to reimagine an initial scheme that was materialized in the built church at a time when comprehensive project documents did not exist (or, if they did exist, they have not been preserved).

Nearby Cistercian sites of Casamari, San Martino al Cimino, and San Galgano, disciplined by Dominican legislation and filtered through local craftsmanship, emerge as key sources behind the original *modellum*. Its plan, relying on Maria Teresa Bartoli's measurements, was generated through a lucid system based on a 25-*braccia* module. Seven nave bays of 25 by 18 *braccia* were planned, which intimates that a √2 relationship shaped interior space. Further, the elevation of "the inner space of the nave was conceived as two identical squares stacked one on top of the other . . . [which] reflects a system and an *a priori* model" (44). It is worth noting that remarkably similar spatial planning patterns, relying on double and rotated squares, are found in thirteenth-century French Gothic buildings, such as the Sainte-Chapelle in Paris and Saint-Urbain de Troyes, so that despite differences in style and effect, basic design methods were shared by master masons on both sides of the Alps and in projects ranging from aristocratic to mendicant.

Smith draws a hard boundary between conservative Florentine building traditions, exemplified by the twelfth-century San Miniato al Monte, and new architectural currents defined by rib vaulting and masonry techniques, such as *martellina dentata*, imported from France, which "set into motion a modernizing trend" (54) that would lead to Santa Maria Novella. Yet by 1280 central Italy was hardly isolated and passive, as witnessed by San Francesco in Assisi and San Francesco in Bologna, and Cavalcanti's scheme, possibly designed by the lay brothers Fra Sisto and Fra Ristoro, surely reflected architectural horizons that encompassed Rome and the papal courts in Orvieto and Viterbo, whose projects featured a creatively varied integration of "foreign" ideas.

Adhering to Dominican legislation that stipulated that "the church should not be vaulted in stone except perhaps for the choir and sacristy," Santa Maria Novella's 1279 scheme seems to have envisioned a seven-bay nave. As part of the friars' choir, the first two bays were to be vaulted along with the transept and Capella Maggiore, while a timber roof was planned for the five succeeding bays beyond the choir screen, or *ponte*, that served as space for the laity. As outlined in chapters 4 and 5, this plan was scrapped and the lower nave was redesigned with four bays of rib vaulting, an opportunity that arose from the unanticipated confluence of changes in Dominican statutes around 1300 that deleted limitations on stone vaulting, the civic unrest that disrupted work between approximately 1305 and 1315, and local inexperience in building vaults that led to the arrival of a new team of masons headed by Jacopo Talenti and Giovanni da Campi. After fitting vaults over the existing rectangular bays of the friars' choir, they reconfigured the lower nave as square bays covered with domical brick vaults, a technique common to Lombardy and Northern Italy. Despite their expansion, these vaults do not rely on lateral buttressing for stability; rather, they are nearly self-supporting, although how exactly their shape, the herringbone pattern of the brickwork, the "crypto-buttresses," and the nave walls operate together as a structure remains vague. Smith posits that the vaulters themselves "drove the redesign of the Lower Nave" (133). Thus, the breathtaking airiness of the Santa Maria Novella interior, completed around 1350, was as much a by-product of construction technology as it was an innovative rethinking of the space of the basilica.

Building Santa Maria Novella's resolute focus on Florence as the source of the convent's friars, craftsmen, funds, and materials conveys a clear picture of the logistics of the church's construction. A broader perspective beyond the building process, one that considers the church within the network of Dominican architecture and as a thoughtfully composed image of the order's identity in conversation or competition with Assisi, Bologna, Rome, or Siena, would have enhanced readers' understanding of the purposes that "guided the Dominicans as they planned their new church and outlined the main features of its design" (22). However, this is the subject of another study, and we can thank Elizabeth Bradford Smith for combining primary sources, a century of scholarship, and a keen awareness of the importance of process and structure to explain the building of Santa Maria Novella. She closes by remarking that the scholastic ideal of rational order "guided the Dominican lay brothers in their creation of the new design for the nave" (174); at the same time, those capacious vaults, hovering over slim piers and between flat walls, defying terrestrial forces of weight and gravity, may well have excited a sense of transcendental wonder. This book reminds us that architectural history is in its essence a history of human beings, one that finds room for the dreams of Aldobrandino Cavalcanti, the skill of Jacopo Talenti, and the prayers and sighs of Pampinea and her companions in the *Decameron*.

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Notes

1. See Paul Frankl, *Gothic Architecture* (Baltimore: Penguin, 1962), 159; Andrew Martindale, *Gothic Art* (New York: Praeger, 1967), 148. Both of these books include photographs of Santa Maria Novella with captions stating that the church was "begun before 1246."

2. Frithjof Schwartz, *Il bel cimitero: Santa Maria Novella in Florenz 1279–1348; Grabmäler, Architektur und Gesellschaft* (Berlin: Deutscher Kunstverlag, 2009).

Leslie A. Geddes

Watermarks: Leonardo da Vinci and the Mastery of Nature

Princeton, N.J.: Princeton University Press, 2020, 256 pp., 124 color and 14 b/w illus. $68 (cloth), ISBN 9780691192697

As Leslie A. Geddes explains in *Watermarks: Leonardo da Vinci and the Mastery of Nature*, Leonardo da Vinci worked on the historical cusp between purely theoretical and more observational methods of analysis in the earth sciences. It was a time, too, that saw the artistic and analytic as intimately entwined. To understand better the special qualities of Leonardo's moment, not to mention his interdisciplinary mind, Geddes takes up the problem of water in his art and thought. She makes use of the art historian's methods, and the resulting book reads like an extended ekphrasis of those works touched by Leonardo's aqueous concerns, whether they address puzzles of engineering or render portraits of natural phenomena. From Madonnas to mapmaking, Geddes reveals how Leonardo's

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understanding of water inflects just about everything.

The book is divided into two parts. The first, titled "Water Tamed," treats Leonardo's mechanical studies employing water, such as his depictions of mills, pumps, and bridges. The second, titled "Water Unleashed," considers the ways in which water acts on landscapes both actual and represented. Although there is a basic chronological logic to the arrangement, the structure invites the reader to consider Leonardo's representations of water in the second part through the lens of his scientific and engineering interests. It therefore guarantees the integration of several strands of Leonardo's thought, meaning both landscape and waterscape are read in terms of water's natural properties as Leonardo understood them.

Within part I, the first chapter provides an extended visual analysis of Leonardo's water machines. No fault of the author, this chapter can be slow going in its descriptions of machines for raising, dredging, or channeling water, but the payoff is worthwhile. Observing that "drawing was perhaps Leonardo's greatest technology" (21), Geddes demonstrates how Leonardo attempted to comprehend the speed and shape of water flow in part through graphic means, tackling it as an artistic and scientific problem. In taking up technologies of water management (crucial to early modern economy and society), Leonardo tended to emphasize legibility over pictorial richness. Unlike some of his Sienese technologist forebears (e.g., Mariano di Jacopo Taccola and Francesco di Giorgio Martini), he does not present his machines within the context of landscapes, commanding lakes, and rivers. Leonardo's primary focus is on how these machines work and how they are activated. He describes their discrete components in minute detail, rendering individual parts in standardized ways across a series of examples. The texts that accompany these drawings emphasize how the machines spring into action.

The second chapter discusses Leonardo's designs for traversing water by way of bridges, balloon-like shoes and stilts, and underwater snorkels. Unlike his depictions of machines, these drawings take in the surrounding terrain. Mobile bridges made of modular parts are components of riverbank scenes made like *vedute* (landscape views). The drawings of these bridges sometimes include tiny figures at work building them, presumably to prove their practical value in war, when speed was important. As Geddes points out, these mobile bridges hover somewhere between architecture and machine. And so, in attempting to relate these constructions to water's natural force, Leonardo deploys graphic techniques that can be described alternately as architectural, pictorial, or mechanical, taking cues from traditions of engineering and architectural drawing. The rapid assembly of these bridges and the concomitant logistical problems are things that Leonardo draws to solve or understand. Geddes suggests that the complexity of the subject is paralleled only by the artist's design of knots, which he and his circle fetishized as symbols of intellectual complexity. Certain difficulties of dealing with water (such as seeing underground or below water's surface) are also encountered here as both design and artistic problems. The question of how to represent the unseen or hard-to-see emerges here and returns throughout the book again and again.

The second part of the book is fast paced and engrossing. Its four chapters deal with water unleashed on things. The first, devoted to water's "flow and flux," treats the aforementioned problem of how water can be seen and shown. Here the focus is on rapid water currents, particularly tracking and drawing them. Leonardo often resorts to words to help make sense of his drawings, apparently frustrated by the difficulty of the task at hand. In his growing understanding, Leonardo's landscapes become sites of constant environmental change: forceful eruptions of rocks, which he discusses or draws elsewhere accompanied by watery cascades that imply their slow erosion, embody a nature always in motion. His famous drawings of deluges are a centerpiece of this discussion, showing how the most spectacular and violent emanations of water's dynamic power frustrate naturalistic representation. Here cities are threatened by looming aerial oceans, while curling airborne rivers engulf forests and drown mountains. In these works, Leonardo's powers of observation are partly thwarted, and fantasy leads where the eye is blind.

The fourth chapter delves into the well-canvassed territory of Leonardo's representation of landscapes. Among other things, we encounter the earliest dated landscape drawing in Western art, the *Tuscan Landscape*, dated 5 August 1473, which oscillates, like Leonardo's later landscapes, between the macro and the micro, the universal and the particular, the imagined and the real. Here and elsewhere in this chapter, Geddes's findings enrich rather than overturn previous interpretations. Geddes places Leonardo's approach to landscape within the tradition that encompasses the likes of Giovanni Bellini, Piero di Cosimo, Fra Bartolommeo, and Albrecht Dürer, who particularly shares Leonardo's investment in how nature transforms landscapes. In her discussion of the *Virgin of the Rocks* (ca. 1482–85), the *Mona Lisa* (ca. 1503–6), and *Virgin and Child with Saint Anne* (ca. 1502–13), we encounter landscapes that speak to ancient forces of watery erosion working since time immemorial against the bulk of mountains, encoding within them the earth's primordial origins. In interpreting the *Mona Lisa*, Geddes does not necessarily disturb the interpretation of David Rosand regarding the way water signifies time (by the slow work of eroding the high mountains and valleys in the background) but rather turns our attention to how early modern persons would have experienced the setting, knowing (as we have learned) the difficulties of traversing such rugged, aqueous terrain.[1] Through the arched stone bridge that appears to sprout in the distance from the sitter's shoulder, Leonardo constructs a symbolic link between the personal and the human, and between the wild and the natural. However, Geddes argues, in contexts like the *Virgin and Child with Saint Anne*, landscape signals both nature's power and the promise of renewal.

Turning to Leonardo's maps in the penultimate chapter, Geddes considers how Leonardo dealt with charting larger territories. As on other occasions, the artist decided on a fusion of tactics in the relevant drawings. His maps of the Val di Chiana, for example, merge a measured bird's-eye view with the conventional and pictorial representation of mountains by way of three-dimensional mounds. Simultaneously, they reveal Leonardo's awareness of how water shapes the natural and built environments by illustrating the spatial relationship of the lake to nearby tributaries and local towns. Particularly nice is the author's reading of

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the Adda River views that Leonardo drew sometime around 1511–13, when he was planning a system of dams and sluices to make the river navigable. In these views of Adda's shorelines, Leonardo understood "the river as an agent gradually shaping the countryside," expressing "an engineer's critical assessment of environmental impact" (165).

The final chapter focuses on another set of drawings, little appreciated because they are hard to make out, rendered in red chalk against a red prepared ground. Perhaps surprisingly, these depictions of mountains, rivers, quarries, and marshlands are accompanied by notes that deal with evanescent phenomena, such as the transparency and murkiness of water and special lighting conditions. These notes supplement what is drawn, encompassing observations that cannot be readily shown in the chosen medium, a theme thereafter discussed in relation to Leonardo's approach to other obscure or invisible things, like smoke and sound.

This is a subtle book that demands the reader's close attention. Like the currents of a rippling tide, it carries along fine sediments, laying them down slowly, building up a fuller image of Leonardo's engagement with nature and environmental change. The author is deft in what she observes and elegant in her presentation. A rich reframing of the artist's work rather than a revisionist interpretation, the result is a compelling portrait of Leonardo's complex mind, perhaps one of the finest. As such, it brings us closer to Leonardo and his world, telling of the ways in which both practical and lofty considerations touched him, and how the environment registered in much of his thinking. Having closed the book, the reader is left to ponder the ramifications. This reader wonders about the outsize role that water plays implicitly or explicitly in the artist's sacred works, for example, his images of the solitary Saint John the Baptist. With Leonardo, there is always more to find.

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Note

1. See David Rosand, "The Portrait, Courtier, and Death," in *Castiglione: The Ideal and the Real in Renaissance Culture*, ed. Robert W. Hanning and David Rosand (New Haven, Conn.: Yale University Press, 1983), 91–129.

Peter H. Christensen

Precious Metal: German Steel, Modernity, and Ecology

University Park: Pennsylvania State University Press, 2022, 236 pp., 83 b/w illus. $99.95 (cloth), ISBN 9780271092317

The cover image features a tall, dark, and sturdy form. Its many bolts secure seams together, leaving no doubt that the material in focus is metal. The expansive structure is a bridge in the Ruhr Valley, captured by photographer Albert Renger-Patzsch in 1928. It encapsulates the unwavering zeal that geologists, industrialists, and architects had for the potential of iron and steel, and the modern worlds they promised.

Peter H. Christensen documents the iron and steel industries at different scales in *Precious Metal: German Steel, Modernity, and Ecology*. In doing so, he contributes to a growing body of scholarship focused on the histories of specific materials and commodities, produced by a group that includes Sidney W. Mintz (sugar), Sven Beckert (cotton), and Adrian Forty (concrete), among many others. Christensen's work connects the field of architectural history to a broader context encompassing ecology, politics, business, and labor history. The result is a narrative that is richly layered and complex. Instead of presenting a comprehensive history of a single national industry or business, the author challenges readers to consider the multifaceted dimensions of construction materials. What makes metal precious? Where does it come from and who manufactures it? How can a better understanding of metal's origins help us to rethink architectural production? By focusing on architecture and metal, Christensen answers these questions while skillfully exploring contemporary themes within the humanities, including the Anthropocene, new materialism, ecology, capitalism, colonialism, and empire.

The book is organized around the life cycle of iron, starting with its origins deep within the earth, followed by the processes of ore extraction and smelting, the popularization of the material through exhibitions and publications, the use of steel in architecture and infrastructure construction, and finally its eventual return to the earth through the scrapyard. At each stage of iron and steel's development, Christensen guides readers through the intricate web of political actors, workers, and cultural objects that shaped or reflected the historical trajectory of the industry.

Whereas Germany, the iron powerhouse, occupies a prominent place in the narrative, the author artfully interweaves other national contexts, including those of the United States, the United Kingdom, France, and the Ottoman Empire. This approach helps us see how the extraction and dissemination of natural resources do not conform to political borders. Christensen's malleable approach to metal is also evident in his use of visual materials. He does not limit his analysis to architecture but instead embraces diverse aspects of the visual culture of iron and steel. He expertly discusses how the development of documentation techniques, ranging from geological maps and cross-sectional representations of mines to decorative plates, reflects the shifts that have taken place in political, artistic, and scientific thinking.

The book's most obvious contribution lies in its examination of steel within the context of the architectural profession, spanning from educational training to practical application. Reviewing the instructional materials of the École des Beaux-Arts, Christensen finds that by the 1920s, a significant 10 percent of architectural education focused on metal fabrication. Graduates of this system returned to their respective homelands as advocates for steel's transformative potential. Publications, material culture, and expositions like the world's fairs of 1851 in London and 1893 in Chicago were likewise important platforms for showcasing the capabilities of this medium of modernity. From I beams to railroad infrastructure, metal was instrumental in shaping not merely visual or aesthetic notions of modernity but also spatial ones. Christensen extends this argument to the manufacturing process itself, highlighting how the assembly-line approach to producing and popularizing metal fostered the integration of systems design within architectural practice.

In addition to the architectural narrative, *Precious Metal* unveils a much broader story about national politics in which steel assumes a central role. The discovery and extraction of iron, wood, and coal not only yielded economic gains but also symbolized cultural progress, national sovereignty, and even supremacy. Christensen

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