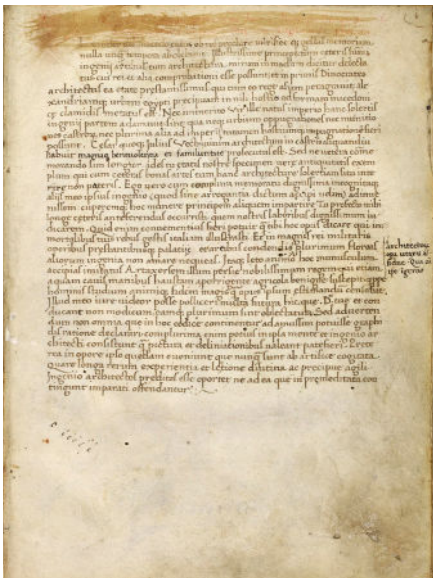
Drawing Matter
Journal —
architecture and
representation

No 3
Storytelling

Francesco di Giorgio's *Opusculum de architectura* as self-portrait — Elizabeth Merrill



1—

Our story begins with the tale of an architect, who traversed mountains and valleys to come to the palace of a great leader, where his feats of ingenuity, spectacular constructions and unwavering loyalty became a subject of myth in his own time and in the centuries that followed. According to Giovanni Santi, Francesco di Giorgio's resounding fame 'coursed about like a cloud soaring through the skies'. He was an admirable architect, the best of project planners, gifted in the conception of arcane machines, and unmatched in his invention of war engines; 'what seemed impossible for others to achieve came so naturally to him that I was truly filled with wonder'.[1] Giorgio Vasari's *Life* of Francesco di Giorgio muddles basic biographical details, but is clear about the impact of the 'excellent sculptor and architect', to whom 'much gratitude is due for his having facilitated the art of architecture, and for his having rendered to it greater services than any other man had done from the time of Filippo di Ser. Brunellescho to his own'.[2]

This image of the architect is reinforced – and one might even say deliberately propagated – in Francesco di Giorgio's *Opusculum de architectura* (London, The British Museum, Ms. 197.b.21). Composed of 84 folios, the compact vellum manuscript celebrates the art and ingenuity of technical design through the illustration of 195 unique mechanical designs. The subjects range from tools and building equipment to artillery and defence works, to fountains and hydraulic systems, to overtly referential figural drawings and labyrinthine building plans. Adhering to the graphic principle of 'one machine – one drawing', each *Opusculum* image conveys the essential components of a given device, yet almost categorically without indication of measure, function or scale. The value that the machine drawings held is evidenced in their astonishing legacy; manually reproduced in direct facsimiles and copy-derivations in the 15th and 16th centuries, the *Opusculum* images came to fill dozens of related drawing books, workshop reference manuals and presentation volumes.

The only writing in Francesco di Giorgio's *Opusculum* is that of its eloquent Latin dedication (see appendix for critical transcription and English translation)[3] (Fig.1). Addressed to Duke Federico da Montefeltro, the text explicitly likens the patron to the great rulers of history, declaring him 'an example of true antiquity in our time', and implicitly placing Francesco di Giorgio alongside antiquity's favoured architects. The little book (*opusculum*) of architecture contains 'many things worth remembering and unknown to others', which Francesco himself has invented. The ingenuity of the drawings is matched only by that of the architect; in emphasis of this

Larger illustrations and captions on pp. 15–22

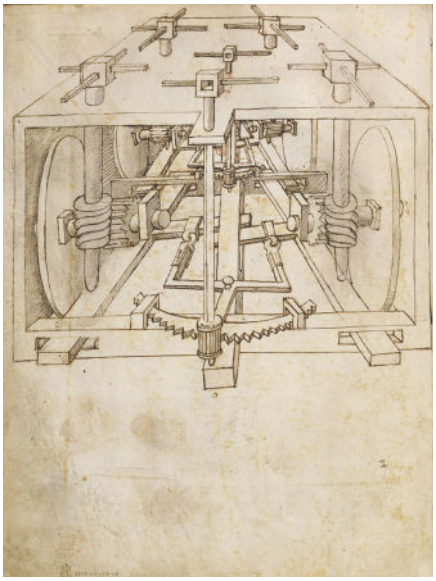
point, the term *ingenio* appears seven times in the opening verses. With unvarnished self-promotion, Francesco asserts that 'not all the aspects dealt with in this manuscript could have been represented by drawing. Indeed, many concepts are better explained by the architect's intellect and intuition than by pictures and plans.' There is a sense that the *Opusculum* models are only apprehended with the guidance of the architect, an individual 'equipped with a long experience in the field, with continuous study and, above all, with a dynamic creativity'. This exalted status of the architect perfectly aligns with the mythology of the Urbino court and the presumed provenance of Francesco di Giorgio's *Opusculum* in the fabled library of the Palazzo Ducale. We are left to imagine a noble manuscript, shelved among the library's treasured volumes, which could be readily consulted by the ruler with the architect at his shoulder.[4] Indeed, if we are to believe Vespasiano da Bisticci, who produced hundreds of manuscripts for the ducal library, Federico da Montefeltro always 'had his architects about him', and in many respects filled the role himself.[5]

As a document of early modern machine design, as a phenomenon of architectural copy-drawing, and as a record of one of Renaissance Italy's most prolific architects, Francesco di Giorgio's *Opusculum de architectura* is beguiling. To date, it has been under-studied and substantially misunderstood.[6] This is ironic, because the manuscript – and its considerably legacy – are certainly known. Within the extensive scholarship on the theoretical works of Francesco di Giorgio, the *Opusculum* is routinely cited as the key record of his architectural excellence in the pivotal period in which he transferred from Siena to Urbino. Chronologically, the manuscript is generally situated after Francesco's execution of his pocket-sized *Codicetto* and before the first rendition of his treatise.[7] In this framework, the *Opusculum* has been considered as akin to a proto-treatise, an exploration of the ingenuity and potential of machine design, albeit in an almost entirely visual discourse. The manuscript's Latin dedication supports this reading. Francesco Paolo Fiore recognises a strong Vitruvian element in the dedication, and suggests that Francesco must have already been well acquainted with the Urbino court.[8] For Nicholas Adams, 'the dedication presents someone who has full mastery of the high style of wooing a patron', with 'the silver tongue of a political master'.[9] Massimo Mussini too understands the *Opusculum* as a record of the architect at court, well acquainted with his patron; possibly Francesco offered it to the duke as a presentation of his engineering skills or as thanks for his appointment at the court.[10]

In the light of my own study of Francesco di Giorgio's *Opusculum* in collaboration with Anna Rebecca Sartore, these conclusions, as far as they go, hold true. On the basis of what is known about Francesco's professional trajectory – as given in the documentary records, his workshop's production, and his valued position as '*architector*' in Urbino – it seems highly probable that the *Opusculum* was executed in the mid-1470s.[11] The learned dedication, which was reproduced in a manuscript copy gifted to Emanuele Filiberto di Savoia in 1568, coupled with the inventories of the ducal library, points to a provenance of the manuscript within Federico da Montefeltro's famed collection.[12] Yet, the *Opusculum* itself, as a material document, tells a very different story. Examination of the rough parchment folios reveals that this was not a presentation manuscript. The composition of the quires, which does not systematically follow the Gregory rule, suggests the book's piecemeal origins from a selection of variously composed folios.[13] The folios themselves are marred with countless erasures, stains, under-drawings, and marks of semi-mechanical transfer. The drawings, finally, lack uniformity in quality, detail, and even drawing media. The *Opusculum de architectura* – at least in its origins – was a workshop model book.

2—

3—



4—

The greater story of this perplexing manuscript is necessarily the subject of a longer contribution. A forthcoming critical edition of the *Opusculum de architectura* will elucidate the origins of its machine drawings and map out the paths of the manuscript's reproduction. Setting aside the questions of material provenance, the following discussion more narrowly considers the implications of the *Opusculum*'s dedication to the duke of Urbino, wherein the architect and noble patron are elevated and inextricably linked through humanist encomia, with both compared to heroes of classical antiquity. The *Opusculum* is analysed as a type of architect's self-portrait through two closely related plot lines: that explicitly forged in the manuscript's dedication with the evocation of Dinocrates ('the best architect'); and that visually pronounced by Francesco's two labyrinthine ground plans, allusions to *the* archetypal architect, Daedalus (Figs 2, 3).

As argued here, the dedication of the *Opusculum* was a custom curation of the Urbino court, studiously crafted to demonstrate Francesco's integral position within the storeyed halls of the Palazzo Ducale. The semi-mythical tales of Dinocrates and Daedalus, known through a handful of canonical texts – principally Pliny and Plutarch, and for Daedalus, Ovid, Virgil and Diodorus Siculus as well – provided a dependable foundation for this theoretical construction. The two fabled architects had professional profiles that paralleled that of Francesco, and both figures feature in the self-propagated mythology of Federico da Montefeltro and the design of the ducal palace. The deliberate re-formulation of the *Opusculum* in Urbino is further signalled in the paradigmatic architect that goes unnamed: Archimedes. By the early decades of the Quattrocento the technical feats of the Greek legend were widely cited, and his moniker was assumed by none other than Francesco's Sienese compatriot and intellectual model: Mariano di Jacopo Taccola (1382–*c.*1453).[14] With historical distance, one might postulate that Francesco's glaring omission of the inventor in the *Opusculum* was the result of a certain 'anxiety of influence'; routinely the unnamed Archimedes (that is, Taccola) is revealed as the dominant influence of Francesco's machine drawings. We might thus conjecture that the *Opusculum de architectura*, at least by the time it arrived in Urbino, was understood as more than just a book of machine models. By aligning himself, through Latin verse and graphic metaphor, with celebrated architects of ancient lore, Francesco thus augmented the symbolic force of his drawings while also accentuating his own role within the court of Urbino.

The manuscript and its origins

Our understanding of the *Opusculum* essentially begins with the manuscript's contents: 82 numbered folios containing 240 machine drawings.[15] The illustrations are distinguished by a general high quality of the draughtsmanship, and the ingenuity of the constructions represented. On folios such as 25v, the foreshortened presentation of the four-wheel cart is a demonstration of both the artist's virtuosity in *disegno* and his mechanical knowledge (Fig.4). The diversity of the subject matter, with many devices featured in variation, further underscores the artistry of machine design and Francesco's excellence in this field. The contents range from building machinery (hoists, wheeled transporters, column-lifting devices, saws, cranes, pile-drivers, drills), to military equipment (trebuchets, chain-breakers, ladders, trolleys, siege engines, mobile shields, harbour defences), to hydraulic mechanisms (bridges, pumps, paddle boats, flotation devices, aqueducts, fountains). There are also tilling machines, automated bells, a huge range of mills (45 in total!), plans for fortifications and two mazes. Turning the pages, the reader is continuously surprised, if not slightly overwhelmed, by the many innovative design ideas.

The conception of such an illustrated manual is unquestionably Sienese: born in the city's vibrant workshop culture of the mid-15th century, which

under the aegis of the Opera del Duomo and the Santa Maria della Scala fostered a close community of technically versatile design practitioners.[16] These individuals, employed within the confines of urban Siena and farther afield in its greater *contado*, were tasked with a wide range of projects involving building construction, infrastructure development and maintenance, hydraulic works, mining activities, and the operation of naval ports. Although the work demanded a high degree of manual and technical skill, it also relied on practical mathematics, mechanics and design.[17] In this realm, and by way of a direct connection between the Studio of Siena and the Spedale di Santa Maria della Scala, there was fostered deep reverence for the work of Mariano di Jacopo Taccola.

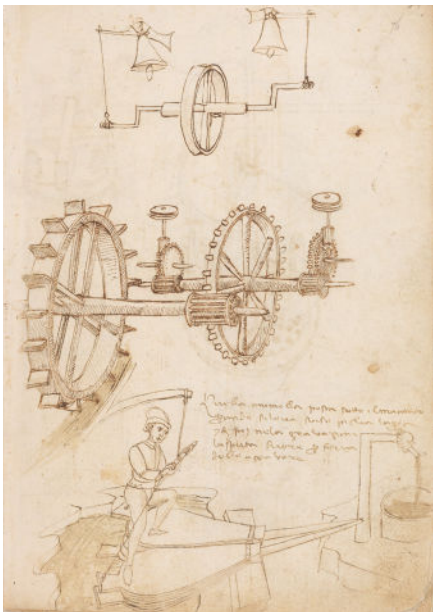
Taccola's self-given appellation as the 'Archimedes of Siena' – a title that was perpetuated through manuscript copies of his treatises – speaks directly to his political and design agenda.[18] By the early decades of the 15th century, humanism had brought renewed attention to the legendary inventor, the canonical *Lives* of Plutarch serving as a principal source.[19] What is crucial here is the characterisation of Archimedes in a context that placed him within a class of liberal thinkers and not alongside labourers in the trenches. As characterised by Plutarch, the design of machines was an amusing exercise in applied geometry.[20] For Taccola, then – and likewise Filippo Brunelleschi, who was also granted the cognomen 'Archimedes' – the epithet was an honorific that spoke to his parallel and mutually reinforcing ambitions as a humanist and designer of machines.[21] The copious, at times outlandish, drawings of his manuscripts were not design proposals. Rather – and as summarily indicated in Taccola's Latin annotations – the drawings had a more documentary agenda. Taccola recorded instructions related to warfare, measurement, hydraulics and building, often Latinising vernacular idioms from the field. He visualised ancient constructions, or those of distant places that he learned of from acquaintances and travellers; and he doodled mechanical inventions that would forever remain confined to paper.[22]

5—

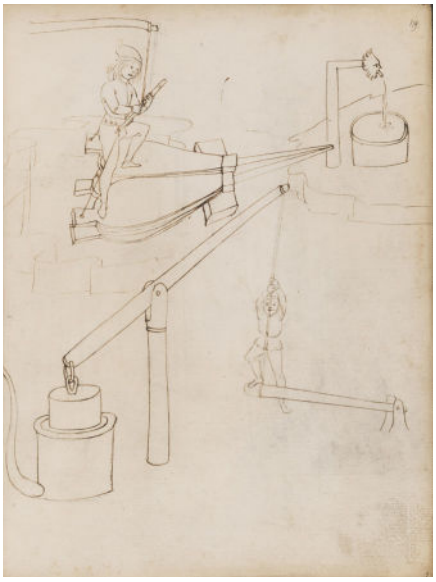
As underscored by Paolo Galluzzi, the element of amusement and unbridled fantasy in Taccola's manuscripts should not be overlooked, nor should it be used as grounds to dismiss the relevance of his drawing.[23] Within his lifetime, and certainly within the course of the 15th century, numerous copies were made of Taccola's autograph manuscripts: *De ingeneis* (today split into two sections, books I and II in Munich, books III and IV in Florence) and *De Machinis* (Munich).[24] The first two books of *De ingeneis* are replete with copyists' 'x' marks and contain drawings added by at least two other hands, including that of Francesco di Giorgio[25] (Fig.5). Individual drawings of *De ingeneis* were copied, modified, and re-copied in a significant number of architectural model books. Taccola's more polished, although arguably less vibrant, *De Machinis* commands respect in the degree to which it was cohesively reproduced. There survive four 15th-century manuscript copies of *De Machinis*, and there is strong evidence that at least two of these stem from an '*alio exemplari*', now lost.[26] While this considerable body of graphic evidence merits further study (particularly in regard to the relationship between the individual manuscript copies and the means by which they were produced), several key points might be made regarding the Sienese culture of machine design and Francesco di Giorgio's conception of the *Opusculum*.

Taccola's profusely illustrated books, which merged antiquarian knowledge with technical acumen, provided a model for the codification of mechanical ideas, technological lore, design speculations and craft information, which until that point were largely maintained in an oral tradition.[27] Within the context of the Studio of Siena, where Taccola was a chamberlain for nearly a decade, we might imagine that his manuscripts came to join those of

the sources he employed – including Pliny, Vegetius, Frontinus, Marcus Graecus and Philo of Byzantium – providing inspiration and references for a community of artists and design practitioners.[28] Even beyond the city, there was a demand for copies of Taccola's manuscripts, and more broadly, the canon of material he had amassed.[29] By the final decades of the 15th century, machine model drawings of Sienese origin were dispersed in Italy.



6—



7—

The drawing books that index this culture follow a uniform pattern: in their subject matter, rigorously confined to machine drawing, and also in their material composition, which is irregular. Exemplars of the type include the Ms. Palatino 767 (Florence, Biblioteca Nazionale Centrale); Ms. Additional 34113 (London, The British Library); Ms. Ob. 13 (Dresden, Sächsische Landesbibliothek); and Ms. S.IV.5 (Siena, Biblioteca degli Intronati) (Figs 6, 7). These model books are compilations, not preconceived works. Most probably, they originated as unbound stacks of folios, and for a significant period of time remained open to reference and annotation among a community of practitioners. The formulation of the Sienese machine drawing books as communal reference material – volumes that took form over an extended period with multiple contributors – is instructive for our understanding of the *Opusculum*. Francesco di Giorgio's 'little book of architecture', which he claimed contained many inventions 'worth remembering and unknown to others', was in this respect not so exceptional. In a very real sense, the content of the 15th-century machine model books – veritably invention, ingenuity – lent itself to collective making. That ancient sources provided a bedrock for these drawing compendia must not be overlooked. Many of the texts that guided Taccola – and which, in turn, came to direct his followers – were the same as those that came to characterise the elite humanist culture of the Urbino court.

The dedication and the court of Urbino

If Francesco di Giorgio's *Opusculum de architectura* was born in Siena, probably as a workshop portfolio of model drawings, it was given new life at the court of Urbino with the addition of the eloquent dedication (Fig.1). Without question, Francesco received assistance in composing in Latin the diplomatic verses, which themselves read as a draft, with several notable corrections. Although it is not impossible that the Sienese architect pulled together the contents of the dedication and had them translated into Latin – and in this regard, passages taken from Taccola are suggestive – a sequence of overtly humanistic references favours the supposition that the 'humanist helper' was a member of the Urbino court. Telling is the text's demonstrable familiarity with Federico da Montefeltro and the norms of courtly patronage.

In tone, the dedication recalls the Renaissance language of *amicitia* that was commonly employed in correspondence, at once both affirming and reinforcing the friendship between the two individuals.[30] The passage opens: 'To the illustrious Prince Federico, Duke of Urbino, the preface to a little book on architecture drawn and composed by Francesco di Giorgio.' In the Latin composition of this line, Francesco's name is linked with that of the duke: '*Principem Federicum Urbinatum Ducem Francisi Georgii Senesis*'. Although Francesco is subordinate to Federico, within this first line the two share the same stage; they are complementary. The text that follows elaborates upon the virtues of the patron, before turning to an exaltation of the architect.

Appropriately, Alexander of Macedonia is the first exemplar cited, an immortal figure celebrated for his many admirable deeds and his patronage of arts and architecture. As evidence, the text underscores Alexander's 'fondness for Dinocrates, the best architect of the time, who travelled with the king through Asia and designed the prestigious city of Alexandria'.

Following this, the dedication presents the standard image of Alexander known from 15th-century literature, portraying him as a model ruler, whose generosity and magnanimity were inextricably tied to his abilities as a military general.[31] 'A man born to rule, he [Alexander] not undeservedly favoured this part of ingenuity [namely architecture], without which there could be no siege of cities, no fortification of camps, nor many other things necessary for the protection of the empire and attack of enemies.'

The text that follows gestures to Julius Caesar, who 'kept the architect Vitruvius in his camps for some time, treating him with great kindness and familiarity', before turning to Federico, 'an example of true antiquity in our time'. The *Opusculum*, full of many things 'unknown to others', is rightly gifted to the duke, who will understand their value thanks to his assiduous employment of architects 'in great military enterprises' and his 'construction of prestigious works such as arches and palaces'. Notably, the reference to Federico's employment of architects, in the plural, was added to the margin of the dedication, in effect drawing attention to the multiplicity of the duke's building endeavours and Francesco di Giorgio's own role within an extensive company of architects and artists. The operations of the duchy were outstanding in their number and the complex logistics involved. The machinery that kept this empire running was both real and symbolic.[32]

The final portion of the dedication underscores the role of the patron in enabling the architect's greatness, and, in turn, the duties of the architect. Here, we find an intriguing reference to the Persian King Artaxerxes, 'who kindly welcomed the water offered to him by a peasant who had collected it in the palm of his hand'. The king, it is said, cared 'more about the effort of the man and the loyalty of his soul than the actual value of the gift'. In a similar manner, Francesco promises his fidelity. The passage that follows, clearly derived from Taccola, speaks of the architect's ingenuity and limits of drawing: 'indeed, many concepts are better explained by the architect's intellect and intuition than by pictures and plans'. Here, the architect is portrayed as a practitioner, 'endowed with long experience in the field, with continuous study, and above all, with a dynamic creativity', which allow him to quickly adapt to unforeseen situations.[33]

To anyone in the ambit of the Urbino court, the *Opusculum*'s evocations to Alexander the Great and Julius Caesar would have been self-evident. Federico da Montefeltro's admiration for the ancient rulers was well known. According to the humanist and courtier Francesco Zambeccari, even as a young man Federico sought to imitate the two fabled leaders, precisely because both excelled in literary knowledge and military pursuits.[34] Accordingly, in texts dedicated to Federico, he is frequently compared to Alexander and Julius Caesar, who are celebrated for their erudition and artistic patronage. In this, the inscriptions bridge the ancient exempla and other topoi of praise bestowed upon Federico regarding the construction of the Palazzo Ducale, the creation of the ducal library, and his extraordinary learning.[35] A letter of March 1474 to Federico da Montefeltro from Francesco Filelfo – by then long-time acquaintances – serves as an example. Here, the prolific humanist celebrates Federico's magnificence and splendour, and likens the construction of the Urbino palaces (in plural) to the great feats of building realised under Caesar. Filelfo then equates the immortal glory of such built works to that enjoyed by texts, citing the constructions of Alexander the Great, which remain for posterity in the annals of history.[36]

To a remarkable degree, the text of the *Opusculum* follows this model. In directly linking the art of building to the humanist culture of the court, the preface affirms the duke's self-propagated identity as a warrior

cognoscente. This image was captured in numerous portraits of the leader and asserted in similar manner in the nascent 'frieze of engineering', programmed to flank the main entrance of the Palazzo Ducale. The 72-panel frieze illustrates the mechanical arts, as known from ancient and early modern sources, with an emphasis on warfare and siege machinery. In terms of visual references, some of the panels appear to be copies from Francesco di Giorgio's *Opusculum*, and following Vasari, early scholars hastened to link the Sienese architect with the iconic frieze.[37] The attribution is problematic for a host of reasons, not least because most of the panels repeat compositions from Roberto Valturio's *De re militari* and other sources.[38] But the frieze may be directly linked to the *Opusculum* in its historicising sentiment, and as an overt reference to Federico da Montefeltro's fascination with the feats of ancient warfare. Within the humanist environment of the court, ancient precedents were veritable references for contemporary innovation. Telling in this regard is a passage of Pius II's *Commentaries*, in which the author recalls advising Federico da Montefeltro – 'who was well read' – to consult ancient sources such as Homer and Virgil for knowledge of warfare. In these writings, Pius II affirmed, 'every kind of weapon used today can be found described, as well as many others that have fallen into disuse'.[39]

The conception of the frieze – and, one might argue, the *Opusculum* too – as an illustration of classical knowledge is even more forcefully apprehended in the commentary of Luca Pacioli, who saw the panels as emblematic of the duke of Urbino and the veritable empire he had built. For Pacioli, the excellence of the ancient Romans, and Federico da Montefeltro too, was manifested in their infrastructure, military accomplishments, machinery, and innumerable building constructions, which were the direct product of their dedication to practical mathematics (arithmetic, geometry and proportion).[40] The sources Pacioli employed to build his argument – the histories of Livy, Frontinus, Julius Caesar and Pliny – were commonplace within the court of Urbino, habitually employed by humanist authors in evocation of the duke and his innumerable feats. To these texts it is imperative to add Plutarch's *Lives*.[41] Not only did Federico da Montefeltro reserve a special fondness for the *Lives*, but the texts served as a common source of information for the three exemplary rulers cited in the *Opusculum*, yet another clue to the provenance of the dedication in the court of Urbino.[42]

Notably, the three rulers celebrated in the *Opusculum*'s dedication represent three distinct cultures: Alexander the Great epitomises the Greek; Julius Caesar, the Roman; and Artaxerxes, the Persian (in fact, the only protagonist in the *Lives* that was of neither Greek nor Roman origin). For Plutarch, Alexander was a virtuous and well-educated ruler; his *Life of Caesar* is resolutely positive. Plutarch's characterisation of Artaxerxes is more nuanced, and as a result, the inclusion of the Persian king in the *Opusculum* offers the strongest link to the ancient biographer. Plutarch's account of Artaxerxes, one of the few literary sources on the ruler, presents positive traits along with the negative.[43] What is then critical for understanding the *Opusculum* dedication is the charitable sentiment that Artaxerxes displays towards his servant, valuing loyalty and character above all else.

Still, in situating the *Opusculum* dedication within the literary culture of the Urbino court, it is evident that the writings of Plutarch were not the sole source of reference.[44] This is ascertained in considering the *Opusculum*'s references to exemplary architects. Intriguingly, Vitruvius is mentioned only in passing, more as an attribute of Julius Caesar's prudence than as an architect worthy of study. In the light of Francesco's self-proclaimed reverence for Vitruvius, and the ancient architect's renowned tenth

book on machine design, one might expect a more direct invocation in the opening verses. Instead, the text highlights Dinocrates as an architect worthy of emulation. The attention given to Alexander the Great's favourite architect – and likewise to Daedalus, emphatically evoked in the two labyrinthine ground plans – demonstrates an astute knowledge of a broader canon of classical literary sources.[45] This is all the more intriguing for our understanding of Francesco di Giorgio and the manuscript that he ultimately gifted to the duke, as it suggests not only a familiarity with the cultural ethos of the Urbino court, but also the judicious construction of the persona of the architect.

Dinocrates and Daedalus

Scholarship has generally passed over the attribution of the *Opusculum*'s Latin preface. The name of Ottaviano Ubaldini has been suggested as a humanist adviser who assisted with the text, principally on the basis of his documented relationship with Francesco di Giorgio.[46] But compelling connections are also found in the coeval writings produced for Federico da Montefeltro by Angelo Lapi and Porcellio de Pandoni, which dwell on the immensity and artifice of the Palazzo Ducale, employing exempla that align with those of the *Opusculum*. While there remains insufficient evidence to name Francesco's amanuensis, the manuscript's dedication – and even certain drawings – are elucidated when viewed in the context of the Urbino court *c.*1475. In the same way that Federico's 1468 patent to Luciano Laurana served a dual function – at face value, avowing the architect's authority on the building site, and more fundamentally, affirming the court's dedication to architecture as the paramount expression of power and the revival of ancient culture – so too the *Opusculum* reveals multiple biographical and contextual nuances.[47]

The invocation of Alexander the Great's architect, Dinocrates, is illuminating: 15th-century architectural theorists knew of the Macedonian architect and variously employed him as an exemplum, although often misspelling his name.[48] For Leon Battista Alberti, 'Polycrates' was a mediocre architect, whose poorly conceived city plan reaffirmed the importance of proper site selection.[49] Filarete, on the other hand, aggrandised Dinocrates, selectively following Vitruvius in reciting the tale of how the architect came to serve Alexander.[50] Buonaccorso Ghiberti also looked to Vitruvius for knowledge of the fabled architect.[51] The *Opusculum*'s approbation of Dinocrates as 'the best architect of the time' was coupled with the idea of the architect as the ruler's second-in-command and constant companion. But whereas 15th-century architectural theorists – and even Francesco in the second rendition of his treatise – reveal a conception of Dinocrates based on the anecdote of Vitruvius, the tone and language of the *Opusculum* suggest a reliance on different sources.[52] There is a strong affinity between the presentation of Dinocrates in the *Opusculum* and that in Pliny.[53] As given in the *Natural History*, the city of Alexandria 'was designed by the architect Dinochares who is memorable for the genius which he displayed in many ways. Building the city […] in the circular shape of a Macedonian chlamys'. Indicative here is the description of the city in the form of a Macedonian chlamys (*effigiem Macedonicae chlamydis*): a cloak characteristically worn by military generals.[54] In the same way, the text of the *Opusculum* specifies that Dinocrates 'designed the prestigious city of Alexandria in the Nile Delta in the form of a Macedonian chlamys' (*ad formam macedonicae clamidis*).

On a more general level, the positive identity of Dinocrates harnessed in the *Opusculum* recalls the description of the architect in Plutrarch's *Moralia*; 'On the fortune and virtue of Alexander the Great' was among the first portions of the *Moralia* to be translated into Latin.[55] Here *Stasicrates* [*sic*] is introduced as a master sculptor who travelled from afar to serve his

patron, and conceived of an urban plan with 'well-proportioned surfaces and heights, limbs and joints and proportions that suggest the human form'.[56] It's not difficult to recognise the affinity between this figure and Francesco di Giorgio. The industrious Sienese architect was also trained as a sculptor – plausibly, some of his first commissions for Federico were in bronze – and in a very explicit manner, he came to conceive of the ideal city in a form of the human figure.[57]

Within the context of the *Opusculum*, and the named and unnamed exempla it puts forth, the characterisation of Dinocrates shares certain affinities with that of Daedalus, evoked in the book's two labyrinthine plans. In the classical tradition, passed down primarily through the *Metamorphoses* of Ovid, Daedalus was predominantly associated with the Cretan maze he devised to detain the Minotaur. The emblem of his construction, a unicursal seven-track labyrinth, embodied a dark prison, a danger from which one naturally sought to escape. In Roman antiquity, the connotations of the labyrinth – and by association the figure of Daedalus – evolved to suggest the ideal fortified city, a place defended from sinister forces, which no evil spirit would dare to penetrate.[58] In the Middle Ages, the idea of the mutual reciprocity of virtue and vice informed the presence of labyrinths on the pavements of Christian churches. In this context, the figure exemplifies the belief that God and Satan are timeless antagonists; just as Christ sacrificed for others, so humankind must struggle through the terrestrial world to achieve everlasting life.[59] By extension, the Athenian mastermind assumed powerful and religiously charged connotations as an unrivalled architect, a brave innovator and defender of good.[60]

Sources from the 15th century offer a glimpse at the heroic status then enjoyed by Daedalus, as well as architects' fascination with the labyrinth. Upon his death, Filippo Brunelleschi was celebrated as a Daedalian figure of divine ingenuity, an assessment echoed by Filarete, who considered him 'a most skilful follower of Daedalus'. Not incidentally, the labyrinth appears four times in Filarete's treatise in the evocation of security, power and artful design.[61] The labyrinth had a similar allure for Giovanni Fontana, who in the early decades of the 15th century had written a treatise, *De laberintis libellus*. Known today only through a reference in Fontana's *Bellicorum instrumentorum liber*, the work delineated three principal types of labyrinths – Greek, Egyptian and Roman – and illustrated five designs, each 'different from the other, where there are closed paths, digressions, confusions, ravines, circumlocutions, fears, convolutions, deviations, returns and conversions, which deceive those who enter'.[62]

Alberti too saw Daedalus as an exemplar for imitation, and in *De re aedificatoria* emphasised his excellence in the conception of urban-scaled constructions that provided security and comfort.[63] Alberti's source appears to have been the *Bibliotheca Historica* of Diodorus Siculus – a text that enjoyed prominent status in early modern libraries – and the characterisation of Daedalus provided here is particularly intriguing considering Francesco di Giorgio's professional background.[64] As given by Diodorus, Daedalus 'towered far above all other men' in natural ability. He 'cultivated the building art, the making of statues, and the working of stone. He was also an inventor of many devices which contributed to the advancement of his art and built works in many regions of the inhabited world which aroused the wonder of men.'[65] Of his late works in Sicily, particularly noteworthy was the grotto he devised in Selinus, which, not unlike a bathing complex, expelled a gentle steam, bringing pleasure and curing the infirmities of those who frequented it.[66] One cannot help thinking here of Francesco, his early commissions as a sculptor and the

all'antica bath complex he engineered for Federico da Montefeltro in the Palazzo Ducale.[67] One might conjecture that the profile of Daedalus celebrated by Diodorus and other popular 15th-century sources, which so fortuitously aligned with Francesco's own, was self-consciously appropriated by the architect in his *Opusculum*.

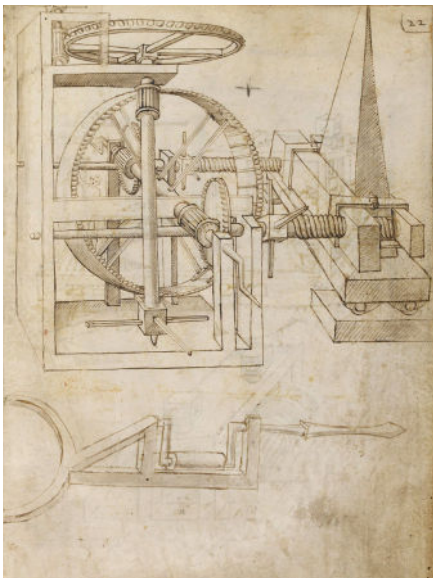
In pursuing this hypothesis, it is not insignificant that humanists who frequented the Urbino court also tapped into the image of the Daedalian architect and the labyrinthine character of the Palazzo Ducale. In a poem of the mid-1470s – conceivably written around the same time Francesco di Giorgio arrived at the court – Angelo Lapi celebrates the learning, the humanity and benevolence of Federico da Montefeltro with an analogy to Daedalus. For Lapi, the splendid palace with its unrivalled library seems to be the work of the fabled Athenian architect. He saw it benefiting a king, its greatness overshadowing even that of Rome and the Colosseum of Caesar.[68] Porcelio de' Pandoni's *Feltria* (*c.*1472) is even more effusive in characterising the ducal palace as the work of Daedalus, appropriating and transferring details of Daedalian myth to the Urbino context. For Porcelio, the palace is a mind-boggling, immense work, with foundations rooted in the mountain rock.[69] The passage closely recalls the description of Diodorus Siculus, and that cited by Alberti, concerning Daedalus' construction of the city of Agrigentum on the steep rock, in a manner that made it impregnable to attack.[70] In the passage that follows, Porcelio describes the entrance – the portal marked by the 'hideous head of Bellona', a fragment of ancient sculpture that the author had in fact gifted to Federico da Montefeltro – and the open courtyard within. 'To here there are a thousand approaches and a thousand doors, which lead, as the Cretan labyrinth, to the important interiors of the house…'.[71] The connotations here are direct: as a labyrinthine structure, the ducal palace displays unrivalled complexity and artifice. Its inner rooms – including the elaborate bath realised by Francesco di Giorgio, not unlike that devised by Daedalus – augment the health and comforts of its inhabitants. In its ramparts and siting, it is the ideal fortress-city.

The maze as self-portrait

While it may seem a stretch to link the labyrinthine analogies of the Palazzo Ducale with the two mazes in the *Opusculum*, and in turn, with Francesco di Giorgio's conscious self-presentation alongside antiquity's fabled architects, the evidence is compelling (Figs 2, 3). The two ground plans – which it should be noted are technically mazes, circuitous structures that offer multiple potential routes, and not properly labyrinths, defined by a single, unicursal path – are unique among the mechanical models of the *Opusculum*.[72] All the same, as illustrations of the architect's ingenuity, they are the perfect complement to some of the book's more elaborate multi-gear mechanisms.

The metaphorical character of the maze drawings is evidenced in their formal composition and meticulous detail – this especially evident in the intricate plan rendered on folio 47v – as well as their foliation and placement within the book. Emphatically, the second plan is the manuscript's final design. Taking inspiration from the writings of coeval architects and the effervescent humanist-poets who then frequented the Urbino court, we might propose that Francesco consciously added the labyrinthine models to the existing body of the drawings as explicit references to his own ingenuity and the character of Federico da Montefeltro as an unrivalled military captain. As a graphic complement to the Latin dedication, the labyrinthine plans elevated the *Opusculum* to the status of a work like Roberto Valturio's *De re militari*, in which the emblem of the labyrinth is similarly used to evoke the Daedalian qualities of the good leader.[73]

In terms of their execution, the two labyrinthine plans are distinguished in their degree of finish. They were composed using a compass, rendered with pen, ink and wash. In contrast to many of the other drawings in the book, the plans display no indication of under-drawing or erasure. The two labyrinths are further exceptional as building plans, rendered orthographically. The majority of compositions featured in the *Opusculum* are multiple-limbed machines: mechanisms of varying complexity, composed of interconnected, moving parts, devised to minimise labour and hasten operations. For the purposes of didactic expediency, Francesco did not hesitate to employ skewed and varied perspective to show the devices in three dimensions. The fictive machine boxes and, similarly, the use of varying scales and inconsistent proportions were tools that facilitated the means of representation. By contrast, the graphic language employed in the presentation of the labyrinths is more literal, direct. Whereas the ingenuity of the machines resides in their moving parts and their outstanding capacity to move great loads, the art of the labyrinth is inherent in its essential design.



8—

The two plans constructed by Francesco are appropriately clever. The extensive maze laid out on folio 47v is in fact far more simple to navigate than it appears (Fig.2). In effect, only a quarter of the structure's paths have to be followed before the centre is found. In a similarly cunning fashion, the maze on 82v, which at first glance appears to be a Cretan-type, unicursal seven-circuit labyrinth, is more properly a maze (Fig.3). At multiple points, a choice must be made as to which path to take, and a wrong turn might lead the reader back to the start. Undeniably, there is an element of amusement and play in the two plans, and in this regard, they reinforce the book's essential function. The *Opusculum*'s machines are meant to amaze and bewilder. Like the foreshortened cart rendered on folio 25v or the over-engineered obelisk hauler on folio 22r, the mazes invite the viewer to engage with the drawing, and to decipher the many intersecting parts of the design (Figs 4, 8).

The hypothesis that the labyrinthine ground plans were a late addition to the *Opusculum* – conceived by Francesco di Giorgio along with the dedication in company with Urbino's erudite poets – finds further support in their categorical exclusion from all other manuscript copies of the iconic drawings. In not one of the nearly 30 drawing compendia associated with the *Opusculum* do we find the mazes. Even the drawing books that appear to have been traced directly from Francesco's manuscript pass over the symbolic plans. Possibly the copyists misunderstood the mazes? Or maybe they simply undervalued their ingenuity? One could similarly think that folios on which the plans appear were simply mislaid or disbound from the manuscript, but the fact that the drawings on the recto sides of both folios were faithfully recorded by copyists negates this assumption.

For the present moment, the questions surrounding the origins and legacy of Francesco di Giorgio's maze designs remain, rather appropriately, a mystery. But unequivocally, the emblematic drawings are a definitive feature of the *Opusculum de architectura*. Without the labyrinthine plans, and without the eloquent Latin dedication, the *Opusculum* might well be another Sienese machine model book, extraordinary in the quality of its drawings, but not necessarily in terms of its content. But with these additions, what was a workshop book was transformed into an erudite manuscript worthy of the ducal library. In some ways, the transformation was akin to that undertaken by the Sienese architect himself. The story of the 'little book of machine designs', and in many ways that of its architect, was crafted at the court of Urbino.

The research for this article stems from a larger ERC-funded project, 'Copying as Common Practice in Early Modern Architecture' (CCPEMA). I am most grateful to Mark Dorrian, Niall Hobhouse and the anonymous reviewers for their encouragement and constructive feedback. Enormous thanks are due to my research collaborators, Anna Rebecca Sartore and Davide Gambino.

Appendix

Francesco di Giorgio, dedication to Federico da Montefeltro, *Opusculum de architectura.* Transcription and translation by Davide Gambino

[*Ad inclytum Principem Federicum Urbinatum Ducem Francisci Georgii Senensis in opusculum de architectura ab eo pictum atque excogitatum praefatio.*]

[*A*]lexander ille macedo, cuius ob res preclare mirificeque gestas memoriam/ nulla unque tempora abolebunt – Illustrissime princeps – tum caeteris summi ingenii artibus, tum architectura mirum in modum dicitur delecta/ tus. Cui rei et alia comprobationi esse possunt, et in primis Dinocrates/ architectus ea etate praestantissimus: qui cum eo rege Asiam peragravit, Ale/xandriamque urbem Egypti praecipuam in Nili hostio ad formam macedoni/ cae clamidis metatus est. Nec immerito vir ille natus imperio hanc solertis/ ingenii partem adamavit, sine qua neque urbium oppugnationes nec munitio/nes castrorum, nec plurima alia ad imperii tutamen hostiumque impugnationem fieri/ possunt. Caesar quoque Julius Vectruvium architectum in castris aliquandiu/ habuit magnaque benevolentia et familiaritate prosecutus est. Sed ne vetera comme/morando sim longior, ades tu aetatis nostre specimen verae antiquitatis exem/plum: qui cum ceteras bonas artes tum hanc architecture solertiam situ inte/rire non pateris. Ego vero cum complura memoratu dignissima incognitaque / aliis meo ipsius ingenio (quod sine arrogantia dictum accipi velim) adinve/nissem, cuperemque hoc munere principem aliquem impartire. Tu profecto mihi / longe caeteris anteferendus occurristi: quem nostris laboribus dignissimum iu/dicarem. Quid enim convenientius fieri potuit quam tibi hoc opus dicare, qui im/mortalibus tuis rebus gestis Italiam illustrasti? Et in magnis rei militaris / operibus praestantibusque palatiis et arcibus condendis [(added in margin) architectorum opera utaris assidue, qui cum ipse ingenio] plurimum floreas / aliorum ingenia non amare nequeas. Itaque laeto animo hoc munusculum / accipias imitatus Artaxersem illum Persiae nobilissimum regem: qui etiam/ aquam cavis manibus haustam aporrigente agricola benigne suscepit. Quippe hominis studium animique fidem magis quam opus ipsum aestimandum censebat./ Illud meo iure videor posse polliceri multa futura hic, quae. D(ominatio)ni tue et con/ducant non modicum, eamque plurimum sint oblectatura. Sed adverten/dum non omnia que in hoc codice continentur adamussim potuisse graphi/dis ratione declarari. Complurima enim potius in ipsa mente et ingenio ar/chitecti consistunt quam pictura et deliniationibus valeant patefieri. Praete/rea in opere ipso quaedam eveniunt que nunquam sunt ab artifice cogitata. / Quare longa rerum experientia et lectione diutina ac praecipue agili / Ingenio architectos praeditos esse oportet ne ad ea quae in premeditata con/ tingunt imparati offendantur.

[To the illustrious Prince Federico, Duke of Urbino, the preface to the little book on architecture drawn up by Francesco di Giorgio.]

Most illustrious prince: Alexander the Macedonian, whose memory time cannot extinguish due to his admirable deeds, is said to have enjoyed all the arts that come from superior creativity, including architecture. There is much evidence for this statement, most notably his fondness for Dinocrates, the best architect of the time, who travelled with the king through Asia and designed the prestigious city of Alexandria in the Nile Delta in the form of a Macedonian chlamys. A man born to rule, Alexander not undeservedly favoured that side of industrious ingenuity (i.e. architecture), without which there could be no siege of cities, protection of fortresses, nor many other things necessary for the protection of the realm and the offence of enemies. Even Julius Caesar kept the architect Vitruvius in his camps for some time, treating him with great kindness and familiarity. But not to dwell too much on the memory of the past, here you are, an example of true antiquity in our time: you who could not allow that the practice of architecture, along with the other good arts, be left to decline through inactivity. And I, who, by the sheer force of my ingenuity, and without wishing to appear arrogant, have invented many things worth remembering and unknown to others, would like to make a gift of them to a prince. But to whom could I dedicate this work more profitably than to you, who have brought glory to Italy with your immortal deeds? You, who assiduously employ architects in great military enterprises, in the construction of prestigious works such as arches and palaces. You, who are so enlightened in your own genius that you cannot help but appreciate the genius of others. Therefore, accept this small gift with a happy heart, following the example of Artaxerxes, the most noble king of Persia, who kindly welcomed the water offered to him by a peasant who had collected it in the palm of his hand. In fact, he cared more about the effort of the man and the loyalty of his soul than the actual value of the gift. I have every reason to believe that much will come out of this work which will be of no small benefit to Your Lordship, and of much pleasure as well. It must be admitted, however, that not all the aspects dealt with in this manuscript could have been represented by drawing. Indeed, many concepts are better explained by the architect's intellect and intuition than by pictures and plans. Moreover, issues that the architect could never have thought of arise in the very course of the work. For this reason, architects should be equipped with a long experience in the field, with continuous study and, above all, with a dynamic creativity, so that they will not be hindered by any setbacks encountered in their projects.

1 '*In summa, quell che parse e pare altrui impossibil oprar, sì facil gli era, che in ciò dal stupor vinto qi quanto io fui!*' Translation by author. *Cronaca Rimata*, Book XIV, ch.LVI. See Giovanni Santi, *La Vita e le gesta di Federico di Montefeltro*, vol.2, ed. L. Michelini Tocci (Vatican City: Biblioteca Apostolica Vaticana, 1985), 418–19. Intriguingly, the passage on Francesco di Giorgio was covered in an act of *damnatio memoriae*, prior to 1494.

2 Giorgio Vasari, *Lives of the Painters, Sculptors and Architects*, vol.1, trans. G. du C. de Vere (New York: Everyman's Library, 1996), 465–66.

3 Full credit for the transcription and translation of the *Opusculum* text, as well as that of the *Indice vecchio* of the Urbino library (see note 4), is owed to Davide Gambino.

4 Massimo Mussini, *Il 'Trattato' di Francesco di Giorgio Martini e Leonardo: il codice estense restituito* (Parma: Univ. di Parma, Istituto di Storia dell'Arte, 1991), 168–74. Based on the late-15th-century inventory (*Indice vecchio*) of the ducal library, conserved in the Vatican, Biblioteca Apostolica Vaticana (hereafter BAV), Ms. Urb. Lat. 1761, the British Museum's *Opusculum* manuscript is commonly identified as item 607. A critical transcription of the entry reads: '*Franc(isc)i georgii senensis lib(er) de Instrume(n)tis bellicis et de aliis machinis suis historia cu(m) p(ro)hemio tantu(m) ad III(ustrissimu)m D(omnium). Federicu(m) feretranu(m)*' ('Francesco di Giorgio of Siena's book on instruments of war and other devices, with a history and a prologue only, [dedicated] to the illustrious Federico da Montefeltro'). However, based on the material condition of the manuscript and the tumultuous history of the Urbino library, which was relocated on multiple occasions within the palace and sustained notable losses, this supposition merits a critical review. On the complex history surrounding the transfer of the library in the 17th century, see M. Moranti and L. Moranti, *Il trasferimento dei 'Codices Urbinates' alla Biblioteca Vaticana. Cronistoria, documenti, inventario* (Accademia Raffaello, Urbino 1981).

5 Liisa Kanerva, *Defining the Architect in Fifteenth-Century Italy. Exemplary Architects in L.B. Alberti's* De re aedificatoria (Helsinki: Suomalainen Tiedeakatemia, 1998), 16. Ludwig H. Heydenreich, 'Federigo da Montefeltro as a building patron', in *Studies in Renaissance and Baroque Art presented to Anthony Blunt on his 60th Birthday* (London: Phaidon, 1967), 1–6.

6 The absence of critical study of the *Opusculum* was most recently noted by Paolo Galluzzi, *The Italian Renaissance of Machines* (Cambridge, MA; London: Harvard University Press, 2020), 11.

7 Francesco di Giorgio's autograph *Codicetto* (BAV, Ms. Vat. Urb. lat. 1757) was more probably assembled over a prolonged period, from roughly 1460 to 1480. On the close relationship between the little book and coeval model books, see Elizabeth Merrill, 'Fifteenth-century Sienese model books and the origins of Francesco di Giorgio's *Codicetto*,' *Journal of the Warburg and Courtauld Institutes* LXXXIII (2020), 37–80.

8 Francesco Paolo Fiore, *Città e Macchine del '400 nei disegni di Francesco di Giorgio Martini* (Florence: Leo S. Olschki Editore, 1978), 23–25.

9 Nicholas Adams, 'Knowing Francesco di Giorgio', in *Francesco di Giorgio alla corte di Federico da Montefeltro. Atti del convegno internazionale di studi. Urbino, 11–13 ottobre 2001*, ed. Francesco Paolo Fiore (Florence: Leo Olschki Editore, 2004), 308.

10 Mussini, *op. cit*., 105–8.

11 In a letter of 25 May 1977, Ottaviano Ubaldini appoints Francesco di Giorgio, '*spectabilis vir et ingeniosus architector*', as his representative in a property transaction in Gubbio, in effect confirming that he was then well-established within the court. See Giuseppe Chironi, 'Appendice documentaria', in *Francesco di Giorgio architetto*, ed. F.P. Fiore and M. Tafuri (Milan: Electa, 1993), 402–3.

12 See note 3. The copy of *Opusculum* in question is now in Turin, Biblioteca Reale, Ms. Serie militare 383. On this manuscript, see Gustina Scaglia, *Francesco di Giorgio. Checklist and History of Manuscripts and Drawings in Autographs and Copies from ca. 1470 to 1687 and Renewed Copies (1764–1839)* (Cranbury, NJ: Associated University Press, 1992), 101–2.

13 The Gregory rule refers to the sequencing of the parchment bifolios so that the hair-side of a folio faces another folio's hair-side, and the smooth, skin-side of a given folio likewise faces another folio's skin-side. This principle of binding was followed for all presentation-quality manuscripts. The *Opusculum* departure from the model is also noted by Albert Elen, *Italian Late-Medieval and Renaissance Drawing-Books* (Utrecht: Elinkwijk, 1995), 408–9.

14 For a general overview of Archimedes in the early modern period, see the short essays of Paolo d'Alessandro and Pier Daniele Napolitani, 'Archimedes in the 12th–16th centuries', and Domenico Laurenza, 'Leonardo da Vinci and Archimedes', in *Archimedes: The Art and Science in Invention* (Florence: Giunti, 2013), 139–44, 153–56.

15 This number depends on how one counts certain devices and what is considered an individual machine. Excluded in this count are the diagrams for joinery and vaulting.

16 See discussion of Elizabeth Merrill, 'The Spedale di Santa Maria della Scala and the construction of Siena', in *Creating Place in Early Modern European Architecture*, ed. E. Merrill (Amsterdam: Amsterdam U. Press, 2022), 161–91.

17 The figure of Pietro dell'Abaco, among the few Sienese design practitioners to have received scholarly attention, is exemplary of this type. See Nicholas Adams, 'Architecture for fish: the Sienese dam on the Brenta river. Structures and design, 1468–1530', *Technology and Culture* 25 (1984), 768–97.

18 In the opening paragraph of *De Machinis*, as known in a copy conserved today in the New York Public Library (Spencer Collection, Ms. 136), the author is introduced as 'I, Sir Marianus Taccola, otherwise known as Archimedes, from the magnificent and powerful city of Siena' ('*Ego aūt Sr. Marianus taccole alias archimedes vochatus de magnificha et potēte civitate Senar(um)*'). Similarly, in the copy now in Venice (Biblioteca Marciana, Ms. Latinus VIII 40 (2941)), the author is named: '*Marini Jacobi cognomento Taccole, necnon et cognomento Archimedis, Senensis*'. Transcriptions are based on those given by Paul L. Rose, 'The Taccola Manuscripts,' *Physis* 10 (1968), 341, 343, with minor adjustments based on my own reading.

19 On the ubiquity and popularity of Plutarch in the late 14th and early 15th centuries see Marianne Pade, *The Reception of Plutarch's 'Lives' in Fifteenth-Century Italy*, 2 vols (Copenhagen: Museum Tusculanum Press, 2007). Marilena Caciorgna, 'Temi plutarchei nella pittura del Quattrocento: Neroccio di Bartolomeo de' Landi e il Maestro di Stratonice', *Fontes* 1 (1998), 177–80 underscores Sienese artists' knowledge of the Lives, drawing attention to the *editio* princeps of Giovanni Antonio Campano (c.1470), which was dedicated to Francesco Todeschini Piccolomini.

20 Kanerva, *op. cit*., 70–71.

21 It is uncertain whether Brunelleschi was referred to as Archimedes in his own lifetime or only following his death. See Paul L. Rose, *The Italian Renaissance of Mathematics Studies on Humanists and Mathematicians from Petrarch to Galileo* (Geneva: Librairie Droz, 1975), 29, 60 (n. 36); W.R. Laird, 'Archimedes among the Humanists,' *Isis* 82 (1991), 633–34. Galluzzi, op. cit., 22–23.

22 Paolo Galluzzi, *Gli ingegneri del Rinascimento da Brunelleschi a Leonardo da Vinci* (Florence: Giunti, 1996), 32–33.

23 Galluzzi, *The Italian Renaissance of Machines*, *op. cit*., 44, 51, 55.

24 Taccola's autograph *De ingeneis* is in Munich, Bayerische Staatsbibliothek, Lat. Monacensis 197, and Florence, Biblioteca Nazionale Centrale, Palat. 766. His autograph *De Machinis* is in Munich, Bayerische Staatsbibliothek, CML Lat. 28800.

25 See Luigi Michelini Tocci, 'Disegni e appunti autografi di Francesco di Giorgio in un codice del Taccola', in *Scritti di Storia dell'Arte in onore di Mario Salmi*, vol.2 (Rome: De Luca Editore, 1962), 203–12.

26 Rose, *Italian Renaissance*, *op. cit*., 346.

27 For discussion of this idea, see Joseph Rykwert, 'On the oral transmission of architectural theory', in *Les Traités d'architecture de la Renaissance*, ed. Jean Guillaume (Paris: Picard, 1988), 31–48.

28 For an overview of Taccola's life, including his role in the Sapienza, which was part of the Studio, see James Beck, ed., *Mariano di Jacopo detto il Taccola* (Milan: Edizioni il Polifilo, 1969), 11–31. The context in which Taccola's manuscripts were consulted merits further study. Although Taccola's writings bear echoes of Vitruvian theory, there is no indication that he knew *De architectura*, at least not directly. See Frank Prager and Gustina Scaglia, *Mariano Taccola and His Book De Ingeneis* (Cambridge, MA: MIT Press, 1972), 62; Galluzzi, *The Italian Renaissance of Machines*, *op. cit*., 40.

29 Indicative here is the copy of *De Machinis* that was dedicated to Bartolomeo Colleoni (pre-1475). See Rose, 'The Taccola Manuscripts,' *op. cit*., 342–43.

30 Paul M. Dover, 'The economic predicament of Italian Renaissance ambassadors', *Journal of Early Modern History* 12 (2008): 141–42. See also Heinrich Lausberg, *Handbook of Literary Rhetoric* (Leiden: Brill, 1998).

31 Kanerva, *op. cit*., 40–41.

32 For an insight into the infrastructure and agricultural production of the Urbino duchy, see Anna Falcioni, 'Il Ducato di Urbino nell'Italia rinascimentale', *Libro de viva pietra. Studi sul fregio della facciata del Palazzo Ducale di Urbino*, ed. Pierluigi Graziani, Davide Pietrini and Laerte Sorini (Urbino: Urbino University Press 2023), 33–52, and Marinella Bonvini Mazzanti, 'Il duca Federico da Montefeltro e gli architetti', *Contributi e ricerche su Francesco di Giorgio nell'Italia centrale*, ed. Francesco Colocci (Urbino: Edizioni Comune di Urbino, 2006), 19–34.

33 While this passage has a Vitruvian resonance, it seems to derive directly from Taccola. See Prager and Scaglia, *op. cit*., 99.

34 Marcella Peruzzi, *Cultura, potere, immagine: la biblioteca di Federico di Montefeltro* (Urbino: Accademia Raffaello, 2004), 101, indicates that of the known manuscripts from Federico's library, at least ten dedicatory prefaces likened the ruler to Caesar and five compared him to Alexander. That the two rulers were considered complementary as examples *par excellence* of princely virtues is also reflected in the fact that the two *Lives* of Plutarch were frequently published together. See Pade, *op. cit*., vol.1, 174–75.

35 See Peruzzi, *op. cit*., 97–158.

36 The letter is transcribed in Francesco Filelfo, *Commentarii della vita e delle imprese di Federico di Montefeltro*, ed. Giovanni Zannoni (Tolentino: Stab. Tip. Francesco Filelfo, 1901), XIII–XIV. On Filelfo and Federico da Montefeltro, see Aulo Greco, 'Francesco Filelfo e Federico di Montefeltro', *Francesco Filelfo nel quinto centenario della morte. Atti del XVII convegno di studi maceratesi, Tolentino 27–30 settembre 1981* (Padua: Editrice Antenore 1986), 495–514.

37 Vasari, *op. cit*., 465. Consider, among others, Ettore Romagnoli, 'Francesco di Giorgio di Martino. Architetto, ingegniere, scultore, pittore, bronzzetta, ec', in *Biografia Cronologica de' Bellartisti Senesi. 1200–1800*, vol.IV (Florence: Edizioni S.P.E.S, 1976), 711; Matteo Ceriana, 'Ambrogio Barocci e la decorazione del palazzo Ducale di Urbino', *Francesco di Giorgio alla Corte di Federico da Montefeltro. Atti del convegno internazionale di studi. Urbino, 11–13 ottobre 2001*, ed. Francesco Paolo Fiore (Florence: Leo Olschki Editore, 2004), 286.

38 Much attention has been given to the panels in recent years. A reliable study remains that of Antonio Manno, 'Architettura e arti meccaniche nel fregio del palazzo ducale di Urbino', in *Federico di Montefeltro. Lo stato, le arti, la cultur. Atti del convegno di studi (Urbino, ottobre 1982)*, ed. G. Baiardi *et al*. (Rome: Bulzoni, 1986), 89–104. Claudio Giorgione, 'Francesco di Giorgio Martini a Urbino Il Fregio dell'Arte della Guerra tra fonti e derivazioni', in *Libro de viva pietra: Studi sul fregio della facciata del Palazzo Ducale di Urbino*, ed. Pierluigi Graziani, Davide Pietrini and Laerte Sorini (Urbino: Urbino University Press, 2023), 58, identifies other panels as reproducing motifs that were also recorded by Taccola and Giuliano da Sangallo.

39 As quoted by Emily O'Brien, 'Arms and letters: Julius Caesar, the commentaries of Pope Pius II, and the politicization of papal imagery', *Renaissance Quarterly* 62 (Winter 2009), 1067.

40 Luca Pacioli, *De Divina Proportione* (Venice, 1509), ch.2: '*qual senza le matematiche discipline, cioè aritmetica, geometria e proporzioni, loro sufficienza non è possibile*.' This passage is routinely cited in discussion of the frieze. See, among others, Giorgione, *op cit*., 53–55; Manno, *op. cit*., 93–94.

41 Manno, *op. cit*., 95.

42 Heinz Hofmann, 'Literary Culture at the court of Urbino during the reign of Federico da Montefeltro', *Humanistica Lovaniensia* 57 (2008), 18. Pade, *op. cit*., vol.2, 259–60, identifies six manuscripts of Plutarch in the Urbino library (five of which were dedicated to Federico da Montefeltro).

43 Eran Almagor, 'The Aratus and the Artaxerxes', *A Companion to Plutarch*, ed. M. Beck (Oxford: Wiley Blackwell, 2014), 283. In Plutarch, Artaxerxes is depicted as a cruel and volatile figure who succumbed to carnal pleasures, engaged in incestuous relationships, and ultimately failed as a military commander and ruler.

44 It is critical to recognise that the texts of Plutarch were not found in a cohesive compendium. Different *Lives* were often bound together, separate from others. The *Moralia* too was disseminated as an independent source.

45 Francesco di Giorgio's reliance on Vitruvius has received enormous attention, with three critical editions of his translation of *De architectura*. See, chiefly, Massimo Mussini, *Francesco di Giorgio e Vitruvio. Le traduzioni del 'De architectura' nei codici Zichy, Spencer 129 e Magliabechiano II.I.141,* 2 vols. (Florence: Leo S. Olschki, 2003); Gustina Scaglia, *Il 'Vitruvio Magliabechiano' di Francesco di Giorgio* (Florence: Edizioni Gonelli, 1985), and Vitruvius, *La traduzione del De Architectura di Vitruvio dal ms. II.I.141 della Biblioteca Nazionale Centrale di Firenze*, ed. Marco Biffi (Pisa: Scuola Normale Superiore, 2002).

46 Galluzzi, *The Italian Renaissance of Machines*, *op. cit*., 87.

47 For the text of the patent, see Heydenreich, *op. cit*., 3.

48 On the treatment of Dinocrates in 15th-century literature, see Martin Kemp, 'From "Mimesis" to "Fantasia": the Quattrocento vocabulary of creation, inspiration and genius in the visual arts', *Viator* 8 (1977), 352–53. Also Wolfgang Lotz, 'Eine Deinokratesdarstellung des Francesco di Giorgio', *Mitteilungen des Kunsthistorischen Instituts in Florenz* 5 (1940), 428–33, and Kanerva, *op. cit*., 84–85.

49 Kanerva, *op. cit*., 42–43; See *De re aedificatoria*, book VI.4, Leon Battista Alberti, *On the Art of Building in Ten Books*, trans. Joseph Rykwert, Neil Leach, Robert Tavernor (Cambridge, MA: The MIT Press, 1988), 160.

50 Filarete passed over definitive aspects of the story as given in *De architectura*; he did not linger on the highly problematic nature of Dinocrates' initial proposal, and failed to problematise Dinocrates' lewd decision to anoint himself with oil and go naked through the streets as a way to catch the king's attention.

51 Lotz, *op. cit*., 431 suggests that Ghiberti's knowledge of Dinocrates stemmed from Vitruvius.

52 Francesco di Giorgio Martini, *Trattati di architettura ingegneria e arte militare*, vol.2, ed. C. Maltese (Milan: Il Polifilo, 1967), 361–62 for the discussion of Dinocrates that more clearly derives from Vitruvius.

53 Notably, Francesco at some point owned a copy of Pliny. See Fabrizio Nevola, 'Lots of napkins and a few surprises: Francesco di Giorgio Martini's house, goods, and social standing in late-fifteenth-century Siena', *Annali di architettura*, 18–19 (2006– 2007), 76.

54 Pliny the Elder, *The Natural History*, trans. John Bostock (London: Taylor and Francis, 1855), Book V, ch.11.

55 Francesco Becchi, 'Humanist Latin translations of the *Moralia*', in *Brill's Companion to the Reception of Plutarch* (Leiden: Brill, 2019), 458, 461. One principal translation of 'On the fortune and virtue of Alexander the Great' is that of Niccolò Perotti, who was in close contact with Federico da Montefeltro in the 1470s. See Peruzzi, *op. cit*., 143–45.

56 The fact that Francesco does not follow Plutarch in naming the architect as '*Stasicates*' indicates that he was not solely reliant on the *Moralia*. The passage in question is translated by Kanerva, *op. cit*., 86. The original text of Perotti's translation, Plutarchus, *De Alexandri Magni fortuna aut virtute* (BAV, Ms. Urb. Lat. 297), fol. 210r, reads: '*Nam Thratius Athos ubi maximus, et manifestissimus extat correspondentes habens latitudines, altitudines, memb(r)a, artus, et distantias pené figuratas: potest: si exculptus: formatúsque fuerit: imago Alexandri, et esse, et vocari extremitatibus quidem tangentis mare: manibus autem hanc quidem civitatem quę decem hominum milia contineat amplectentis, atq(ue) gestantis: dextra vero fluvium perpetue fluentem, et in mare erumpaentem é patera libantis. [...].*' I am grateful to Ruben Celani for his assistance with this transcription.

57 On Francesco's conception of man as a microcosm of the universe and as a formal model for the design of the city, see Francesco di Giorgio Martini, *Trattati di architettura ingegneria e arte militare*, ed. C. Maltese, vol.2 (Milan: Il Polifilo, 1967), 361–62. For the ideal in the second rendition of his treatise, see discussion of Lotz, *op. cit*. Francesco di Giorgio's bronze Deposition of Christ (*c*.1474), originally located in the Oratorio di Santa Croce in Urbino, is a notable example of his early work in sculpture. See Allan S. Weller, *Francesco di Giorgio 1439–1501* (Chicago: University of Chicago Press, 1943), 141.

58 Craig Wright, *The Maze and the Warrior. Symbols in Architecture, Theology and Music* (Cambridge, MA: Harvard University Press, 2001), 7–10.

59 *Ibid*., 16, 73–77.

60 Kanerva, *op. cit*., 75, calls attention to the connotations of Daedalus and Icarus conveyed in Boccaccio.

61 *Ibid*., 76. Peter Fane-Saunders, 'Re-writing the fables: Filarete and ancient descriptions of near eastern architecture,' in *Citation and Quotation in Early Modern Architecture*, ed. A. Hopkins (Berlin: De Gruyter, 2025), 19–20, draws a link between Filarete's interest in the labyrinth and his reliance on texts that chronicled the ancient East, including the writings of Pliny the Elder, Diodorus Siculus and Strabo. See also discussion of Paolo Carpeggiani, 'Zwischen Symbol und Mythos: das Labyrinth und die Gonzaga', *Daidalos* 3 (1982), 30–31, who hypothesises the substantial impact of Filarete's treatise in 16th-century imagery.

62 Eugenio Battisti and Giuseppa Saccaro Battisti, *Le Macchine cifrate di Giovanni Fontana* (Milan: Arcadia Edizioni, 1984), 60–61. See also Hermann Kern, *Through the Labyrinth: Designs and Meanings Over 5,000 Years* (Munich; New York: Prestel, 2000), 138.

63 Kanerva, *op. cit*., 77, in reference to *De re aedificatoria*, prologue. See Alberti, *op. cit*., 3.

64 Following Fane-Saunders' (*op. cit*.) study of Filarete's reliance on Diodorus, and given that Filarete's humanist advisers (namely, Porcelio Pandoni and Francesco Filelfo) also maintained close contact with the court of Urbino, it seems highly probable that Francesco di Giorgio was also aware of the *Biblioteca Historica*. An excerpt of the *Bibliotheca Historica* is found in Urb.gr.125, among the oldest manuscripts of Federico da Montefeltro's library. More complete, Latin translations of Diodorus circulated in the 15th century and were held in the libraries of Nicholas V and Pius II (now BAV), among others.

65 Kanerva, *op. cit*., 74–75.

66 *Ibid*., 77.

67 On the bath complex and its affinity to ancient prototypes, see Francesco Paolo Fiore, 'Il Palazzo Ducale di Urbino', in *Francesco di Giorgio architetto*, ed. F.P. Fiore and M. Tafuri (Milan: Electa, 1993), 171.

68 Hofmann, *op. cit*., 22–23 for summary; Peruzzi, *op. cit*., 134–35.

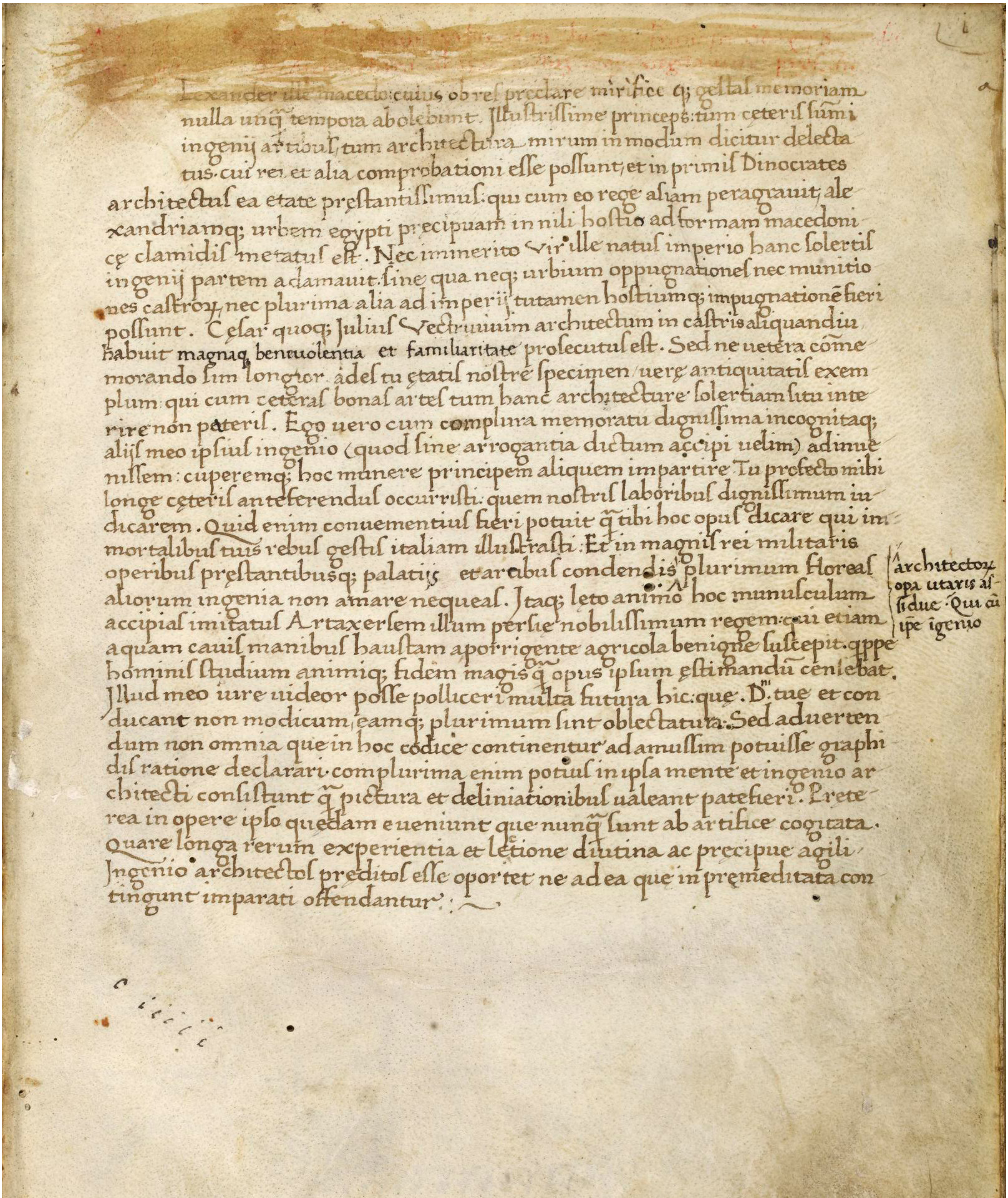
69 Porcelio Pandoni, *Feltria*, Book 8, as transcribed from BAV, Ms. Urb. Lat. 373, fol. 94r: '*Immensum illud opus mirandaq(ue) dicere me(n)s est [...]/ Atria mole feri non inferiora Neronis. / Qualia nec reges unquam posuere latini / Urbinum fœlix quo Feltrius ardua iecit / Fundamenta loco atq(ue) eq(u) avit mo(n)tibus ędes*.' Ruben Celani receives credit for the transcription of the *Feltria*.

70 See Kanerva, *op. cit*., 77.

71 BAV, Ms. Urb. Lat. 373, fols. 94r-94v: '*Horrendum Bellona tuo de co(r)pore vulsum / Stat caput intortosq(ue) tenes galeata capillos / Intus inest nudus campus stat nudus et aer / Quem cingit niveis centum lustrata columnis / Porticus hic aditus su(n)t mille: atq(ue) hostia mille / Quæ ducunt Crete tanq(uam) laborintus ad ample / Interiora domus miro celata labore / Marmore de pario postes: et limina ce(r)nes / Stant aule innumere fulgentes marmore et auro*.' On Porcellio's gift of the Bellona head to Federico da Montefeltro, see Enrico Londei, 'Lo stemma sul portale di ingresso e la facciata "ad ali" del palazzo ducale di Urbino', *Xenia* 18 (1989), 109–10.

72 On the distinction between a maze and a labyrinth see Kern, *op. cit*., 23.

73 The manuscript copy of Valturio's *De re militari* from Urbino is BAV, Ms. Urb. Lat. 281. The relevant passage and illustration appear on folio 176r: '*Minotauri natura duplici ut qui usque ad humeros tauros caetera homo sit proinde quod non minus varia et occulta esse debent consilia ducum quid fuit domicilium quondam eius laborinthus*.' Francesco Paolo Fiore, *Città e Macchine del '400 nei disegni di Francesco di Giorgio Martini* (Florence: Leo S. Olschki Editore, 1978), 31–32 has suggested a close relationship between Francesco's two labyrinth plans and those of Valturio.



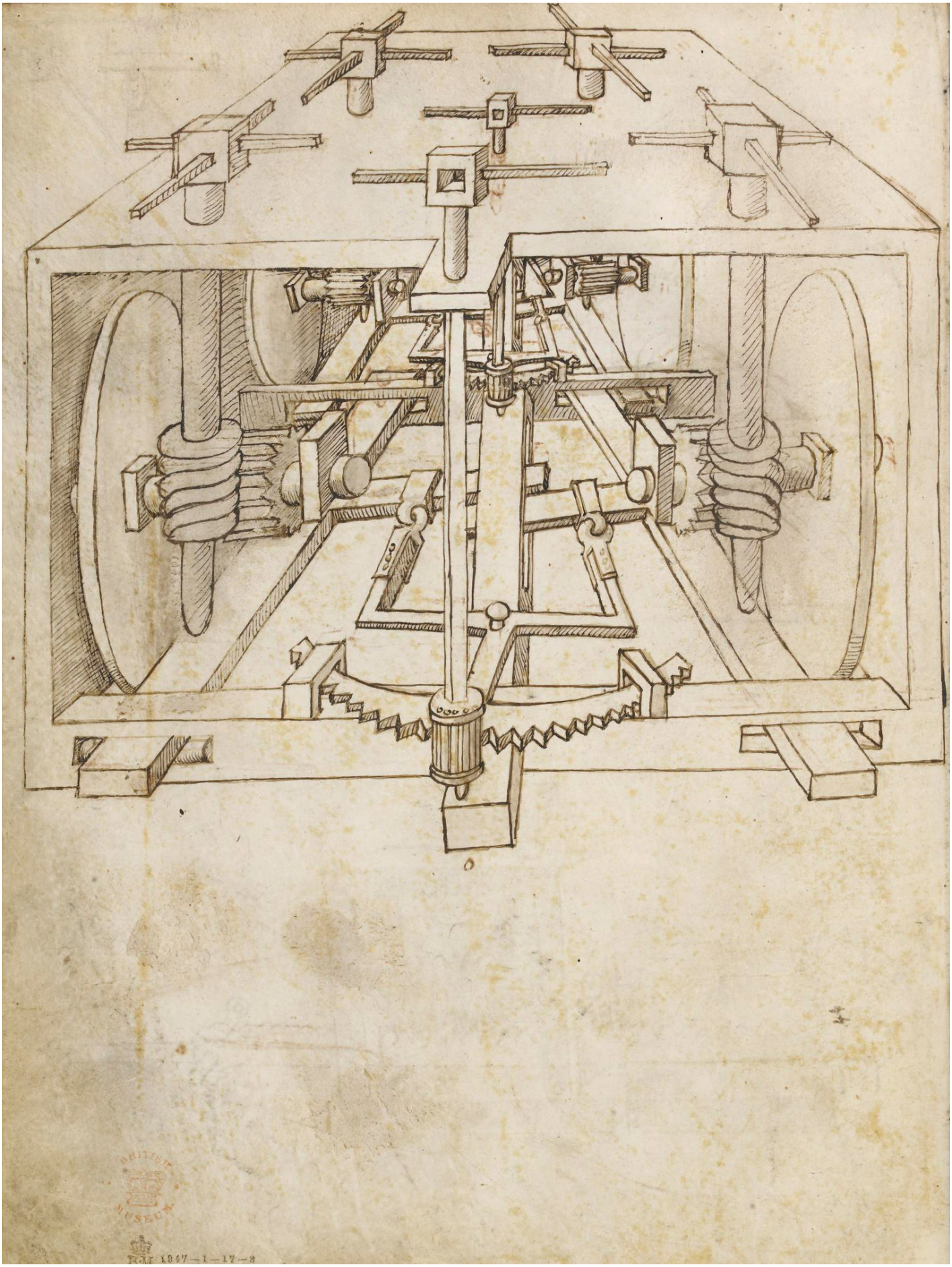
[A]Lexander ille macedo cuius ob res preclare mirifice q; gestas memoriam nulla unq̃ tempora abolebunt. Illustrissime princeps: tum ceteris sumi ingenij artibus, tum architectura mirum in modum dicitur delectatus. cui rei et alia comprobationi esse possunt, et in primis Dinocrates architectus ea etate prestantissimus: qui cum eo rege asiam peragrauit, alexandriamq; urbem egypti precipuam in nili hostio ad formam macedonice clamidis metatus est. Nec immerito vir ille natus imperio hanc solertis ingenij partem adamauit. sine qua neq; urbium oppugnationes nec munitiones castrorum, nec plurima alia ad imperij tutamen hostiumq; impugnationẽ fieri possunt. Cesar quoq; Julius Vectruuium architectum in castris aliquandiu habuit magnaq; beniuolentia et familiaritate prosecutus est. Sed ne uetera cõmemorando sim longior. ades tu etatis nostre specimen uere antiquitatis exemplum: qui cum ceteras bonas artes tum hanc architecture solertiam situ interire non pateris. Ego uero cum complura memoratu dignissima incognitaq; alijs meo ipsius ingenio (quod sine arrogantia dictum accipi uelim) adinuenissem: cuperemq; hoc munere principem aliquem impartire. Tu profecto mihi longe ceteris anteferendus occurristi: quem nostris laboribus dignissimum iudicarem. Quid enim conuenientius fieri potuit q̃ tibi hoc opus dicare qui immortalibus tuis rebus gestis italiam illustrasti: Et in magnis rei militaris operibus prestantibusq; palatijs et arcibus condendis plurimum floreas aliorum ingenia non amare nequeas. Itaq; leto animo hoc munusculum accipias imitatus Artaxersem illum persie nobilissimum regem: cui etiam aquam cauis manibus haustam aporrigente agricola benigne suscepit. quippe hominis studium animiq; fidem magis q̃ opus ipsum estimandũ censebat. Illud meo iure uideor posse polliceri multa futura hic: que .D. tue et conducant non modicum, eamq; plurimum sint oblectatura. Sed aduertendum non omnia que in hoc codice continentur ad amussim potuisse graphidis ratione declarari. complurima enim potius in ipsa mente et ingenio architecti consistunt q̃ pictura et deliniationibus ualeant patefieri. Preterea in opere ipso quedam eueniunt que nunq̃ sunt ab artifice cogitata. Quare longa rerum experientia et lectione diutina ac precipue agili Ingenio architectos preditos esse oportet ne ad ea que in premeditata contingunt imparati offendantur.

architector opa utaris assidue. Qui cũ ipe igenio

Francesco di Giorgio, dedication to Federico da Montefeltro, *Opusculum de architectura* (London, The British Museum, ms. 197.b.21), fol. 1r.

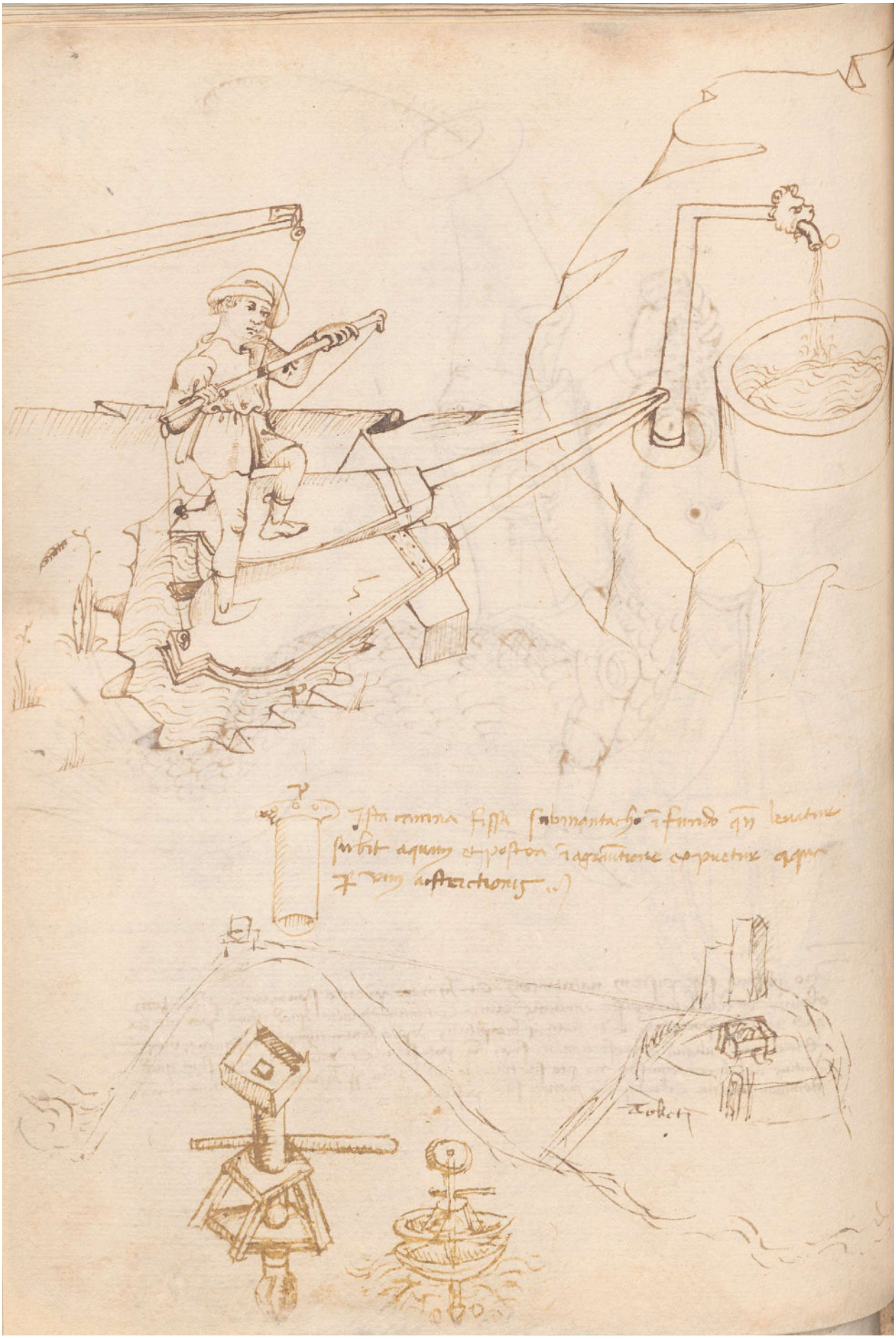
Francesco di Giorgio, design for a maze, *Opusculum de architectura* (London, The British Museum, ms. 197.b.21), fol. 47v. © The Trustees of the British Museum

Francesco di Giorgio, seven-track maze design, *Opusculum de architectura* (London, The British Museum, ms. 197.b.21), fol. 82v. © The Trustees of the British Museum



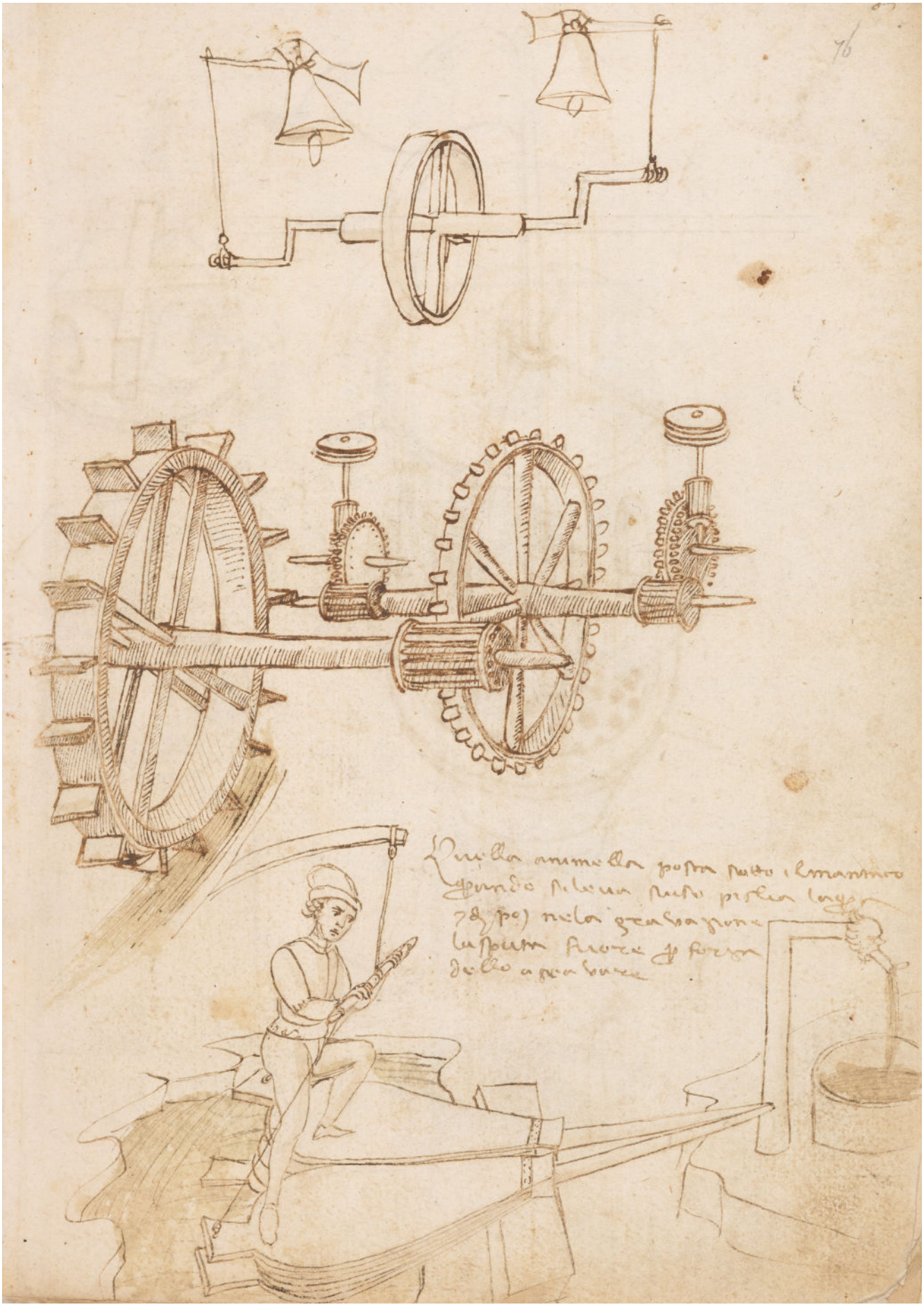
Francesco di Giorgio, four-wheeled cart, *Opusculum de architectura* (London, The British Museum, ms. 197.b.21), fol. 25v. © The Trustees of the British Museum

5—

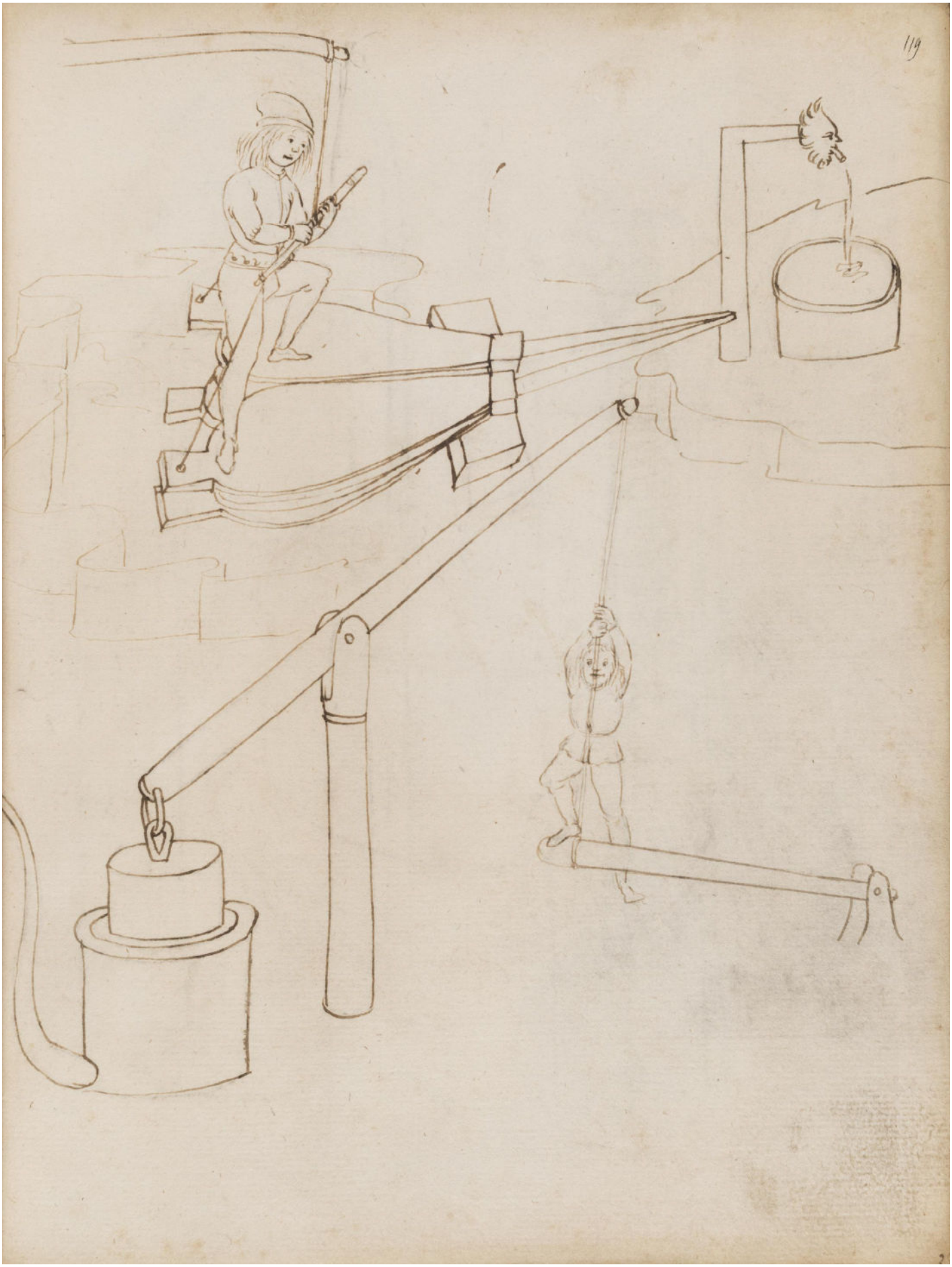


Mariano di Jacopo Taccola, double bellows used as water pump, siphon and boring devices, *De Ingeneis* (Books I & II) (Munich, Bayerische Staatsbibliothek, Codex Monacensis 197 II), fol. 31v.

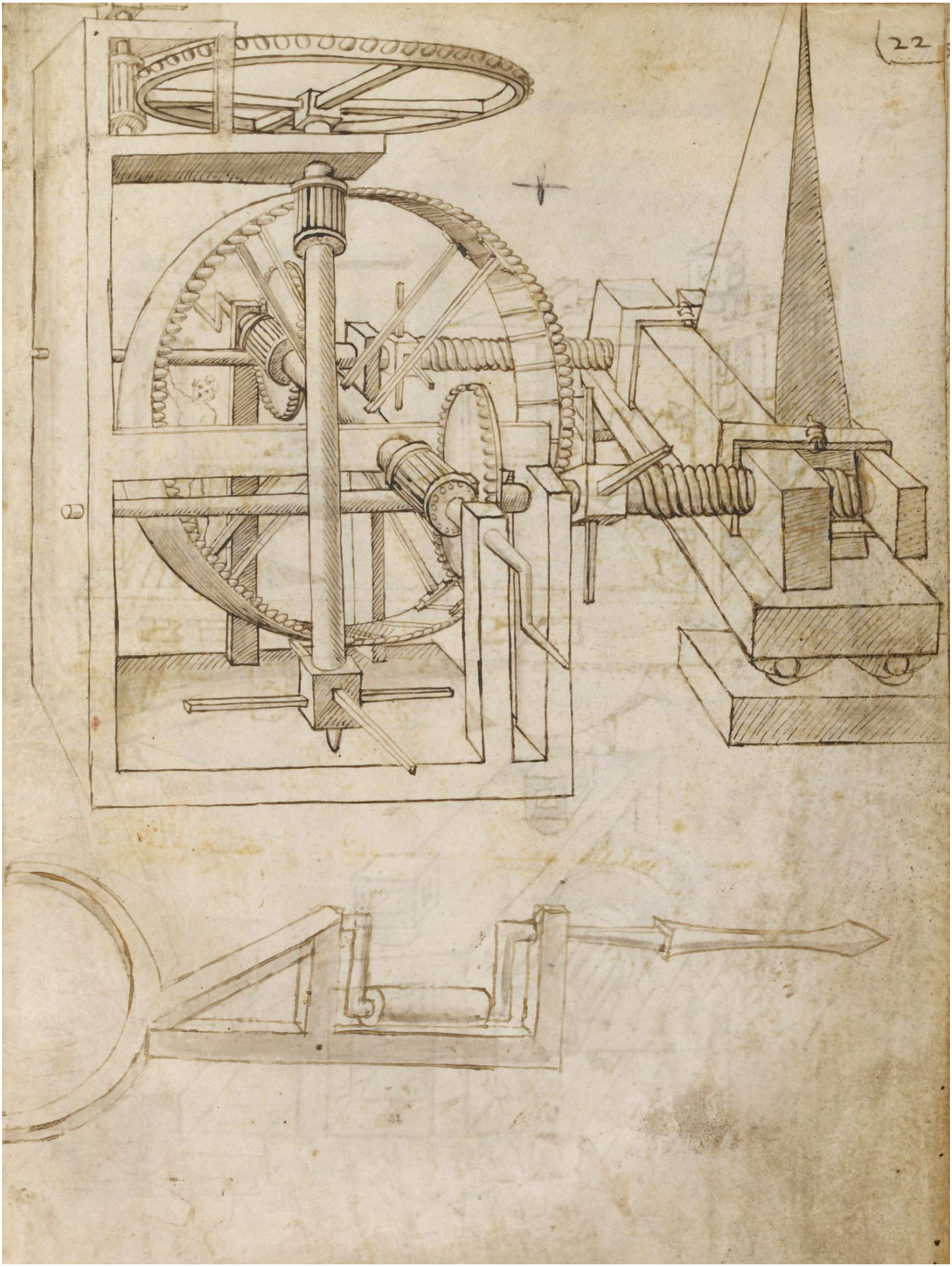
6—



Anonymous Sienese, concept for automated bells, water-powered mill, double bellows used as water pump (London, The British Library, Codex Additional 34113), fol. 76r. © British Library Board



Anonymous Sienese, double bellows used as water pump, man-operated suction pump (Dresden, Sächsische Landesbibliothek, ms. Ob. 13), fol. 119r.



Francesco di Giorgio, obelisk hauler, *Opusculum de architectura* (London, The British Museum, ms. 197.b.21), fol. 22r. © The Trustees of the British Museum