheyde treffelijcke cappen […]*[38] (fig. 1). This modest folio on civil architecture with thirty-nine engravings has escaped attention in architectural history, but it is actually the first publication in Dutch on building technique and is a milestone in architectural publication in the Republic[39]. The engraved title page catches the eye, being an adaptation of the frontispiece by Salomon Savery (1594-1683) for Joost van den Vondel's famous poem on the inauguration of the Amsterdam town hall: *Inwydinge van 't Stadthuis t'Amsterdam* (Amsterdam: Widow of Abraham de Wees, 1655). Danckerts copied the general layout and main iconography, with the personification of *Architectura* (reflecting the title of the book). In her right hand she holds a compass, square and plumb line, and in her left, a model of the town hall of Amsterdam, thus mirroring the title page of the *Inwydinge*. The cross-

[32] Ch. Perrault, *[…] 't Dool-hof tot Versailles*, Amsterdam [1682].

[33] Undated, c. 1675-1686; reprint by Reinier & Josua Ottens c. 1726-1750 or 1750-1765; Fuhring, *Ornament Prints*… cit., cat. nos. 7350-7354.

[34] A unique copy in the Nijmegen University Library: shelf mark OD 330 c 109.

[35] G. Desargues, A. Bosse, *Algemeene manier van de hr Desargues tot de praktyk der perspectiven […]*, Amsterdam 1664, and Justus Danckerts 1686; A. Bosse, *Algemeen middel tot de practijck der doorsicht-kunde op tafereelen […]*, Amsterdam 1686.

[36] J. Heyman, *Geometry, Mechanics, and Analysis in Architecture*, in *Geometrical Objects. Architecture and the Mathematical Sciences 1400-1800*, edited by A. Gerbino, Cham 2014, pp. 193-201. Of course, there was the famous seventeenth-century Dutch engineering school *Duytsche Mathematique* in Leiden as well as others for studying fortification and practical mathematics, but these lacked a theoretical reflection and as institutions did not contribute to mathematical developments as such. Older, but still most relevant are: E. Taverne, *In 't land van belofte: in de nieue stadt. Ideaal en werkelijkheid van de stadsuitleg in de Republiek 1580-1680*, Maarssen 1978; P.J. van Winter, *Hoger beroepsonderwijs avant-la-lettre. Bemoeiingen met de vorming van landmeters en ingenieurs bij de Nederlandse universiteiten van de 17de en 18de eeuw*, Amsterdam-Oxford-New York 1988. On the mathematization in Dutch architectural theory: J. Goudeau, *Nicolaus Goldmann (1611-1665) en de wiskundige architectuurwetenschap*, Groningen 2005.

[37] For mediaeval style and praxis in the Renaissance, see E.M. Kavaler, *Renaissance Gothic*, New Haven-London 2012.

[38] *Architectura chivilis vertoonende verscheyde treffelijcke cappen soo van toorens, kercke, als mede veelderhande voorname huysen, etc en eenige wenteltrappe: dienstigh voor alle lief-hebbers en leerlingen van de bouw-konst*, Amsterdam s.a. [c. 1680]. Engravings numbered 9-43; figs. 1-4. A second undated edition (on the title page next to Justus Danckerts' name 'cum privilegio' added) was probably issued c. 1686 or later, and a third c. 1750 by Reinier & Josua Ottens in Amsterdam. Cf. editions in the University Libraries of Amsterdam and Nijmegen and in the collection of the Rijksmuseum Amsterdam. Fuhring, *Ornament Prints*… cit., cat. nos. 5112-5151; 5152-5191. An extra print of the interior of the old Lutheran church in Amsterdam (1633) is found in all three editions, though not in all the copies and in a different format.

[39] Goudeau, *Denken in steen*... cit., p. 86.

Fig. 4 Wilhelm, *Architectura Civilis… cit., engraved title page (München, Bayerische StaatsBibliothek; Europeana Collections).*

staff (an instrument for navigation, referring to the Amsterdam sea trade) is copied, whereas several other craftsman's tools are added. The title page clearly tried to seduce the reader, without giving anything away of the unusual contents of the book itself. As mentioned above, Danckerts promised to treat remarkable *roof constructions*, many of which, he writes in his preface, had been destroyed by acts of war. Although the Republic had known its own Eighty Years' War, this remark gives a clue to the real provenance of his material.

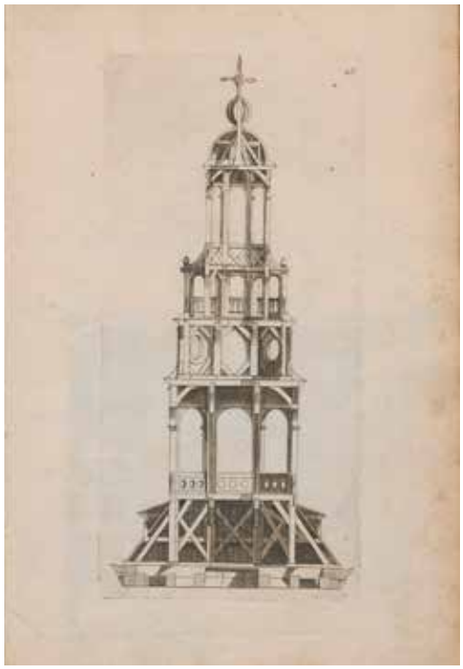
The war referred to was the Thirty Years' War (1618-1648) that had brutally ravaged the German countries. Danckerts' book turns out to have indeed an undisclosed German source[40]. Though without citing it directly, the book can be traced back to the equally unique book on roof construction *Architectura civilis: das ist Beschreib- oder Vorreißung der fürnembsten Tachwerck […]* by master builder Johann Wilhelm (1595-after 1669) from Frankfurt am Main[41]. First published by the author in Frankfurt in 1649, a year after the Peace of Westphalia, this book became a handbook and ran to six editions[42] (fig. 4[43]). Danckerts copied (thus printed mirror images of) twenty of the thirty-eight original illustrations by the Frankfurt artist Sebastian

[40] As in all other fields of publication, of architectural books and prints, foreign and domestic, rights were sold, copies, translations and excerpts were issued, simultaneously struggling against a lively market of counterfeits and pirate editions. How Danckerts acquired this title is unknown.

[41] J. Wilhelm, *Architectura civilis das ist: Beschreib- oder Vorreißung der fürnembsten Tachwerck, nemlich hoher Helmen, Creutztächer, Wiederkehrungen, Welscher Hauben, so dann Kelter, Pressen, Schnecken, oder Windelstiegen, vnd dergleichen*, Frankfurt am Main 1649. Fuhring, *Ornament Prints… cit.*, cat. nos. 5401-5471.

[42] Frankfurt am Main: with the author, 1654, 1662; a second part added: Nuremberg: (widow of) Paul Fürst c. 1668, c. 1675; Rudolf Johann Helmers 1705.

[43] J. Wilhelm, *Architectura Civilis* […], Frankfurt am Main 1662, in Europeana Collections: http://mdz-nbn-resolving.de/urn:nbn:de:bvb:12-bsb11053805-1, last accessed on 8 August 2020.



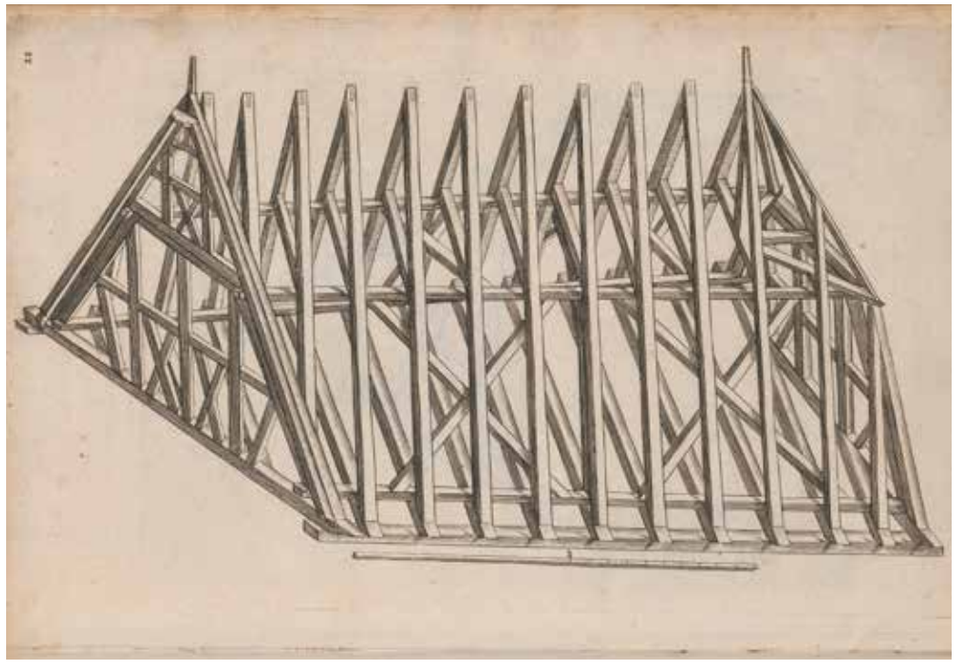


Fig. 5 *Architectura chivilis… cit., tab. 26 (Nijmegen, Radboud University, Coll. University Library, shelf mark OD 9 b 30).*

Fig. 6 *Architectura chivilis… cit., tab. 11 (Nijmegen, Radboud University, Coll. University Library, shelf mark OD 9 b 30).*

Furck (1589/98-1655/66), likely from the 1662 edition. He adapted the preface only slightly. The engravings, showing different and in some cases rather unusual roof types, tower constructions, wooden vaults, and two spiral staircases, had to speak for themselves, with only a very short introduction. It is highly doubtful that the examples in the book fitted the Dutch context and apparently those engravings that were too 'German' because of their specific and deviant wood constructions were left out[44]. Danckerts replaced them with examples from other sources, of which the most remarkable is the engraving of the famous (later added) tower construction of the Maastricht town hall (fig. 5). Other illustrations are taken from the French Palladio edition by Pierre Le Muet, *Traicté des cinq ordres d'architecture […] Traduit du Palladio […] Augmenté de Nouvelles inventions pour l'art de bien bastir par le Sr. Le Muet* (Paris: François Langlois, 1645, or a later edition). Earlier, Cornelis Danckerts had used this edition for his own Dutch Palladio edition. These sections of houses and roof constructions were not Palladio's, of course, but the work of the French architect Le Muet, and they suited the Dutch context better. Some stone bridges at city gates depicted by Wilhelm were left out by Danckerts. He replaced them with three engravings of wooden drawbridges, taken from two typical Dutch books on fortification by Adam Freitag (1608-1650) and Nicolaus Goldmann (1611-1665)[45]. The models of spiral stairs were also new. The real importance of this somewhat hybrid book lies probably not so much in its content as in the presentation and details which would become standard in later technical manuals: the startling oblique projection of complex roof constructions, the construction lines revealing the proportions and underlying geometry, the consequent scales, and the accurate rendering of joints (fig. 6). Thus, this book formed the pinnacle, so far, of an architectural book *on building technique*, in which different developments came together. It combined the exclusive focus on building construction, the transmission of knowledge from abroad through built examples, the application of carefully arranged projection with a technical purpose by avoiding perspectival foreshortening, and the illustrations accompanied by a short explanatory text using a technical vocabulary. With both the seductive engravings and the symbolically charged title page Danckerts inserted the publication smoothly into the existing context of the familiar architectural book.

A new angle: the German tradition and a Dutch roundabout route

The connection between German and Dutch books on building technique is more complex than Justus Danckerts borrowing from Johann Wilhelm. It even seems that from the last quarter of the seventeenth century on, there emerged a German-Dutch exchange of knowledge, resulting in the rise of the technical treatise in both countries. Earlier, Dürer, Agrico-

[44] Compare with H. Janse, *Houten kappen in Nederland 1000-1940*, Delft-Zeist 1989, part 3; S. Holzer, B. Köck, *Structure of Baroque Church Roofs in Bavaria*, in *Structural Analysis of Historic Construction*, edited by D. D'Ayala, E. Fodde, I-II, Bath 2008, pp. 235-242.

[45] J. Goudeau, *Freitag, Adam (1602-1664)*, and: id., *Goldmann, Nicolaus (1611-1665)*, in *Architectura. Les livres d'architecture*, éd. F. Lemerle, Y. Pauwels, Tours 2015; http://architectura.cesr.univ-tours.fr/traite/Auteur/Freitag.asp?param=en; and: http://architectura.cesr.univ-tours.fr/traite/Auteur/Goldmann.asp?param=en, last accessed on 8 August 2020. Note that these books were not published by Danckerts but by Elzevier.

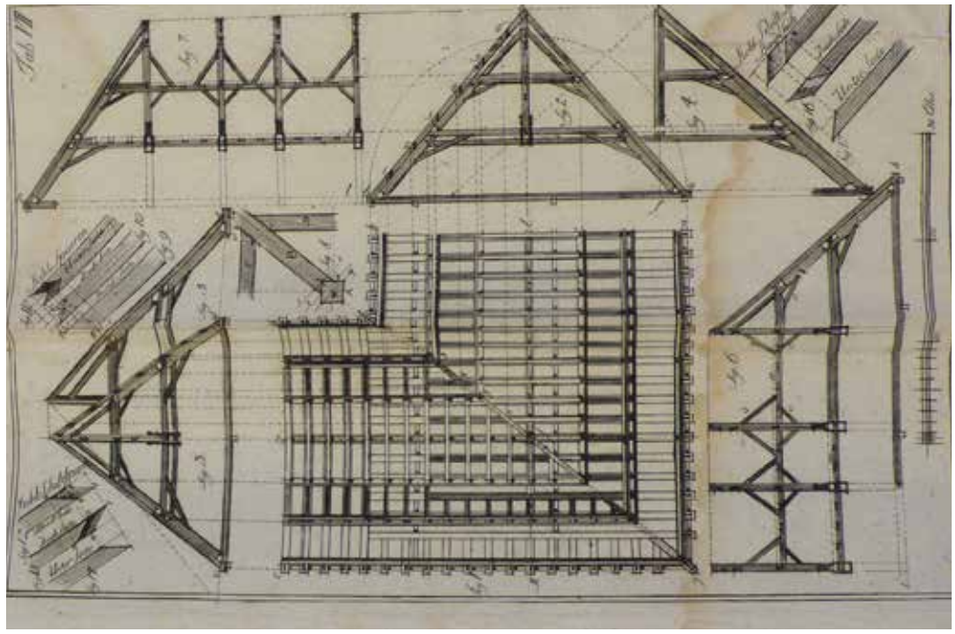


Fig. 7 *Reuss, Anweisung zur Zimmermannskunst… cit., tab. VII (Tilburg, University, Coll. University Library, shelf mark CBC TFK D 590).*

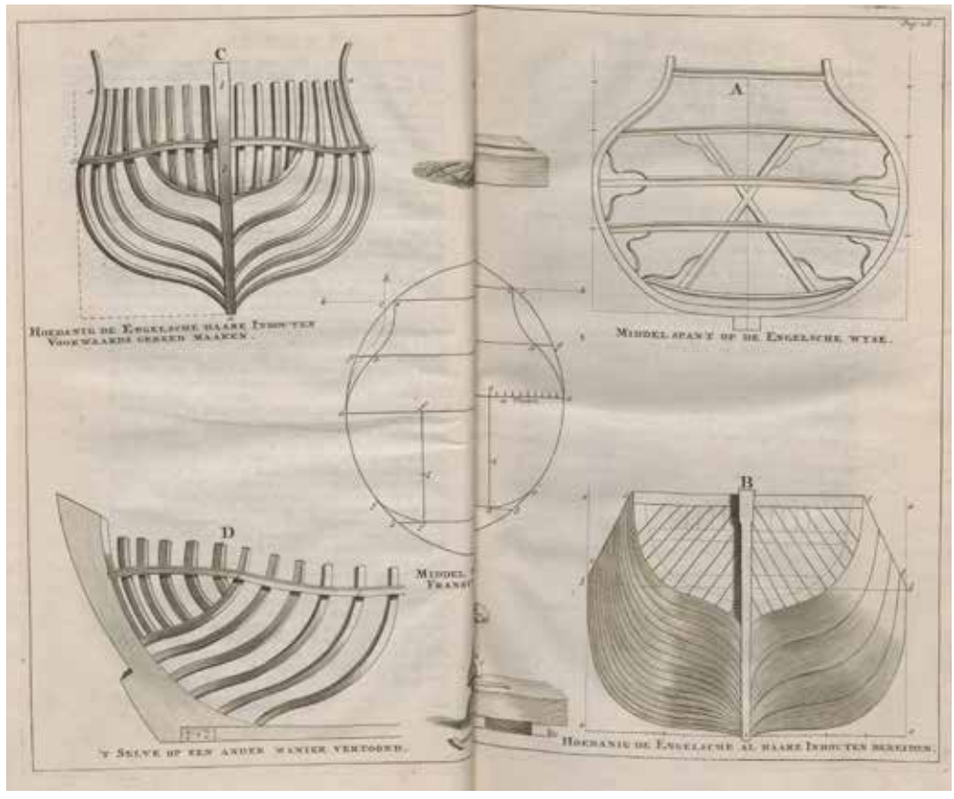


Fig. 8 *Van Yk, De Nederlandsche scheeps-bouw-konst open gestelt... cit., p. 18 (Nijmegen, Radboud University, Coll. University Library, shelf mark OD 165 b 7).*

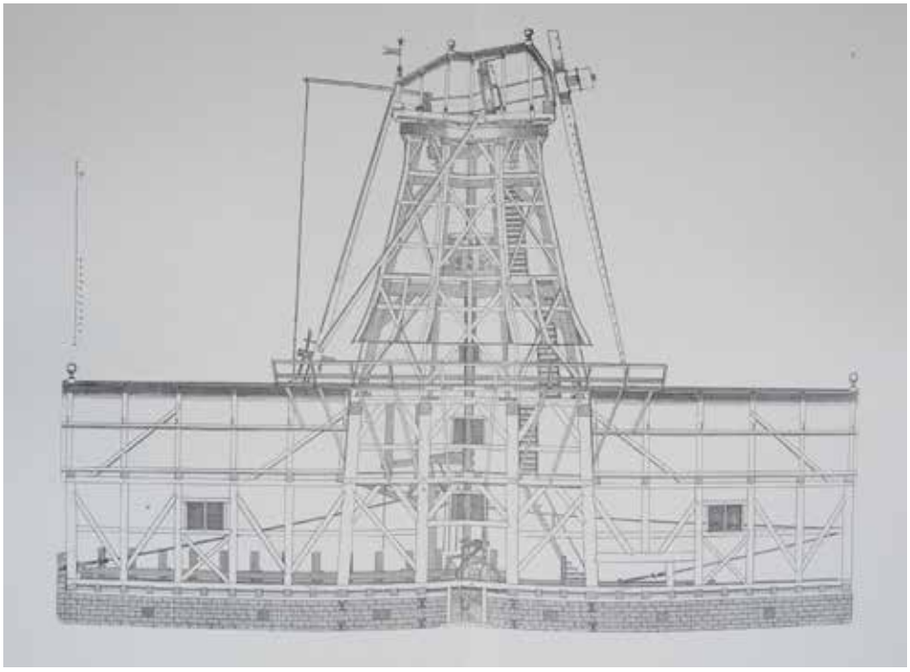
la, Ryff and De Caus had dealt with technical problems and mechanics. Seventeenth-century writers on building, then, became almost entirely absorbed with the mathematical approach, dealing with architecture and design *more geometrico*. Mechanical phenomena were primarily treated as wonders of nature. From the early eighteenth century on, the architectural publicists Leonhard Christoph Sturm (1669-1719) and Johann Jacob Schübler (1689-1741) engaged in two new genres: wooden constructions and industrial architecture, including roofs, bridges, sluices, and mills. As the titles of their works reveal, Sturm and Schübler based their general theory on the architectural theorist Nicolaus Goldmann (1611-1665) who worked and taught in the Dutch town of Leiden. Danckerts took engravings for his *Architectura chivilis* from Goldmann. Sturm's father, Johann Christoph, had studied with Goldmann and Leonhard Christoph himself had travelled through the Netherlands. That was where he be-

Fig. 9 *Linperch, Architectura mechanica… cit. (1700), engraved title page (rare copy sold by Zwiggelaar Auctions, Amsterdam 2018).*

came fascinated by the theoretically neglected works of engineering, to which he would dedicate various books that set a standard in the field[46]. The Nuremberg draughtsman and engraver Schübler must have been well aware of Wilhelm's work, as is evident from his *Nützliche Anweisungen zur […] Zimmermans-Kunst* and his *Sciagraphia artis tigniariae […] Zimmermannskunst* (Nuremberg: Joh. Christoph Weigel, 1731, resp. 1736). These books were lavishly illustrated with very detailed prints, for example, of roof constructions. The line started by Wilhelm and Schübler was continued throughout the eighteenth century in Germany. A fine example in this respect is the rare book *Anweisung zur Zimmermannskunst* (Leipzig: Bernhard Christoph Breitkopf and Johann Breitkopf, 1764), by the royal architect of Saxony in Dresden Christian Gottlob Reuss (1716-1792)[47] (fig. 7). In twelve chapters of text, illustrated by thirty large fold-out engravings, Reuss gives detailed descriptions of the construction of roofs. He uses

[46] Relevant titles by Leonhard Christoph Sturm: *Von Häng- oder Sprengwerken* (1713), *Fang-Schläussen* (1715), *Mühlen Baukunst* (1717), *Reise-Anmerckungen* (1719), *Wasser-Künste* (1720), *Schiff-Häuser* (1721). Most of these books posthumously compiled in *Der auserleßneste […] Goldmann […]*, Augsburg 1721, in which twenty-two of his works on civil architecture. See Goudeau, *Nicolaus Goldmann…* cit., app. 4.

[47] Only remaining copy in the Netherlands: Tilburg University Library, shelf mark CBC TFK D 590.



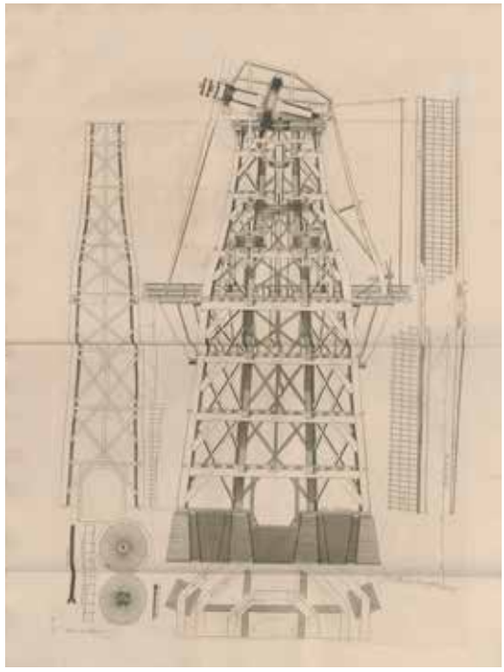


Fig. 10 *Linperch, Architectura mechanica… cit. (1725), tab. 8 (Amsterdam, University, Coll. University Library, shelf mark OTM: OF 80-142)*

Fig. 11 *Van Natrus, Polley, Van Vuuren, Groot volkomen moolenboek... cit., part 2, tab. V-VI (engravings by J. Punt; Nijmegen, Radboud University, Coll. University Library, shelf mark OD Kluis).*

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professional terms for the different beams, trusses, tie-beams, spars, and braces. He also pays minute attention to the specific joints by which the parts of the roof are assembled. During the eighteenth century, these and similar technical books made headway in the academies and practical architectural education in northern Europe, a tradition that started with Wilhelm and Danckerts.

Technique gets a foothold: mills, sluices, stairs, and roofs

The legacy of Justus Danckerts' *Architectura chivilis* in the Northern Netherlands was the emergence of a lasting genre of books on building technique. The Amsterdam architect and teacher Adrianus Erzey (1719-1777) used material from this work for his own *Architectura of bouw-konst […]*, [Amsterdam: s.n., 1777][48]. In the early nineteenth century, the Amsterdam architect Johannes van Straaten (1781-1858) reworked Danckerts' material on the construction of stairs, this being originally seventeenth-century material, in *Nieuwe verbeterde bouwkunde van A. Erzey […]* (Amsterdam: Simon de Grebber, 1829). In this rather silent way print began to complement the traditional way of dealing with technical problems by best practice and rules of thumb, solutions handed down by education on site, in manuscripts, notebooks, drawings, and scale models. Occasionally practical knowledge had found its way into print, as in the book on the typical Dutch craftsmanship involved in shipbuilding written by the specialist Cornelis van Yk, *De Nederlandsche scheeps-bouw-konst open gestelt [...]* (Delft and Amsterdam: Andries Voorstad voor Jan ten Hoorn, 1697). It shows, above all, the construction and dimensions of ribs for different types of ships (fig. 8). This became one of the first printed books to openly share this kind of specialist information normally kept hidden[49]. Yet, by the turn of the century the tide had turned permanently[50]. The Danckerts house was quick to serve a new audience of educated builders and the upcoming class of civil engineers. Around 1700, Justus Danckerts came up with *Architectura mechanica, of Moole-boek van eenige opstallen van moolens, nevens hare gronden […]*, containing a series of thirty-two detailed and accurate prints of wind-, water-, and horse mills, five of them in Holland, and six in Copenhagen and Stockholm[51] (fig. 9). For this book Justus partnered with the experienced millwright and draughtsman Pieter Linperch (also Pehr Lindberg) from Stockholm. It is a curious fact that initially Dutch windmill technology had found its way north, so the Scandinavian examples also had Dutch roots[52]. The preface of the book explains that Linperch had travelled to the Netherlands in order to study the Dutch windmills on site. Before going back, he gave proof of the knowledge he had gathered, particularly using examples from Amsterdam and the Zaanstreek, the by then already highly 'industrialized' region along the Zaan river. The mills were for grinding barley and corn, oil pressing, and sawing trees

[48] Some remarks in D. de Vries, *Kapconstructies uit de 18de eeuw: stilstand of vernieuwing?*, "Bulletin KNOB", 107, 2008, 5-6, pp. 224-232.

[49] Although naval architecture in early modern theory was sometimes regarded as a full branch of architecture, it was in practice a separate discipline. Contemporary with Van Yk: N. Witsen, *Architectura Navalis […]*, Amsterdam 1690. See also M. Peters, *De wijze Koopman*, Amsterdam 2010, pp. 151-167; D. McGee, *Ships, Science and the Three Traditions of Early Modern Design*, in *The Power of Images in Early Modern Science*, edited by W. Lefèvre *et al.*, Basle-Boston 2003, pp. 28-46; *Nicolaes Witsen and Shipbuilding in the Dutch Golden Age*, edited by A.J. Hoving *et al.*, College Station 2012.

[50] The emergence of this new architectural book genre seems to be in step with a broader development sketched by Davids, who argues that Dutch technology became a successful export product just when the Republic as a world power was on its way back. C.A. Davids, *The Rise and Decline of Dutch Technological Leadership*, I-II, Leiden 2008.

[51] First edition before 1700, printed by Justus' son Cornelis (the date 1686 cannot be verified); reissue in 1725 by his other son Theodorus; third print in Amsterdam in 1727 by Johannes Covens & Cornelis Mortier.

[52] C.A. Davids, *The Transfer of Windmill Technology from the Netherlands to north-eastern Europe from the 16th to the early 19th Century*, in *Baltic Affairs*, edited by J. Lemmink, J. van Koningbrugge, Nijmegen 1990, pp. 33-52.

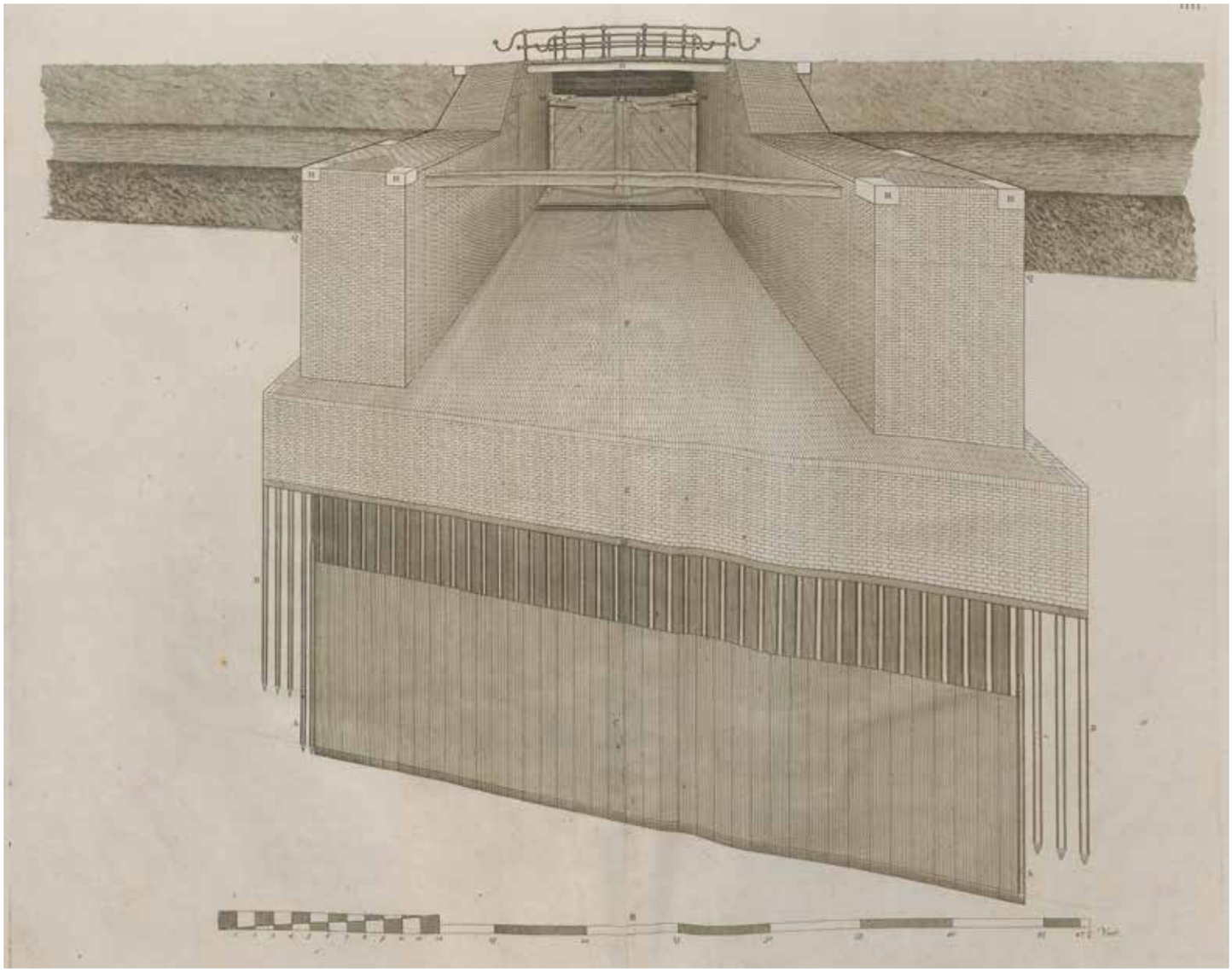


Fig. 12 *Van der Horst, Theatrum machinarum... cit. (1757-1774), part II, extra tab. IIII (Nijmegen, Radboud University, Coll. University Library, shelf mark OD 46 a 3).*

into beams and planks. It is likely that this folio with its large prints, drawn to scale and showing *in plano* sections, plans and installations, is the earliest Dutch specialist book on windmills. It surely is of high standard, both in respect of its illustrations and in the short description of the buildings' parts and measurements (fig. 10).

By 1734, the book seems to have been overtaken by the *Groot algemeen moolen-boek […]* which remains somewhat hidden behind its main title *Theatrum machinarum universale*. The author is Johannes van Zyl, a millwright from Lexmond near Utrecht and the publisher is Pieter (II) Schenk (1693-1775) in Amsterdam[53]. Published simultaneously, and closely related to this, is the *Groot volkomen moolenboek, of Naauwkeurig ontwerp van allerhande tot nog toe bekende soorten van moolens […]* of 1734-1736. It consists of two volumes with drawings by Leendert van Natrus (chief millwright of the East India Company in Amsterdam), Jacob Polley (millwright at Zaandam), and Cornelis van Vuuren. These were engraved by the multitalented Jan Punt (1711-1779)[54] (fig. 11). Remarkably enough, Covens & Mortier, the publishers of this last book, also had Danckerts' Linperch book reprinted in 1727, as a prelude to Van Natrus.

The books on mills must have initiated an interest in high quality books on engineering works. Pieter Schenk planned a more encyclopaedic series of technical treatises under the already mentioned umbrella title *Theatrum machinarum universale*, most likely inspired by a comparable initiative by the German scientist Jacob Leupold (1674-1727). The series as a whole stands out for its quality of engravings and the professionalism of the descriptions, which raised Linperch's work to a new level. The book on mills by Van Zyl was followed by a two-vol-

[53] Two parts. Simultaneously an octavo edition without illustrations, including *Nieuwe beschryving […]* (21 pages and 6 tables). Later folio editions, engraved by Jan Schenk, published by Pieter Schenk in 1761 and c. 1780. Undated German translation by Pieter Schenk in Leipzig.
[54] Engravings nos. I: 1-27; II: 1-27, 28-32.

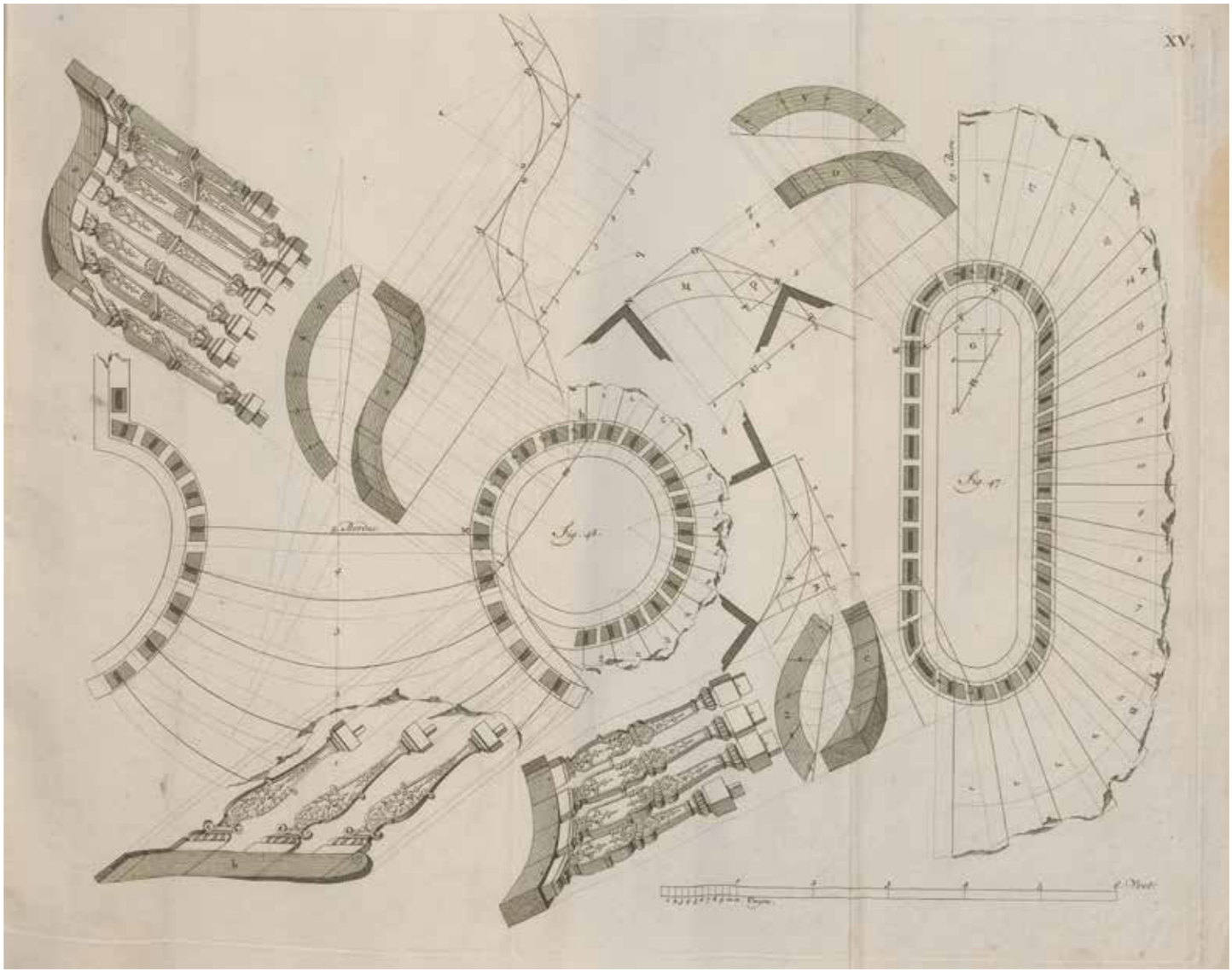


Fig. 13 *Van der Horst, Theatrum machinarum... cit. (1739), pl. XV (Nijmegen, Radboud University, Coll. University Library, shelf mark OD 60 a 1).*

ume publication on Dutch waterworks, sluices, dams, and bridges by the well-informed Tieleman van der Horst and the abovementioned Jacob Polley, with Jan Schenk (1698-1752) as the engraver: *[…] Keurige verzameling van […] waterwerken, schutsluizen, waterkeringen, ophaal- en draaibruggen […]* (Amsterdam: P. Schenk, 1736-1737)[55] (fig. 12). In the third book in the series, Tieleman van der Horst presented in 1739 a lavish work on wooden stairs: *[…] Nieuwe algemeene bouwkunde […] veelerley soorten van trappen […]*[56] (fig. 13). This is still one of the finest books on the subject. A fourth book by Jacob Polley deals with roofs: *Architectura civilis, of naauwkeurige ontwerpen en verzamelingen van verscheide zeer fraaye groote kap-werken […]* (Amsterdam: P. Schenk, 1770)[57] (fig. 14). Now, with the stairs and roofs, the circle was closed. These books took up the two oldest technical topics in the Netherlands – introduced in Danckerts' *Architectura chivilis* of 1680.

Conclusion

The case of the Danckerts press makes clear that in the Dutch Republic the interest in autonomous information on building techniques arose relatively late. Even the Danckerts dynasty, based in the internationally oriented city of Amsterdam, at the heart of architectural innovation, specialized in architectural books, and leading in printing and publishing, only gradually engaged in this specific genre. For their material, Danckerts mostly looked abroad: first to Italy, then to France and, as is demonstrated here, also to Germany.

On the whole, the role of building technique in the early period of the printed architectural book is quite limited, in any case, this is so for the Danckerts catalogue. In the various gen-

[55] French and German translations by Pieter Schenk in 1737 and 1738 respectively. Dutch reprint by Schenk in 1757-1774; and by Willem Holtrop & Nic. Theod. Gravius in Amsterdam, 1774.

[56] German translation in 1739, 1763, 1782 (as part of J.J. Schübler, *Nützliche Anweisungen*) and 1790. See also D. van de Vijver, *Ingenieurs en architecten op de drempel van een nieuwe tijd (1750-1830)*, Leuven 2003, pp. 62-63.

[57] More information on the publications by Van Zyl, Van der Horst, Van Natrus and Polley in N. Rossbach, *Poiesis der Maschine*, Berlin 2013, pp. 239-264.

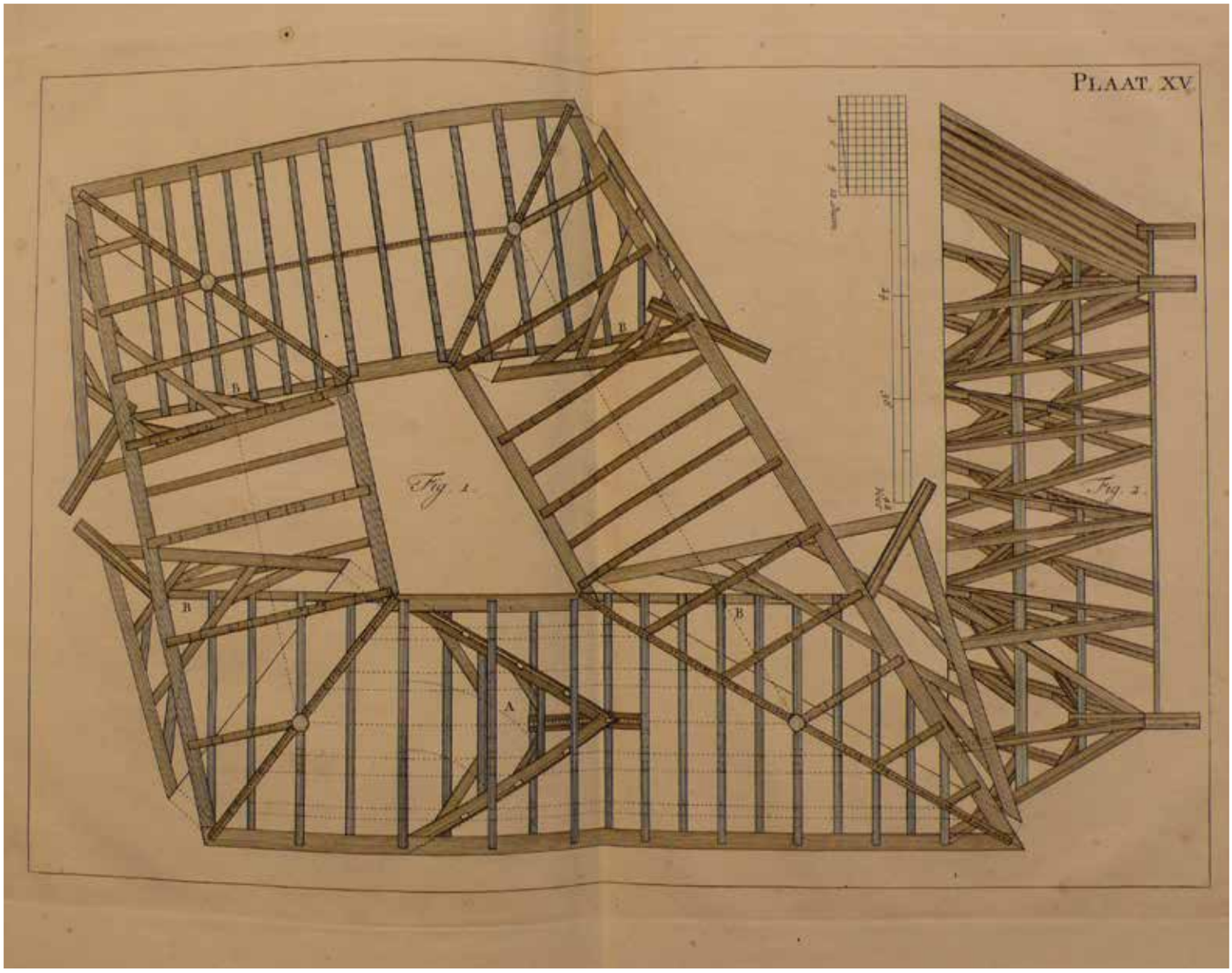


Fig. 14 *Polley, Architectura civilis... cit., pl. XV (Amsterdam, University, Coll. University Library, shelf mark OTM: KF 62-2564).*

res discussed, actual building techniques can only be traced to a very limited extent. It is perhaps more precise to speak of technical details in the *communication* of architecture. In the first stage a 'technical', that is, professional, Dutch vocabulary was developed together with simplified methods for dimensioning the column orders. Then there was a limited interest in building materials, as the work of Goeree, Bommenee and the interest in the Italian Rusconi show. The professional representation of buildings by measured drawings, ground plan, elevation, and section, which mostly contain details of their construction, were equally inspired by the Vitruvian tradition. Fortification and perspective were scientifically developed within the domain of mathematics. Around 1680 Danckerts' *Architectura chivilis* was a turning point. In the guise of an ordinary architectural book, for the first time a publication was fully dedicated to the technique of wood constructions (roofs and stairs), displayed by an advanced projection, and described in an architectural jargon. Only around 1700, when the heyday of Dutch classicism was over, books on actual building techniques and construction appeared, combining text and, often magnificent, engravings. Books on elements of civil architecture (roofs, stairs) were now accompanied by publications on engineering (mills, sluices, bridges). It was only then that building technique in the strict sense found its way to books. In this development the Danckerts press proved to be a keen adapter of foreign material, a pioneer in the Dutch architectural book, and a source of inspiration for what would become an independent technical book genre.

Isabelle Gilles

LES TERMES LIÉGEOIS ET FRANÇAIS DANS L'ARCHITECTURE DOMESTIQUE À LIÈGE AU XVIII[E] SIÈCLE : L'EXEMPLE DU VOCABULAIRE DE LA CHEMINÉE

This article first discusses the change in technical terminology of domestic architecture in Liège in the course of the 18th century, which saw an increasing appropriation of French words originating from Paris and a progressive disappearance of the local, Walloon vocabulary – the memory of which is preserved in the first Walloon-French Dictionary, published in 1787 by the Liège ecclesiastic Remi-Henri-Joseph Cambresier. It then examines more closely the case of the domestic chimneypiece, as this illustrates the use of a vocabulary that was distinctive to Liège, where coal was customarily employed for domestic purposes (heating and cooking), resulting in a terminology that had no equivalent in the French language but was subsequently exported to Paris, particularly through the writings of the French physician Jean-François-Clément Morand (1726–1784).

Introduction

Cet article donne l'occasion d'observer d'abord quelques exemples de modification du vocabulaire de l'architecture domestique à Liège au XVIII[e] siècle, sous l'influence du français de Paris. Le cas de la cheminée est ensuite approfondi car il offre d'observer l'emploi d'un vocabulaire propre à Liège. En effet, le charbon de terre (la houille) y est couramment employé à des fins domestiques (chauffage et cuisine) et son développement implique une terminologie qui ne trouve pas nécessairement son équivalent dans la langue française. Paris s'intéresse d'ailleurs à cette technique de la cheminée liégeoise à la houille dans la seconde moitié du XVIII[e] siècle, et le vocabulaire liégeois s'exporte ainsi à Paris, en particulier à travers les écrits du médecin français Jean-François-Clément Morand (1726-1784).

Les observations du vocabulaire liégeois ont été permises par l'étude de diverses sources d'archives, essentiellement textuelles[1] et, dans une moindre mesure, iconographiques[2]. La littérature publiée à Liège et mise en comparaison avec celle de la France permet la comparaison du vocabulaire. À cet égard, le *Dictionnaire walon-françois ou recueil de mots et de proverbes françois extraits des meilleurs dictionnaires*, publié à Liège en 1787 par l'ecclésiastique liégeois Remi-Henri-Joseph Cambresier (né en 1756), constitue un outil précieux d'étude[3]. Il s'agit du premier dictionnaire portant sur la langue liégeoise[4].

L'influence française sur le vocabulaire de l'architecture domestique

Capitale d'une vaste principauté épiscopale, Liège est une ville dense et peuplée qui compte, à la fin du XVIII[e] siècle, pas loin de 55.000 habitants, faubourgs compris. En 1791, la « cité », territoire intramuros, abrite quelque 33.000 âmes réparties en près de 5.500 habitations[5]. Lieu de croisement, Liège côtoie différentes cultures, celle des Pays-Bas méridionaux autrichiens, principal partenaire, celle de l'Empire germanique, dont Liège est un fief, d'autant plus proche que de nombreux princes-évêques en sont issus, celle de la Hollande avec laquelle se pratique un grand commerce, celle de l'Angleterre, présente à Liège dans le célèbre collège des Jésuites anglais et à Spa où les curistes passent quelques mois en alternance avec la location de maisons dans la Cité[6], celle de l'Italie aussi, surtout présente en matière architecturale, et celle de la France[7].

Il faut encore préciser qu'« en matière d'architecture, la cour liégeoise montre, comme les autres cours d'Europe, une nette prédilection pour la France »[8], comme l'écrit Dirk Van de Vijver. Le goût français se manifeste déjà dans l'architecture liégeoise par petites touches dès la seconde moitié du XVII[e] siècle. Puis, les édifices qui se lèvent, ou se relèvent, après le bombardement de la ville par les troupes de Louis XIV en 1691, seront de plus en plus imprégnés par ce goût, et l'inclination ne fera que se renforcer au fil du XVIII[e] siècle.

La prédilection architecturale pour la France se traduit clairement par « le choix des princes pour des architectes français » ou pour « des architectes de formation française »[9]. Cela conduit les concepteurs liégeois en France, pour s'y former par l'observation ou l'apprentissage, et cela mène aussi à la diffusion des modèles français, à travers planches et traités d'architecture[10]. Ces ouvrages constituent effectivement des vecteurs de diffusion importants des goûts nouveaux à Liège. Ils manifestent leur autorité non seulement sur l'architecture bâtie, et particulièrement sur l'architecture civile privée patricienne, car la cour donne le ton, mais encore sur les ouvrages écrits et publiés dans la Cité.

L'influence française pourrait aussi être la plus prégnante car elle est celle de la langue, laquelle structure pensée et matérialité, société et architecture. En effet, à Liège au XVIII[e] siècle, le patriciat parle et écrit en français. En revanche, pour la grande majorité de la population, si elle maîtrise au moins un peu le français, le wallon, dialecte local, reste la langue d'usage courant, ainsi qu'en témoignent par exemple de nombreux visiteurs du XVIII[e] siècle[11]. « Qu'on ne s'imagine pourtant pas que la populace de Liège parle françois. Son langage n'est qu'un patois gaulois, tel que le valon ; mais si défiguré, que les François n'en comprennent que peu de mots », exprime Mathieu Brouerius van Nidek vers 1705. Il précise qu'on « parle à Liège, et en Isle de Liège, à la Fran-

Opus Incertum (2020) pp. 130-139 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12366 www.fupress.com/oi

Fig. 1. Fig. 2.

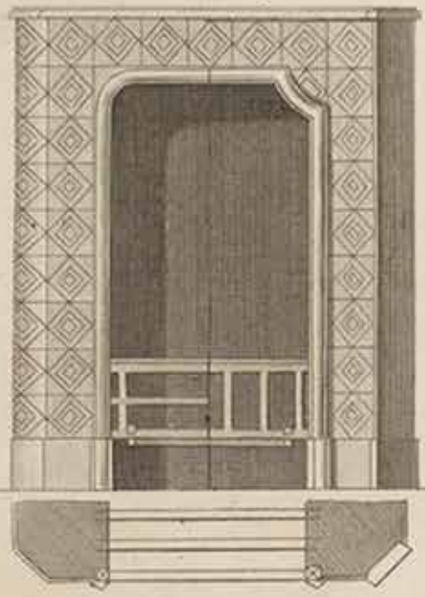
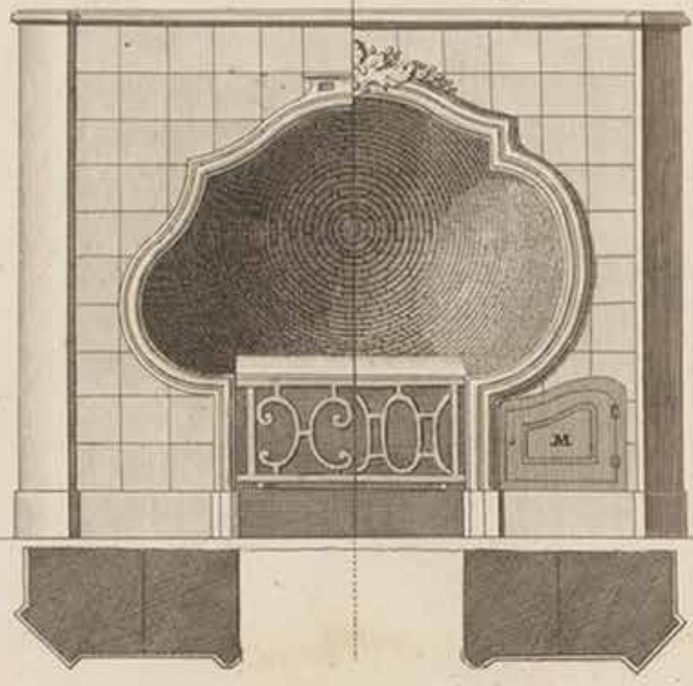


Fig. 6. Fig. 7.



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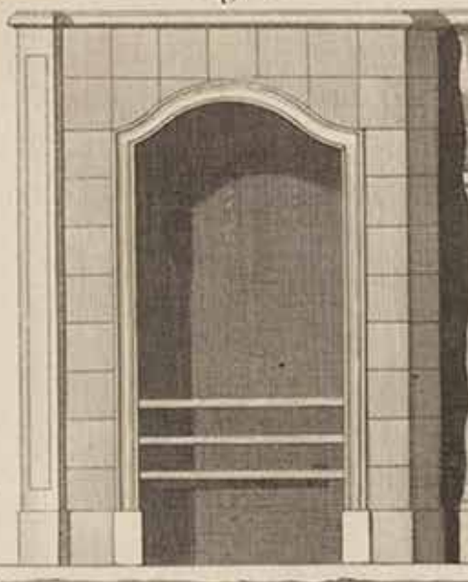
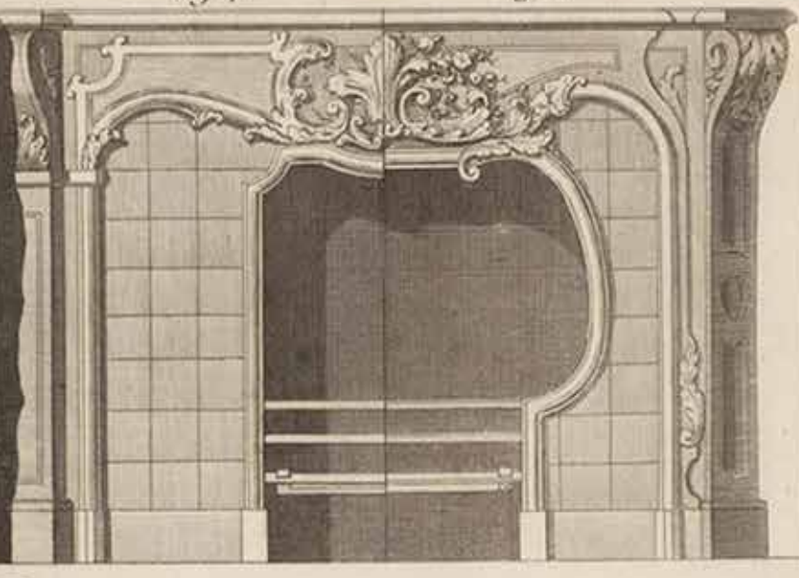
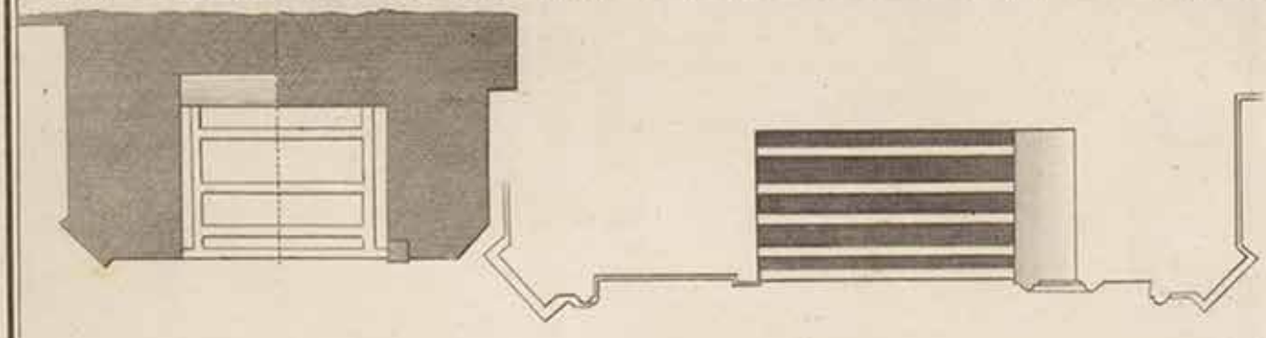


Fig. 4. Fig. 5.





Echelle de 9. lignes de pied de Roi.

Del. Leodii C. A. Galhausen.

Pourvé Sculp.

pagina 131

Fig. 1 *Cheminées d'appartement, « en chapelle » et « en œil de bœuf » (in* Morand, *L'art d'exploiter… cit., pl. XXX, légende p. 1571).*

* Pour la réalisation de cet article, je m'appuie sur les recherches menées dans la thèse de doctorat soutenue en septembre 2012. Elle a été l'occasion d'approfondir la connaissance de quelque trois-cents demeures patriciennes à entrée cochère habitées au XVIII[e] siècle sur le territoire intramuros liégeois. I. Gilles, *Les demeures patriciennes et leur organisation intérieure, à Liège au XVIIIe siècle. L'influence du modèle français*, thèse de doctorat, Université de Liège 2012 (publication prévue en 2021).

[1] Inventaires mobiliers (après décès, pour location ou pour réquisition) ; *rendages proclamatoires* (soit la vente ou la location des biens des orphelins par voie d'adjudication publique) ; procès-verbaux de vente des biens nationaux (à partir de 1796) ; *devis & conditions* de construction et de transformation, et *estime et appréciation* (de la main de maître-maçons, d'architectes, ou d'experts en construction) ; correspondances.

[2] Peu de documents figurant la demeure patricienne de la Cité de Liège durant le XVIII[e] siècle sont parvenus jusqu'à notre époque : trois vues en plans (dont deux seulement portent des annotations), quelques dessins d'élévation et de détails.

[3] M.R.J.H. Cambresier, *Dictionnaire walon-françois ou recueil de mots et de proverbes françois extraits des meilleurs dictionnaires*, Liège 1787. Sur Cambresier, voir la brève notice d'Ulysse Capitaine dans la *Biographie nationale*, Bruxelles 1872, III, p. 273.

[4] Il contient de nombreux termes architecturaux et il serait intéressant de réaliser un dépouillement systématique de l'ouvrage sur cette question, de même qu'obtenir une meilleure connaissance de l'auteur et de ses motivations.

[5] É. Hélin, *La population des paroisses liégeoises aux XVII[e] et XVIII[e] siècles*, Liège 1959, p. 40, 190, 234, 263, 271, 379.

[6] D. Droixhe, *Une histoire des Lumières au pays de Liège*, Liège 2007, p. 31.

[7] L'influence prégnante de cette dernière, plus précisément de Paris sur Liège, a été explorée sous divers angles par de nombreux auteurs. Par exemple, Daniel Droixhe, Carmélia Opsomer, Daniel Jozic et Pierre-Marie Gason en ont montré l'influence littéraire ; Renée Doize, François Souchal, Paul-Christian Hautecler, Maurice Lorenzi et Bernard Wodon, en ont relevé de nombreux exemples architecturaux. Dirk Van de Vijver a mené les études les plus approfondies sur ce sujet, notamment à travers sa thèse de doctorat : *Les relations franco-belges dans l'architecture des Pays-Bas méridionaux, 1750-1830*, thèse de doctorat, KU Leuven 2000, I-IV.

[8] D. Van de Vijver, *Les architectes des princes-évêques de Liège au XVIII[e] siècle*, "Aachener Kunstblätter", 63, 2003-2005, p. 69-92 : 76. L'historien de l'architecture n'omet cependant pas les diverses influences qui animent Liège : les goûts d'une cour souvent germanique, les goûts anglais et hollandais qui se manifestent par exemple, à la fin du XVIII[e] siècle, dans la conception des jardins, et l'Italie. Sur le sujet, voir : Van de Vijver, *Les relations franco-belges dans l'architecture des Pays-Bas méridionaux*… cit. ; Id., *Het Franse en Italiaanse model in de architectuur van de Zuidelijke Nederlanden en het prinsbisdom Luik in de 18de eeuw (1700-1830)*, in *Vreemd gebouwd. Westerse en niet-westerse elementen in onze architectuur*, red. S. Grieten, Turnhout 2002, p. 171-197 ; Id., *Les relations franco-belges dans les publications d'architecture au siècle des Lumières*, in *Claude-Nicolas Ledoux et le livre d'architecture en français. Étienne Louis Boullée, l'utopie et la poésie de l'art*, éd. D. Massounie, D. Rabreau, Paris 2006, p. 98-108 ; Id., *Les bibliothèques d'architectes dans les Pays-Bas méridionaux, 1750-1830*, in *Bibliothèques d'architecture*, éd. O. Medvedkova, Paris 2009, p. 57-72.

[9] Van de Vijver, *Les architectes des princes-évêques*… cit., p. 76.

[10] *Ibidem*.

[11] Voir en particulier : B. van Nidek en 1705, dans L. Halkin, *Une description inédite de Liège en 1705*, Liège 1948, p. 81 ; P.L. Saumery, *Délices du païs de Liège ou description géographique, topographique et chrorographique des monumens sacrés et profanes de cet évêché-principauté et de ses limites*… , Liège 1738-1744, I, p. 80-81 ; G. Forster en 1790, dans A. Hansay, *Liège en 1790 d'après le voyageur allemand Georg Forster*, "Bulletin de l'Institut archéologique liégeois", 32, 1902, p. 63-76.

çoise » et qu'en « Oultre-Meuse, on tire sur l'Ardennois quelque peu »[12].

Dans les *Délices du Païs de Liège*, publiés entre 1738 et 1744, Pierre-Lambert Saumery est plus explicite :

> J'épargnerois la vérité si j'avançois qu'on parle à Liège la langue française dans sa pureté. J'ose néanmoins assurer qu'on la parle moins mal qu'en plusieurs grandes villes de France, & beaucoup mieux que dans la plupart des provinces de ce royaume. […] Elle est successivement perfectionnée, & se perfectionne tous les jours à Liège comme en France [13].

Effectivement, la langue évolue à Liège au fil du XVIII[e] siècle. Plus la fin de l'Ancien Régime est proche, plus les termes employés se rapprochent de ceux de la langue de France, plus précisément de celle de Paris. Les mots wallons disparaissent au profit de leurs équivalents français. Dans les documents étudiés, nous arrêtant plus spécifiquement aux termes liés de près ou de loin à l'architecture, nous observons cette modification de la langue au fil du siècle, qui tend de plus en plus à s'accorder aux usages des dictionnaires français, et la disparition progressive des termes wallons.

Comment parvient ce nouveau vocabulaire architectural ?

Se tenant à la voie littéraire, ces mots ou ces usages nouveaux se retrouvent dans la littérature française en circulation à Liège : romans, dictionnaires, encyclopédies… et traités d'architecture. Ces derniers, émanant essentiellement de Paris, circulent à Liège[14] et constituent un remarquable outil de transmission de termes architecturaux[15]. Une petite production de traités d'architecture liégeois émerge également, dont certains constituent des reproductions, parfois mot pour mot, d'ouvrages français[16].

La référence que constitue à Liège l'Académie royale d'Architecture, à l'origine d'une bonne part de la production théorique à partir de la fin du XVII[e] siècle, renforce également l'emploi d'un vocabulaire théorique de l'architecture. Liège sollicite en effet l'avis de cette Académie pour plusieurs chantiers importants[17].

Enfin, les architectes participent encore à la diffusion de ce vocabulaire. Outre la présence d'architectes français à Liège[18], la connaissance de l'architecture française pour un Liégeois, ou une formation française, semble mener plus facilement à l'octroi du titre d' « architecte », de même qu'à celui d' « architecte du chapitre de la cathédrale » ou d' « architecte du prince ». Dans le cas contraire, il est plus généralement qualifié de « maître-maçon »[19].

Un vocabulaire socialement différencié

L'analyse de sources exprime clairement des différences dans le choix du vocabulaire pour les lieux et les équipements de l'habitation. Trois facteurs, déterminant l'emploi des termes et ayant partie liée, peuvent être relevés : la qualité de l'occupant de la demeure décrite ; le statut de l'auteur de la source ; et les usages changeants de la langue.

La qualité de l'occupant de la demeure ou du destinataire du document conditionne le choix des termes. L'emploi du mot *hôtel* en est un exemple notable. En effet, à Liège, la réalité bâtie patricienne se décline dans la littérature et dans l'usage sous les vocables de *maison* et d'*hôtel*. Ce dernier terme est employé avec une relative parcimonie, puis plus généreusement à partir de la fin du XVIII[e] siècle, pour désigner l'habitation de personnages socialement importants. Trois catégories sociales voient leur habitation systématiquement qualifiée d'*hôtel* : les tréfonciers, soit les chanoines du chapitre cathédrale de Saint-Lambert ; les membres de l'État noble, soit des personnages de très haute noblesse, dans le sens de très ancienne ; et les diplomates étrangers actifs à Liège. À côté

de ce « haut du pavé » liégeois, quelques personnages voient leur demeure qualifiée d'*hôtel*. Ils appartiennent à des familles qui se sont distinguées durant le XVIII[e] siècle, connaissant une ascension sociale notoire : anoblissement dans tous les cas, emplois prestigieux, alliances honorables, proximité du prince, valeur intellectuelle… autant de distinctions à rassembler pour que sa demeure soit, éventuellement, qualifiée d'*hôtel*. Il faut bien noter que le caractère architectural ne semble pas déterminant dans le choix de cette appellation. En effet, plusieurs édifices passent, au fil des ans, de *maison* en *hôtel* sans pour autant que leur configuration architecturale n'ait évolué. En revanche, la qualité sociale de l'occupant a changé[20].

Cette distinction sociale se retrouve dans les termes accordés aux espaces à l'intérieur de l'habitation liégeoise. La qualification de « grand » est par exemple réservée aux espaces patriciens : le *grand escalier*, la *grande salle*… Il y a aussi, pour des espaces destinés aux mêmes usages, un choix de vocabulaire précis, selon la qualité de l'occupant de la demeure. Par exemple, l'accès aux étages de la maison patricienne se réalise par un *escalier* ou un *grand escalier*, et dans la maison ordinaire par une *montée*. De même, le terme wallon *scaillie* n'est jamais employé pour la demeure patricienne. Le mot *cour* lui est systématiquement préféré, même lorsque l'on évoque une cour de service. De la même manière, le *vestibule* remplace le *poisse*, même s'il s'y apparente parfois formellement dans certaines petites demeures patriciennes. La remise se substitue à la *pachuse*, l'officine à la *bouwereie*, la cheminée au *toccage*, le corridor à l'*alaie*. La qualité sociale du destinataire du document ou de l'occupant de la demeure conditionne le choix des termes. Plus elle est élevée, plus les mots sont français, réservant le wallon aux maisons plus modestes.

Le statut de l'auteur du document détermine également une préférence dans les appellations. Il y a la langue du notaire dans les inventaires après décès, celle de l'expert dans les procès-verbaux de vente, celle du maître-maçon et de l'architecte, celle de l'habitant dans ses correspondances, celle de l'artisan dans ses livres de comptes… Autant de qualités et de cultures différentes. Les architectes privilégient, par exemple, dans leurs devis de construction ou dans leurs plans, les termes en usage à Paris et employés dans les traités et les modèles d'architecture. Le « projet de restauration » de l'hôtel de la famille de Selys-Longchamps, signé en 1771 par l'architecte liégeois Étienne Fayn[21], en offre un beau témoignage. S'y trouvent un *grand vestibule*, une *grande salle d'assemblée*, un *office*, des *lieux*, un *salon*… [22].

Enfin, les usages de la langue changent tout au long du XVIII[e] siècle, et les termes employés se rapprochent finalement de ceux de la langue de Paris. Une disparition des termes wallons et leur remplacement par leurs équivalents français se marque particulièrement dans la maison ordinaire. Les différences de vocabulaire entre les classes sociales semblent ainsi s'estomper à l'approche de la fin de l'Ancien Régime. Le terme *scaillie*, utilisé de préférence à celui de *cour* au début du XVIII[e] siècle dans les maisons ordinaires, est progressivement remplacé par ce dernier vers 1740. Pour s'accorder plus finement à l'usage de la *scaillie*, apparaît, très ponctuellement, l'expression française *cour d'aisance*. Dans les maisons modestes, l'*alcôve* remplace la *forme de lit enclose* et l'*escalier* se substitue à la *montée* dès les années 1750. Disparaîtront de la même manière : le *poisse*, la *pachuse*, la *bouwereie*, la *dispens*e, la *houbette*, l'*abatou*, le *toccage*… Il en est de même des termes qui s'appliquent au mobilier ou aux objets usuels, tels que décrits dans les inventaires mobiliers : la cage remplace la *gaïoûl*, l'écran le *brise-feu*, le lambris la *banchée* etc.

[12] B. van Nidek en 1705, dans Halkin, *Une description inédite de Liège en 1705*… cit., p. 81.
[13] Saumery, *Délices du païs de Liège*… cit., I, p. 80-81.
[14] À l'examen d'inventaires de bibliothèques privées et publiques, ainsi que de catalogues de ventes de libraires, il apparaît que certains de ces ouvrages sont en vente à Liège et souvent l'année même de leur publication (voir notamment dans les inventaires de vente après décès dans les fonds des notaires des archives de l'État).
[15] La présence des traités d'architecture à Liège est une donnée essentielle. Elle ne rentre pas dans le cadre de nos recherches, mais il conviendrait de l'étudier, notamment afin de déterminer plus finement l'influence de ces ouvrages sur les différents acteurs de l'architecture liégeoise, dont les architectes et les maîtres-maçons. Dirk Van de Vijver a amplement montré l'intérêt d'une telle démarche, qu'il a appliquée aux bibliothèques des architectes et des Académies, ainsi qu'aux publications d'architecture, dans les Pays-Bas méridionaux, entre 1750 et 1830 : Van de Vijver, *Les relations franco-belges dans l'architecture des Pays-Bas méridionaux*… cit., I, p. 237-248 ; 249-254. L'auteur analyse et propose en annexes un « Essai de bibliographie d'ouvrages d'architecture publiés dans les Pays-Bas méridionaux et la Principauté de Liège entre 1700 et 1830 » (ivi, II, p. 85-92) ; un « Catalogue de bibliothèques d'architecture des architectes et ingénieurs belges » (ivi, II, p. 93-151) ; et un « Catalogue de bibliothèques d'architecture des académies : livres d'architecture » (ivi, II, p. 153-178). Sont étudiées : Bruges, Bruxelles, Anvers, Gand et Louvain.
[16] Par exemple, les ouvrages d'Alexandre Carront. Il est l'auteur d'un nombre important de livres, la plupart composés à partir de traités français, dont A. Carront, *L'art de bien bâtir*…, Liège 1749. Sur les traités de Carront, voir Van de Vijver, *Les relations franco-belges dans les publications d'architecture au siècle des Lumières*… cit., p. 98-108 ; Id., *"Cahier des charges" et "conditions générales". Évolution d'une forme d'écrit technique à travers l'architecture publique en Belgique, 1750-1930*, in *La construction savante*, Paris 2008, p. 113-121 ; Id., *Les bibliothèques d'architectes dans les Pays-Bas méridionaux*… cit., p. 57-72.
[17] Par exemple, le chapitre de la collégiale Saint-Jean sollicite l'avis de l'Académie royale d'architecture pour la reconstruction de son église à partir des années 1750. Voir : H.R. Heyer, *Gaetano Matteo Pisoni – Leben, Werk und Stallung in der Auseinandersetzung zwischen der Architektur des Spätbarocks und des Frühklassizismus*, Bern 1967, p. 52-53, 60-65, 157-163, 206-209 ; Ph. Stiennon, *La nouvelle église baroque Saint-Jean l'Évangéliste (1752-1770)*, in *La collégiale Saint-Jean de Liège. Mille ans d'art et d'histoire*, éd. J. Deckers, Liège 1981, p. 85-112 ; Id., *La reconstruction de Saint-Jean l'Évangéliste (1752- 1770)*, in *Millénaire de la collégiale Saint-Jean de Liège. Exposition d'art et d'histoire*, catalogue de l'exposition (Liège, 17 septembre-29 octobre 1982), Bruxelles 1982, p. 71-105 ; Id., *Contribution à l'étude des églises de Liège (16[e]-18[e] siècles)*, "Revue du Nord", 68, 271, 1986, p. 893-928.
[18] Notons par exemple l'intervention de l'architecte français Guillaume Hauberat dans la reconstruction de l'hôtel de ville, dès 1714, et celle de Robert de Cotte pour un projet d'achèvement de la collégiale Saint-Paul, vers 1715.
[19] La formation des architectes liégeois est peu connue, mais il est avéré que plusieurs se rendent à Paris. François-Joseph Duckers y est par exemple envoyé par le prince Velbruck en 1776 (D. Jozic, *François-Charles de Velbruck, prince-évêque francophile. Aperçu de l'influence de la France sous le règne d'un prélat éclairé (1772-1784)*, in *Études sur le XVIII[e] siècle*, Bruxelles 1979, VI, p. 53-62 : 60). Une dizaine d'années plus tard, Mathieu Beyne (ou Beine) est formé à Paris, où il obtient en 1785 le premier prix de l'Académie royale d'architecture, ce qui lui vaut une gratification de cent quarante florins brabant du Conseil de la Cité de Liège (Van de Vijver, *Les relations franco-belges dans l'architecture des Pays-Bas méridionaux*… cit., I, p. 164). Jean-François de Neufforge (1714-1791), né dans la principauté de Liège, réalise toute sa carrière à Paris et contribue à la diffusion des modèles de la capitale (ivi, I, p. 163-164, 216-223, 376-389 ; D. Van de Vijver, *Jean-François de Neufforge, architecte-graveur à Paris*, in *Les Wallons à Versailles*, actes de la journée d'études (Versailles, 5 décembre 2007), éd. C. Carpeaux, Liège 2007, p. 302-312).
[20] Gilles, *Les demeures patriciennes et leur organisation intérieure, à Liège au XVIIIe siècle*… cit., I, p. 60-105.
[21] Une recherche approfondie de l'histoire de l'édifice permettrait peut-être de déterminer s'il s'agit du père (I, 1720-1773) ou du fils (II, 1753-ca.1790).
[22] Archives de l'État à Liège, *Famille Selys-Longchamps*, 2384 : É. Fayn, *Projet de restauration pour la Maison de Madame la Baronne de Sélis, en prennant l'entièreté du Fonds*, 3 juin 1771, dessin à la plume et aquarelle.

Liégeois	Français	Source	Commentaire
abatou	appentis	Cambresier 1787, p. 7.	*Abatou* : « appentis, f. m. Bâtiment bas, qui est appuyé contre un plus haut & dont la couverture n'a qu'un égout ».
alaie	allée, corridor	Cambresier 1787, p. 10.	*Alaie* : « Allée, f. f. Passage entre deux murs dans une maison ».
banché	lambris	Cambresier 1787, p. 15.	*Banché* : « *bâchi* lambrisser, v. a. Revêtir de lambris ».
bouwereie	buanderie, officine	Cambresier 1787, p. 20.	*Bouwereie* : « buanderie, f. f. Lieu où sont un fourneau & des cuviers pour faire la lessive ».
brise-feu	écran	Archives de l'État à Liège	Écran à placer devant le feu.
dispense	dépense	Cambresier 1787, p. 45.	*Dispense* : « dépense, f. f. Lieu où dans les maisons particulières on serre ordinairement le fruit, la vaisselle & le linge qui servent pour la table, serrez cela dans la dépense, on le nomme l'office dans les grandes maisons ».
gaïoül	cage	Cambresier 1787, p. 74.	*Gaïoûl* : « cage, f. f. Petite logette de bâtons d'osier ou de fil de fer, pour mettre des oiseaux, mettre un oiseau dans sa cage ».
houbette		Archives de l'État à Liège	Petite case faite de branchages pour s'abriter.
montée	escalier	Cambresier 1787, p. 121.	La montée, *montaie* en wallon, est un « petit escalier d'une petite maison (…) il n'est en usage que parmi le peuple ».
pachuse	remise	Archives de l'État à Liège	Remise à véhicule ou de lieu de stockage.
poisse	vestibule	Cambresier 1787, p. 140.	*Poisse* : « vestibule, f. m. La pièce du bâtiment qui s'offre la première à ceux qui entrent, & qui sert de passage pour aller aux autres pièces, il n'entra pas dans la salle, il resta dans le vestibule ».
scaillie	cour	Archives de l'État à Liège	—
toccage	cheminée	Cambresier 1787, p. 182.	*Toccage* : feu, cheminée. « *Toké l'feu*, on dit, attiser le feu, pour dire, approcher les tisons l'un de l'autre, pour les faire mieux brûler ».
forme de lit enclose	alcôve	Archives de l'État à Liège	—

Tab. 1 *Aperçu des termes liégeois/wallons remplacés par leurs équivalents français au XVIII[e] siècle*

Les usages locaux et leur vocabulaire : le cas de la cheminée

Il existe des usages locaux qui ne trouvent pas leur équivalent à Paris, et pour lesquels il n'existe pas de vocabulaire français établi. Cambresier l'évoque dans son dictionnaire Wallon-Français publié à Liège en 1787 :

> Au défaut de ces oracles de la langue françoise, chacun est en droit, me paroît-il, de forger des mots pour exprimer les choses qui existent dans son pays [23].

Il illustre ce propos, alors qu'il est à la recherche d'un terme qui traduirait de la façon la plus précise le *brocalî*, soit « un ustensile oblong, qui est fait de cuivre ou de fer-blanc & qui sert à contenir des allumettes », parce que, dit-il, « nous manquons absolument de terme, pour rendre la chose qu'il désigne ». Il consulte en vain les ouvrages français :

> Le Dictionnaire de l'académie Françoise ne nous en fournit point ; le Dictionnaire de M. de Wailly, si riche en mots, ne parle point de cet ustensile ; ce qui me fait croire qu'on n'en fait pas usage en France [24].

La cheminée « à feu de houille » constitue un bel exemple d'usage local pour lequel un vocabulaire parisien fait défaut. Les sous-sols liégeois regorgent de houille – *hoïe* en wallon –, soit du charbon de terre, d'excellente qualité, en quantité si importante qu'outre un usage propre, la ville approvisionne ses voisins proches et lointains. Avec une première mention à la toute fin du XII[e] siècle, Liège, à l'instar de l'Angleterre, exploite très tôt le charbon à des fins industrielles. Il est difficile de déterminer à partir de quand l'usage de la houille fut domestique mais, au XVIII[e] siècle, il est certain que la majorité des maisons liégeoises bénéficient du charbon pour se chauffer et faire la cuisine.

[23] Cambresier, *Dictionnaire walon-françois*… cit., p. 21.
[24] *Ibidem*. Le « Dictionnaire de M. de Wailly » évoqué par Cambresier est *Le vocabulaire français* du grammairien et latiniste François de Wailly (1724-1801), qui participa également au *Dictionnaire de l'Académie* cité par Cambresier.
[25] I. Gilles, *L'évolution du comble à la lecture des traités français d'architecture du XVI[e] au XVIII[e] siècle*, in *Les charpentes du XI[e] au XIX[e] siècle. Grand Ouest de la France. Typologie et évolution, analyse de la documentation de la Médiathèque de l'architecture et du patrimoine*, éd. P. Hoffsummer, Turnhout 2011, p. 29-39.
[26] Terme local qui désigne une demi-croupe.
[27] Voir par exemple N. Coquery, *L'hôtel aristocratique. Le marché du luxe à Paris au XVIIIe siècle*, Paris 1998, p. 139-146.
[28] Annick Pardailhé-Galabrun, qui a étudié plusieurs milliers de maisons parisiennes des XVII[e] et XVIII[e] siècle, notamment via les inventaires mobiliers, explique : « la fin du règne de Louis XV, qui implique une cheminée par pièce et des cheminées qui à quantité de bois égale rayonnent quatre fois plus de calories dans la pièce que les cheminées larges et droites, les cheminées bêtes d'avant les progrès modestes de la caminologie, une de ces modestes petites conquêtes du XVIII[e] siècle, ce siècle de l'intimité, du premier bien-être, d'une meilleure économie des gestes ». A. Pardailhé-Galabrun, *La naissance de l'intime. 3000 foyers parisiens XVII[e]-XVIII[e] siècles*, Paris 1988, p. 14.

Fig. 2 *Cheminée « en chapelle », Liège, 1765 (© IRPA-KIK, photo n° B168407 ; 1957).*

Son emploi à Liège permet d'ailleurs de pallier la pénurie de bois qui grève toute l'Europe dès le XVII[e] siècle. Celle-ci entraîne, notamment en France, des modifications dans les pratiques architecturales visant à économiser cette matière devenue rare : l'abaissement général de la pente des toitures et le comble brisé[25]. Cette forme nouvelle de toiture, devenue très en vogue, ne connut guère de succès à Liège où les fortes charpentes des hauts combles en bâtière perdurent tout au long du siècle, simplement allégées par des croupes et des croupettes[26].

Si l'usage du charbon à des fins domestiques constitue une pratique commune à Liège, ce combustible ne trouve pas bonne publicité à Paris[27], laquelle désapprouve son emploi dans la maison, évoquant sa mauvaise odeur, le danger pour la santé… alors que la cheminée est déterminante dans le confort de l'habitation[28] et que le bois devient rare. Cela signifie que Paris n'offre pas de termes associés à ce savoir-faire. À Liège, il existe un vocabulaire propre, souvent issu du wallon, et qui trouvera une place dans l'ouvrage du médecin français Jean-François-Clément Morand.

En effet, afin de promouvoir l'emploi du charbon dans les maisons parisiennes, l'Académie des Sciences soumet à ce médecin une recherche visant à faire le point sur les avantages et inconvénients du charbon comme combustible domestique. Morand s'intéresse ainsi aux pays producteurs de houille – Angleterre, Allemagne, quelques provinces françaises… –, « mais c'est dans la région liégeoise qu'il a recueilli, en 1761, le plus clair de ses informations »[29]. De ces recherches sortiront un *Mémoires sur la nature, les effets, propriétés, & avantages du feu de charbon de terre apprêté, pour être employé commodément, économiquement, & sans inconvénient, au chauffage, & à tous les usages domestiques*, en 1770, et *L'art d'exploiter les mines de charbon de terre*, entre 1768 et 1779, dans la série des *Descriptions des arts et métiers*, avec une réédition condensée, en 1780, à Neufchâtel[30]. Le médecin y consacre de nombreuses pages à la « perfection de la méthode liégeoise »[31] en matière d'utilisation et de préparation de la houille pour le chauffage et la cuisine.

Il apprend à ses lecteurs que le charbon n'est pas employé tel quel dans les cheminées liégeoises, mais qu'il nécessite une préparation qui consiste à « mêler la houille avec une terre grasse, à la bien corroyer, & à en faire à la main, ou dans des formes, des pelotes que les Liégeois nomment *hochets* »[32]. Morand conclut en affirmant que l'emploi « qu'en font généralement les riches comme les pauvres, est une preuve de la perfection de la méthode liégeoise »[33].

La houille est effectivement accessible au plus grand nombre. Saumery remarque que grâce au charbon le chauffage des Liégeois « est la plus legère de toutes leurs dépenses, & que pour deux cent livres une famille entretient huit à dix feux, pendant toute l'année »[34]. Morand, qui reprend le propos de Saumery, complète en comptant leur consommation en termes de charrées par années :

> il y a des maisons bourgeoises qui, pour le feu de leur chambre & pour leur cuisine, ne consomment dans leur année que quatre charrées de houille. Les plus fortes n'en consomment, pour le chauffage & pour les autres besoins du ménage, que dix à douze charrées. Enfin, un petit ménage qui n'a qu'un feu allumé depuis le matin jusqu'à dix ou onze heures du soir, consomme à peu près deux charrées de houille [35].

Élément majeur d'un espace, portant souvent seule toute la décoration du lieu, la cheminée représente sans doute pour les futurs lecteurs un sujet plus alléchant que le long propos technique dédié à l'extraction de la houille et à toutes ses préparations. Aussi, Morand consacre-t-il plusieurs pages et planches gravées à la cheminée liégeoise, dont la conception est parfaite-

[29] E. Hélin, in *Le siècle des Lumières dans la principauté de Liège*, catalogue d'exposition (Liège, Musée de l'art wallon et de l'évolution culturelle de la Wallonie, octobre-décembre 1980), Liège 1980, p. 64-65.

[30] J. Morand, *Mémoires sur la nature, les effets, propriétés, & avantages du feu de charbon de terre apprêté, pour être employé commodément, économiquement, & sans inconvénient, au chauffage, & à tous les usages domestiques. Avec figures en taille-douce. Par M. Morand le médecin, assesseur honoraire du Collége des médecins de Liége, &c.*, Paris 1770 ; Id., *L'art d'exploiter les mines de charbon de terre*, [Paris] 1768-1779 ; Id., *Descriptions des arts et métiers, faites ou approuvées par messieurs de l'Académie royale des Sciences de Paris avec figures en taille-douce. Nouvelle édition (…) Tome XVI. Contenant les trois premières sections de la seconde partie de l'art d'exploiter les mines de charbon de terre. Par M. Morand, médecin (et) Tome XVII. Contenant la quatrième section de la seconde partie de l'art d'exploiter les mines de charbon de terre. Par M. Morand, médecin*, Neuchâtel 1780.

[31] Morand, *Descriptions des arts et métiers*… cit., p. 154.

[32] *Ibidem*. Terme wallon, le hochet est « une boule ou un gâteau de charbon de terre, de tanée, de tourbe, &c. ». Cambresier, *Dictionnaire walon-françois*… cit., p. 91. Les avantages de ces *hochets*, de la taille et de la forme d'un œuf de poule, sont d'augmenter la durée du feu, de corriger l'odeur, de consommer moins de combustible, et de rendre ainsi la houille « d'un usage aussi commode que peu dispendieux ».

[33] Morand, *Descriptions des arts et métiers*… cit., p. 154.

[34] Saumery, *Délices du païs de Liège*… cit., p. 271-272.

[35] Morand, *Descriptions des arts et métiers*… cit., p. 163-164.

Fig. 3 *Cheminée « en œil de bœuf », Liège, 1767 (photo I. Gilles, 2009).*

Fig. 4 *Cheminée « en œil de bœuf », Liège, ca. 1780 (photo I. Gilles, 2010).*

ment adaptée à l'emploi et aux avantages de la houille, « pour que la chaleur augmente, & que la dépense soit diminuée »[36]. L'auteur distingue les *cheminées d'appartements* des *cheminées de cuisine*. Leur construction varie en effet selon

> qu'il s'agit, ou de chauffer une piece de compagnie, ou de donner du feu pour la cuisine, ou de chauffer un appartement, & y faire en même tems une petite cuisine [37].

Morand observe à Liège deux modèles de *cheminées d'appartement* destinées au chauffage, relativement à la forme de l'ouverture du foyer : la cheminée *en chapelle* et celle *en œil de bœuf* (figs. 1-4). Le principe général consiste à rétrécir l'ouverture et le volume du foyer proportionnellement au haut potentiel calorique que dégage la houille, par rapport au bois ou au charbon de bois.

Les hochets sont disposés dans un porte-feu, « espèce de coffret, cage, ou corbeille » appelé à Liège *fer à feu*[38]. Il peut être indépendant, ou intégrer la construction de la cheminée. L'espace sous le *fer à feu* est réservé au cendrier. Une pièce de fer ou de cuivre débordante placée devant le cendrier protège l'âtre et contient les cendres. On retrouve cette pièce dans certaines descriptions de maisons liégeoises, sous le terme de *platine*[39] ou de *bande*[40] ou de *tour de fer*[41]. Morand ne mentionne pas cette pièce, mais emploie le terme *platine*, « en cuivre poli », pour désigner l'élément qui ferme le haut de l'ouverture *en chapelle* et sert à renvoyer la fumée vers l'intérieur de l'âtre. Cette pièce mentionnée par Morand apparaît clairement dans une description de cheminée de cuisine sous le nom de *garde fumée* ; il est « de fer étamé aussi large que la cheminée »[42]. En fait, le terme *platine*, en wallon *platenne*, se traduit par *tôle*, « plaque de fer battue dont on fait des poêles & d'autres ouvrages (…), cheminée garnie de tôle »[43].

La *cheminée d'appartement à deux usages* est réservée aux « petits ménages, dont une même piece sert à la fois de piece de compagnie, de salle à manger, & de cuisine »[44] (fig. 5). Deux petits *potagers*[45] en fonte sont intégrés de part et d'autre du *fer à feu*. Remplis de charbon, ils sont fermés sur le dessus par une taque en fonte sur laquelle on dispose le récipient à chauffer. D'une manière générale, pour toutes les *cheminées d'appartement*, il existe des accessoires en fer s'adaptant au *fer à feu* et qui permettent de poser « caffetieres, bouillotes ou autres petits ustensiles que l'on veut faire réchauffer »[46].

Les principaux accessoires de préparation et d'entretien des feux de houille dans les cheminées sont : le *baquet*, petite caisse, pour transporter le combustible ou les cendres ; le *marteau* pour casser houille et hochets si nécessaire ; les *pincettes*, « à charnière, & terminées en cuilleron », pour ramasser les braisons ; la *palette*[47], pour ramasser les cendres ; le *râve*[48], que Morand libelle *raf*, s'accordant à la prononciation wallonne, râteau pour séparer les braisons des cendres ; et le *forgon*[49], broche de fer pointue « pour écarter les hochets les uns des autres quand ils n'ont pas assez d'air, & faciliter l'embrasement en changeant leur position dans le fer à feu »[50]. Parfois sous des noms un peu différents, on retrouve tous ces accessoires dans les inventaires mobiliers, ainsi que le *brise-feu*, qui apparaît régulièrement. Il s'agit de l'écran à placer devant le feu et qui peut être entièrement réalisé en fer ou en association avec du cuivre, du tissu, de

[36] Ivi, p. 165.
[37] *Ibidem*.
[38] Ivi, p. 159-160.
[39] Par exemple : Archives de l'État à Liège, *Officialité, Rendages proclamatoires*, 37, f° 355 et sv., décembre 1763 ; *Archives de l'État à Liège*, Notaire Q. Denis, *Répertoire des meubles de Madame de Cortis, douairière du baron d'Hasselbrouck*, 27 avril 1789.
[40] Archives de l'État à Liège, *Famille de Selys Longchamps : Répertoire commencé le douze février 1771 à la maison mortuaire de noble et généreux seigneur Michel François baron de Selys seigneur de Willin et Petit Aaz &c.*, 12-30 février 1771 ; Archives de l'État à Liège, Notaire Q. Denis, *Répertoire des meubles de Madame de Cortis*… cit., 27 avril 1789 ; Archives de l'État à Liège, Notaire A. J. Ansiaux, *Devis ou conditions pour bâtir à neuf une maison pour Monsieur le chevalier de Chestret capitaine de Vierset*, 17 mai 1775, f° 283-286.
[41] Archives de l'État à Liège, Notaire Q. Denis, *Répertoire des meubles de Madame de Cortis*… cit., 27 avril 1789.
[42] Archives de l'État à Liège, *Famille Crassier*, 1013 : *Répertoire des meubles, effets, linges &c. reposants et fournis par Monsieur le baron de Crassier à Monsieur le colonel d'Escafen sique locataire de la maison du dit seigneur baron située en Mont Saint-Martin à Liège*, 8 mars 1768.
[43] Cambresier, *Dictionnaire walon-françois*… cit., p. 138.
[44] Morand, *Descriptions des arts et métiers*… cit., p. 166.
[45] Le potager est un fourneau secondaire qui sert à chauffer à feu plus doux potages et autres plats mijotés. Ch. Morin, *Au service du château. L'architecture des communs en Île-de-France au XVIII[e] siècle*, Paris 2008, p. 39-41.
[46] Morand, *Descriptions des arts et métiers*… cit., p. 167.
[47] Terme qui désigne une pelle à feu, « instrument de fer dont on se sert à prendre du feu & à d'autres usages ». Cambresier, *Dictionnaire walon-françois*… cit., p. 132.
[48] *Râve*, terme wallon : « rable, f. m. Instrument pour tirer la braise du four, barre de fer en crochet pour remuer des substances que l'on calcine ». Cambresier, *Dictionnaire walon-françois*… cit., p. 148.
[49] Traduction wallonne de *fourgon*, « longue perche de bois garnie de fer par le bout, & servant à remuer & à accommoder le bois & la braise dans le four ». Cambresier, *Dictionnaire walon-françois*… cit., p. 71.
[50] Morand, *Descriptions des arts et métiers*… cit., p. 168.

la tapisserie, de l'osier… toujours en accord avec le décor général du lieu.

Les modèles de cheminées de cuisine « de seigneurs ou de grand hôtel », présentées par Morand, possèdent un équipement de cuisson très complet (fig. 6). Sous une large hotte on trouve rassemblés : un grand *fer à feu* dont on peut réduire le volume à souhait grâce à une grille mobile intérieure ; un *potager* à plusieurs taques de cuisson ; une grande marmite à eau chaude sur trépied ; une crémaillère ; un tourne-broche ; une longue barre de fer horizontale, munie de crochets et de chaînes, « garnie d'ornemens auxquels on peut accrocher une bouillote, un coquemar & d'autres petits ustensiles de ménage, qui s'entretiennent chauds au feu »[51]. On peut rôtir, mijoter, bouillir, frémir, saisir… , mais pas dans toutes les maisons. Seules les demeures patriciennes bénéficient en effet d'un tel équipement, en tout ou partie. Pour décrire et dessiner ses modèles, Morand a dû observer à Liège une ou plusieurs cheminées de cuisine[52]. Dans les archives, l'ensemble le plus complet et le mieux décrit se trouve dans la cuisine de l'hôtel du comte de Lannoy-Clervaux, sur la place Verte, en 1791. La cheminée est équipée d'un « fer à feu avec deux réchauds » et des potagers sont placés à côté. Elle comprend les accessoires suivants :

> une brosse ; un bac aux cendres ; un rave ; une pellette aux cendres ; deux pincettes de fer ; deux coquemars de cuivre rouge ; trois chaînes de crémaillère ; un tourne broche au-dessus du feu, en forme de moulin à vent ; à côté du foyer entre les potagers : une petite pellette ; une crémaillère ; une fourche ; une losse servant au lèchefrite […] ; au-dessus des potagers, sous la fenêtre : une bande de fer supportant une grille, neuf porte-[casseroles], une pellette de fer servant à mettre les charbons dans les dits potagers [53].

Seules deux mentions de « poêle » sont apparues dans les descriptions étudiées à Liège, uniquement dans l'hôtel du comte de Lannoy-Clervaux, d'une part dans un pièce réservée au domestiques, le *commun*, « un poêle tout monté prêt à y faire du feu avec une pincette », d'autre part, dans l'*antichambre* du rez-de-chaussée, « un poêle tout monté avec son porte-cendre de fer battu ; un rave ; pincette ; fourgon ; palette de fer garnie en cuivre jaune ; platine idem »[54]. Il semble, d'après les descriptions étudiées, que ce système de chauffage soit rare à Liège. Morand précise en outre que « pour chauffer les poêles, on se sert toujours de bois, & rarement de houille »[55]. Cambresier précise dans son *Dictionnaire* que le poêle « se dit aussi de toutes les chambres où est le poêle, en Allemagne on est presque toujours dans le poêle »[56].

Conclusion

Le cas de la cheminée montre l'usage d'un vocabulaire propre à Liège. Il convient dès lors de se demander si, à l'inverse, il y a eu une assimilation de ces expressions en France. L'ouvrage de Jean-François-Clément Morand, largement diffusé, aurait en effet pu être un vecteur de transmission de choix. Plusieurs termes spécifiques à la cheminée sont bien sûr déjà en usage dans la langue française et concernent le feu de bois, par exemple : *baquet*, *coquemar*, *crémaillère*, *fourgon*, *palette*, *pincette*, *potager*, *tourne-broche*. Mais d'autres proviennent du wallon, comme *hochet* et *rave*. Une rapide vérification montre qu'il faut attendre la fin du XIX[e] siècle pour voir apparaître la définition du terme « hochet », dans le contexte du feu à charbon, dans le *Dictionnaire de la langue française*, d'Émile Littré, publié entre 1872 et 1877[57]. En revanche, le terme « rave » n'apparaîtra jamais dans les dictionnaires de langue française. Une étude sur la réception des travaux de Morand en France, et en particulier à Paris, serait attendue. Elle permettrait d'y éva-

[51] Ivi, p. 167-168.

[52] Comme par exemple celle de l'hôtel de Haxhe (Archives de l'État à Liège, Notaire N.A. Gilman, *Description des meubles, effets, ors, argents, papiers, registres &c qui se sont retrouvez dans la maison mortuaire de feu monsieur Nicolas Joseph Closset vivant l'un des greffiers des Seigneurs échevins de Liège*, 8 février 1754) ; ou celle de la maison que le baron de Crassier loue en 1768 au colonel d'Escafen (Archives de l'État à Liège, *Famille Crassier*, 1013 : *Répertoire des meubles, effets, linges &c*.… cit., 8 mars 1768).

53 Archives de l'État à Liège, Notaire H. Catoir, *Répertoire […] comte de Lannoy de Clervaux*, 22 septembre 1791.

[54] *Ibidem*.

[55] Morand, *Descriptions des arts et métiers*… cit., p. 164.

[56] Cambresier, *Dictionnaire walon-françois*… cit., p. 166.

[57] « Les formes dans lesquelles on moule la houille » et « Charbon préparé avec le moule nommé hochet ». Littré cite comme source un extrait de la "Gazette de Liège", du 17 décembre 1873.

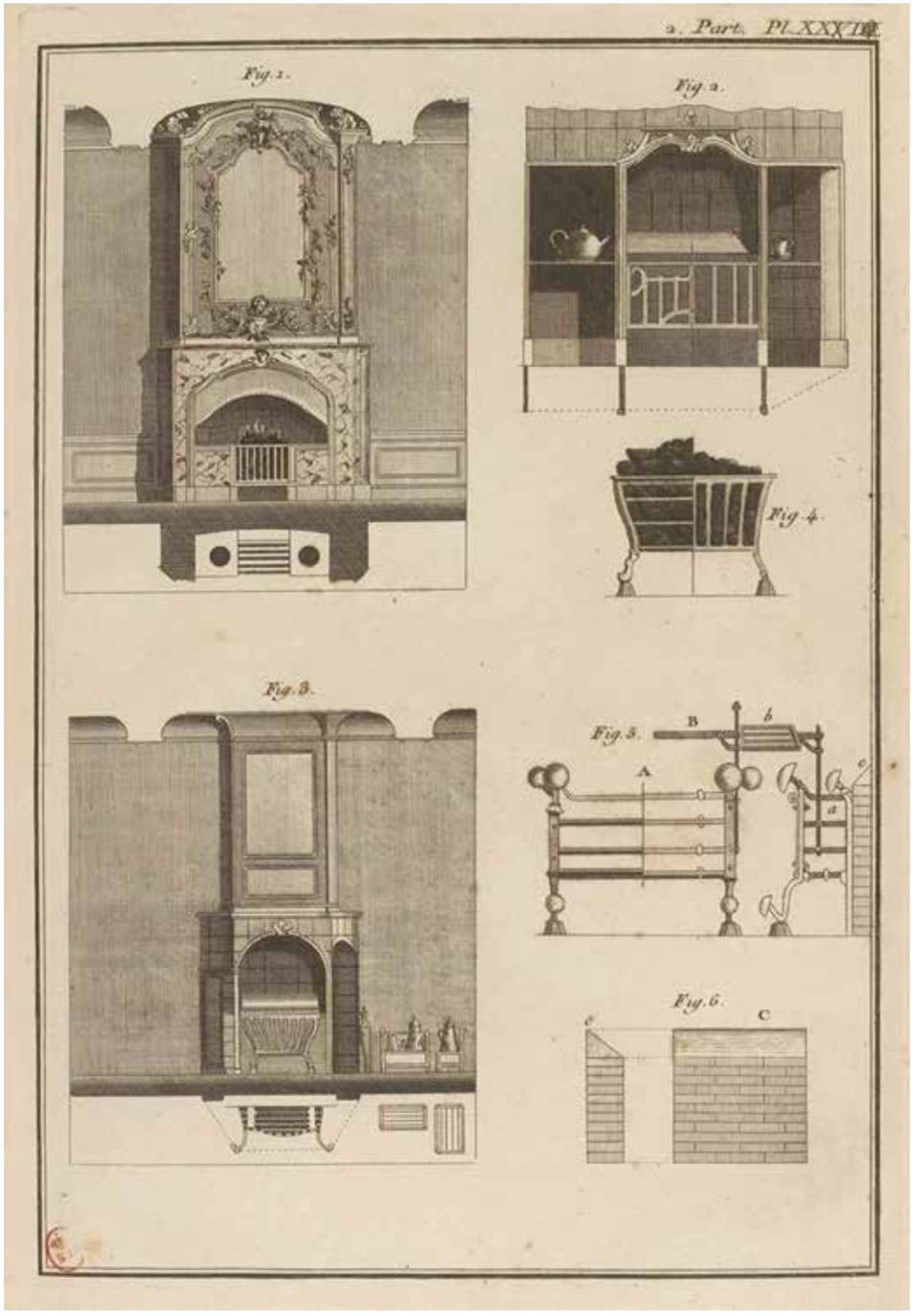


Fig. 5 *Cheminées d'appartement, « à double usage » (in* Morand, *L'art d'exploiter… cit., pl. XXXI, légende p. 1571-1572).*

luer l'usage du charbon de bois à des fins domestiques, à la fin du XVIII[e] et au cours du XIX[e] siècle. Elle apporterait de surcroît des réponses quant à une éventuelle assimilation de termes liégeois. Une table des matières détaillée, libellée sur près de deux-cents pages, « servant en même temps de Dictionnaire des termes & expressions du métier en différentes langues », proposé par Morand à la fin de son Art d'exploiter les mines de charbon de terre, constituerait à cet égard un outil très précieux.

L'étude porte sur l'appropriation de la langue française, a priori la plus prégnante, et montre que le vocabulaire architectural liégeois évolue nettement dans le courant du XVIII[e] siècle pour s'accorder au français de Paris. Cependant, vu la position centrale de la ville, il serait pertinent d'observer également l'introduction de termes néerlandais ou allemands à Liège dans le vocabulaire de l'architecture.

Dans ces modifications de la langue à Liège, il apparaît que la dimension sociale prédomine, et elle concerne à la fois l'auteur et le destinataire du document. La question du rôle de l'auteur dans l'acceptation de la terminologie française mériterait d'être approfondie, notamment

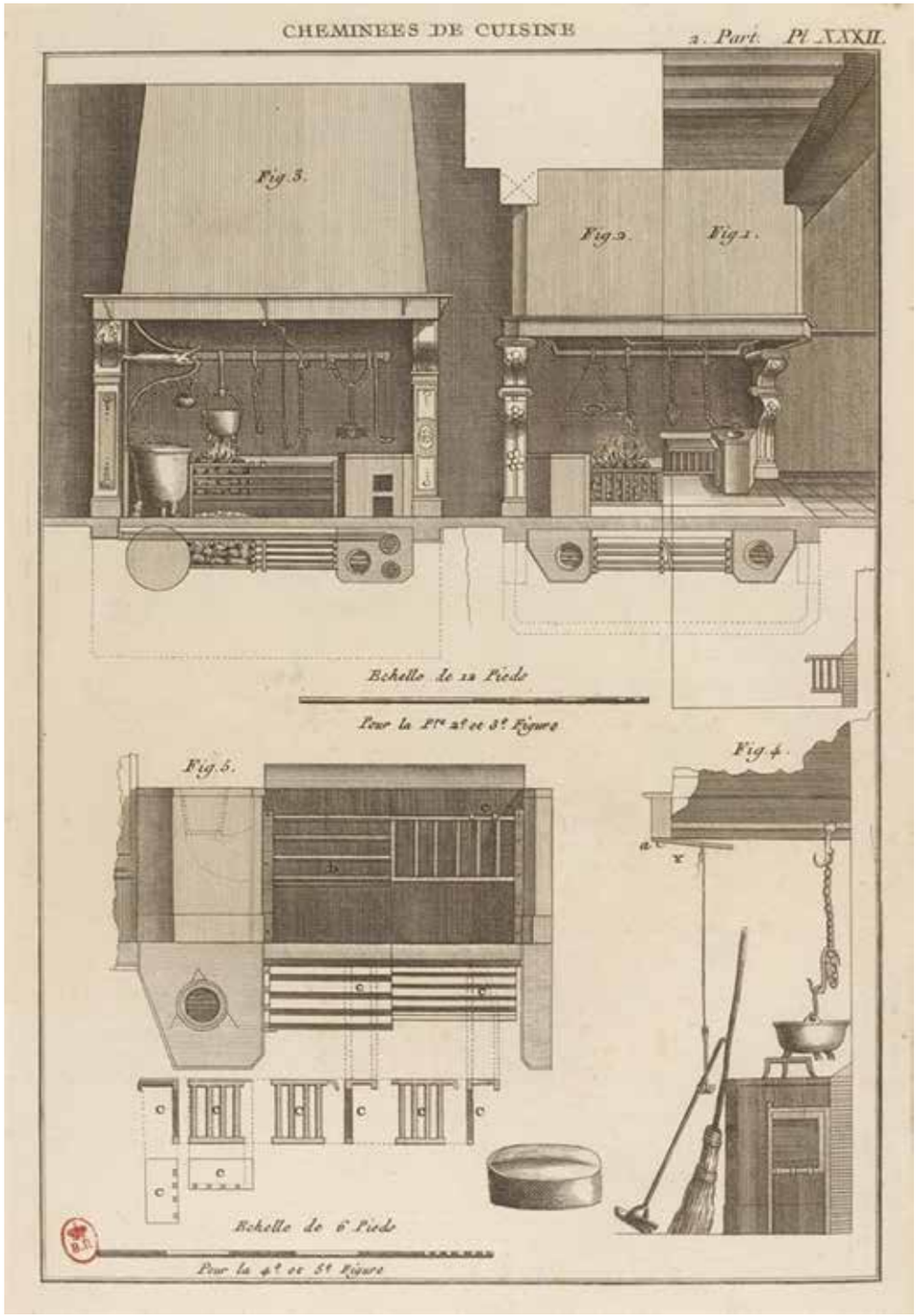


Fig. 6 *Cheminées de grandes cuisines (in* Morand, *L'art d'exploiter… cit., pl.* XXXII, *légende p. 1572).*

par l'étude du monde des architectes (en particulier ceux qui ont voyagé à Paris) en regard de celui des artisans. Il serait intéressant par exemple de répondre à la question de la persistance plus longue des termes wallons dans le contexte plus local des métiers de la construction ; ou encore d'observer les modes de communication entre architecte et maître de l'ouvrage, par opposition à ceux qui existent entre architecte et artisan.

Il serait de même pertinent de sortir de l'exemple liégeois et de comparer les mécanismes généraux d'appropriation du vocabulaire architectural français avec d'autres villes francophones des Pays-Bas méridionaux au XVIII[e] siècle, par exemple Namur ou Bruxelles.

Enfin, les conclusions devraient aussi être comparées avec les mécanismes observés par Krista De Jonge et Pieter Martens en matière de vocabulaire de l'architecture antique et militaire[58]. Le cas de la cheminée, dans le contexte de l'architecture domestique, ne constitue en effet qu'un petit aspect d'une question beaucoup plus vaste qu'est la langue de l'architecture. Autant d'invitations aux chercheurs à poursuivre l'investigation.

[58] Voir P. Martens, *Ingénieur (1540), citadelle (1543), bastion (1546) : apparition et assimilation progressive de termes italiens dans le langage de l'architecture militaire aux Pays-Bas des Habsbourg*, in *Les mots de la guerre dans l'Europe de la Renaissance*, éd. M.M. Fontaine, J.L. Fournel, Genève 2015, p. 105-140 ; K. De Jonge, *Inventing the Vocabulary of Antique Architecture. The Early Translators and Interpreters of Renaissance Architectural Treatises in the Low Countries*, in *Translating Knowledge in the Early Modern Low Countries*, edited by H.J. Cook, S. Dupré, Berlin-Zürich 2012, p. 217-240.

Nicoletta Marconi

"LITTERARUM PLANE RUDIS SED INGENII ACUMINE ADEO PRAESTANS": IMPALCATI PER LA MANUTENZIONE DELL'ARCHITETTURA NELLA ROMA SETTECENTESCA TRA PRATICA ARTIGIANALE, SPERIMENTAZIONE TECNICA E CODIFICA TEORICA

Renaissance and Baroque building machines and construction techniques have been widely explored in the scientific literature, but scaffoldings for ordinary and extraordinary maintenance remain less well-documented, and were rarely part of architectural treatises. This is because on the building sites of the early modern age the construction of scaffolding was entrusted to the experience of craftsmen like bricklayers and carpenters. Nicola Zabaglia (1667–1750) was a master carpenter of the Fabbrica of St. Peter's and, exceptionally, his astonishing inventions and those of his successors were considered virtuoso examples of operational empiricism and were included in the main European treatises on construction up until the early 20th century. Their long-lasting fortune shows that the scientific method did not make the empirical approach obsolete, but a gradual incorporation of theoretical precepts sanctioned the successful qualitative transition in the relationship between theory and practice even on the construction site.

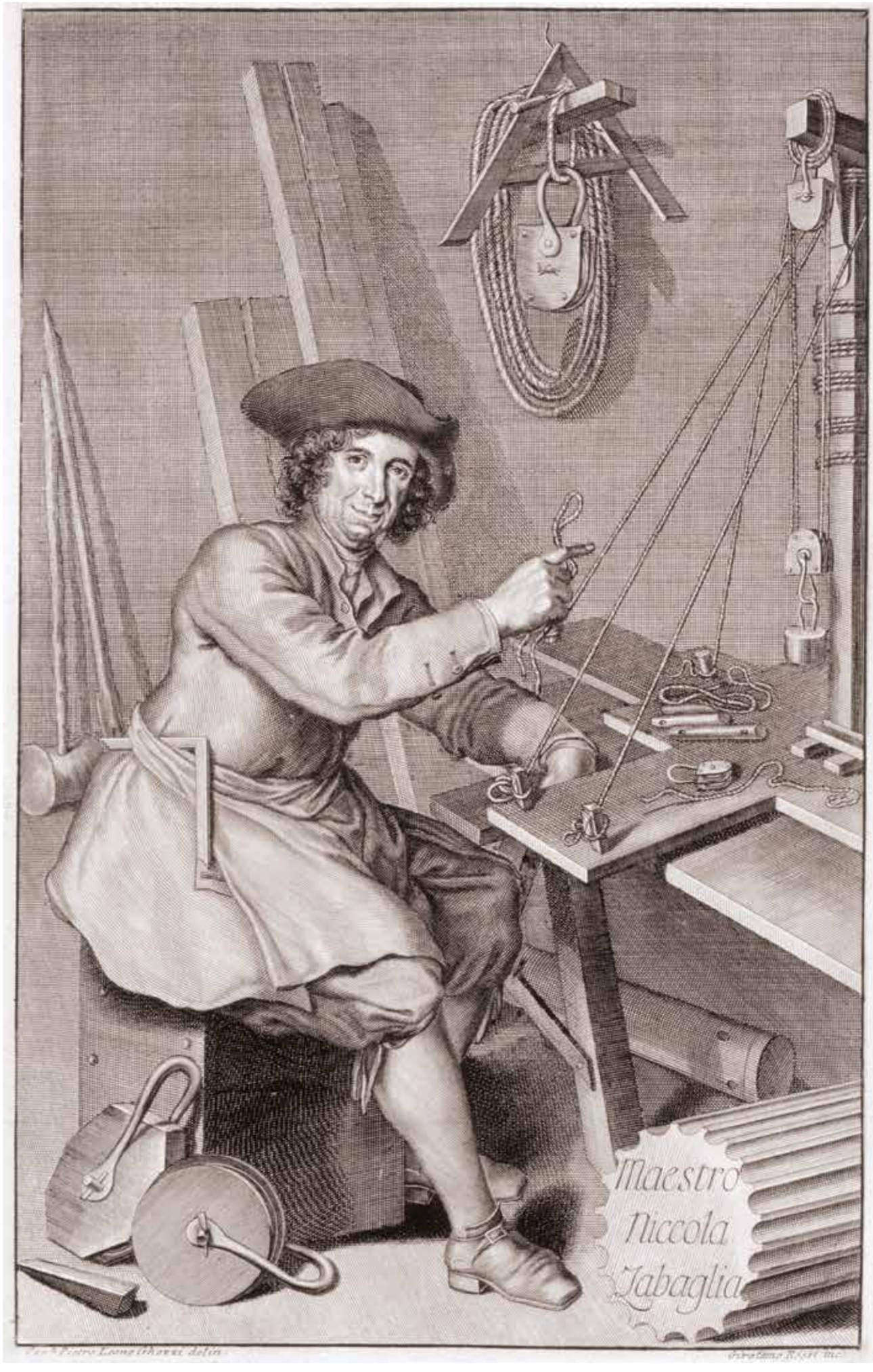
L'industria edilizia romana acquisì forma compiuta alla metà del XVII secolo con la definizione dell'articolato congegno gestionale e tecnico sotteso ai grandi cantieri papali e a una miriade di fabbriche private. Tale perfezionamento avvenne contestualmente al lento procedere del cantiere del nuovo San Pietro e alla sperimentazione da esso indotta, tanto in ambito tecnico-operativo, quanto organizzativo e amministrativo. In contemporanea, tecniche costruttive e tecnologie edilizie, espressione della singolare specificità del contesto romano e del suo congenito rapporto con l'antico, trovarono proficuo sviluppo nei molti cantieri aperti in città, fecondi laboratori sperimentali per architetti e maestranze di diversa provenienza. L'esperienza dei mastri lombardi e la fruttuosa collaborazione tra fabbriche papali e cantieri privati, risolutiva nel primo Seicento, tradussero la pratica edificatoria romana in riconosciuto e apprezzato modello per tecniche costruttive, approvvigionamento dei materiali, organizzazione delle maestranze e potenziamento della tecnologia edilizia. Macchine, centine e ponteggi per la costruzione in uso nei cantieri di età rinascimentale sono stati ampiamente discussi in letteratura, al pari di organizzazione del lavoro, produzione dei materiali e tecniche operative. Meno indagato rimane invece il settore dei ponteggi per la manutenzione, ordinaria e straordinaria, pur diffusamente praticata in età moderna e documentata in letteratura per alcuni autorevoli interventi in edifici romani. Note le strabilianti invenzioni tecniche dell'incolto carpentiere Nicola Zabaglia, impegnato nella Fabbrica di San Pietro in Vaticano per il primo cinquantennio del XVIII secolo, questo contributo introduce nuovi elementi di conoscenza sul tema degli apparati di servizio per la manutenzione, illustrandone successivi perfezionamenti e universalità di applicazione[1]. Tale sguardo, spaziando oltre i confini petriani, indaga diffusione e fortuna critica del compendio *Castelli e Ponti di maestro Niccola Zabaglia* (Roma 1743, Roma 1824)[2] nella letteratura tecnica italiana ed europea fino ai primi del Novecento[3].

Empirismo e precettistica nei cantieri di Roma moderna

Nel contesto edilizio romano, l'autorità della Fabbrica di San Pietro – istituzione preposta all'amministrazione finanziaria e tecnica del cantiere basilicale a partire dal 1506 –, superò a tratti gli stessi precetti dei teorici, influenzando la diffusione di un sapere tecnico sostanziato da un affidabile pragmatismo sperimentale[4]. In oltre due secoli di incessante attività, le sbalorditive dimensioni dell'erigenda basilica Vaticana, le sue imperative esigenze funzionali, la macchinosa gestione degli approvvigionamenti e le atipiche necessità costruttive contribuirono a conferire alla Fabbrica indiscussa supremazia in campo edilizio, riconosciuta anche oltre i confini italiani. Nella proficua permanenza delle pratiche costruttive tardocinquecentesche, i cantieri – pubblici e privati – di XVII e inizio XVIII secolo, pur emancipati dalle consuetudini gestionali della Fabbrica, furono da questa indirettamente informati grazie al noleggio di macchine e attrezzature e alla fruttuosa condivisione di manodopera esperta e qualificata. L'esperienza maturata dalle maestranze petrine, spesso chiamate a coordinare le diverse fasi esecutive di cantieri esterni al Vaticano[5], filtrò dunque nella pratica edilizia romana, informandone la struttura organizzativa e l'intero processo costruttivo, dal confezionamento delle materie prime al perfezionamento di macchine e apparati provvisionali.

Pur nella sostanziale convergenza di teoria e pratica edilizia, l'indifferibile ottimizzazione dei tempi di esecuzione, l'obbligata parcellizzazione delle lavorazioni e ragioni di convenienza economica imposero inevitabili deroghe ai dettami dei teorici, comunque mai contraddetti nella sostanza. Gli autorevoli precetti dei trattatisti vennero così ad assumere posizioni liminari alla manifesta commensurabilità della realtà tratteggiata dai documenti di cantiere. Se, nei trattati di architettura, l'interesse al dato materiale rimase marginale alla più nobile ricerca delle molteplici espressioni formali dell'architettura e delle sue regole compositive, i resoconti di cantiere documentarono la sostanziale autonomia di coloro che dovettero destreggiarsi nella quotidianità di una pratica operativa mutevole e complessa. Tale discrasia trapela nitidamente dalle *Misure e stime* dei lavori condotti in diversi autorevoli can-

Opus Incertum (2020) pp. 140-157 | ISSN 2239-5660 (print) ISSN 2035-9217 (online)
 DOI: 10.13128/opus-12368 www.fupress.com/oi


Maestro
Niccola
Jabaglia

pagina 141
Fig. 1 *Castelli e Ponti di Maestro Niccola Zabaglia… cit. Frontespizio con ritratto di Nicola Zabaglia (incisione G. Rossi, disegno P.L. Ghezzi).*

tieri secenteschi e riguarda i diversi aspetti della pratica operativa.

È noto che la teorizzazione dell'*ars aedificatoria* cinque e secentesca, rivolta al consenso di artisti e dotti committenti, e affidata al solido modello della pratica antica, raramente incluse aggiornamenti e progressi della pratica operativa corrente. La frattura tra cultura speculativa e cultura operativa si fece evidente nella definizione di modalità e tempi di esecuzione di alcune lavorazioni. Valga per tutte la procedura di confezionamento della calce, destinata a vari impieghi e dunque prodotta con materie prime diversificate per natura e consistenza. Vitruvio e i suoi commentatori suggerirono l'impiego di calcare puro, bianco e compatto, apprezzato per la presa lenta, che consentiva il progressivo assestamento della struttura muraria e l'omogenea distribuzione delle spinte; per la calce da intonaco e stucco ammisero invece anche l'impiego di pietre porose[6]. Ancor più rigorosamente, Leon Battista Alberti (1404-1472) raccomandò l'indistinto impiego di calcari bianchi, provenienti da cave fresche e umide, in grado di prolungare e rendere più efficace il processo di cottura[7]. Eppure, nel caso specifico di Roma, gli enormi quantitativi di residui della lavorazione del travertino tiburtino e l'ampia disponibilità di pietra calcarea ben stagionata presso le "cave" dei monumenti antichi, resero superflua qualsivoglia diversificazione. Aderendo a una più pragmatica istanza di convenienza economica, Vincenzo Scamozzi (1548-1616) ammise il ricorso alle materie prime locali, purché accuratamente selezionate e preparate in tempo opportuno[8]. Anche in questo caso, però, le necessità imposte dal ritmo serrato delle lavorazioni obbligarono a tempi non compatibili con le prescrizioni dei teorici, che, dunque, difficilmente aderirono alla quotidianità della pratica esecutiva. Se Plinio il Giovane, Vitruvio e loro commentatori consigliavano tempi di spegnimento della calce lunghi addirittura due o tre anni[9], più realisticamente, nelle fabbriche rinascimentali e barocche prevalsero modalità e tempi di idratazione decisamente più rapidi, contratti fino a una decina di giorni, ma comunque garantiti dall'esperienza.

Teoria e pratica concordarono invece sull'adozione di accorgimenti utili alla buona programmazione del lavoro, pur nelle variabili dettate dalle specificità e dalle urgenze delle singole fabbriche. Fu ad esempio possibile gestire e accordare i prodotti delle diverse giornate lavorative attraverso il controllo della presa e del processo di carbonatazione di malte e conglomerati, in aderenza a quanto raccomandato, ancora ai primi del Settecento, dall'anonimo *Manuale ad uso di muratori e misuratori*, silloge della tecnica edificatoria dell'epoca e di consuetudini operative pregresse[10]. Queste aderiscono ai resoconti dei documenti di cantiere, quali ad esempio i *Patti e convenzioni dell'Opera de Muratori* per la fabbrica della cappella Paolina in Santa Maria Maggiore, o le consuntive *Mesure et stime*, che informano puntualmente su modalità costruttive, materiali, specializzazione delle maestranze, quantità e qualità delle lavorazioni eseguite[11]. In aderenza ad una prassi consolidata, asseverata dai teorici, gli stessi documenti attestano anche la costruzione di archi, volte e cupole delle cappelle liberiane in "muro di tevolozze", secondo la nota accezione alludente ai laterizi di recupero menzionata anche dai trattatisti. Per le ottime proprietà idrauliche e la buona resistenza a compressione guadagnate dalla lunga stagionatura, le tevolozze, commiste a laterizi interi, innervarono le compagini murarie più sollecitate, furono miscelate come *coementa* ai conglomerati, oppure disegnarono gli aggetti rustici di ornati architettonici. Il loro uso fu pluriscolare. Alla metà dell'Ottocento, Nicola Cavalieri San Bertolo (1788-1867) specificava che, seppure disuguaglianza e irregolarità delle tevolozze necessitano di una posa attenta per evitare peri-

[1] N. Marconi, *Castelli e Ponti. Apparati per il restauro nell'opera di mastro Nicola Zabaglia per la Fabbrica di San Pietro in Vaticano*, Foligno 2015; più in generale, sui cantieri romani di XVI-XVIII secolo, si veda Ead., *Edificando Roma barocca. macchine, apparati, maestranze e cantieri tra XVI e XVIII secolo*, Città di Castello 2004.
[2] *Castelli e Ponti di Maestro Niccola Zabaglia con alcune ingegnose pratiche e con la descrizione del trasporto dell'Obelisco Vaticano e di altri del Cavaliere Domenico Fontana*, Roma 1743 (ristampa Roma 1824).
[3] Questo contributo anticipa parzialmente gli esiti di uno studio in pubblicazione, condotto da chi scrive con Stefan M. Holzer, incentrato sul rapporto tra teoria e pratica nel cantiere edile relativamente alla progettazione degli apparati provvisionali, nonché sulle reali finalità del monumentale progetto editoriale di *Castelli e Ponti*, promosso e sostenuto dalla Fabbrica di San Pietro in Vaticano nel 1743 e nella seconda edizione ampliata del 1824.
[4] M. Basso, *I privilegi e le consuetudini della Reverenda Fabbrica di San Pietro in Vaticano (secc. XVI-XX)*, Roma 1987; Marconi, *Edificando Roma barocca*… cit., pp. 25-36; V. Lanzani, *La Fabbrica di San Pietro. Una secolare istituzione per la Basilica Vaticana*, in *Magnificenze Vaticane. Tesori inediti dalla Fabbrica di San Pietro*, a cura di A.M. Pergolizzi, Roma 2008, pp. 55-60; S. Turriziani, *La Fabbrica di San Pietro in Vaticano: istituzione esemplare del "saper fare" nei secoli XVI-XVIII*, in *Sapere e saper fare nella Fabbrica di San Pietro*, a cura di A. Marino, Roma 2008, pp. 106-120; R. Sabene, *La Fabbrica di San Pietro. Dinamiche internazionali e dimensione locale*, Roma 2012.
[5] "I Capomastri [...] addetti al servigio della Fabrica di San Pietro [...] non eran allora tali di nome soltanto, ma ben anche di fatti. Sopraintendevano bensì agli altri mastri, detti di cucchiara, ed ai garzoni assunti secondo il bisogno; insieme però con tutti gli altri lavoravano ancor essi manualmente, e mettevano in pratica quanto insegnavano": *Castelli e Ponti di Maestro Niccola Zabaglia*… cit. (ed. 1824), p. II.
[6] *I dieci libri dell'architettura di Marco Vitruvio Pollione*, a cura di M. Morresi, Milano 1987, II-V, p. 79.
[7] L.B. Alberti, *L' architettura. De re aedificatoria*, a cura di P. Portoghesi, G. Orlandi, Milano 1966, I-III, pp. 150-153, 220.
[8] V. Scamozzi, *L'Idea dell'Architettura Universale*, Venezia 1615, capo II, p. 176.
[9] J.P. Adam, *L'arte di costruire presso i romani*, Milano 1988, p. 76
[10] Biblioteca Apostolica Vaticana (d'ora in avanti BAV), ms. *Vaticano Latino*, 14070, f. 8*r*.
[11] Archivio di Stato di Roma (d'ora in avanti ASR), *Segretari e Cancellieri della Reverenda Camera Apostolica*, 358/32, ff. 501*r*-503*v*; ivi, Camerale I, *Fabbriche*, 1527, ff. 87*r*-106*v*.

colose discontinuità nel piano di compressione, esse costituiscono comunque garanzia di solidità e durevolezza dell'opera[12]. I suggerimenti di Cavalieri San Bertolo seguono una prassi operativa di lungo corso, diffusamente praticata dalle maestranze romane, use al reimpiego dei materiali antichi e ai segreti dell'antica arte edificatoria, diffusamente reiterata e codificata dalla trattatistica.

Impalcati e dispositivi provvisionali tra obliterazione teoretica e pratica operativa

Alcuni aspetti della costruzione non trovarono spazio nella trattazione teoretica; tra questi, un assordante silenzio avvolge il progetto e la costruzione dei ponteggi di servizio e, più in generale, degli impalcati provvisionali, riscattati solo dalla manualistica tecnica di metà Ottocento[13]. A differenza delle più scenografiche macchine da sollevamento, eredi della tecnologia antica, i dispositivi di supporto alla costruzione occuparono un ruolo marginale tanto nelle opere di Vitruvio e Leon Battista Alberti, quanto di Andrea Palladio, Vincenzo Scamozzi e perfino nelle *Nouvelles Inventions pour bien bastir et à petits fraiz* di Philibert de L'Orme (1561), che pure trattò ampiamente il tema della carpenteria strutturale associata alla disamina delle caratteristiche e delle proprietà meccaniche delle diverse specie legnose. Tale silenzio si deve probabilmente al fatto che nei cantieri di età moderna la costruzione di ponteggi e apparati provvisionali era inclusa tra le mansioni ordinarie dei muratori, rientrando in una pratica tanto nota quanto sottaciuta. A muratori e carpentieri – più raramente falegnami – spettava l'invenzione di nuovi impalcati, il perfezionamento di quelli di uso corrente e l'adattamento alle specifiche esigenze operative. Eppure, il loro contributo, spesso risolutivo per il cantiere, fu trascurato dalla trattatistica architettonica e questo nonostante l'importanza dei ponteggi fosse nota anche ai sostenitori della componente intellettuale della professione edile. È possibile trovare rapsodici accenni alla costruzione di impalcature per pittori e stuccatori in alcuni compendi dedicati alle tecniche artistiche, quali il *Perspectiva Pictorum et Architectorum* del gesuita Andrea Pozzo (1642-1709), pubblicato a Roma nel 1693, *El Museo Pictorico* del pittore spagnolo Antonio Palomino de Castro y Velasco (1655-1726)[14] e l'*Abecedario pittorico* dell'abate Antonio Pellegrino Orlandi (1660-1727)[15]. Queste opere si inseriscono tra i compendi riccamente illustrati, fioriti durante il XVI e il XVII secolo, ma destinati a scomparire a inizio Settecento per un mutato atteggiamento nei confronti della tecnologia. Analogamente, sporadici riconoscimenti sono tributati ad acrobatiche invenzioni di centine per volte e cupole[16]. La descrizione di ponteggi e impalcati di servizio ordinari compare invece di rado, finanche nella contabilità dei lavori, ove la loro realizzazione risulta inclusa nell'importo complessivo delle opere di muro. Esistono però alcune eccezioni, quali *misure e stime* più accurate e puntuali, riferite a opere di grande prestigio o di carattere straordinario. Tra le altre, l'esecuzione del celeberrimo *Trionfo della Divina Provvidenza* nel salone grande di palazzo Barberini alle Quattro Fontane, tra la fine del 1632 e il 1639, fu senz'altro impresa eclatante, per le dimensioni eccezionali, le tecniche impiegate, il suggestivo intreccio di temi narrativi e la superba invenzione figurativa. Se molto è stato scritto su quest'opera celeberrima di Pietro da Cortona (1596-1669)[17], la *misura e stima* "del Ponte per li Pittori sotto la volta del salone Grande per depingerla fatto fare dall'Em.mo Sig. Card. Barberini et fatto da mastro Cesare Bartolomei falegname a tutta sua robba et fattura eccettuato n. 433 tavole di castagno che sono di sua Em.za"[18], saldata dal principe Taddeo Barberini (1603-1647) il 6 luglio 1632 e sottoscritta dall'architetto Bartolomeo Breccioli (seconda metà XVI sec – post 1637)[19], testimonia

[12] N. Cavalieri San Bertolo, *Istituzioni di architettura statica e idraulica*, Mantova 1869, II, pp. 61, 69-71.
[13] Un'eccezione è rappresentata da A. Capra, *La nuova architettura famigliare*, Bologna 1678, pp. 278-279, nel quale è illustrato un ponteggio di servizio di impiego comune.
[14] A. Palomino de Castro y Velasco, *El museo pictorico, y escala óptica*, Madrid 1795.
[15] P.A. Orlandi, *Abecedario pittorico del M. R. P. Pellegrino Antonio Orlandi, bolognese, contenente le notizie de' professori di pittura, scoltura, ed architettura*, Venezia 1753.
[16] S.M. Holzer, *Nicola Cavalieri San-Bertolo und sein Ingenieur-Handbuch von 1826*, in *Alltag und Veränderung: Praktiken des Bauens und Konstruierens*, tagungsband (Innsbruck, 23.-25. April 2015), herausgegeben von Gesellschaft für Bautechnikgeschichte, Dresden 2017, pp. 221-232; Id., *Modèle et transformation. Trois dessins du XVIII^e siècle et leur fortune au travers de traités européens de charpenterie (1714-1859)*, in *Les temps de la construction: processus, acteurs, matériaux*, actes du congrès (Lyon, 29-31 janvier 2014), éd. L. Baridon, F. Fleury, A. Mastrorilli, R. Mouterde, N. Reveyron, Paris 2016, pp. 121-130.
[17] A. Lo Bianco, *La volta di Pietro da Cortona*, Roma 2004; Ead., *Pietro da Cortona e gli anni della volta Barberini*, in *I Barberini e la cultura europea del Seicento*, atti del convegno (Roma, 7-11 dicembre 2004), a cura di L. Mochi Onori, S. Schütze, F. Solinas, Roma 2008, pp. 213-220.
[18] BAV, *Archivio Barberini*, Giust. II, 7, ff. 631r-632r. Devo un sentito ringraziamento a Marco Buonocore, Luigi Cacciaglia e Isabella Aurora della Biblioteca Apostolica Vaticana per aver reso possibile la consultazione del fondo *Giustificazioni II* dell'Archivio Barberini in Vaticano, oggetto di un mio studio sulla committenza architettonica dei principi feudatari di Palestrina tra 1630 e 1750, ora in corso di stampa.
[19] M. Tafuri, A.M. Corbo, *Breccioli (famiglia)*, in *Dizionario Biografico degli Italiani*, XIV, Roma 1972, p. 93. L'attività di Breccioli come misuratore della Fabbrica di San Pietro è documentata in O. Pollak, D. Frey, *Die Kunsttätigkeit unter Urban VIII*, Wien 1931, II, *ad indicem*.

la complessità esecutiva del grandioso impalcato, che ne giustifica la computazione scorporata, esplicitando la singolarità dell'invenzione tipologica di un apparato modellato sulla duplice altezza del salone. Il ponteggio, costato ben 223 scudi, era costituito da un "ponte grande"– munito di tavolato di servizio, fissato alla quota d'imposta della cornice e stabilizzato da due catene in ferro e staffe – e un "sopraponte" per l'accesso alle quote più elevate e una struttura di sostegno alle scale di servizio[20]. Il complesso dispositivo assemblava oltre 750 tavole di castagno "refilate con la pialla", 90 carrarecci, diversi arcarecci, saettoni, tavoloni, 110 "pezzi de legno grossi" e gattelloni innestati e legati tra loro con zeppe di legno, legature di corde e perfino con "una catena di ferro alta palmi 17 [3,8 m circa] messa per mantenimento della corda". Sul ponteggio furono montati sei cavalletti "fatti per li pittori per fare li sopra ponti di travicelli di castagno con suoi piedi sotto simili e tavole a traverso, […] 3 cassette per tenere li colori, […] 3 cassette di albuccio per servirsene per sotto piede […], una porticella che entra in detto Ponte e una scaletta che sale in detto ponte di castagno fatta alla fratesca e foderata sotto et con soi parapetti"[21]. La dettagliata *misura* è prova dell'inusuale complessità del dispositivo, nonché del suo costo consistente, e conferma la consuetudine alla definizione puntuale di apparati che esulano dalla pratica ordinaria[22].

Ponteggi per la manutenzione dell'architettura: l'extra-ordinario laboratorio della Fabbrica di San Pietro in Vaticano e il contributo di Nicola Zabaglia

Nonostante simili eccezioni, le specifiche costruttive di ponteggi e impalcati di servizio rimasero comunque episodiche, se non del tutto estranee, alla letteratura tecnica. Eppure, nuove peculiari necessità si imposero nei cantieri romani di metà XVI secolo, obbligando in prospettiva ad un aggiornamento dei temi illustrati dalla trattatistica. Tali urgenze riguardarono in particolare la pratica della manutenzione, nuova finanche alla codifica teorica dell'architettura. Le occorrenze della conservazione, divenute improrogabili, indirizzarono utilmente la divulgazione del prezioso sapere operativo di muratori e carpentieri, contribuendo alla nobilitazione e alla diffusione della loro arte. Eppure, la maggior parte degli studi editi risulta ancora incentrata sugli aspetti progettuali dei "restauri" di XVII e XVIII secolo, dei quali sono stati opportunamente messe in luce finalità e prospettive concettuali. Queste ultime, connotate da un carattere innovativo, piuttosto che conservativo, e informate al rapporto tra progetto, continuità e trasformazione, si tradussero di fatto in un processo di continua *renovatio*, nel quale la questione della legittimità del "nuovo" rispetto al "vecchio", della conciliabilità tra linguaggio contemporaneo, preesistenze urbane e architettoniche fu interpretata in modo tutt'altro che univoco. Valgano per tutti gli interventi di completamento e rinnovamento eseguiti nelle basiliche papali di San Pietro in Vaticano e San Giovanni in Laterano e chiaramente informati da opposti significati. Se, infatti, i necessari requisiti di magnificenza e autorità sottesi al completamento della basilica Vaticana si materializzarono nella monumentale addizione maderniana, nella basilica lateranense prevalse l'istanza conservativa, più aderente ai principi del "restauro" e simbolicamente connotata dal mantenimento dell'antico impianto costantiniano[23]. Più in generale, a Roma, gli indirizzi d'intervento seguiti per quasi due secoli furono additati dal cardinale Cesare Baronio (1538-1607) e risultano sostanzialmente orientati al rispetto degli impianti delle antiche chiese e alla conservazione della loro materia, pur nelle diverse variabili interpretative[24]. Successivamente alla distruzione della costantiniana basilica di San Pietro, tali istanze trovarono in San Giovan-

[20] D. Di Marzio, *La Sala Clementina in Vaticano. Procedimento per la costruzione diretta della prospettiva su superfici curve: ipotesi teorica e verifica sperimentale*, in *La costruzione dell'architettura illusoria*, a cura di R. Migliari, Roma 1999, pp. 171-173.

[21] BAV, *Archivio Barberini*, Giust. II, 7, ff. 631*r*-632*r*. Il documento barberiniano, finora non noto, fornisce una descrizione analoga a ASR, *Notai del Tribunale A. C.*, Istromenti, Notaio Domenicus Fonthia, vol. 3175, f. 1009*r*, citato in O. Verdi, *Il voltone di Pietro da Cortona in Palazzo Barberini: le fonti documentarie*, "Quaderni di Palazzo Venezia", 1983, 2, pp. 91-98. Sull'argomento anche B. Zanardi, *Il voltone di Pietro da Cortona in Palazzo Barberini: il restauro e le tecniche di esecuzione originali*, "Quaderni di Palazzo Venezia", 1983, 2, pp. 11-52; J.B. Scott, *The Art of the Painter's Scaffold. Pietro da Cortona in the Barberini Salone*, "The Burlington Magazine", 135, 1993, pp. 327-337.

[22] G. Briganti, *Pietro da Cortona o della pittura barocca*, Firenze 1962, p. 198.

[23] Tra gli altri, M. Villani, *Strategie papali nell'età di Alessandro VII: il "restauro" barocco della tribuna di San Giovanni in Laterano*, "Palladio", 11, 1998(1999), 22, pp. 39-60; A. Borgomainerio, *Il contributo di Bernini nel restauro del battistero lateranense*, in *Porre un limite all'infinito errore. Studi di storia dell'architettura dedicati a Christof Thoenes*, a cura di A. Brodini, G. Curcio, Roma 2012, pp. 159-168.

[24] A. Roca De Amicis, *Rinnovare le basiliche romane, prima e dopo San Giovanni in Laterano*, in *Alla moderna. Antiche chiese e rinnovamenti barocchi: una prospettiva europea*, a cura di Id., C. Varagnoli, Roma 2015, pp. 45-68.

ni in Laterano il terreno per nuove sperimentazioni, giungendo alla matura formulazione borrominiana e, nel primo Settecento, all'innovativo esito della basilica di San Clemente, ove antico e nuovo si confrontano liberamente e senza prevaricazioni[25].

Nella dibattuta interpretazione dei concetti di conservazione e restauro[26], gli interventi sei e settecenteschi si muovono dunque nell'ambito del rifacimento, del completamento e della trasformazione, ma anche in un sottaciuto quanto diffuso atteggiamento mimetico verso gli edifici del passato che prelude all'istanza stilistica[27]. Non meno rare sono le opere di consolidamento, primo tra tutte, per complessità e significato, quello della cupola di San Pietro in Vaticano, progettato come noto da Giovanni Poleni e diretto da Luigi Vanvitelli nel 1742[28].

Più in generale, a Roma, gli interventi di manutenzione ordinaria e straordinaria seguirono la naturale pratica del reintegro, mutuata dal restauro scultoreo e diffusamente praticata nei cantieri barocchi[29]. Risarciture e integrazioni di decorazioni a stucco, indorature, modanature, cornici, cassettoni e motivi figurati, così come il reintegro di lesioni, fessure e giunti murari costituirono la comune pratica del "restauro" sei e settecentesco, al pari della fisiologica sostituzione di elementi e ornati corrotti con copie identiche per forma e materia, eppure mai interpretate come "falso". L'esecuzione materiale di tali interventi richiese la predisposizione di adeguate impalcature provvisionali, sospese o da terra, opportunamente modellate sulle geometrie e le quote degli spazi d'intervento, soffitti, volte e cupole.

Nella Fabbrica di San Pietro, che per prima dovette confrontarsi con il tema della "conservazione", l'efficienza conseguita nell'organizzazione della manodopera e nella pratica esecutiva fu utilmente riconvertita all'ottimizzazione progettuale, strutturale e funzionale di apparati provvisionali necessari alle opere di manutenzione, mentre rimasero immutate le tecniche esecutive e le procedure d'intervento. Se i momenti topici dell'edificazione della basilica Vaticana erano coincisi con le tappe risolutive del perfezionamento dell'arte edificatoria, con la conclusione dei lavori e l'avvio dell'imponente programma di decorazione musiva si affermò inderogabile la necessità di definire procedure, tecniche e impalcature di servizio per interventi di consolidamento, manutenzione ordinaria e, più occasionalmente, di "restauro"[30]. Questi obbligarono all'ideazione di nuovi apparati, adatti alle singolari specificità del sedime basilicale, ma al contempo sufficientemente versatili da poter essere utilmente impiegati anche in altri contesti. Gli obbligati vincoli posti al montaggio e alla manovra di ponteggi, interni ed esterni, comportarono notevoli sfide costruttive: il prezioso invaso architettonico della basilica Vaticana impose severe restrizioni alla progettazione e alla funzionalità degli impalcati per la manutenzione, oltre all'obbligo di predisporre operazioni di assemblaggio e smontaggio non interferenti con le funzioni liturgiche.

Avviati già dalla fine del XVII secolo, gli interventi di manutenzione comportarono la predisposizione di impalcati di servizio adeguati alle quote e all'articolato spazio petrino. Questi furono concepiti come impalcati sospesi e mobili, assemblati con robuste orditure lignee, saldati da staffature metalliche e legature di funi calibrate sullo sforzo esercitato dagli argani addetti alla loro movimentazione. Per le oggettive difficoltà spaziali e le inderogabili necessità funzionali della basilica, valenti carpentieri dovettero ingegnarsi sia per ottimizzare struttura e funzionalità di ponteggi già in uso, sia per concepirne di nuovi nel pieno rispetto dei richiesti requisiti di economia, sicurezza e reversibilità. A tali improrogabili esigenze rispose l'inventiva intuizione di un incolto "mastro pontiere", Nicola Za-

[25] C. Varagnoli, *La 'riduzione alla moderna' delle basiliche: Roma 1700-1750*, in *Saggi in onore di Renato Bonelli*, a cura di C. Bozzoni, G. Carbonara, G. Villetti, "Quaderni dell'Istituto di Storia dell'Architettura", 15-20, 1992, 2, pp. 765-776.

[26] L'accezione contemporanea del termine "restauro" implica l'adozione di aggettivazioni liminari alla reale natura della pratica del "recupero" di XVI e XVIII secolo. Questa risulta piuttosto sostanziata da interventi oggi identificabili come manutenzione (ordinaria o straordinaria), ripristino e consolidamento.

[27] V. Russo, *Architettura nelle preesistenze tra Controriforma e Barocco. "Istruzioni", progetti e cantieri nei contesti di Napoli e Roma*, in *Verso una storia del restauro: dall'età classica al primo Ottocento*, a cura di S. Casiello, Firenze 2008, pp. 139-205.

[28] Tra i molti contributi sull'argomento, per l'attinenza con i temi qui trattati si rimanda a G. de Martino, *Aspetti della cultura del restauro nel secondo Settecento nell'opera di Luigi Vanvitelli*, in *Verso una storia del restauro…* cit., pp. 237-246; N. Marconi, *Technicians and Master Builders for Restoration of the Dome of St. Peter's in Vatican in the 18th Century: The Contribution of Nicola Zabaglia (1664-1750)*, in *Proceedings of the Third International Congress on Construction History* (Cottbus, 20-24 May 2009), edited by W. Lorenz, V. Wetzk, Cottbus 2009, II, pp. 991-1000.

[29] G. Martellotti, *Tecniche e metodologie dei restauri del XVI e XVII secolo*, in *Rilievi storici Capitolini. Il restauro dei pannelli di Adriano e Marco Aurelio nel palazzo dei Conservatori*, a cura di E. La Rocca, Roma 1986, pp. 61-67. N. Marconi, *Cantiere, tecniche e operatori della costruzione e del restauro nella Roma settecentesca*, in *Il cantiere storico. Organizzazione, mestieri, tecniche costruttive*, a cura di M. Volpiano, "Quaderni del Progetto Mestieri Reali", 2012, pp. 72-93.

[30] N. Marconi, *Procedure e tecnologie per il restauro tra XVIII e XIX secolo: il contributo della Fabbrica di San Pietro in Vaticano*, in *AID Monuments. Conoscere, Progettare, ricostruire. Galeazzo Alessi architetto ingegnere*, atti convegno (Perugia, 24-26 maggio 2012), a cura di C. Conforti, V. Gusella, Roma 2013, pp. 473-486.

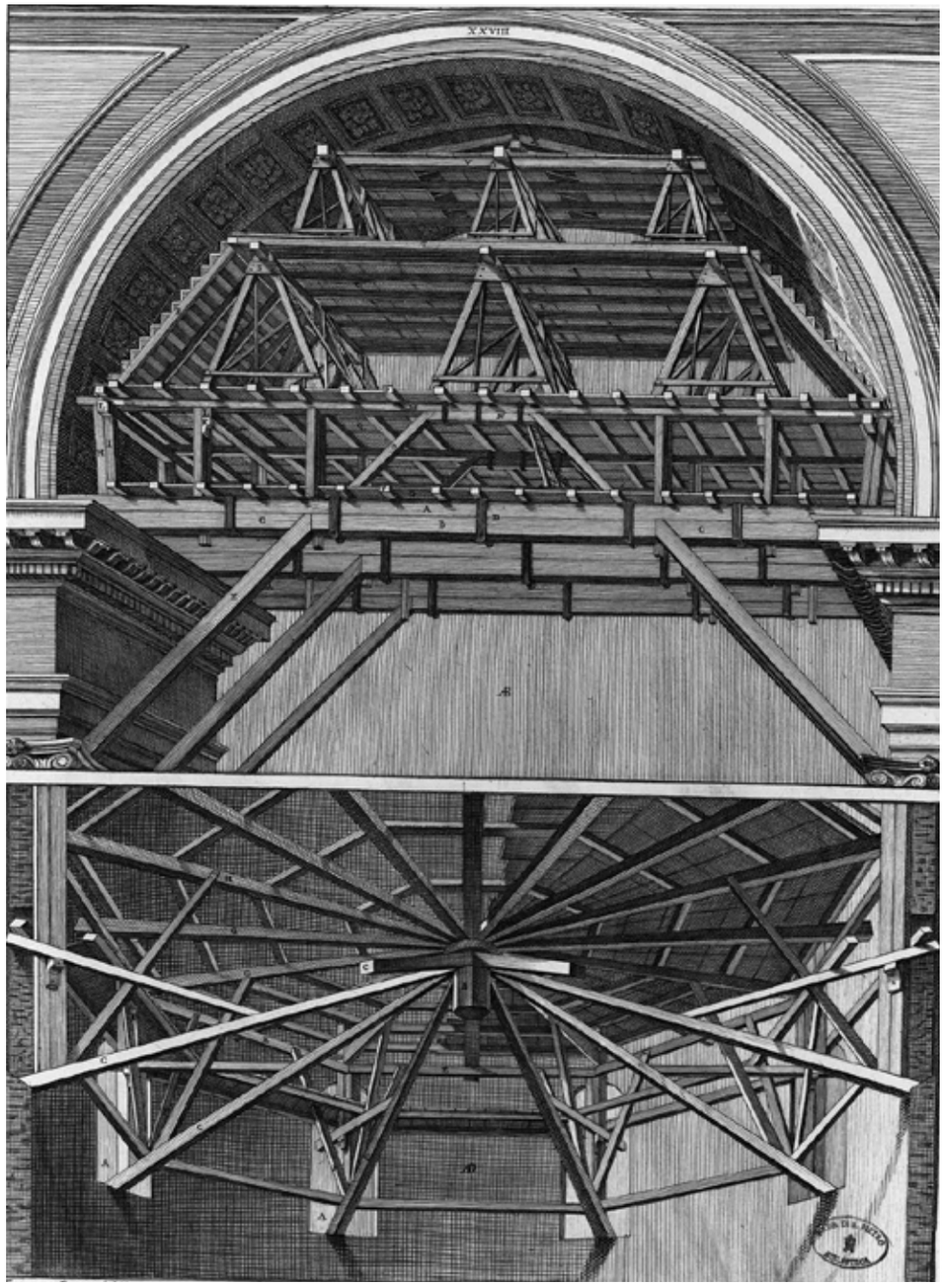


Fig. 2 *Castelli e Ponti di Maestro Niccola Zabaglia… cit., tav. XXVIII. Esempio di ponte "comodo e sicuro […]. Può servire di esempio e di regola per farne dei consimili".*

baglia (1667-1750), il quale rivoluzionò composizione e struttura di impalcati provvisionali anche complessi, perfezionandone criteri e modalità di assemblaggio. Ciò consentì un notevole risparmio di materiale, particolarmente prezioso in un'epoca in cui taglio e commercio del legname da lavoro furono oggetto di rigida regolamentazione da parte dell'autorità pontificia, inevitabilmente coincidente con un deciso incremento dei prezzi[31]. Grazie ai ponteggi ideati da Zabaglia, trasportabili, smontabili e riutilizzabili, la Fabbrica fu in grado di contrarre sensibilmente costi e tempi di esecuzione, nella più assoluta garanzia del buon esito delle opere e della sicurezza degli operai. Pertanto, nell'autorevole contesto petriano, la questione del restauro dell'architettura, ancora libera da sovrastrutture critico-concettuali e da sempre diffusamente praticata come ripristino di elementi deteriorati, si impose non tanto in relazione alle procedure esecutive, rimaste sostanzialmente immutate, quanto piuttosto in merito alla definizione di idonee tipologie di dispositivi provvisionali. Si apriva così un nuovo ambito di sperimentazione per la tecnologia edilizia vaticana, informata da sostanziale empirismo e sviluppatasi in un contesto unico e vincolante. Dalla fine del Seicento e fino a tutto il XIX secolo, soprastanti e carpentieri sanpietrini furono gli ingegnosi protagonisti del rapidissimo sviluppo di un settore vitale

[31] R. Sansa, *L'oro verde. I boschi nello Stato Pontificio tra XVIII e XIX secolo*, Bologna 2003; F. Diosono, *Il legno. Produzione e commercio*, Roma 2008.

per la pratica edilizia, nato orfano dell'eredità dei grandi teorici, ma costretto ad ingegnarsi per rispondere, presto e bene, a questioni di prioritaria urgenza. Le soluzioni elaborate sul campo e gradualmente perfezionate furono codificate solo in un secondo momento in una nuova branca della teoria dell'architettura, presto tradotta in manualistica e diffusa dalla letteratura specialistica d'oltralpe.

Riguardo agli apparati provvisionali destinati alla manutenzione, dunque, la frattura fra cultura speculativa e cultura operativa registrò in questo periodo connotazioni e sviluppi opposti a quelli relativi al cantiere di costruzione. In tale specifico ambito, la pratica operativa anticipò e informò la codifica teorica; in linea con la coeva ricerca epistemologica, essa divenne strumento utile a diffondere soluzioni e invenzioni tecniche efficaci e virtuose, replicabili e sicure. Nella improrogabile necessità di un salto qualitativo del rapporto tra scrittura e pratica di cantiere, la scelta di affidare alla stampa un saper fare ancora sostanzialmente sperimentale si tradusse in alcune eclatanti iniziative editoriali promosse dall'autorità papale. La progettazione di impalcature di servizio, fisse o mobili, divenuta centrale nell'attività edilizia vaticana di inizio XVIII secolo, fu celebrata dalla pubblicazione nel 1743 del volume *Castelli e Ponti di maestro Nicola Zabaglia*, che compendia l'opera straordinaria di un umile carpentiere[32] (fig. 1). Il volume è strutturato con formula editoriale analoga al celebre *Templum Vaticanum* di Carlo Fontana (1694), rispetto al quale, però, rivendica una maggior considerazione del ruolo dei "meccanici" nell'ambito della costruzione. Non a caso, i due compendi esplicitano l'atavico conflitto tra esperienza pratica e conoscenza teorica, intrinseco all'arte edificatoria. Il contributo di Zabaglia e le ragioni che sottesero all'impresa editoriale di *Castelli e Ponti* vanno pertanto contestualizzati nella realtà dell'industria edilizia romana di inizio Settecento, erede della tradizione costruttiva antica, perfezionata nei grandi cantieri rinascimentali e barocchi e interpretata nell'ambito del fecondo laboratorio petrino. L'attività di Zabaglia si svolse nei primi cinquanta anni del XVIII secolo, epoca in cui, mentre si andavano definendo le specifiche competenze tecniche dei ruoli artigianali dell'edilizia, trasmissione orale del sapere tecnico e supremazia dell'esperienza pratica furono messe in crisi dall'incalzante progresso della scienza e dalle sue applicazioni al cantiere edile. In tale contesto, le invenzioni di Zabaglia e dei suoi successori rappresentarono un autorevole modello di coesione tra teoria architettonica, pratica esecutiva e meccanica applicata. Se nel Seicento era definito "ingegnere" colui che sapeva professare *ars* e *technè* con abilità e perspicacia intellettuale, nel secolo successivo, tale appellativo fu tributato anche all'illetterato mastro Zabaglia, a riconoscimento della sua non comune abilità professionale; la conoscenza e l'intuitivo controllo del "contrasto e dell'equilibrio delle forze" gli consentirono di ideare e perfezionare ponteggi da terra o sospesi, fissi o mobili, economici, solidi, sicuri e adatti tanto a opere di manutenzione ordinaria, quanto straordinaria. Tra le sue invenzioni figurano i ponteggi utilizzati per il ripristino degli stucchi della volta del portico di San Pietro (tav. XXI) e per la manutenzione delle cupole minori e dei pennacchi della cupola grande. Non meno interessanti, dal punto di vista costruttivo e funzionale, sono i dispositivi costruiti per la volta della navata principale (tav. XXV) e le piattaforme multilivello denominate "Ponti Reali" (tav. XXIX-VIII) (fig. 2). Da segnalare anche i ponteggi realizzati per la manutenzione dell'imponente baldacchino berniniano (tav. XXXIV) e la gru mobile perfezionata per l'installazione di 50 statue di travertino, alte circa 3 metri, sulle ali rettilinee di piazza San Pietro[33]. Zabaglia fu anche l'ideatore degli impalcati provvisionali necessari all'interven-

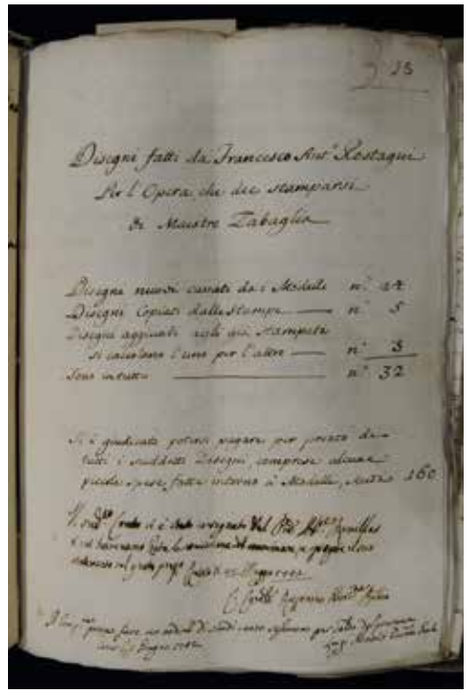


Fig. 3 *"Disegni fatti da Francesco Antonio Rostagni per l'opera che dee stamparsi di Maestro Zabaglia" (Città del Vaticano, Fabbrica di San Pietro, Archivio Storico, AFSP, arm. 43, D, 83, Liste Mestrue 1742, c. 15r; foto FSP).*

[32] *Castelli e Ponti di Maestro Niccola Zabaglia*… cit.
[33] Ivi, tav. VII.


L'ART
DE
CHARPENTERIE
DE
MATHURIN JOUSSE.
Corrigé & augmenté de ce qu'il y a de plus curieux dans cet Art, & des Machines les plus necessaires à un Charpentier.
Par Mr. D. L. H.
Le tout enrichy de Figures & de Tailles douces.
A PARIS,
Chez THOMAS MOETTE, rue de la Boucherie, au bas de la rue de la Harpe, près le Pont Saint Michel, à Sainte Alexis.
M. DCCII.
AVEC PRIVILEGE DU ROY.

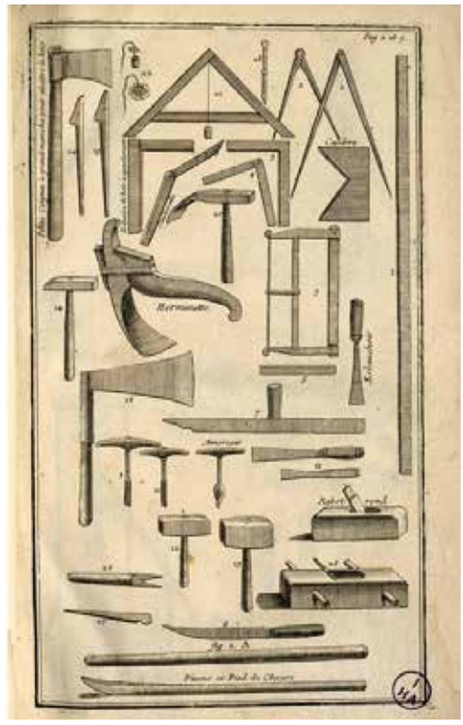


Fig. 4 *De La Hire, L'art de charpenterie de Mathurin Jousse… cit. Frontespizio e p.* 3.

to di consolidamento della cupola grande, eseguito con la supervisione di Giovanni Poleni e Luigi Vanvitelli dal 1743[34].

Nel complesso, i dispositivi progettati da Zabaglia condividono l'attenzione alla conservazione delle superfici murarie, alla sicurezza dei lavoratori e al riutilizzo dei materiali. Essi costituirono un esempio di efficacia e notevole progresso rispetto alle macchine e ai ponteggi di uso corrente nel cantiere edile, che valsero l'impiego senza soluzione di continuità fino alla prima metà del XX secolo, quando furono sostituiti dai moderni ponteggi metallici. La Fabbrica di San Pietro, per non perderne memoria, garantirne la trasmissione a future generazioni di artieri e ribadire la propria supremazia tecnica, promosse una monumentale impresa editoriale utile a fissare le invenzioni di Zabaglia in un'opera ispirata ai coevi manuali tecnici francesi e tedeschi, ma esemplata sull'autorevole trattatistica rinascimentale, richiamata anche nell'adozione del testo in latino[35]. I trattati d'oltralpe, soprattutto francesi, considerati vettori autorevoli di informazioni tecniche, furono di ispirazione agli esperti petriani nella definizione della struttura editoriale di *Castelli e Ponti*, pur nella differente formulazione dei testi, qui stringati e ridotti a didascalie.

L'*aeditio princeps* data all'agosto 1743 e si deve all'iniziativa dell'erudito senese Ludovico Sergardi, allora economo della Fabbrica, e di Lelio Cosatti, matematico di valore e "intendente" di meccanica, al quale fu affidata la redazione dei testi, probabilmente coadiuvato dall'architetto e soprastante Antonio Valeri. L'idea di illustrare graficamente i congegni ideati da mastro Zabaglia risale al primo decennio del XVIII secolo, ma la lavorazione venne differita al 1720, quando Sergardi e Cosatti commissionarono a Baldassarre Gambucciari la realizzazione di 12 rami "mezzani" e 4 grandi, eseguiti in collaborazione con l'architetto e incisore Filippo Vasconi (1687-1730), autore anche delle tavole aggiunte all'edizione settecentesca del *Manuale di Architettura* di Giovanni Branca, curata da Paolo Giunchi (1722)[36] (fig. 3). Il compendio è organizzato in tre sezioni. Nella prima sono illustrati strumenti, sistemi di giunzione e annodatura dei canapi, ma anche macchine e attrezzature a uso di muratori e falegnami (tavv. I-XVII). La precisione con la quale sono rappresentati gli strumenti ne esplicita l'appartenenza al tradizionale corredo da lavoro di muratori, scalpellini e falegnami, mentre l'ordine di rappresentazione segue il criterio della diffusione d'impiego. La composizione grafica e la selezione mirata delle attrezzature raffigurate (tav. I) rimandano ad alcuni compendi francesi del secolo precedente, quali *L'art de charpenterie* di Mathurin Jousse (1575-1645), nuovamente pubblicato a Parigi nel 1702[37] (fig. 4), come ad altri manuali di carpenteria pubblicati in Francia tra XVII e XVIII secolo. La seconda sezione di *Castelli e Ponti* è invece interamente dedicata ai

[34] Marconi, *Technicians and Master Builders*… cit.; P. Dubourg Glatigny, *L'architecture morte ou vive. Les infortunes de la coupole de Saint- Pierre de Rome au XVIII*[e] *siècle*, Rome 2017.

[35] Marconi, *Castelli e Ponti*… cit.

[36] Tra il 1741 e il 1742 altri importanti artisti furono incaricati dell'esecuzione dei complessivi 54 rami delle tavole: Francesco Antonio Rostagni, François Philotheé Duflois, Nicola Gutierrez, Giuseppe Vasi, Paolo Pilaja, Francesco Mazzoni, Martin Schedel, Angelo Guiducci e Miguel de Sorel. Il frontespizio con il ritratto di Zabaglia fu eseguito da Pier Leone Ghezzi e inciso da Girolamo Rossi.

[37] M. Jousse, *Le theatre de l'art de la charpenterie*… , La Fléche 1627; G.Ph. de La Hire, *L'art de charpenterie de Mathurin Jousse, corrigé & augmenté de ce qu'il y a de plus curieux dans cet art, & des machines les plus nécessaires à un charpentier par Mr D.L.H.*, Paris 1702.

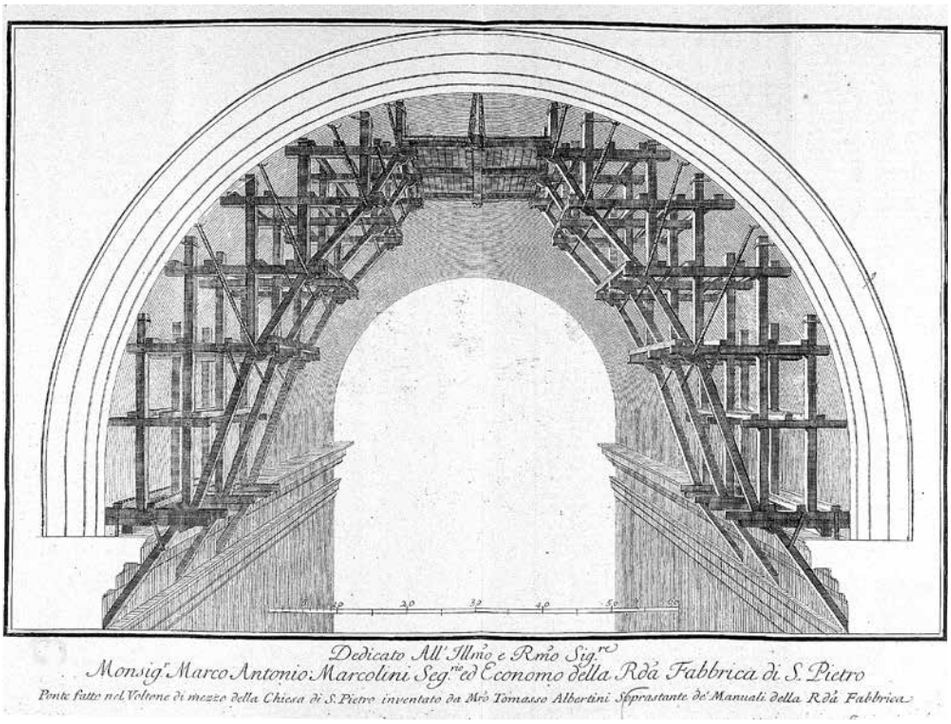


Fig. 5 *Castelli e Ponti di Maestro Niccola Zabaglia… cit., tav. LV. Ponte inventato da Tommaso Albertini per il restauro della volta grande della Basilica di San Pietro in Vaticano.*

ponteggi progettati da Zabaglia per interventi di manutenzione (tavv. XVIII-XXXVI). A sua volta, essa è organizzata in due parti chiaramente distinte: la prima illustra i ponteggi necessari a pittori, stuccatori e mosaicisti, oltre che a muratori, falegnami e scalpellini (tavv. XVIII-XXX), mentre la seconda parte raduna apparati provvisionali di varia tipologia per interventi anche al di fuori del Vaticano (tavv. XXXI-XXXVI). Le due sezioni risultano organicamente strutturate in un crescendo di complessità costruttiva e funzionale, nella quale si distinguono utilmente ponteggi da terra e ponti sospesi. Alla rigorosa struttura editoriale non corrisponde però l'immediata comprensione dei dispositivi raffigurati. La lettura delle stringate didascalie va infatti necessariamente integrata a un'osservazione attenta delle dettagliatissime informazioni grafiche, estese ai materiali costituenti, alle misure e al peso dei singoli componenti. La terza ed ultima sezione del volume ripropone la corretta sequenza delle tavole illustranti il trasporto dell'obelisco Vaticano (tavv. XXXVII-LIV), nota dal celebre compendio di Domenico Fontana del 1590[38], ma disattesa per un preciso intento programmatico nel *Templum Vaticanum* di Carlo Fontana del 1694[39]. Chiude il volume un'incisione del ponteggio costruito da Tommaso Albertini, che sarà soprastante della Fabbrica di San Pietro dal 1773 al 1787, in sostituzione di un analogo dispositivo precedentemente realizzato da Zabaglia per il restauro della volta della navata della basilica Vaticana, preludio di ulteriori sviluppi ad opera di altri artieri sanpietrini (fig. 5).

Il perfezionamento dei ponteggi per il restauro tra cultura del saper fare e inedite necessità formative

Nonostante Zabaglia non fosse mai stato a capo di una "scuola", come erroneamente affermato da Filippo Maria Renazzi (1745-1808) nella nota biografica allegata alla seconda edizione di *Castelli e Ponti*, per i valenti suoi collaboratori, apprezzati carpentieri sanpietrini, l'esempio e l'insegnamento impartito sul campo da mastro Nicola costituirono una formidabile esperienza formativa, a sua volta garanzia di competenze affidabili e utili alla trasmissione del sapere operativo. In particolare, Giovanni Corsini, Angelo Paraccini e Tommaso Albertini contribuirono attivamente al perfezionamento della tecnologia edilizia, tanto che alcuni ponteggi di loro invenzione furono aggiunti alla seconda edizione dei *Castelli e Ponti* e da qui successivamente riproposti in diversi trattati di carpenteria europei. Tra gli altri, Albertini fu anche l'autore dei ponteggi usati per il restauro della cupola della cappella Gregoriana, della "cupola grande" e, come sopra anticipato, della volta della navata. Quest'ultima fu risarcita negli ornati e nel modellato del cassettonato grazie all'allestimento di un poderoso impalcato, versione perfezionata di quello

[38] D. Fontana, *Della Trasportatione dell'Obelisco Vaticano*, Roma 1590.
[39] *Il Tempio Vaticano 1694: Carlo Fontana*, a cura di G. Curcio, Milano 2003, pp. CLXX-CLXXXVII.

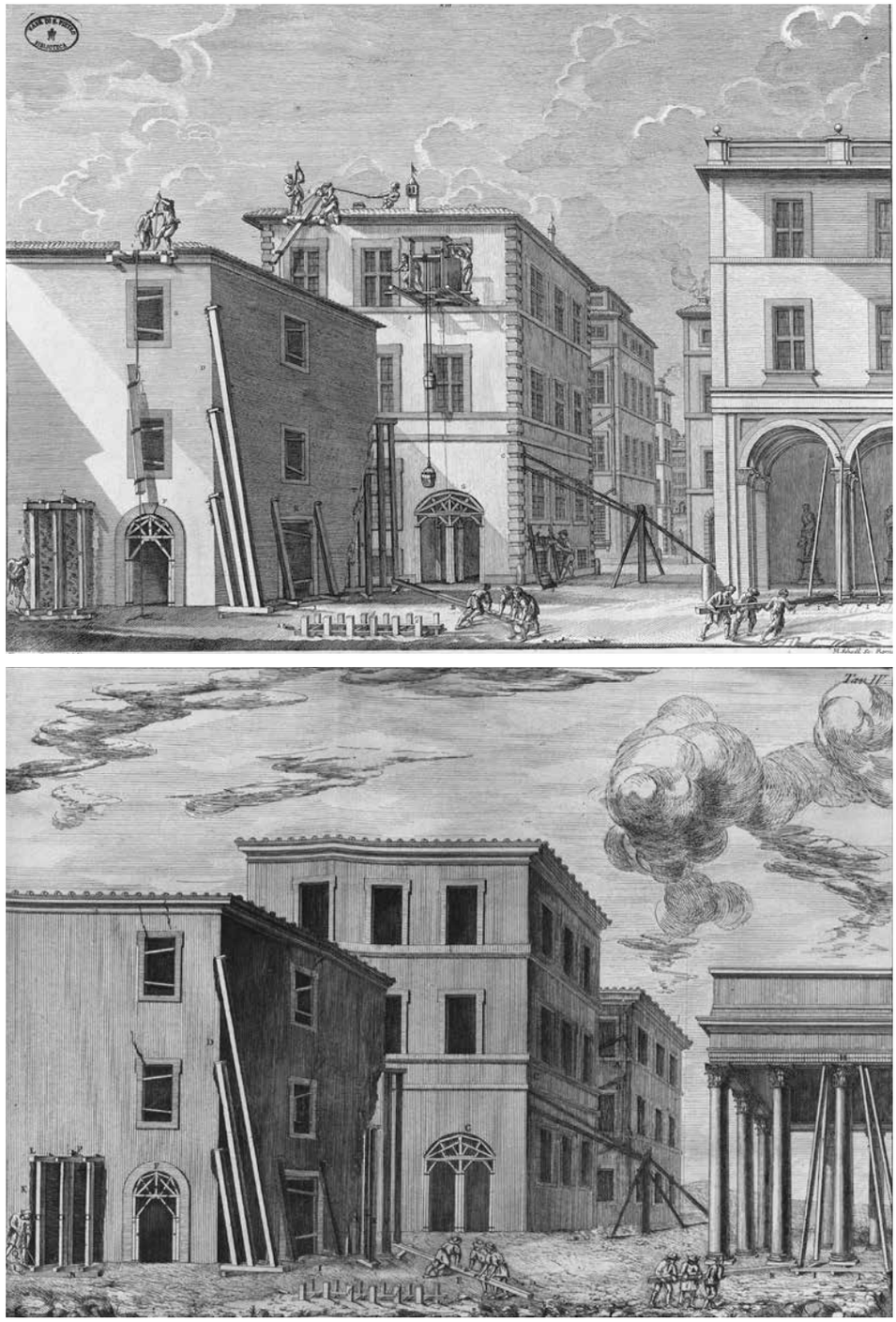


Fig. 6 *Castelli e Ponti di Maestro Niccola Zabaglia… cit., tav. XIII, a confonto con* Masi, *Teoria e pratica di architettura civile… cit., tav. IV.*

in precedenza realizzato da Zabaglia[40]. Qualche anno più tardi, lo stesso dispositivo fu ulteriormente raffinato nei componenti e nella manovrabilità da Pietro Albertini, figlio di Tommaso, e fissato nella bella incisione di Giacomo Sangermano (att. 1743-1773)[41]. Altrettanto documentata è l'attività di Angelo Paraccini, impegnato in importanti lavori diretti dagli architetti Giuseppe Piermarini e Giuseppe Valadier, e di Giovanni Corsini, detto il Campanarino, chiamato nel 1756 con Tommaso Albertini ad assistere i Fabbricieri del Campidoglio nell'esecuzione del ponteggio per il restauro della cupola del Pantheon[42]. Eppure, negli anni di governo francese (1798-1799; 1808-1812), autorità e tradizione secolare della Chiesa di Roma entrarono in crisi e il primato tecnico della Fabbrica di San Pietro fu messo a rischio dall'inderogabile esigenza di un sostanziale rinnovamento dell'istruzione professionale indotto dalla rivoluzione scientifica. Tra le innovazioni più dirompenti figura l'imposizione di nuovi criteri di insegnamento per tutti i settori della formazione, compresi quelli professionali e artigianali, da riorganizzare sugli esempla-

[40] *Castelli e Ponti di Maestro Niccola Zabaglia…* cit. (ed. 1824), tavv. LV, LVI, LVII.
[41] Ivi, tav. LVIII.
[42] F. Piranesi, *Seconda parte de' tempj antichi che contiene il celebre Panteon*, Parigi 1836, tav. XXIX. Giovanni Corsini fu chiamato a Lisbona "per metter in opra i gran quadri in mosaico, colà da Roma trasmessi". Juan Bordes ha recentemente rinvenuto un manoscritto di Corsini (1747-1753), intitolato *Miscellanea di Architettura*, nella quale è inclusa una "Guida meravigliosa del Pratica Manuale da osservarsi nella sollevazione di qual singola Machina per manegiarla con più facilità e sicurezza", dalla quale trapela l'esperienza maturata nel cantiere petrino al fianco di Zabaglia (J. Bordes, *Un Colofón inédito: Giovanni Corsini*, in *Castelli e Ponti. N. Zabaglia*, por J. Bordes, Madrid 2005, pp. 28-30).

ri modelli delle *Scuole di Arti e Mestieri* di Francia per avviare quell'indispensabile apertura al progresso scientifico che la Chiesa non poteva più rinviare. Il 1817 fu un anno cruciale per le istituzioni deputate alla formazione dei tecnici dell'edilizia romana: se la *Scuola degli Ingegneri Pontifici* provvide alle conoscenze necessarie all'esercizio della professione dell'ingegneria civile, lo *Studio Pontificio delle Arti*, amministrato dalla Fabbrica di San Pietro, rispose alle esigenze formative di aspiranti carpentieri[43]. Questi vennero istruiti ai precetti teorici della geometria, dell'ornato e della meccanica applicati alla costruzione di armature, ponteggi e macchine da costruzione[44]. La Fabbrica tentò così di arginare la dispersione del prezioso bagaglio di esperienza accumulato nel corso della sua plurisecolare attività e, con esso, di riconfermarsi custode privilegiata della tradizione edilizia romana. Non fu dunque casuale la scelta di inserire tra i compendi didattici dello *Studio* il trattato di Girolamo Masi, *Teoria e pratica di architettura civile*, pubblicato a Roma nel 1788 (con copia di alcune tavole di Zabaglia)[45] (fig. 6), i testi dei francesi Jean Baptiste Rondelet (1743-1829)[46] e Jean Rodolphe Perronet (1708-1794)[47], ma anche *Castelli e Ponti*, la cui riedizione fu concertata fin dal 1809, "vista la necessità di fare una simile nuova edizione stanti le continue ricerche delli artisti"[48] e stante il suo riconosciuto ruolo di persuasivo veicolo di adesione ad una tradizione operativa ancora ineguagliata.

Esperienza, autorità, diffusione: dalla Fabbrica di San Pietro ai trattati di carpenteria europei

Alla nuova edizione di *Castelli e Ponti* furono aggiunte alcune tavole, una *Nota alla seconda edizione* e le *Notizie storiche della vita e delle opere di maestro Niccola Zabaglia ingegnere* [sic!] *della Reverenda Fabbrica di San Pietro*, opera postuma di Renazzi integrata da Filippo Luigi Gigli (1756-1821). Rimase la versione latina delle "spiegazioni", seppur ormai considerata inutile retaggio della trattatistica, come esplicitato dalla riedizione del *Manuale di Architettura* di Giovanni Branca[49]. La lavorazione fu avviata nel 1821; qualche anno prima, nel 1818, Giuseppe Antonio Borgnis (1781-1863) aveva pubblicato a Parigi il *Traité complet de Mécanique appliquée aux arts*, con incluse tavole illustranti legature di funi, strumenti da sollevamento e trasporto degli obelischi, chiaramente mutuate dall'edizione settecentesca di *Castelli e Ponti*. La seconda edizione di quest'ultimo, corredata da sette nuove tavole (tavv. LVI-LXII) incise da Sangermano e raffiguranti i ponteggi ideati da Angelo Parraccini, Pietro e Tommaso Albertini, uscì nel 1824 per i tipi di Crispino Puccinelli[50]. Si distingue il poderoso impalcato, sospeso e scorrevole, usato per la manutenzione e il parziale ripristino degli stucchi della navata principale della basilica di San Pietro e progettato da Pietro Albertini, innalzato e montato nel novembre 1773 sulla cornice d'imposta della volta a forza di sei argani[51] (fig. 7).

Grazie al diffuso interesse riscosso dai congegni rappresentati e alla potenza evocativa del roboante corpus grafico, la seconda edizione di *Castelli e Ponti* si affermò come autorevole riferimento teorico-pratico di carpenteria ed ebbe fortuna critica superiore alla prima edizione. Questa contava infatti misurate citazioni nella letteratura estera, forse per il suo specifico riferimento ai bisogni conservativi della basilica Vaticana. Non è menzionata, ad esempio, nel *Traité théorique et pratique de l'art de bâtir* di Jean-Baptiste Rondelet (prima ed. 1802-10), forse perché assente anche in una delle principali fonti di Rondelet sulla carpenteria, vale a dire l'opera di Jean-Charles Krafft, *Plans, coupes et élévations of diverses productions de l'art de la charpente* (Paris 1805). Pur essendo Krafft un abile carpentiere, oltre che architetto e incisore, non incluse alcun riferimento alle tavole di *Castelli e Ponti*

[43] A. Di Sante, *"Non tutti, anzi rarissimi sono i Zabaglia": lo Studio Pontificio delle Arti nelle Scuole Cristiane presso San Salvatore in Lauro*, in *Sapere e saper fare*… cit., pp. 92-105; Ead., *Apprendere le arti applicate a Roma tra '700 e '800. La Scuola del Disegno e lo Studio Pontificio delle Arti a San Salvatore in Lauro*, "Rivista Lasalliana", 2009, 2, pp. 297-308.

[44] Nella seconda metà dell'Ottocento, l'urgenza di formare artigiani per l'edilizia è dichiarata dallo *Statuto della Scuola di Arti e Mestieri e della Scuola Professionale di Belle Arti Tecniche nell'ospizio di San Michele in Roma*, pubblicato da Giacomo Lovatelli nel 1875. Nella scuola era prevista una sezione di arti meccaniche, che prevedeva un percorso formativo di sei anni con obbligo di frequenza alle lezioni teoriche, comprensive di geometria applicata, disegno di modelli e di macchine, e applicazioni pratiche. In seguito furono aggiunti altri insegnamenti mutuati dalle *Scuole di Arti e Mestieri di Francia*, "le quali sono al certo le migliori di Europa, affinché se ne possa fare il confronto".

[45] Si confrontino le evidenti analogie tra *Castelli e ponti di maestro Niccola Zabaglia*… cit., tav. XIII e G. Masi, *Teoria e pratica di architettura civile per istruzione della gioventù specialmente romana*, Roma 1788, tav. IV.

[46] J.B. Rondelet, *Traité théorique et pratique de l'art de bâtir*, Paris 1802-17.

[47] J.R. Perronet, *Oeuvre*, Paris 1783-1788.

[48] Archivio Storico Generale della Fabbrica di San Pietro in Vaticano, Arm. 19, B, 6, n. 37.

[49] "Il testo latino fa meno onore […] del volgare", in G. Branca, *Manuale di Architettura corretto a accresciuto*, Roma 1783[4], lettera XXV.

[50] *Castelli e Ponti di Maestro Niccola Zabaglia*… cit. (ed. 1824).

[51] Ivi, tav. LIX. Il possente ponteggio copriva un intero settore della volta e favoriva il ripristino degli ornati a stucco del cassettonato. L'impalcato, celebrato per economicità, sicurezza e rispetto delle superfici architettoniche, si colloca tra le più geniali evoluzioni dei ponti mobili per la manutenzione.

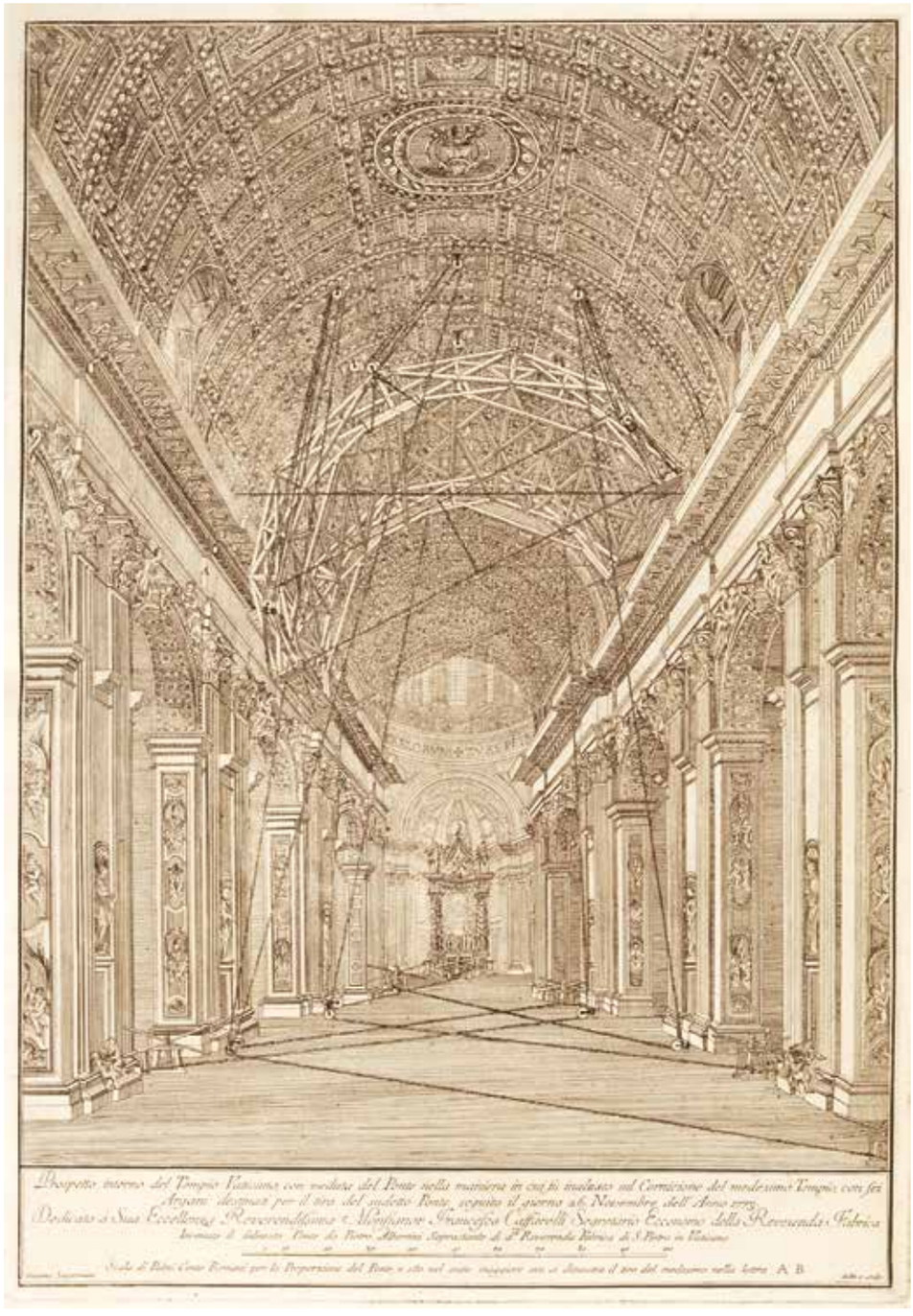


Fig. 7 *Castelli e Ponti di Maestro Niccola Zabaglia… cit. (ed. Roma 1824), tav. LIX. Ponteggio ideato da Pietro Albertini per il restauro della volta della navata della basilica Vaticana, 1773 (incisione G. Sangermano).*

nemmeno nel suo *Traité sur l'art de la charpente, théorique et pratique* (Paris 1819-22). Tale mancanza è ascrivibile al fatto che impalcati provvisionali e macchine da sollevamento furono oggetto specifico del suo *Traité des échafaudages*, stampato postumo nel 1856.

Tra le citazioni della prima edizione di *Castelli e Ponti*, si distingue – nel già menzionato *Traité complet de mécanique appliquée aux arts* di Giuseppe Antonio Borgnis del 1818[52] – l'acrobatica rimozione dell'affresco del Domenichino e il suo trasporto dalla basilica Vaticana a quella di Santa Maria degli Angeli:

> quando fu emesso l'ordine, la maggior parte degli artisti considerava questo un compito impossibile; tuttavia, ciò non ha impedito al famoso Zabaglia di accettare la sfida e di portarla a compimento con pieno successo[53].

Analoga ammirazione trapela dalla descrizione dell'installazione delle statue di piazza San Pietro[54]. Eppure, nessuna replica o traduzione grafica di tali dispositivi compare nel compendio di Borgnis. Al contrario, Giuseppe Valadier, pur rimandando stringatamente e senza ulteriori commenti alle opere di Zabaglia e Fontana, non disdegna di adottare la tavola IV di *Castelli e Pon-*

[52] M. Cigola, M. Ceccarelli, *Giuseppe Antonio Borgnis and Significance of His Handbooks on Representation and Terminology of Machines Systems*, in *New Advances in Mechanisms, Transmissions and Applications*, proceedings of the conference (Bilbao, 2-4 October 2013), edited by V. Petuya, C. Pinto, E.C. Lovasz, Berlin 2014, pp. 301-308.
[53] J.A. Borgnis, *Traité complet de mécanique appliquée aux arts: Mouvement des Fardeaux*, Paris 1818, p. 221.
[54] Ivi, p. 324.

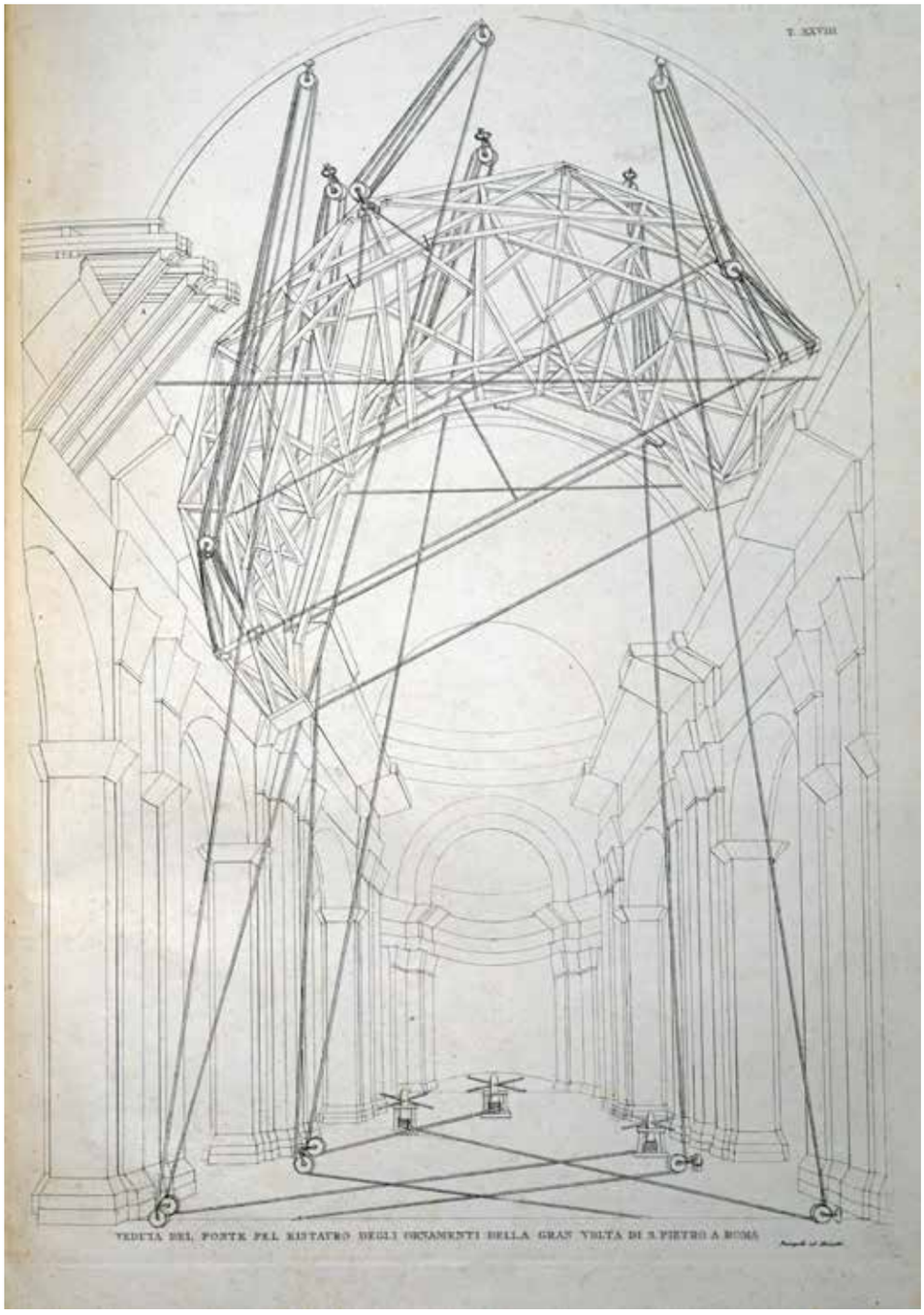


Fig. 8 *Pizzagalli, Aluisetti, L'Arte pratica del Carpentiere… cit., II, tav. XXVIII.*

ti come modello per la sua tav. XVI dedicata alle capriate, così come per la tav. XXXI sulla sostituzione delle colonne[55].

Più ampio consenso registrò invece la seconda edizione di *Castelli e Ponti*, certo dovuto a un rinnovato interesse della scienza meccanica per le audaci sperimentazioni petriane e per l'innovativo riferimento alla pratica del restauro. Eppure, le date di pubblicazione delle due edizioni segnarono il tramonto del modello editoriale adottato dalla prima letteratura tecnica per l'illustrazione delle invenzioni tecnologiche e la divulgazione della meccanica. L'approccio alla tecnologia edilizia registrò infatti un graduale mutamento fin dal XVII secolo, indotto dal crescente interesse per l'applicazione delle conquiste scientifiche alla pratica operativa, particolarmente sentito in Francia. Tale trasformazione investì anche il settore della meccanica, interpretata dal matematico Jakob Leupold (1674-1727) nel suo *Theatrum Machinarum*, poderoso compendio illustrato della tecnologia di inizio XVIII secolo. Una piena integrazione di pratica esecutiva, indagine teorica e sperimentazione tecnica si ebbe solo con l'avvento dell'educazione politecnica, tra fine XVIII e inizio XIX secolo, quan-

[55] G. Valadier, *L'architettura pratica*, Roma 1833, IV, p. 88 e tav. CCLXXII.

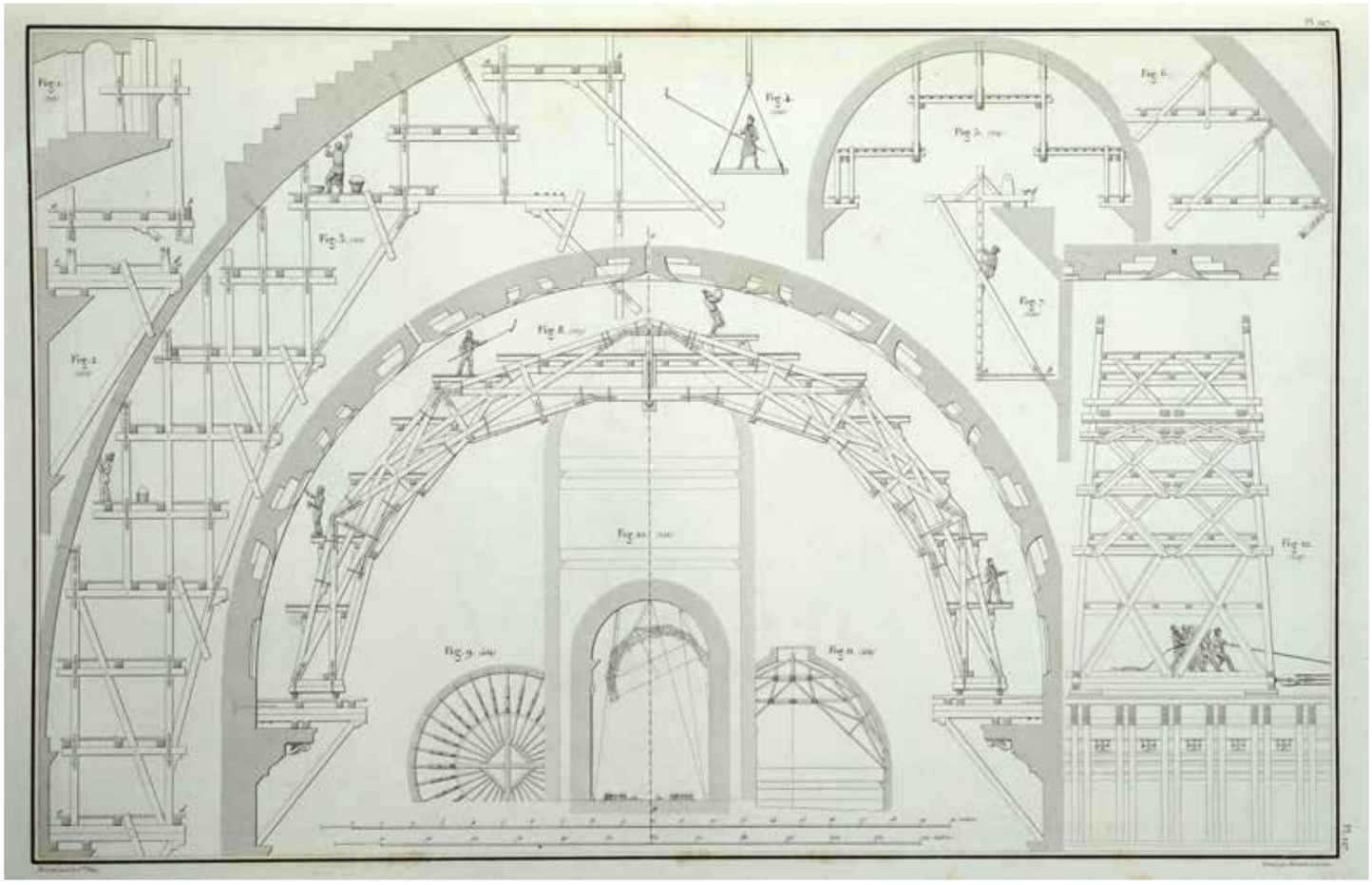


Fig. 9 *Émy, Traité de l'Art du Charpentier… cit., tav. 127. Ponteggio per il restauro della volta della navata di San Pietro in Vaticano (da Castelli e Ponti di Maestro Niccola Zabaglia… cit. (ed. Roma 1824), tav. LVIII).*

do la progettazione dei dispositivi meccanici trovò solido fondamento nei principi scientifici[56]. Al contempo, la ruvida e immediata realtà del cantiere edile continuò a praticare un'istintiva fiducia nel saper fare e nell'antica regola dell'arte, decodificata e certificata da secoli di applicazioni divenute modelli indiscussi di pratica architettonica. Il rimando alla tradizione operativa rimase solidamente radicato nell'ombroso settore dei dispositivi provvisionali, meno suggestivi di macchine e impalcati da sollevamento, ma altrettanto indispensabili. Ne è consapevole, tra gli altri, l'architetto francese Emmanuel Eugène Viollet-le-Duc (1814-1879), per il quale

> un'impalcatura ben progettata è uno degli elementi del'arte della costruzione che mostra meglio l'intelligenza e la buona leadership di progetto. Si può giudicare la scienza del costruttore dal modo in cui installa le impalcature. Piattaforme ben costruite consentono di risparmiare tempo e, garantendo la sicurezza dei lavoratori, consentono loro di lavorare con maggiore regolarità, metodo e cura[57].

In Italia l'edizione ottocentesca dell'opera di Zabaglia non risentì della pubblicazione dell'autorevole *Architettura pratica* di Giuseppe Valadier (dal 1828), né delle coeve opere di Jean Baptiste Rondelet e Nicola Cavalieri San Bertolo. Proprio quest'ultimo, tra i più autorevoli esponenti della cultura tecnico-scientifica dello Stato Pontificio, a proposito delle invenzioni di Zabaglia affermò che

> servono tuttora di modello nella costruzione dell'armature pensili, che occorrono di continuo per gl'interni ed esterni ristauri del mirabile edificio di S. Pietro in Vaticano […]. E non ometteremo d'inculcarne lo studio ai giovani ingegneri che sono desiderosi d'addestrarsi nell'arte di disporre e combinare utilmente il legname in queste difficili occorrenze dell'arte del fabbricare[58].

Con il passare degli anni tale interesse non sembrò affievolirsi; al contrario, esso si diffuse oltre i confini italiani, rafforzandosi in occasione degli interventi di manutenzione periodicamente eseguiti nel sedime vaticano, nel Pantheon e in altri prestigiosi edifici. Tali operazioni si tradussero in rinnovate occasioni di studio da parte di architetti e ingegneri di tutta Europa, tanto che alla fine del XIX secolo, mai caduta nell'oblio, l'opera di Zabaglia rappresentava ancora l'indiscusso termine di confronto nella progettazione dei

[56] I primi esempi della nuova letteratura tecnico-scientifica annoverano saggi di José María Lanz (1764-1839), Augustin de Bétancourt (1758-1824), Jean Nicolas Pierre Hachette (1769-1834) e Gérard Joseph Christian (1778-1832).
[57] E.E. Viollet le Duc, *Dictionnaire raisonné de l'architecture française du XI^e^ au XVI^e^ siècle*, Paris 1861, IV, ad vocem *échafaud*.
[58] Cavalieri San Bertolo, *Istituzioni di architettura…* cit., II, p. 218; altri riferimenti alle opere di Zabaglia alle pp. 269, 292, 296, 306, 316, 318.

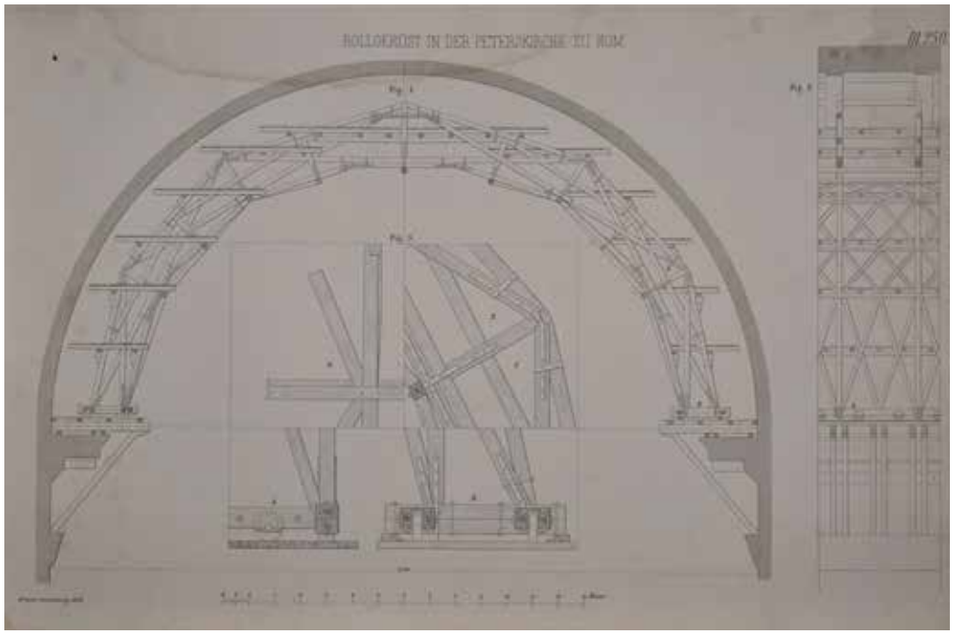


Fig. 10 KRAFFT, *Traité des échafaudages… cit., tav.* 32. *Ponteggio scorrevole usato nella basilica di San Pietro in Roma.*

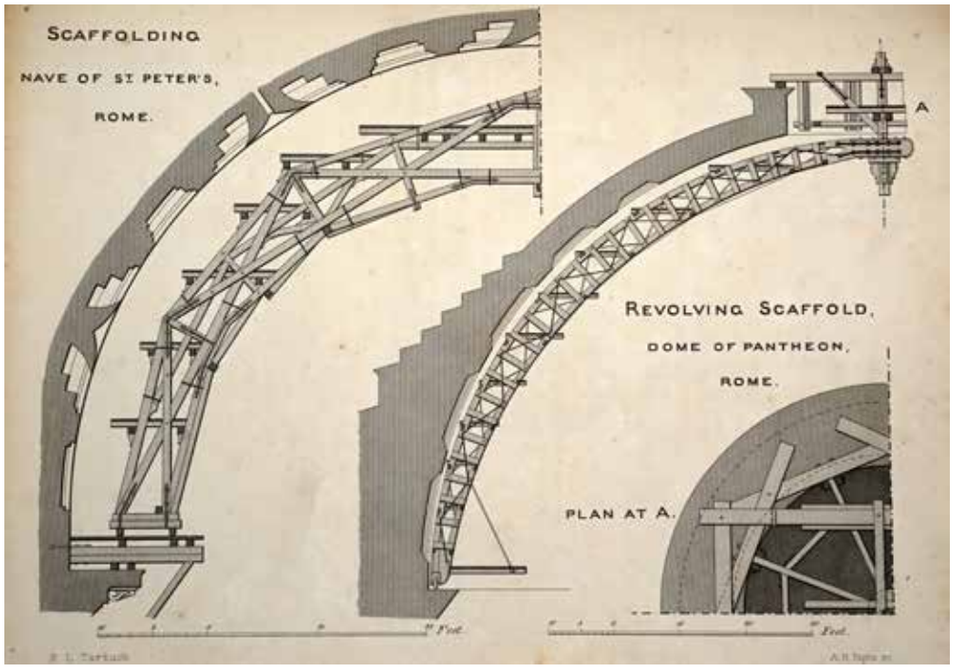


Fig. 11 TARBUCK, *Enyclopaedia of Practical Carpentry… cit., tav. 49. Ponteggio per il restauro della cupola del Pantheon e della volta della navata di San Pietro (ipotesi restitutiva E.L. Tarbuck, incisione A.H. Payne).*

ponteggi. La fortuna di *Castelli e Ponti* si diffuse al pari della propaganda cui fu funzionale; i capolavori di Zabaglia assursero a emblema della forza intramontabile della pratica empirica, mai sottomessa agli sviluppi della scienza più avanzata. La seconda edizione di *Castelli e Ponti* guadagnò diverse citazioni nella letteratura scientifica, italiana ed europea: se ne trovano espliciti rimandi nella *Pratica del fabbricare* di Carlo Formenti (Milano 1893), in *Particolari di costruzioni murali e finimenti di fabbricati* di Giuseppe Musso e Giuseppe Copperi (Torino 1885-1887) e anche nel più tardo *Manuale dell'Architetto* di Daniele Donghi (Torino 1906-1925).

Felice Pizzagalli e Giulio Aluisetti si avvalsero delle incisioni di *Castelli e Ponti* per il corredo grafico dell'ambizioso *Dell'arte pratica del carpentiere*, edito tra il 1827 e il 1835 (fig. 8). Qui, se la maggior parte delle 30 tavole allegate al primo volume sono copie da Zabaglia mutuate da Krafft, dodici tavole della seconda parte derivano direttamente dall'edizione ottocentesca di *Castelli e Ponti*. A discapito della qualità grafica, le incisioni riprodotte da Pizzagalli e Aluisetti furono spogliate degli utilissimi dettagli raffigurati nell'originale e ridotte a mero contorno, seppur copiate precisamente anche nelle dimensioni[59]. Il compendio dei due architetti milanesi

[59] F. PIZZAGALLI, G. ALUISETTI, *L'arte pratica del carpentiere*, Milano 1827. Nella seconda, le tavole 10, 11, 21, 24, 25, 26, 27, 28, 29 e 30 sono copie dirette di Zabaglia, mentre le tavole 3 e 9 combinano alcuni dettagli di *Castelli e Ponti* con altre fonti, soprattutto Krafft.

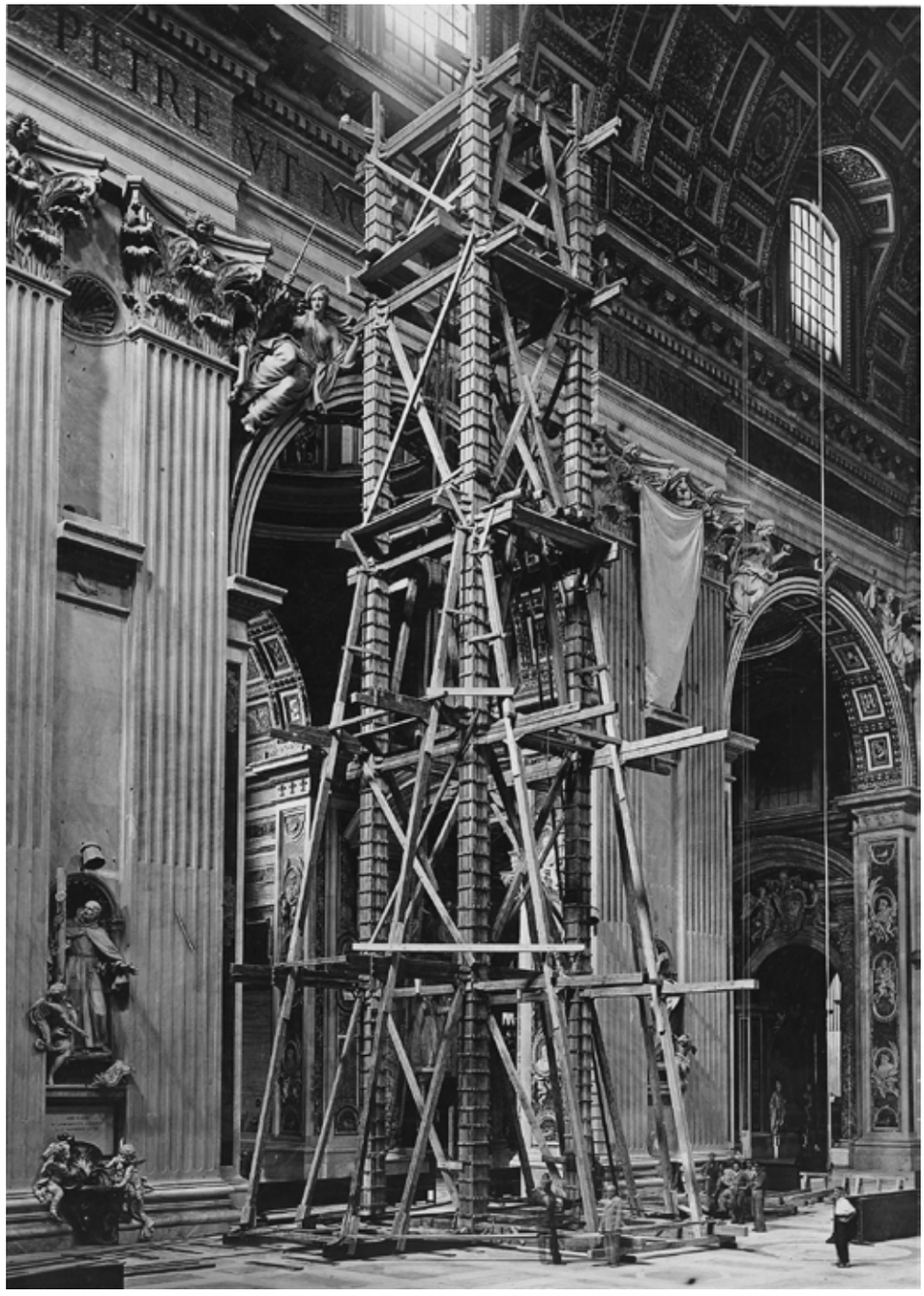


Fig. 12 *Città del Vaticano, Basilica di San Pietro. Castello per l'installazione delle statue di santi fondatori, inizio XX secolo (Città del Vaticano, Fabbrica di San Pietro, Archivio Fotografico; foto FSP).*

rimase riferimento essenziale per la costruzione in legno in Italia fino alla seconda metà del XIX secolo, quando il primato passò al più importante lavoro di Luigi Mazzocchi, *Trattato su le costruzioni in legno* (Milano 1872-1879)[60], che alle tavole 28 e 29 ripropose i grandiosi ponteggi elaborati da Pietro Albertini per la navata di San Pietro, peraltro già adottati da Pizzagalli e Aluisetti.

Ancora nel 1886, Andrea Busiri Vici (1817-1911), presidente dell'Accademia Romana di San Luca e architetto della Fabbrica di San Pietro, rese omaggio a Zabaglia e ai soprastanti suoi successori, che considerò testimoni validissimi della pratica operativa tradizionale, da loro traghettata al XX secolo grazie ai modelli lignei "siccome si riserbano nel Palazzo Vaticano […] a perpetuo benefitio di detta Reverenda Fabbrica" e di suoi futuri artieri.

> Questi sono i brillanti successi dei degni successori dello Zabaglia, al cui semplice ingegno sono dovute le più difficili combinazioni nei legamenti, negli innesti, nei nodi dei canapi e delle funi alle quali è affidata la vita degli operai[61].

Oltre i confini italiani, l'opera di Zabaglia e dei suoi successori è considerata esempio virtuoso di empirismo operativo in tutti i principali trattati di carpenteria, incluso l'autorevole *Traité de l'art*

[60] L. Mazzocchi, *Trattato su le costruzioni in legno*, Milano 1879², tav. 45.
[61] A. Busiri Vici, *L'obelisco vaticano nel terzo centenario della sua erezione*, Roma 1886, pp. 8, 13.

de la charpenterie (1837-1841) di Amand-Rose Émy, testo di riferimento essenziale per i tecnici di lingua francese. Émy fu affascinato dai ponteggi costruiti da Albertini, che definì "le più straordinarie impalcature sospese" e raffigurò alla tav. 127 del suo compendio[62] (fig. 9). Prima di allora, il ponteggio per il restauro della cupola grande, nella versione di Tommaso Albertini, era già stato inserito tra le incisioni del *Détails des plus intéressantes parties d'architecture de la Basilique de St. Pierre de Rome*, di Gabriel Martin Dumont, pubblicato nel 1763[63]. La differenza più evidente tra gli originali vaticani e le riproduzioni francesi consiste nella riduzione delle scenografiche viste prospettiche a più canoniche proiezioni ortogonali, universalmente interpretabili e riproducibili, nonché nell'inserimento di precise scale grafiche, in linea con l'approccio scientifico francese alla progettazione delle macchine. L'uso della proiezione ortogonale, presupposto indispensabile alla codifica di tali dispositivi, mirava a facilitare l'uso dei disegni, rispondendo alle esigenze della pratica costruttiva meglio di un trattato didattico quale era quello di Émy. I ponteggi di Albertini compaiono anche nell'autorevole *Traité des échafaudages* di Jean-Charles Krafft[64] (fig. 10); tuttavia, non essendo citata alcuna fonte, non è chiaro se le tavole furono copiate direttamente da Zabaglia, oppure da Émy, al quale lo accomuna la scelta delle proiezioni ortogonali. Nel 1847, il mastro sanpietrino fu menzionato anche da Edward Cresy:

> to Nicholas Zabaglia, who was born in Rome in 1674 [sic], we are indebted for designs of some of the best scaffolds that have been erected. This celebrated mechanic, first employed at the Vatican as a carpenter, afterwars became the chief director of the works at St. Peter's[65].

Al pari di Émy e Krafft, Cresy optò per la riproduzione dei ponteggi in proiezione ortogonale.
Negli anni a seguire altri compendi europei di carpenteria resero omaggio all'opera di Zabaglia e dei suoi epigoni; valga per tutti l'enciclopedico volume di Edward Lance Tarbuck, nel quale si affermò esplicitamente che

> lightness and beauty can hardly be too much admired. The Italians, indeed, are the boldest and most skilful scaffold builders in the world […][66] (fig. 11).

Tra gli ultimi riferimenti a *Castelli e Ponti* e ai ponteggi di Albertini, figura la raccolta di tavole sciolte pubblicata nel 1908 dall'appaltatore e carpentiere viennese Andreas Baudouin[67]. Tuttavia, nella successiva ristampa del 1926 le tavole con i ponteggi petriani vennero omesse.
La fortuna critica di *Castelli e Ponti* potè dirsi dunque conclusa. Non altrettanto valse per la costruzione di ponteggi sospesi e mobili per opere di manutenzione, che, soprattutto a Roma e in Italia, proseguì ancora a lungo nella scia dell'insegnamento dei carpentieri sanpietrini (fig. 12). Tale longeva fortuna prova che il metodo scientifico non rese obsoleto l'approccio empirico, profondamente radicato nella tradizione artigianale, ma lo combinò utilmente ai precetti teoretici, sancendo l'avvenuto passaggio sostanziale nel rapporto tra teoria e pratica anche nel cantiere edile.

[62] A.R. Émy, *Traité de l'art de la charpenterie*, Paris 1841, II, pp. 353, 357-358. Le tavole 123-127, di grande interesse, sono dedicate ai ponteggi mobili per la manutenzione ordinaria e straordinaria di volte e cupole, simili nei componenti e dell'uso a quelli impiegati nella Fabbrica di San Pietro, da cui derivano anche nella rappresentazione grafica.
[63] G.M. Dumont, *Détails des plus intéressantes parties d'architecture de la Basilique de St. Pierre de Rome*, Paris 1763, tav. 48.
[64] J.C. Krafft, *Traité des échafaudages ou choix des meilleurs modeles de charpentes*, Paris 1856, tavv. 32-33.
[65] E. Cresy, *An Encyclopaedia of Civil Engineering*, London 1847, II, p. 1414.
[66] E.L. Tarbuck, *The Encyclopaedia of practical carpentry and joinery*, Leipzig s.d. [1857-59], p. 195, tav. 49.
[67] A. Baudouin, *Der Zimmerer-Meister. Ein Überblick über die gesamten Zimmerungen und ihre Vorbedingungen in vier serien*, Wien 1908, tav. 399.

€ 14,00

Poste Italiane spa - Tassa pagata - Piego di libro
Aut. n. 072/DCB/FI1/VF del 31.03.2005

ISSN 2239-5660

ISBN 978-88-6453-692-7