Woolen Fibers and Waxy Esters: An Expanded Material History of the Baptistry Doors of San Giovanni

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Keywords: Material ecology, material culture, formation.

On one of the longest days of 1401, the ambient temperature of the air over Florence may have been warm enough to soften wax. The hot air of the city-state, provided a befitting context for the announcement of a competition to design a set of bronze doors for the baptistry of San Giovanni; an event that is widely regarded as one of the establishing marks of the Renaissance. The sanctioned inventory of factors that pressed the aesthetic dimensions of the Quattrocento into service can be accounted for in four sheets of bronze, the demands of a quatrefoil frame measuring thirteen by seventeen inches, the old testament passage of Genesis 22:2-13, The Sacrifice of Isaac, and the constraint of one year.

If we begin to imagine the milieu of the Baptistry competition, and the flow of events into and out of it, an expanded record of the doors should include the fibers of a sheep's fleece, and the waxy ester of the honey bee, as well as the forb-covered pastures on which these species graze. For it was ultimately these two substances that the doors were staked upon.

This paper will explore two distinct aspects of the ecology from which the doors emerged: first, the precursive conditions of foreign trade in wool cloth that engendered the economic mise en scène of patronage for the Baptistry project; and second, an amendment of the door's material attribution to include beeswax—the substance from which the formal and aesthetic integrity of the project derives. These inquiries into wool and wax will serve as models, which seek to recalibrate our understanding of the conditions that form a historical instance, and to enlist structures of ecological thinking that lend agency and legibility to fields of knowledge which lie beyond the evident.

ESTABLISHING MARKS

On one of the longest days of 1401, honeybees might have been seen culling the nectar of clover, dandelions, or chestnut blossoms in the hills surrounding Florence. A shipment of wool may have arrived by carriage along the Via di Calimala after twelve weeks at sea on a Genoese carrack from the Port of Calais. On that day, the ambient temperature of the air over the city-state could have been warm enough to soften wax; which would prove a befitting atmosphere for an announcement widely regarded as one of the establishing marks of the Renaissance.

In the first years of the 15th century, Florence was struggling to rebound from another devasting plague, coupled with a severe grain shortage, and the mounting threat of Giangaleazzo Visconti's recent capture of neighboring Pisa.[1] This conflation of woe was the tinder that caused the Arte di Calimala—the guild of cloth finishers and merchants—to announce a competition to design a pair of bronze doors for the Baptistry of San Giovanni, as a gesture of hope in dark times.

The Calimala was the oldest and wealthiest Florentine guild. Since its founding in 1190, they had been responsible for the "maintenance and decoration of the Baptistry, establishing a pattern of guild patronage and supervision of public art that would continue into the Renaissance."[2] The competition was intended to yield a single bronze panel; an emblematic part demonstrating the final arrangement of 28 scenes from the Old Testament. Although the announcement drew submissions from a number of accomplished artists, the committee would find itself deliberating between the merits of the two youngest entrants: Filippo Brunelleschi, a 23-year-old master goldsmith who had recently completed a remarkable pair of bronze statues for the altar of the Pistioa Cathedral, and 20-year-old Lorenzo Ghiberti, an illegitimate son who had not yet achieved membership to a guild. In 1403, the commission was granted to Ghiberti, and before the contract for the project was drawn, the Calimala decided, inexplicably, to change the subject of the doors from the Old Testament narrative to one of the Life of Christ.[3] Two decades later, on April 19, 1424, over 10 tons of bronze was set on hinges in the eastern portal of the Baptistry facing the construction site of the emerging Duomo.

In the intervening centuries, that preponderance of bronze has claimed its rightful place as a linchpin in the history of Western art, but its position in the canon is habitually restricted to its countenance and carriage; rendering an opacity to its manifestation and to aspects of its existence that occur outside of its apparent, corporeal reality. Though the doors contain a scene of the Annunciation, they did not materialize out of nowhere like an immaculate conception. They arose from a dynamic system of social, political, economic, and material flows—an ecology, that

requires forms of investigatory accounting to become legible. In his recent work on the geographic and ecological dynamics of material, Kiel Moe has argued for methods of forensic inquiry to "account directly for the material and energetic appearance of buildings—not so much in the conventional analysis of their visual disposition, but rather the literal constitution of their becoming."[4] Moe goes on to caution that, "Without a clear understanding of formation, how will we ever understand anything more about architecture's perennial preoccupation with form?"[5] The knowledge of formation that Moe advocates for can be found in the notion of ecological thinking; where an instance is understood in relationship to the conditions of its emergence and persistence. Ecological thinking instrumentalizes context—establishing that it is not an inert backdrop to objects of historical significance, but an active, participatory agent in the constitution and condensation of composed works such as architecture. If we begin to imagine the milieu of the Baptistry competition, and the flow of events into and out of it, an expanded record of the doors should include the fibers of a sheep's fleece, and the waxy ester of the honey bee, as well as the forb-covered pastures on which these species graze. For it was ultimately these two substances that the doors were staked upon.

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WOOLEN FIBERS

On an unremarkable morning, at the onset of the fifteenth century, sheep could be witnessed grazing the Flemish countryside, unaware of the era. They would roam as they did for thousands of years, before there were windmills or monarchies, before the Crucifixion, each step unencumbered by the liabilities of knowing.

A sheep does not know that the grass it is masticating will be converted to protein in the mystery of its four byzantine stomachs, and expressed through its follicles as a constellation of fibers varying in density, thickness, and crimp. The coat of this creature evolved over eons to insulate it from the asperities of winter. Its fleece has adapted to hold air, heat, and value.

The hide of a sheep is a division of offerings. The side of its skin adjoining its organs, can be dried and stretched to become vellum. The outer surface which addresses the external world of commerce and governance, will clothe a populace, and will be responsible for the expansion of wealth in a limestone city on the Italian peninsula.

In medieval Europe, "wool was the single most valuable animal product,"[6] but the geographic features of the Florentine province were not pastoral in the strict, agricultural sense. This made the cultivation of local wool a futile proposition. Instead, the commercial achievement and political reach of the Calimala had been facilitated by their shrewd positioning as merchants and finishers of woolen cloth from the northern climes of England, France, Flanders, and the Brabant. It is significant that the Calimala did not traffic in wool as a raw material, but in the refinement of woolen cloth, and foreign cloth at that.

In a late 19th century account of the medieval Florentine wool trade, historian E. Dixon informs us that Florentine merchants saw their opportunity for financial gain in the raw material of woolen cloth, despite its woven quality when she states, "He invested his money in a stock of these coarsely worked Flemish and Dutch cloths, and brought them to Florence to refine and re-dye. Before very long the merchants of Calimala were doing a brisk trade in cloth of excellent quality."[7] In addition to the prominence of wool as an article of trade, it was also one of the most abundant materials of the medieval world. Every citizen of Florence would have been dressed in wool, and depending upon their financial means, may have had many garments made of it. In other words, the number of woolen vestments in the city far outnumbered the inhabitants.

This profusion of woolen fabric can also be witnessed in the San Giovanni doors themselves. Across 28 panels there are 204 figures: 164 humans, 13 angels, 8 saints, 1 devil, and Christ, appearing 18 times in his supernatural status as the son of God. There are 196 textiles dressing the bronze populace, most of which are presumably woolen. Cloth covers more surface area than any other pictorial element of the doors, apart from the background. Considering the specificity of the Calimala as refiners of foreign cloth and patrons of the Baptistry, the visual dominance of these woolen surfaces might reveal an intention to bestow subliminal reverence on the sponsors (Figure 1).

To stand in front of San Giovanni and observe this display of sculpted garments, could prompt one to think about the scale of mercantile exchange in woolen cloth, and its relationship to the Calimala's patronage of the Baptistry doors. While there are no direct correlations between the fluctuating value of cloth as a commodity and the expense of the Baptistry project, there are speculative chains of logic that illuminate the political economies and material ecologies of Ghiberti's doors. Estimates of the final cost of the doors vary from source to source, but 16,204 gold florins seems to be a number most would agree on.[8] At the beginning of the Quattrocento a bale of wool, which was composed of 60 fleeces, cost roughly 48 florins.[9] This means that 338 bales of wool, or approximately 20,280 sheep, were required in trade to fund the expense of the doors. But

Figure 1. The surface area of the baptistry doors covered in "cloth." Image by author.

what of the land required to raise those sheep? In the late 14th century, an average of 4 sheep could graze on an acre of land.[10] The total surface area of the bronze doors is a mere 120 square feet; the 20,280 sheep which funded their stance in the eastern threshold of the Baptistry required some 5,070 acres of pasture, or 220 million square feet (Figure 2).

These calculations unseat our understanding of the doors as static, bounded objects. They expose and implicate exchanges from monetary unit to article of trade, and from article to estate. Kiel Moe has spoken about the value of such enumerating exercises in his own research when he states, "Without such (historical) accounting, we parochially continue to imagine an autonomy for architecture that the world never grants. Without such accounting, we continue to construe the question of materials in predominantly scenographic terms and art-historical concerns about the stylistic appearance of buildings."[11] Forensic quantification can do much to impart the values of ecological thinking, and we can also learn a great deal more by tracing the provenance of materiality, itself.

Just as one can stand before the doors and imagine the visual consequences of these calculations, one can also begin to conceive of the 2,000-mile-long journey of cloth shipments arriving in Florence, and trace them back by carriage to the Porto Pisano on the Ligurian Coast, their distribution and repacking upon arrival in Genoa, and the sea route experienced in reverse; west across the Mediterranean, through the Straits of Gibraltar, along the coast of Portugal and the Bay of Biscay, to enter the maw of the English Channel, and return to their port of origin in Southampton, Calais, or Bruges.[12] But this time travel only takes us back to woolen cloth as a packaged commodity. From there we can imagine freight merchants unbundling soft bales of fleece into an undifferentiated flock that doesn't bleat or move, but still feels, somehow, living. In the quiet animation of the shearing blades we see a shepherd magically returning fleece to the bodies of 20,280 animals, while on an unremarkable morning, in the flat pasturage of the Low Countries, sheep graze unaware.

WAXY ESTERS

In the early weeks of 1401, members of the Calimala would have gathered to decide upon the terms of the competition for the Baptistry doors, eventually settling on The Sacrifice of Isaac as a suitable subject. On the summit of Mount Moriah, God tested Abraham with a single command: "Sacrifice your only son."[13] Abraham proceeds, and as he draws his blade to Isaac's neck, an angel intervenes, and a substitution occurs. "Abraham looked up and there in a thicket he saw a ram caught by its horns. He went over and took the ram and sacrificed it as a burnt offering instead of his son."[14] When all is said and done, it is a ram (an uncastrated male sheep) that bears the sacrifice. Sheep are mentioned more frequently than any other animal in the Bible, and this instantiation might have intentionally served as yet another veiled promotion for the guild, but the sacrificial fate of the ram points to another substitutional aspect of the doors regarding their material constitution.

As was customary, the competition panels and the completed doors were cast in bronze and gilded with lead and gold, but what is rarely acknowledged is that bronze was not the material from which the project was shaped. The actual substance in which Ghiberti worked was the far humbler and more fugitive medium of beeswax. The reasons for this oversight are manifold. Like the story of Abraham and Isaac, bronze casting demands a sacrifice. The lost-wax technique, employed by Ghiberti, involves many substitutional and transformational steps, wherein the qualities of an original beeswax model are transferred to the interior surface of a clay mold, the wax is dematerialized into a void, and then transfigured into a bronze cast, which is later chased and gilded. While clay and gold also merit proper discussion for their contributions to the material ecology of the Baptistry project, we will focus our attention on beeswax and its role as the originating medium from which the formal and aesthetic identity of the doors were first established.

Many of the corporeal qualities witnessed at the end of the casting process, and conferred upon bronze, are—in fact—a misattribution; for these virtues of fidelity, plasticity, and figuration derive from the rheologic behavior of wax. Bronze is simply adept at retaining them.

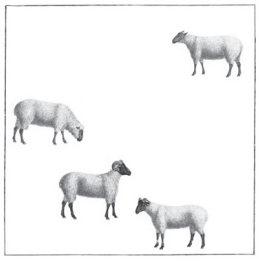
The ability of wax to yield under heat demonstrates one aspect of its range as a modeling material. It can be cast or carved, and is uniquely amenable to iterative development. It is said that the young Ghiberti "unmade and remade"[15] his wax competition panel numerous times, melting it down and redesigning it with each instance of counsel that he received from the city's esteemed goldsmiths. Regrettably, no record of the wax panels exist. In an age before photographic documentation and mechanical reproduction, there was simply no way to chronicle the physical precarity and disappearance of wax modeling.

In the days of the medieval guild system, beeswax was not regarded as a material of aesthetic value. It was an abundant, ubiquitous, and local substance that Florentines used in nearly all aspects of life: the preservation of food, the security of private documents, toward medicinal and cosmetic ends, as sealants, lubricants, or votive offerings, and perhaps most significantly, as fuel to extend the day into darkness. Wax was subjugated to a material hierarchy, as evidenced in the following claim from French philosopher and art historian Georges Didi-Huberman, "Wax seems to partake more of artisan technique than of artistic disegno: it does not belong among the "noble" materials of sculpture, it only enters humanist aesthetics at the bottom rungs of the ladder, linked as it can be—like plaster, for instance—to the "intermediary" or "humble" procedures of artistic creation."[16] This grading of artistic substances was due, in part, to the organizational logic of the guilds themselves, which were defined, to a large degree, by the materials in which they worked, rather than by discipline. If you were a goldsmith, you worked in the spectrum of jewelry, hardware, coinage, or bronze sculpture, but you would have to be a master of the stonemasons' or woodworkers' guild to carve a sculpture out of those respective materials. Therefore, the relative value of a material determined the position of a guild. While the value of wool cloth established the prominence of the Calimala, among the artisan guilds, Paul Robert Walker informs us that, "the goldsmith had the greatest earning potential, for he handled the most expensive materials, and in the medieval world a man's earnings depended more on the materials than the quality of his art."[17] The function of gilding bronze can then be seen not only as a preemptive act of preservation—as bronze oxidizes over time—but as a symbol of economic aspiration.

When we behold the panels of Ghiberti's doors we are confronted with a corporeal paradox; we see only the materiality of the last stage in the production process, which—technically speaking—is not even bronze, but the gilt veil that dresses the surface of the doors. We receive the morphology of that gold surface through a long chain of procedures, but astonishingly what survives and asserts itself is not the heroics or perceived endurance of bronze. It is, rather, the uncommon workability and impressionable nature of beeswax.

The formal constraints and subject matter of the competition required a single, agile material to faithfully render the diverse forms, textures, and details of geologic outcroppings, vegetation, curls and strands of hair, the bone structure of dramatic facial expressions, embroidery at the hemlines of garments, the geometry of an altar, and the raised veins and tendons in the arm of Abraham as he draws the blade of his knife to the nubile flesh of Isaac. In his seminal work on the modeling properties of wax, Didi-Huberman praises its physical virtues in almost religious terms:

Wax is the material of all resemblances. Its figurative virtues are so remarkable that it was often considered a prodigious, magical material, almost alive—and disquieting for that very reason… To say that it is a plastic material is above all to say that it gives way almost without resistance before every technique, before every formative process that one would impose on it.[18]



5,070 acres
220 million square feet

The amount of pasture required to raise the 20,280 sheep (at 4 sheep per acre), whose wool financed Ghiberti's doors.

.00275 acres
120 square feet

Ghiberti's doors measure 15' high by 8' wide, with a surface area of 120 square feet, and weigh approximately 20,000 lbs. The equivalent volume in beeswax weighs 2,145 lbs.

137 acres
5.96 million square feet

In order to supply the 2,145 lbs of beeswax need to model Ghiberti's doors, 17,160 lbs. of honey needed to be converted from the nectar and pollen over nearly 137 acres of land.

1,235 acres
53.8 million square feet

At the beginning of the Quattrocento, the city of Florence was one quarter the pasture area required to graze the sheep that (in trade) would fund Ghiberti's doors.

Figure 2. Comparative acreage of pasture, door surface, field, and Florentine city boundary. Image by author.

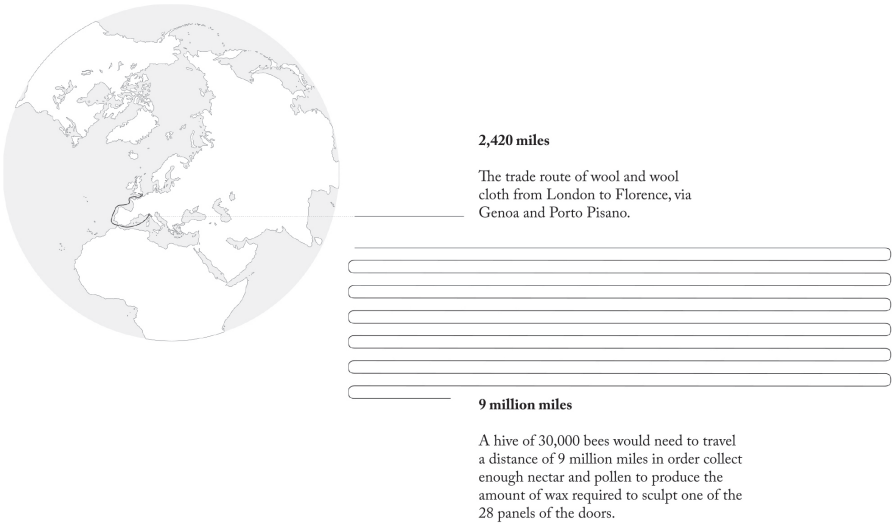


Figure 3. Comparison of distances between the trade route of wool from England to Italy, and the foraging distance of a bee hive required to produce wax for the baptistry doors. Image by author.

These life-like qualities have much to do with the conditions under which beeswax is formed. The interior temperature of a beehive is carefully regulated and maintained at 95 degrees Fahrenheit, which is close to the internal temperature of the human body—98.6 degrees Fahrenheit. At around 144 degrees wax crosses the threshold from solid to liquid; the approximate temperature at which skin burns with a signature blister. The propinquities in behavior between wax and flesh is part of what makes us attribute a vitality to it. In contrast to the inorganic substances of bronze or marble, beeswax is—like wool—a living material, the result of a long sequence of biological processes.

It seems so unlikely that a substance as vulnerable and fleeting as beeswax could be responsible for the monumental project that stands undeterred—some six centuries later—at the Baptistry threshold. If it had been possible for the doors to stand in their original wax form at the entrance to San Giovanni, they would have weighed 2,145 pounds.[19] The methods of forensic accounting that were employed in the previous discussion of wool, can also be applied to the provenance of wax; for the work of the bee is wide-ranging and diffuse—at times—evading direct perception. It takes roughly 1 acre of land for a hive of 30,000 bees to produce 125 pounds of honey, and in turn, about 8 pounds of honey to make 1 pound of beeswax.[20] In order to supply the wax required to model Ghiberti's doors, it was necessary to convert 17,160 pounds of honey from the nectar and pollen foraged from over 137 acres of land, or nearly 6 million square feet (Figure 2).

A hive of 30,000 honey bees must fly over 150,000 miles to collect enough vegetal material to produce 1 pound of wax. Each of the 28 panels of Ghiberti's doors used approximately 60 pounds of wax to produce the bronze cast. The wax for one door panel would have required a hive to fly over 9 million miles. In order to supply the 2,145 pounds of wax for the entire project, a hive would have to have flown 321 million miles—12,921 times the circumference of the Earth, or nearly 2 and half times the distance to Mars (Figure 3).

That a cast of immense weight and proportion could be contingent upon the work of an animal as diminutive and delicate as a honey bee, or that the staggering expenditure of the doors could depend upon the qualities of a soft pile of fleece is stirring and challenging to comprehend. The calculation of areas, distances, volumes, and weights concerning the labor of these creatures, exposes the complexities of apprehending where the material boundaries of a work reside—expanding their reach into more extensive fields of manifestation and exchange. The choreography of foraging and digestion that transfigures a field of clover into the raw materials that can fuel fundamental shifts in culture and mind, occur, it seems, through millions of small quotidian acts—the humble work of bleating and buzzing, that simply carries on.

CONCLUSIONS: THE CONSEQUENCES OF TRANSFIGURING A FIELD OF CLOVER

The esteemed British science writer, Philip Ball, once said that, "manipulating matter is part of what it means to be civilized."[21] It is one of the central human impulses to transform the physicality of the world as we find it, into the conditions of material culture. In our time, the transformation of the substances of the world, through the human identification of their material possibilities into cultural artifacts, has become increasingly difficult to apprehend. The scale, complexity, and abstraction of our social, cultural, and economic realities often make a knowingness or accountability to material origins and processes inscrutable to the point of utter opacity. As contemporary societies become ever more globalized and networked, the need to understand formation—how things come into being—in terms of economic agency and physical ecology weighs upon the ethical and material consequences of the world. The magnitude and scope of financial and material investiture that produced Ghiberti's bronze doors offers a meticulous and legible model for understanding how a particular cultural instance emerged, as well as an opportunity to understand—and methodologies to see—the instrumentality of our own complex ecologies and collaborations with other species.

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ENDNOTES

1. Paul Robert Walker, ***The Feud That Sparked the Renaissance: How Brunelleschi and Ghiberti Changed the Art World*** (New York: Harper Collins, 2002), p.3-4.
2. Ibid, p.14.
3. Ibid, p.40.
4. Kiel Moe, ***Empire, State & Building*** (Barcelona: Actar Publishers, 2017), p.20.
5. Ibid, p.21.
6. M.J. Stephenson, "Wool Yields in the Medieval Economy," ***The Economic History Review***, vol. 41, no. 3 (1988), p.369.
7. E. Dixon, "The Florentine Wool Trades in the Middle Ages: A Bibliographical Note," ***Transactions of the Royal Historical Society,*** vol. 12 (1898), p.157.
8. Paul Robert Walker, ***The Feud That Sparked the Renaissance: How Brunelleschi and Ghiberti Changed the Art World*** (New York: Harper Collins, 2002), p.124.
9. George Holmes, "Anglo-Florentine Trade in 1451," ***The English Historical Review,*** vol. 108, no. 427 (April 1993), p.372-375. This calculation is implied from the transport and taxation documents for a shipment of wool from Southampton, England to Florence, Italy in 1451.
10. M.J. Stephenson, "Wool Yields in the Medieval Economy." ***The Economic History Review***, vol. 41, no. 3 (1988), p.388.
11. Kiel Moe, ***Empire, State & Building*** (Barcelona: Actar Publishers, 2017), p.30.
12. George Holmes, "Anglo-Florentine Trade in 1451," ***The English Historical Review,*** vol. 108, no. 427 (April 1993), p.372-375.
13. A paraphrase of Genesis 22:2. https://www.biblica.com/bible/niv/genesis/22/
14. Ibid, Genesis 22:13.
15. Paul Robert Walker, ***The Feud That Sparked the Renaissance: How Brunelleschi and Ghiberti Changed the Art World*** (New York: Harper Collins, 2002), p.19.
16. Georges Didi-Huberman, "Wax Flesh, Vicious Circles," in ***Encyclopedia Anatomica***, ed. Petra Lamers-Schütze and Yvonne Havertz (Köln: Benedikt Taschen Verlag, 1999), p.67.
17. Paul Robert Walker, ***The Feud That Sparked the Renaissance: How Brunelleschi and Ghiberti Changed the Art World*** (New York: Harper Collins, 2002), p.6.
18. Georges Didi-Huberman, "Wax Flesh, Vicious Circles," in ***Encyclopedia Anatomica***, ed. Petra Lamers-Schütze and Yvonne Havertz (Köln: Benedikt Taschen Verlag, 1999), p.64.
19. A cubic foot of bronze weighs 550 pounds. By volume, the equivalency in wax would weigh 59 pounds. This conversion is how we arrive at the equivalent weight of the doors in wax as 2,145 pounds. Figures provided from the Weight Chart for Non-Living Substances. http://mojobob.com/roleplay/weight_chart.html
20. E.E. Crane, "Honey Yields per Acre of Land," ***Bee World***, 32, 2 (1951), p.13.
21. Philip Ball, ***Life's Matrix: A Biography of Water*** (Berkeley: University of California Press, 2001), p. 188.