The Making and Knowing Project: Reflections, Methods, and New Directions

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The Project

The Making and Knowing Project is a five-year initiative to create an open-access digital critical edition of an intriguing late sixteenth-century French manuscript, Bibliothèque nationale de France MS Fr. 640. This anonymous manuscript contains techniques, recipes, and notes on processes and products that are now classified as part of the fine arts, the crafts, and mechanics (fig. 1). Our study of the manuscript has shown that the text is the written result of actual workshop practice in the sixteenth century, thus providing unique insight into craft and artistic techniques, daily life in the sixteenth century, and material and intellectual understandings of the natural world. Through text- and object-based research and hands-on reconstruction, the Project's researchers seek understanding of the materials and techniques in the manuscript and the context out of which this compilation of technical recipes arose.

The Manuscript

Based on orthography and internal references in the manuscript, it is probable that MS Fr. 640 was written in the final decades of the sixteenth century by an experienced practitioner (hereafter referred to as the "author-practitioner"), who likely worked in the vicinity of Toulouse.[1] In its 171 folios, the manuscript contains the written record of the author-practitioner's collection of recipes and his workshop investigations. Its scope is remarkable. MS Fr. 640 provides instructions for drawing, varnish and pigment making, and diverse casting procedures,

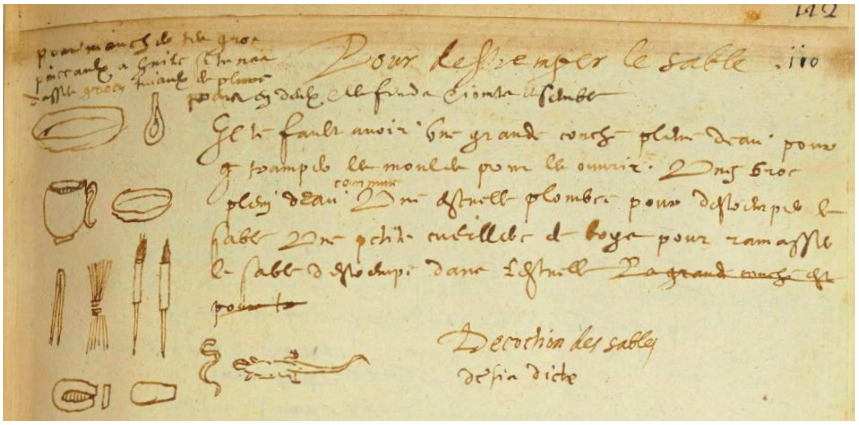

Fig. 1
Bibliothèque nationale de France, MS Fr. 640, fol. 112r, "Pour destremper le sable" (To temper the sand). MS Fr. 640 contains a large variety of processes. Here the author-practitioner describes some of the necessary tools for mixing sand with binder and handling the molds used for casting.

including portrait medals in sand molds; life castings of delicate butterflies, roses, and spider webs; and castings of such large-scale objects as cannon. The manuscript also describes processes for making gemstones, methods for the taxidermy of composite animals (e.g., a kitten with wings), and making papier-mâché masks. Other entries discuss methods for luring and capturing animals to be used in life castings; the author-practitioner also treats land surveying and even describes practical jokes and sleight-of-hand tricks. This multifarious collection has not been published or thoroughly studied, and while it shares many similarities with other "how-to" texts from the Renaissance, particularly those from the genre known as "books of secrets," its descriptions of a practitioner's careful experimentation and engagement with materials render it quite rare among such technical writing.[2] Its contents thus offer a remarkable window into the early modern workshop, revealing not only the materials and methods of artisans and practitioners, but also insights into how and why nature was studied, investigated, represented and used in art, collected, and appreciated in the early modern period. It grants an invaluable view into the continuous, methodical experimentation through which art objects were created by skilled labor and how the process of artistic creation yielded insights into knowledge of nature. The digital critical edition of this extraordinary text will be a significant addition to a relatively small body of early modern technical treatises, and its open access will provide diverse audiences easy access to the contents of the manuscript.

Research Methods

The Making and Knowing Project is producing the critical digital edition and English translation of this manuscript through a series of collaborative workshops and courses that involve students, practitioners, scholars of the humanities and social sciences, natural scientists, and practitioner-scholars from the emerging field of the digital humanities. Our approach combines a collaborative and iterative research process with a strong pedagogical component. The first stage of transcription and translation of the manuscript is carried out in a series of three-week summer paleography workshops that bring together graduate students (with advanced French skills) to learn Middle French script

by intensive transcription and translation of MS Fr. 640. Led by Pamela Smith, director of the Making and Knowing Project, and Marc Smith (no relation), professor of medieval and modern paleography at the École nationale des chartes in Paris, with support from the Making and Knowing Project's postdoctoral scholars and its project administrators,[3] the paleography students work and edit together in a collaborative digital space facilitated primarily by Google Docs and Google Drive. Beyond simply translating and transcribing, students also mark up the text according to basic Text Encoding Initiative (TEI) guidelines, thus contributing to the critical edition's preliminary preparation.

As readers of early modern recipe literature will know, simply having the legible text of a recipe is often insufficient for understanding either the process being described or the desired product. Researchers may thus find themselves in a world of unfamiliar materials, foreign measurements (if any are provided), and peculiar descriptors that leave them bewildered. It is the task of the students in the Making and Knowing Project's "laboratory seminars" to make sense of the manuscript's recipes. Beginning in September 2014, Smith, Boulboullé, Bilak, and Klein began teaching semester-long laboratory seminars in which MA and PhD students make use of the textual work of the summer paleographers to critically annotate and explicate the recipes.[4] The critical edition is thus constituted largely by student-generated content. To write publication-ready critical commentary on the manuscript, the students undertake document-based historical research, object-based research, and hands-on reconstruction of the recipes in the Making and Knowing Project's 1940s-era chemistry laboratory.[5] Much emphasis goes toward crafting these annotations into a historical argument that records what the students' research (both textual and hands-on) reveals about process, materials, sixteenth-century culture and society, and the identity of the author of MS Fr. 640, among many other topics. Each year, students focus their research on a specific group of thematically related recipes in MS Fr. 640. In 2014–15, it was metalwork and moldmaking; in 2015–16, it was color making (including dyes, painting, staining, varnishes, and imitation gems); and in 2016–17, it will be natural history and mechanics. Students work in close consultation with academic and museum-based scholars, including an intensive two-week period each semester during which the class hosts an expert maker who helps to hone the students' skills in relevant techniques. In Fall 2014, we drew upon the expertise of Tonny Beentjes, head of the Metal Conservation Programme at the University of Amsterdam and a practicing silversmith, in sand casting. In the next semester, Spring 2015, Andrew Lacey, a sculptor, bronze founder, archaeometallurgist, and independent scholar with a specialty in the research of Renaissance bronzes, led nature-casting techniques from the manuscript. Color making experts for 2015–16 were specialists in technical art history: Marjolijn Bol (University of Amsterdam and the Max Planck Institute for the History of Science), whose work explores intersections in art, history, material culture, and science; and Erma Hermens (Rijksmuseum), whose research focuses on historical painting techniques, materials, and studio practice.

The laboratory seminar and the paleography workshop inform one another, particularly in the ways that historical reconstructions allow the students to refine the paleographers' translations. For example, certain verbs that were

obscure to the translators in the recipe "Imitation Coral" became clear during reconstruction:

> (fol. 3r) Imitation coral
> One must first make the branches from wood or take a fantastical thorn branch, then melt a pound of the best possible clear pine resin and add one ounce of finely ground vermilion together with walnut oil, and if you add a little Venice lake the color will be all the more vivid, and stir all together into the resin, molten over a charcoal fire, not over an open flame, lest it catch fire. Then dip in your branches with a swirling motion. And should there remain any filaments, turn the branch over the heat of the charcoal.[6]

This recipe for coral was among the first to undergo translation during the June 2014 paleography workshop, and the phrase "tournoya{n}t tes branches" provoked intense (and hilarious) debate about whether a "swirling motion" or a "twirling motion" was being described. Confirmation came during reconstruction that a "swirling" motion was the only possible way to coat the branches with the liquid formed by the hot pine resin and walnut oil. Together with Elisabeth Berry Drago (art history and conservation research fellow, Chemical Heritage Foundation), we mulled the vermilion with walnut oil to make a paste, which we incorporated into melted resin. The mixture immediately turned a deep red. Following the recipe instructions to the word, we dipped and swirled branches into this thick, viscous mixture. The branches indeed streamed with "filaments" when they were lifted out, necessitating the turning action also described by the author-practitioner.

Research-Driven Pedagogy

Most students who come into the laboratory seminar have been formally trained in the humanities but generally have little experience in either a laboratory or an art studio. Even those students with experience have usually never encountered nor attempted a historical reconstruction. We thus begin the course with six to seven weeks of skill-building exercises that introduce students to the subject matter of the theme for the year as well as the general methods of historical reconstruction. The students begin each semester by working in pairs to reconstruct a historical culinary recipe from the sixteenth or seventeenth century with the express goal of simulating, as far as possible, early modern ingredients, apparatus, and methods. Students have, for instance, reconstructed a sixteenth-century recipe for a "Tart of Hippes," a seventeenth-century recipe for a chocolate drink, and even some of the few culinary recipes in MS Fr. 640, including "Excellent Mustard."[7] Students bring the results of their reconstructions to the following week's class, where we discuss and digest the outcome. The point of this exercise is to elicit from the students a working template for reconstruction that addresses some common questions and pitfalls related to reconstruction. One of the important aims of this skill-building exercise is to bring the students to reflect upon the process of reconstruction and its status as historical evidence. What degree of authenticity is sought? Which compromises

in tools, materials, and time-saving are acceptable in reconstruction, and which are not? What makes a reconstruction persuasive evidence? How should it be employed in a historical argument?

Beyond introducing students to basic methods of historical reconstruction, further skill building acquaints the students both with the theme of the year's working group and with methods of data collection and recording of field notes. Students are presented with methods of physical scientists for keeping a laboratory notebook as well as the methods used by anthropologists for taking field notes. They upload their own field notes to a course wiki (hosted by Columbia Wikischolars) that allows instructors to give feedback and observe student progress but also provides the primary repository for raw data produced in the laboratory. During the first year, skill-building exercises included recipes from MS Fr. 640 that prescribed a simple method for making a quick cast of an object by impressing it in freshly baked bread and then pouring wax, sulfur, and tallow mixtures into the imprint.[8] The students' work to research and reconstruct this recipe revealed no other contemporaneous texts that mentioned casting sulfur and wax in bread. As the author-practitioner gave no instruction about the type of bread he used, the students engaged in extensive research on early modern varieties of breads, coming to find that recipes with clear instructions for quotidian varieties of early modern bread are extremely scarce. Like many other recipes in MS Fr. 640, this simple (and quite effective) process of molding in fresh bread led students to many further investigations on techniques and the material properties of everyday materials as well as opening up a window onto previously unknown (and unimagined) techniques.[9] The new vistas of research into unknown objects, techniques, and material uses that are opened up by "reading" the text through "doing" the processes described in it constitute one of the unexpected and important outcomes of the Making and Knowing Project's research on the manuscript. We have learned how fruitful this method of reading and researching a text can be for opening up novel avenues and subjects of investigation.

Other skill-building exercises have included casting in cuttlefish bones, gessoing a panel, preparing and priming a canvas, and making lake pigments. We have found that we can build on the previous semester's knowledge and work; for example, the research on sand casting in the first semester was then turned into skill building in the second semester, and the gessoed panels and lake pigments then were employed in students' skill building in the next semester. We find that skills learned in the laboratory are cumulative, such as the "squeeze test" developed on the basis of fol. 118v for determining the proper consistency of the mixture of "sand" and binder for sand casting, or the "paper test" for determining the proper heat of an alloy before pouring. In this way, we have come to see how techniques, skills, and knowledge quite literally accumulate in the participants and the objects of the workshop.

Collaborations

We are fortunate in having many collaborators working with us on the Making and Knowing Project. Foremost are the scholars invited to an annual three-day

working group meeting at the end of each academic year. These participants read student annotations, give lectures on the relationship of their own work to MS Fr. 640, and remain engaged with the Project after the meeting. Local museum staff have also been crucial participants. When the class created portrait medals by casting into two-piece sand molds, we first visited the Metropolitan Museum of Art, where curators led an examination of relevant medals from the museum's collection. Back in our laboratory, the group then worked with Tonny Beentjes to reconstruct a method for "Excellent Sand," which called for ground plaster and brick dust moistened with a solution of sal ammoniac and brandy in water. This was only one of a remarkable variety of recipes in the manuscript for powders and binders. Our students took their sand molds to the workshop of Ubaldo Vitali—silversmith, conservator, and independent scholar—who supervised the process of pouring molten metals (tin and silver) into our molds (fig. 2). These first attempts at casting both silver and tin were, in short, failures, albeit valuable learning experiences. In our haste to pour metal, we neglected the clear instructions in the margin of the manuscript that explain how to dry the molds over a fire. Our molds were thus too wet, and the heat from the silver created steam, which resulted in considerable metal flashing and, in one case, a geyser of molten metal escaping from our molds. The lessons learned during these exercises contributed directly to further research, for we were eventually able to use the same recipe from the manuscript to copy a medal with relative success.

Another collaborator in sand molding is Pascal Julien (professor of art history, Université Toulouse), who followed the detailed instructions in MS Fr. 640 for obtaining earth (i.e., *sable*) from areas near Toulouse for casting:

> The [sand] generally considered good is the one found in a vineyard near Puy David [now Pech-David]. But the best is the one from the Touch, a river close to Saint-Michel and Blagnac, in a vineyard at a high altitude. This [sand] is thinner, and a bit greasier than the other, and better for small works.[10]

Julien actually located both areas (even finding the vineyard still in operation) and collected samples of sand, sending it to us by post. We used this sand from Pech-David to make a sand cast of a medal with relative success (fig. 3). More importantly, we were compelled to engage more deeply with processual research into the author-practitioner's experimentation with mold materials and his preoccupation with, for instance, the impalpability of mold materials.

What We Have Learned

The student-authored annotation essays integrate historical document-based and object-based research with hands-on reconstructions. Expanding the mainly text-oriented toolbox for historical research with hands-on recipe reconstructions has taught us much about MS Fr. 640 and its author, obscure early modern materials, techniques, and workshop practices. One of the major insights we gained from doing reconstructions has been how to study early

Fig. 2
Silversmiths Ubaldo Vitali (*left*) and Anthony Cavaleri (*right*) pour silver into molds made by the students of the Fall 2014 Craft and Science laboratory seminar.

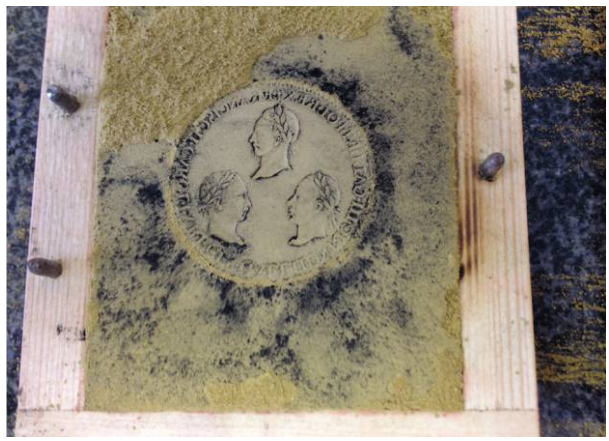

Fig. 3
A mold containing earth (*sable*) collected by Dr. Pascal Julien from Pech-David, Toulouse, France. The mold has been impressed using a modern re-creation (acquired on eBay) of a medal made by Guillaume Martin (1558–ca. 1590), portraying Catherine de Medici and her sons, held by the Bibliothèque nationale de France.

modern recipe books. In what follows, we aim to show in particular how material practices of reconstruction have fostered perceptive reading modes. Over the last three semesters, we have come to see the ways in which material and textual practices are, in fact, mutually informing on multiple levels: reconstructions not only provide a window into artisanal workshop practices but also work as effective close-reading methods for recipe texts. The following examples illustrate how making reconstructions in the laboratory led to better textual analyses and translations of the original manuscript text.

Recipe literature is a challenging genre to read, not only because of its frequent technical obscurity and abridged prose, but often even more so because of its simple style and apparent straightforwardness.[11] Experimenting with appropriate reading methods for the study of early modern recipes is an important part of our pedagogical and research initiative, given that recipe books have only recently become subject to serious scholarly attention in the history of science and material culture. Reconstruction research allows for a practice-driven

engagement with recipe texts, which in many cases might be much closer to their original use as "texts of action."[12]

Our students' experiments with materials and techniques show how manifold layers of meaning in the text, especially regarding the complexity of technical know-how, become visible through material reconstructions and intimate engagement with materials and tools. We realized that our study of "entangled histories" of material and textual explorations, which MS Fr. 640 testifies to,[13] itself takes the form of an entangled endeavor. The act of writing field notes that record material practice is critical to forming the necessary record of practice for the annotation essays but also, and importantly, to fostering a reflective attitude toward material reconstructions and critical engagements with recipe texts. Field notes provide a space for reflection on pertinent questions for "hands-on historians." How does one kind of evidence (material or textual) affect the way we understand another? What is the status, as historical evidence, of the emergent knowledge produced by reconstructions? Thus, in the laboratory seminars, the students learn to experiment, not only with unfamiliar materials and techniques, but also with different genres and modes of writing.

These insights come to light in exit interviews conducted with the students. When asked what they learned from hands-on reconstructions, the students emphasized that reconstruction research trained them in attentive and critical close reading of how-to instructions and their translations.[14] They noticed, for example, how recipe reconstructions make us aware of the significance of textual omissions, additions, and annotations and prompt us to scrutinize the apparent simplicity of the recipes' plain prose: "When you read it [the recipe]," Marilyn Bowen recalls, "it seems very straightforward, it seems he [the author-practitioner] knows what it is written about, but when you start to do some of the 'experiments' you see he was experimenting as well and there is a lot of the unsaid and some of the little words may mean more than what you think."[15] Reflecting on her experiences with skill-building exercises at home and in the laboratory, Wenrui Zhao spoke about how reconstructions offer experiential insights into early modern temporalities and materialities that are utterly foreign to us (post)modern readers and how they engender, at the same time, a more imaginative and more rigorous historical approach: "You have to think about what people's pace at that time was, how to control the heating and the original recipes and the original ingredients which are totally alien . . . to us . . . now. I just felt it makes me on one side more imaginative about history, on the other side more precise about history."[16] Emily Foyer and Wenrui Zhao observed how reconstructions and skill-building exercises foster a reading mode that generates historical research questions, which are difficult to arrive at with textual analysis alone. As Emily Foyer put it, hands-on reconstruction "was not necessarily a way to get answers about things," but "it was a great way to get questions about things."[17]

In what follows, we provide two examples from the laboratory seminar student reconstructions, one from the first year (moldmaking and metalworking), on the uses of sulfur in casting, and one from the second year (color making), on a technique for reverse painting on glass that is known today as *verre églomisé*. Both illustrate how recipe reconstructions not only provide a window into past

workshop practices but also foster thorough textual analyses of individual recipes and help to understand intertextual connections between different recipes, both within MS Fr. 640 and with other extant sources.

As noted above, a legible text is seldom sufficient for understanding the layered meanings of historical recipes and the material, technical, and embodied knowledge contained in them. The transcriptions and translations produced by the paleography workshops thus provide only a first and preliminary step in textual interpretation. Our first example shows how reconstructions can illuminate apparently implausible or obscure passages in the recipe text.

Moldmaking and Metalworking (Year 1): Sulfur-Wax Casting

The first case study focuses on a group of short recipes that include sulfur (a particularly versatile material[18]) and on the instructions given in a marginal note (fig. 4).[19] In their reconstruction of these recipes, the students re-created intermediary processes of artisanal activities that have only rarely been preserved, such as "sands" for casting in box molds and, in this case, sulfur casts for testing the quality of molding materials and surface details of the casting patterns. From our reconstructions of these intermediate stages, we gained insights into understudied aspects of early modern material culture and artisanal workshop practices that, despite the increasing scholarly interest in material culture and the study of things, have rarely been the focus of scholarly attention. As Malcolm Baker, in his short essay "Making and Knowing, Then and Now," notes, scholarly attention has "remained primarily focused on the uses of, and social attitudes toward, things rather than to their materials and making."[20] Recently, however, techniques of facture have come to be the focus of collaborations between art historians and conservation scientists, and they are also the subject of a new field of technical art history. Reconstruction research can be a valuable part of such investigations; however, it requires access to laboratories, financial means for sourcing materials, and hands-on technical training, all of which are generally not part of historical training and certainly difficult of access for scholars of the humanities.

Rozemarijn Landsman and Jonah Rowen conducted many experiments on the uses of sulfur (*soufre*) in MS Fr. 640. They compared a bread-molding recipe (fol. 140v) to other casting-related recipes that employ sulfur.[21] In the manuscript, these recipes tested the properties of sulfur and constituted trials that aimed to augment sulfur with other materials to overcome its deficiencies for specific applications. For example, the author-practitioner mixed sulfur with wax to temper sulfur's combustibility and brittleness, and he added pigmenting agents, like soot black, to make it more durable and to give it "a fine luster,"[22] thus altering its visual appearance, perhaps to imitate more closely the surfaces of metals. These experiments gave insights into the author-practitioner's exploration of material properties, testing their suitability for various purposes and tempering them with other materials to alter these properties.

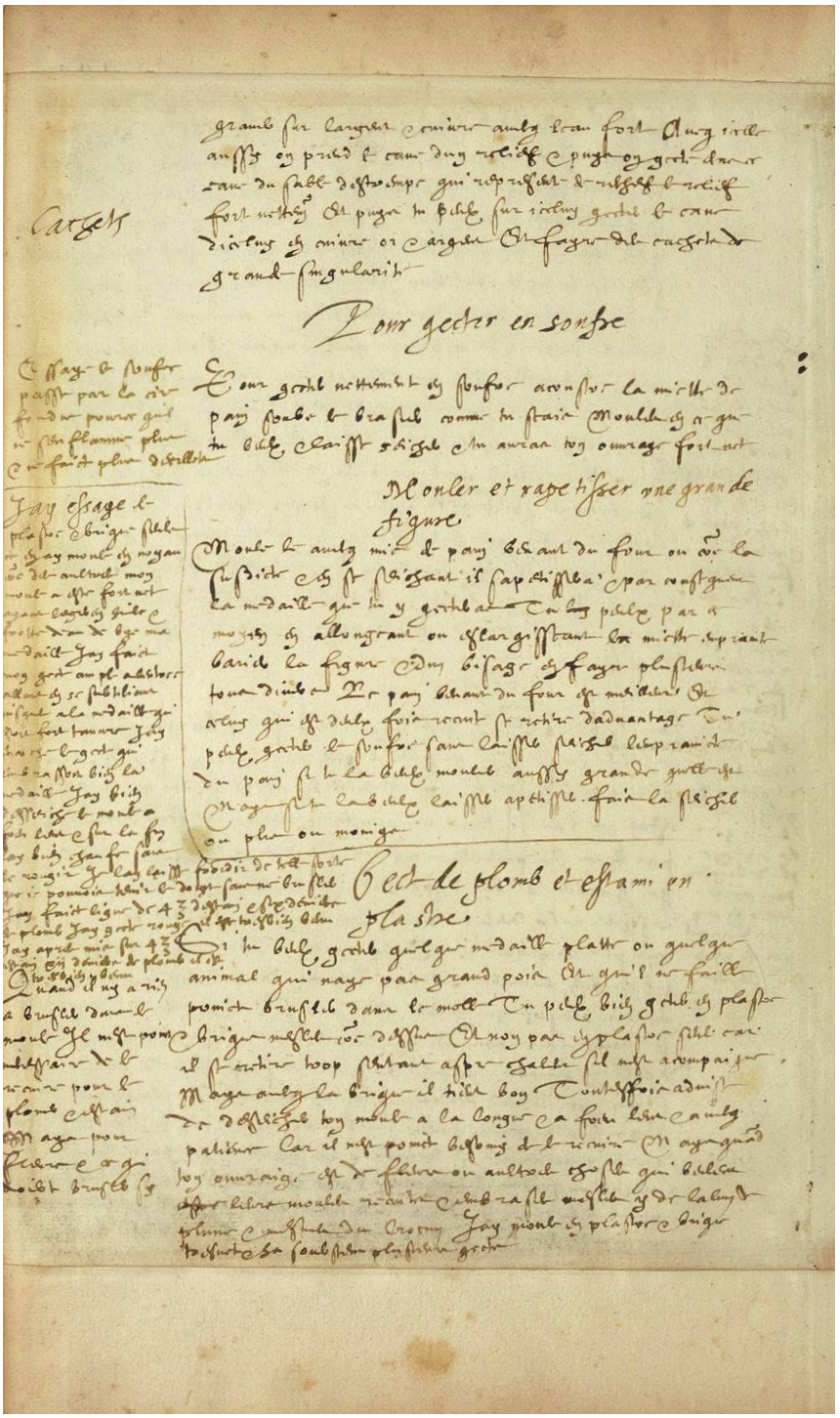

Fig. 4
Bibliothèque nationale de France, MS Fr. 640, fol. 140v, “Pour gecter en soufre” (To cast in sulfur),” with additional instructions to “try sulfur passed through molten wax” in a note in the left margin.

Landsman and Rowen's reconstruction experiments with wax and pigments especially illustrate the author-practitioner's trials to improve sulfur's properties for carving and casting. Landsman and Rowen based their reconstructions on a note written into the margins of a recipe on fol. 140v, "To cast in sulfur." "To make a clean cast in sulfur, arrange the pith of some bread under the brazier, as you know how to do. Mold whatever you want & leave it to dry & you will have a very clean work."[23] On the top left margin, a note suggests to "Try sulfur passed through melted wax, since it won't catch fire & won't make more little eyes."[24] They conducted a variety of trials, finding that the process of "passing through" was crucial for understanding the purpose and results of the author-practitioner's trials.[25] Their first attempts to mix the two materials into a homogenous liquid showed that wax is not miscible with sulfur, as the two materials remained separate on mixing, as do oil and water. A search for other sulfur-and-wax recipes in the manuscript revealed further information about the procedure of "passing through." Two other recipes (fols. 109r, 131r–v) contain comments on the miscibility of wax and sulfur, advising not to stir the sulfur but to allow it to sit in the molten wax, where it falls to the bottom. Instead of trying to "fuse" both materials, Landsman and Rowen let the molten sulfur sink down to the bottom of the liquid wax, a procedure described on fol. 140v as "sulfur passed through melted wax." Mixing sulfur with wax in this way led to many functional improvements in sulfur's properties for casting. In comparison to their trials of pure sulfur casts, the wax-sulfur casts were less brittle. Moreover, these castings had lost none of the malleability of wax and, in being permeated with the "substance" of sulfur, appeared more opaque, thus rendering details of the casting model more clearly to the naked eye than the translucent surfaces of pure wax. In addition, pure sulfur crystallizes when exposed to air, which can result in blistered surfaces (the "little eyes" of the recipe?), but sulfur passed through wax did not blister. The reconstructions thus not only clarified the initially cryptic instruction to "pass sulfur through wax" but also showed why the author-practitioner experimented with this procedure.

Despite the many alchemical meanings that sulfur carried at this time, Landsman and Rowen found no evidence for such connotations in the sulfur recipes they studied. Their reconstructions suggest instead that the author-practitioner had very practical interests in sulfur, and their reconstructions of his sulfur trials gave a better understanding of the inherently explorative and "experimental" nature of workshop practices. For example, suggestions in marginal notes to try other materials and instructions for augmenting sulfur with a variety of materials (e.g., metal filings, resin, tin, and verdigris) not only indicate a workshop and a writing practice in which recipes are collected, recorded, and tried, but, as in all such workshop trials, they invite further trials and material explorations.[26] Because of the ubiquity of sulfur in the manuscript, Landsman and Rowen's research tentatively suggests that the numerous recipes calling for sulfur attest "not only to the material's availability and versatility, but perhaps more significantly, its *perceived* versatility." "It would seem," they write, "that in its ubiquity in trying and testing in this manuscript, sulfur both denoted the idea of experimentation and, as a versatile material, invited further trials." The perceived versatility, indicated by the author-practitioner's frequent use of sulfur in assaying, testing, and augmenting materials, might even indicate that sulfur is a kind of

"material metaphor," not in an alchemical sense but rather because it is so versatile and leads continuously to further trials. Landsman and Rowen thus suggest that sulfur perhaps comes to metonymically represent to the author-practitioner "the process of trying and assaying, or in other words, 'experimenting' itself."[27]

"Layers of Making and Meaning"[28]—Reconstructions as a Critical Close-Reading Method

The second case study focuses on the complex and rich layers of artisanal knowledge contained in a recipe for reverse painting on glass, relating to a diverse set of goldsmithing and painting techniques. This example shows how hands-on reconstruction and skill-building exercises allow us to "disassemble" the recipe's plain prose of materials and techniques to gain an understanding of the hidden realms of practical and material knowledge that are embedded in the text. It also shows how hands-on laboratory work complements other methods used to study material culture (e.g., visual analysis of extant objects), as it allows us to start our analysis by engaging with material transformations and manipulations and move from there to conceptualizations of materials, techniques, and references to artisanal expertise in early modern texts. It can function as a method of building a historical analysis from the bottom up instead of from the top down, starting from hands-on experiences and materialities rather than from an already-formed analytical nomenclature and set of descriptive categories in which distinctions between art and craft, art and science, and painting and decorative art are already taken for granted at the outset.

Rather than understanding reconstructions as material "test cases" that can provide answers or verify hypotheses (e.g., show whether a technique or an experiment actually works or has actually been performed),[29] we also learned how material engagements prompt us to "think with materials" and to critically reflect, from a maker's perspective, on our current media-specific conceptual apparatus and our use of art historical nomenclature. What we had not anticipated is that the hands-on approach also fosters a critical awareness of anachronistic "ordering principles" and "conceptual lenses" that inevitably guide our study of past material practices and can—if naively taken for granted—obscure, rather than illuminate, early modern makers' material taxonomies and understandings of their own creative process.

Colormaking and Application (Year 2): Reverse Painting on Glass—"Tracing a Story on Glass" (fols. 39v–40r)

The detailed recipe "Tracing a story on glass" offers different ways of transferring a printed image onto a glass pane and creating a painted image on glass:

> (fols. 39v–40r) Tracing a story on glass
> If you want to trace a story in intaglio on glass, you can do so in different ways. Place your glass pane, as thin as possible, over the printed

image, and having cleaned the glass well with lye and ashes so that it is not greasy, trace over the lines visible to you with some oily black or skales black, using a brush, if you want to paint with colors in the manner of glaziers, who spread a wash of skales black all over their glasses and then scratch and uncover the areas where they want to apply colors, leaving whatever is necessary for shadows. But if you want to realize gilt stories on glass with a colored background, imitating the *basse-taille* of goldsmiths, gild the whole glass with gum water or garlic juice or fig-tree milk. Then moisten your printed story with two damp linen cloths and lay it down on your gilt glass, then with a pin hafted to a small stick, follow your story lines as if you wished to pounce it, and thus you will roughly draw it on the gilt glass. And next you will uncover the background and what needs to be cleared using a very sharp steel awl, and retrace precisely the lines and complete your work and make faces and skin colors in pounded silver. Then you will fill the background with fine turpentine-soaked enamel azure or verdigris or laque platte, mixed with a little mastic if you want the colors to be more unified and not to flow. Next, apply on the underside of the glass and over the colors a white tin sheet. And once dry, you can cover your tin sheet with color to hide your secret. The tin sheet gives light to the colors. Thus you will be able to paint without hardly being expert in the art of painting. If your glass pane is curved as taken from the middle part of a jar, it will show better. When you apply your turpentine colors to your glass panes, first put them on a hot tile and, once they are hot, apply your colors and leave them a while on the tile. Then lay down your tin sheet.[30]

This recipe contains no marginal notes or first-person references, which could suggest that the author-practitioner obtained it from another written source or had written it down from hearsay. However, an instruction at the end of this recipe (at the top of fol. 40r) to heat the turpentine-based colors and to keep them warm while working on a glass pane is written in a less formal script into the white space between this and the next recipe (fig. 5). This might indicate that the author-practitioner had tried the recipe and added this passage later, after he learned from his experience that these omitted details were critical to the making process.[31]

The many references in the instructions to craft professions and the specialized techniques of various artisans raise important questions about the range of skills for sixteenth-century craftsmen. For example, this recipe gives instructions such as "to paint in the manner of glaziers" (*vitriers*) or "to realize gilt stories on glass with a colored background, imitating the *basse-taille* of goldsmiths" (*orfevres*). Such mentions of crafts or professions, as if the observer was not a member, occur throughout the manuscript. Especially interesting here is the remark in the last paragraph that groups the processes laid out in this recipe under the art of painting and recommends these techniques to imitate the work of professional painters: "Thus you will be able to paint without hardly being expert in the art of painting."[32] This remark raises questions about the "art of painting" (*la paincture*) and the expertise, skill, and knowledge involved in this "ars." On the one hand, it could suggest that the author-practitioner obtained

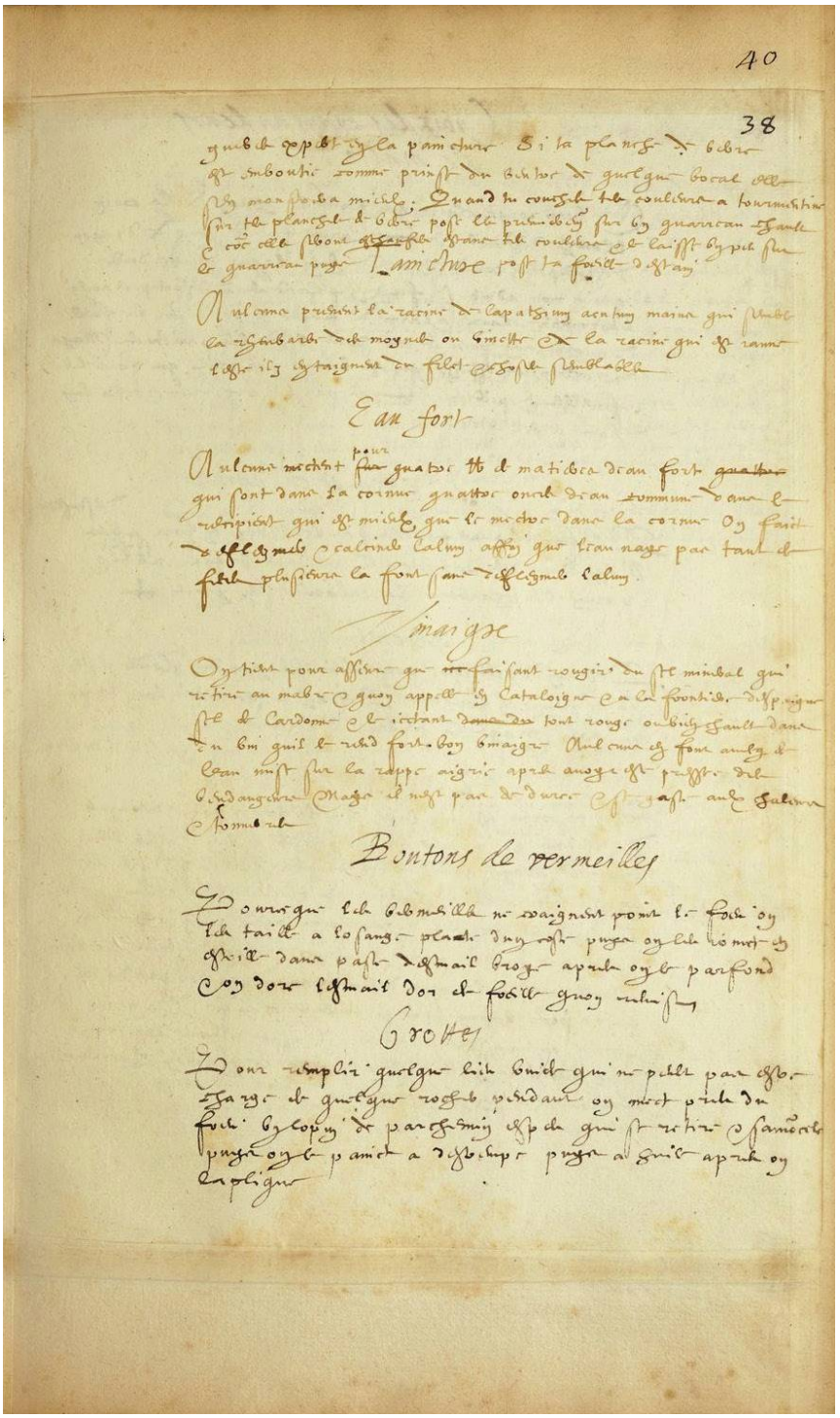

Fig. 5
Bibliothèque nationale de France, MS Fr. 640, fol. 40r, later addition in line 3, beginning with "Quand . . .," to the recipe "Trasser sur le verre quelque histoire" (Tracing a story on glass; fols. 39v–40r).

this recipe from someone not very expert at painting. On the other hand, one could also read recipes like this one, that refer to a "secret," as being communicated by someone with expert knowledge.[33]

The method described in this recipe calls for a varied set of skills that involve the layering and manipulation of several materials, including tin, glass, gold, and turpentine-based varnishes, to achieve a lustrous visual effect with turpentine colors applied to a gilded surface, an effect that is similar to the surface appearance achieved with *basse-taille* enameling. For the reconstruction, Zhao followed the many steps: making and applying "gum water," gilding the glass panel with silver or gold, transferring a printed image to the gilded surface, following the lines of the design "as if you wished to pounce it," then roughly drawing the image on the gilded glass, scraping away the background and shadows with a sharp tool (in this case, a nail), and preparing a turpentine-based colored varnish and applying it to the back (Venice turpentine with ground madder lake mixed with a little walnut oil and, to prevent the colors from running, a few drops of mastic dissolved in a small amount of Venice turpentine).[34] Finally, Zhao tested the visual effects of a tin backing, which indeed "gives light to the colors" (fig. 6).[35] Here, the recipe alludes to well-known "tricks" concerning the setting of gemstones on metal foils (e.g., silver for emeralds and sapphires, gold for rubies) used by jewelers and goldsmiths to enhance their luster.[36] Painters used a similar technique when applying transparent glazes or colored varnishes to gilded surfaces to represent the luminous and lustrous effects of gemstones.

This short summary of the steps performed in the reconstruction glosses over the highly skilled expertise that many of these stages require. Take alone the art of gilding, an extremely delicate and costly "ars" that requires a set of skills shared by painters, illuminators, and goldsmiths acquired through years of training in a workshop.[37] In the fall semester of 2015, Dr. Marjolijn Bol directed skill-building exercises in the art of gilding, using detailed

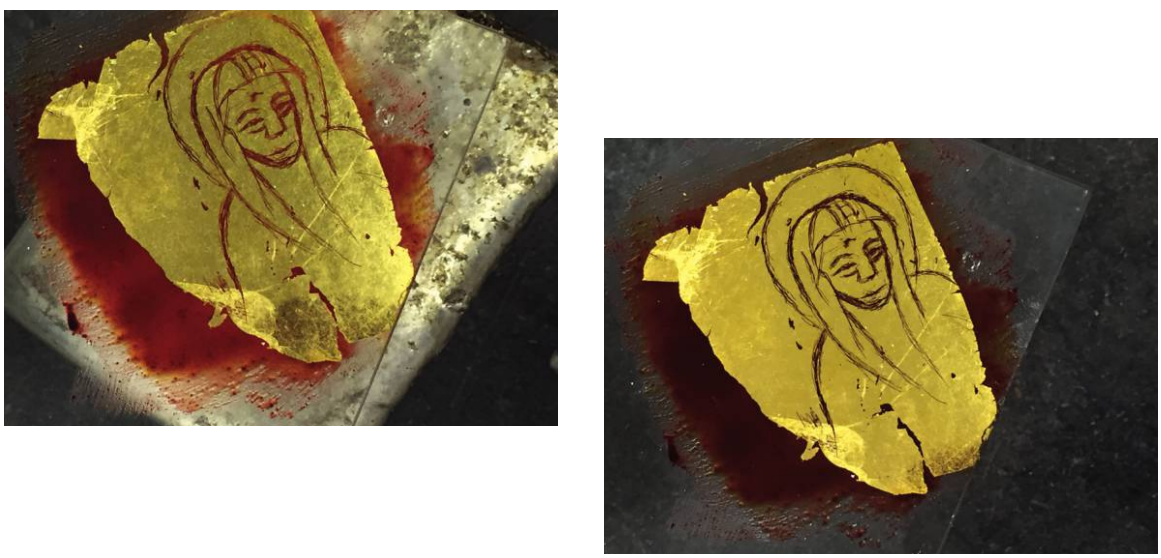

Fig. 6
Reconstruction of a reverse glass painting, following instructions on fols. 39v–40r. Details of the gilded glass show it with (a) and without (b) a tin backing. Note the luminosity of the turpentine-based red lake varnish in (a).

descriptions from Cennino Cennini's *Il Libro dell'arte*.[38] The few hours of exercise gave us a feeling for the exacting nature, delicacy, and deftness of this craft[39] that easily go unnoticed in the simple instruction "gild the whole glass with gum water or garlic juice or fig-tree milk." Zhao's talent for delicate handiwork allowed her to achieve a fair impression of reverse painting on glass, but we should keep painter Cennini's instructions for apprentices in mind, which start with one year of drawing training as a "youngster," then call for six years of workshop practice with a master learning how to prepare a panel for painting, including mulling pigments, cooking glues, and gilding "so that you know how to work in all the branches that are included in our profession," followed by six more years "practising painting, decorating with mordants, doing cloths of gold," attaining more diverse skills while "drawing all the time," as it is only "in this way, by constant practice, [that] natural ability turns into good technique."[40] Like most of our reconstructions, this one too made us intimately aware of the complexity of artisanal techniques and our lack of skilled expertise.

Cennini also gives careful instructions for drawing freehand on a gilded glass pane[41] that offer a vivid impression of the dexterousness this painting technique requires and make us aware of the rather crude attempts at reconstructing this fine art in the Making and Knowing laboratory. Cennini advises making the initial drawing very lightly "because you can never rub it out." The unforgiving nature of this technique demands that the drawing be done with great care and precision. To give different shades to the shadows, an expert painter needs a "light hand" to penetrate the thin golden layer at different depths, creating lighter shadows "by not passing all the way through the gold, which is so fine." To make sure that one's hand is well rested for gilding, he cautions his readers "the day before keep your hand at your neck, or on your chest if you prefer, to get it completely unburdened and soothed of blood and fatigue."[42] Despite this recipe's difference from that in MS Fr. 640 (which starts by transferring a print to the glass rather than drawing freehand), it gives us an impression of the painstaking intricacy of the various procedures described in the recipe, such as "roughly drawing on the gilded glass"[43] to "uncover the background and what needs to be cleared using a very sharp steel awl,"[44] and to "retrace precisely the lines."[45]

Today, reverse painting on glass is called by an anachronistic eighteenth-century term, *verre églomisé*, associating it with the material substrate of glass.[46] Objects made with this technique are generally relegated in today's museum collections to the lower status of "decorative arts," rather than the art of painting, despite the praise this method received from painters such as Cennini, who describes this manner of working on glass as "beautiful, refined and rare as it is possible to describe."[47] Reverse painting on glass was a painting technique that simulated precious metal work and was highly valued in early modern Europe for the "fine skills the technique requires and the splendid visual effect."[48] Similarly, Vasari and Cellini see the goldsmith's technique of *basse-taille* enamel, to which reverse glass painting is related in this recipe, as a part of painting. These techniques were all understood to be part of the art of painting and remind us that painters and goldsmiths in this period shared techniques, workspaces, and often training.[49] From these sources, and from remarks in MS Fr. 640 about "la paincture,"

it is clear that this "ars" encompassed a greater range of techniques than are commonly associated with painting today.[50] Zhao's suggestion to refer to this technique as "reverse painting on glass," instead of by the anachronistic term *verre églomisé*, generally used for reverse-painted glass artifacts of any period, would appear to be not only more appropriate for the early modern period but also more fruitful for understanding the close imbrication of painting and goldsmithing, the period conceptions of and ambitions for painting as an art, and the versatility of early modern "artists,"[51] whether painters or goldsmiths.

Conclusion

We observe a new trend in historical research that—in the wake of the material turn and the return of things[52]—critically examines how "[m]useums and scholarship frequently reinforce modern hierarchies, for example privileging painting over the decorative arts, and create overly rigid categories that fail to account for combinatory media," in particular in regard to the early modern period.[53] Historical reconstruction would seem to provide a fruitful methodological expansion to respond to the here-diagnosed challenges. We have learned from hands-on research of recipes that reconstructions not only provide another window into artisanal workshop practices but also make us aware of the inevitable "modern framings" or "lenses" through which we tend to look at the material world of the early modern period. Our research in materials suggests the inadequacy of some modern classifications for understanding not only the variety of that early modern material world but also the ways in which practitioners thought with and through their materials and experiences to form hypotheses, taxonomies, and knowledge systems.

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1 According to the orthography and various dates in the manuscript, it was written after 1581 and probably before 1600. It contains two dates, one on a reused bill of 1579 and one in an example of an account book of 1581. The manuscript was part of the bequest of Philippe de Béthune (1565–1649) and his son Hippolyte de Béthune (1603–65), which was given to the Royal Collection in 1662 (and registered by Parlement in 1664). Much more study is necessary to understand the genesis of the manuscript and its entrance into the collection of the Béthunes.
2 On books of secrets, see William Eamon, *Science and the Secrets of Nature: Books of Secrets in Medieval and Early Modern Culture* (Princeton, NJ: Princeton University Press, 1994).
3 Claire Sabel, Miriam Pensack, and Jef Palframan facilitated these workshops and provided both intellectual and technical support.
4 The course "Craft and Science: Making Objects in the Early Modern World" is co-taught by professor of history Pamela Smith and postdoctoral scholars Jenny Boulboullé, Donna Bilak, and Joel A. Klein. Jef Palframan, Naomi Rosenkranz, Nilam Patel, and Isabella Buscarino have provided support.
5 The reconstruction of historical recipes and experiments is not a novel method, neither with regard to research nor with regard to pedagogy, and has been fruitfully used by conservators, historians of science, art historians, food historians, and many others. See, for example, Ken Albala, "Cooking as Research Methodology: Experiments in Renaissance Cuisine," in *Renaissance Food from Rabelais to Shakespeare: Culinary Readings and Culinary Histories*, ed. Joan Fitzpatrick (Aldershot, UK: Ashgate, 2010), 73–88; Marjolijn Bol, "Coloring Topaz, Crystal and Moonstone: Gems and the Imitation of Art and Nature, 300–1500," in *Fakes!? Hoaxes, Counterfeits and Deception in Early Modern Science*, ed. Marco Beretta and Maria Conforti (Sagamore Beach, MA: Science History Publications, 2014), 108–29; Lawrence M. Principe, "'Chemical Translation' and the Role of Impurities in Alchemy: Examples from Basil Valentine's *Triumph-Wagen*," *Ambix* 34 (1987): 21–30.
6 MS Fr. 640, fol. 3r, "Coral contrefaict": "Il fault premierement faire les branches de boys ou prendre une branche despine bisarre puys fondre une lb. de poix resine claire de la plus belle et y mectre une once de vermeillon broye subtillem{ent} avecq huile de noix Et si tu y adjoustes un peu de laque platte de venise la couleur en sera plus vive et remuer le tout dans la resine fondue sur foeu de charbon et non de flamme de peur que le feu ne sy prenne Apres trempe en tournoya{n}t tes branches dedans & sil y restoit quelque filament tourne la branche sur la chaleur du charbon."
7 Thomas Dawson, *The good huswifes iewell Wherein is to be found most excellent and rare devises for conceits in cookerie* (London, 1587), 18; Antonio Colmenero de Ledesma, *Chocolate, or An Indian drink*, trans. James Wadsworth (London: Dakins, 1652), 29–35; MS Fr. 640, fol. 48r, "Excellente moustarde."
8 MS Fr. 640, fol. 140v, "Pour gecter en soufre" and "Mouler et rapetisser une grand figure."
9 Rozemarijn Landsman (PhD student, art history) and Jonah Rowen (PhD student, School of Architecture), "Concerning the Uses of Sulfur for Casting," and Emogene Cataldo (PhD student, art history) and Julianna Van Visco (PhD student, Italian literature), "Wax and Tallow: A Material Investigation." All annotations are forthcoming in the digital edition.
10 MS Fr. 640, fol. 87r, "Sable de Thoulouse": "Le ~~bo~~communem{ent} bon est celuy qui se trouve en une vigne de puy david Mays celuy qui est le plus excellent est celuy du touch pres de S{ainc}t Michel & vers blagnac En une vigne qui est bien haulte Cestuy est plus delie & un peu plus gras que laultre & meilleur pour petits ouvrages Il ne veult pas estre trop recuit."
11 On recipe literature and books of secrets, see Eamon, *Science and the Secrets of Nature*; Michelle DiMeo and Sara Pennell, eds., *Reading and Writing Recipe Books, 1550–1800* (Manchester, UK:

Manchester University Press, 2013); Elaine Leong and Alisha Michelle Rankin, eds., *Secrets and Knowledge in Medicine and Science, 1500–1800* (Burlington, VT: Ashgate, 2011). On alchemical recipes, which are often intentionally written in opaque prose for nonadepts, see Lawrence Principe, *The Secrets of Alchemy* (Chicago: University of Chicago Press, 2013).

12 This does not mean that we can simply assume artisanal recipes and technical writings have been intended as workshop manuals; compare, for example, Lara Broecke, trans., *Cennino Cennini's "Il Libro dell'Arte": A New English Language Translation and Commentary and Italian Transcription*, bilingual edition (London: Archetype, 2015), 7; William Eamon, "How to Read a Book of Secrets," Leong and Rankin, *Secrets and Knowledge*, 23–46.

13 Compare Pamela H. Smith, "Why Write a Book: From Lived Experience to the Written Word in Early Modern Europe," *German Historical Institute Bulletin* 47 (2010): 27, which notes that "writing became another site of experimentation and a tool of craft." In 2012, she writes that MS Fr. 640 "is an account of the practice of a workshop, where materials were tested, experiments undertaken, skills learned, and things made. But as that oxymoronic kind of thing, a book of practice, it forms an experiment in rendering a written account of handwork and skill, which at the same time makes real the impossibility of using words alone to do the job" ("In the Workshop of History: Making, Writing, and Meaning," *West 86th: A Journal of Decorative Arts, Design History, and Material Culture* 19 [2012]: 4–31). In the Making and Knowing laboratory, we expand on this observation, suggesting that reading alone does not do the job for the study of artisanal writings.

14 Yuan Yi (PhD student, history, Fall 2015) describes reconstruction as a "very effective way" to read recipes. All exit interviews with students participating in the laboratory seminar "Craft and Science: Making Objects in the Early Modern World," Fall 2015, were held on January 22, 2016. Exit interviews will be made available in the forthcoming digital edition.

15 Exit interview, Marilyn Bowen (MA student, medieval and Renaissance studies, Fall 2015).

16 Exit interview, Wenrui Zhao (PhD student, history, Fall 2015).

17 Exit interview, Emily Foyer (MA student, history, Fall 2015).

18 On sulfur's versatility, Rozemarijn Landsman and Jonah Rowen cite Vannoccio Biringuccio: "As I told you, sulfur melts and by means of its fusion one can mold any desired object from it as if it were plaster of Paris, wax, or melted metal. It serves human needs in medicine, in the purifying and bleaching of wool, and in divers other things. But the greatest quantity today is consumed in making gunpowder." Vannoccio Biringuccio, *The Pirotechnia of Vannoccio Biringuccio*, trans. Cyril Stanley Smith and Martha Teach Gnudi (New York: Dover, 1990), 90, cited in Rozemarijn Landsman and Jonah Rowen, "Concerning the Uses of Sulfur for Casting," annotation forthcoming in the digital edition.

19 Landsman and Rowen argue in their annotation that the marginal notes are very likely the written results of our author-practitioner's own trials and firsthand observations. Landsman and Rowen, "Concerning the Uses of Sulfur for Casting."

20 Malcolm Baker, "Epilogue: Making and Knowing, Then and Now," in *Ways of Making and Knowing: The Material Culture of Empirical Knowledge*, ed. Pamela H. Smith, Amy R. W. Meyers, and Harold J. Cook (Ann Arbor: University of Michigan Press, 2014), 409.

21 For a complete list of recipes in MS Fr. 640 that mention sulfur (*soufre*), see Landsman and Rowen, "Concerning the Uses of Sulfur for Casting."

22 MS Fr. 640, fol. 12r, "Sulfur is improved by mixing in soot black or powdered sanguine, which makes it harder and more resistant." Marginal note on the same folio: "You must not cast it until it has cooled down again, lost all its bubbles and eyes, and its surface has fallen and become flat as water. Soot black gives it a fine luster and makes it neater."

23 MS Fr. 640, fol. 140v, "Pour gecter en soufre": "Pour gecter nettement en soufre acoustre la miette de pain soubs le brasier comme tu sçais Moules en ce que tu veux & laisse seicher & tu auras ton ouvrage fort net."

24 MS Fr. 640, fol. 140v, marginal note top left, "Essaye le soufre passe par la cire fondue pource quil ne senflamme plus & ne faict plus doeillets."

25 Experimentation with different measurements and procedures was necessary because the recipes did not specify amounts or proportions, which is common for premodern recipe books. Lacking quantitative information should not be read as lacking precision. Rather, premodern recipes' openness to iterate by varying ratios might be indicative of a recipe culture that prompted practitioners to try out different proportions, as the quality and properties of their materials often depended on local factors.

26 See the discussion of recipes as "prescriptions for an experiment" in Eamon, *Science and the Secrets of Nature*, 194. On readers deviating from and experimenting with recipe instructions, see Eamon, "How to Read a Book of Secrets," 34. Hasok Chang coined the term "extension" for reconstruction practices that are not limited to attempts to "re-perform" a recipe but rather oriented toward further experimentation. Hasok Chang, "How Historical Experiments Can Improve Scientific Knowledge and Science Education: The Cases of Boiling Water and Electrochemistry," *Science & Education* 20, nos. 3–4 (March 2011): 317–41. Though Chang introduces this term in reference to historical reconstructions, it seems tenable to broaden its meaning to include any form of recipe or experiment reconstruction.

27 Quotations from Landsman and Rowen, "Concerning the Uses of Sulfur for Casting."

28 "That is my major thing [I learned from hands-on reconstruction]: the layers of meaning and making," exit interview, Ana Estrades (MA student, Bard Graduate Center, Fall 2015).

29 On the historiography of historical reconstruction in the history of science, see Heinz Otto Sibum, "Experimental History of Science," in *Museums of Modern Science*, ed. Svante Lindqvist, Marika Hedin, and Ulf Larsson (Canton, MA: Science History, 2000), 77–86; and Chang, "How Historical Experiments Can Improve Scientific Knowledge and Science Education," who includes a suggested taxonomy of historical reconstruction research in science, distinguishing between historical and physical replications and extensions. For reconstruction in conservation science and (technical) art history, see, for example, the *Proceedings of the Art Technological Source Research Group*, starting in 2005 with Mark Clarke, Joyce Townsend, and Ad Stijnman, *Art of the Past: Sources and Reconstructions—Proceedings of the First Symposium of the Art Technological Source Research Study Group* (London: Archetype, 2005).

30 MS Fr. 640, fols. 39v–40r, "Trasser sur le verre quelque Histoire": "Si tu veulx trasser sur le verre quelque histoire de taille doulce Tu le peulx faire en plusieurs sortes Pose ta table de verre sur le plus tanvre que tu pourras sur lhistoire imprimee & ayant bien nettoye le verre avecq lessive & cendre de sorte quil ne soict point gras trasse sur les lignes qui te sont apparentes avecq du noir a huile ou du noir descaille avecq le pinceau si tu veulx paindre de couleurs en la facon que font les vitriers qui lavent leur table de verre de noir descaille & puys esgratignent & descouvrent ce quilz veulent coucher de couleur laissant ce qui est necessaire pour les ombres Mays si tu veulx faire histoires dorees sur le verre avecq fonds de couleurs qui imitent la taille basse des orfevres Dore avecq eau gommee ou suc dail ou laict de figuier toute ta planche de verre Puys humecte entre deulx linges mouilles ton histoire imprimee Et lestends sur le verre dore puys avecq une espingle manchee au bout dun petit baston suys les lignes de ton histoire comme si tu la voulois poncer & ainsy tu la trasseras naifvement sur la doreure du verre & apres tu descouvriras le fonds & ce qui doibt estre vuide avecq une aleine dacier bien poinctue & resuivras nettement les traicts & acompliras ton ouvrage & feras tes visaiges & carnations dargent moulu Puys rempliras le fonds dazur desmail ou de verdegris ou de fine laque platte platte destrempee avecq tourmentine clere meslee dun peu de larme de mastic si tu veulx que les couleurs soient plus unies & ne sespandent poinct Apres couche au dos du verre & sur les couleurs une foeille destain blanche Et cela sec tu pourras couvrir de couleur la foeille destain de pour cacher ton secret La foeille destain donne jour aulx couleurs Ainsy tu pourras paindre sans estre gueres expert en la paincture Si ta planche de verre est emboutie comme prinse du ventre de quelque bocal elle sen monstrera mieulx Quand tu couches tes couleurs a tourmentine sur tes planches de verre pose les premierem{ent} sur un quarreau chault & comme elles seront eschaufees estans tes couleurs & le laisse un peu sur le quarreau puys pose ta foeille destain."

31 Other recipes, such as casting "thin things" on fol. 142v, which includes butterflies, also seem to indicate that the author-practitioner was learning as he experimented.

32 MS Fr. 640, fols. 39r–40v, "Ainsy tu pourras paindre sans ester gueres expert en la paincture." We translated "la paincture" as "the art of painting," rather than "painting," because this better reflects the use of the article "la" in French. Moreover, Cotgrave's 1611 French-English dictionary defines "paincture/peincture" as "a picture, counterfeit, piece of painting, also painting; the Art or act of Painting." See also the Oxford English Dictionary entry on the etymology of *painture*: "Old French, Middle French *peinture*: painted image, picture, verbal depiction, art or profession of painting, action of painting." Oxford English Dictionary Online. March 2016. Oxford University Press. http://www.oed.com/view/Entry/136099?redirectedFrom=painture (accessed March 15, 2016).

33 MS Fr. 640, fol. 82v, also mentions a professional secret under the heading "Watchmakers": "Formerly, they dipped their springs by immersing them into molten lead. Today they dip their straight springs, and afterwards bend them, which is a beautiful secret." In instructions for casting from life, for example on fol. 114r, the author-practitioner shares his own secrets, often accompanied by marginal notes and drawings. Reconstruction research supports the hypothesis that these are based on the author-practitioner's own experiences. Pamela H. Smith and Tonny Beentjes, "Nature and Art, Making and Knowing: Reconstructing Sixteenth-Century Life-Casting Techniques," *Renaissance Quarterly* 63, no. 1 (2010): 128–79; and Smith, "In the Workshop of History."

34 Zhao followed instructions on fol. 6r to make turpentine-based red lake varnish.

35 For a close comparison of *basse-taille* enameling and reverse glass painting techniques and their art historical reception, see the annotation by Wenrui Zhao, "Reverse Painting on Glass, fols. 39v–40r." She recorded a detailed, experiential account of her reconstruction in her field notes.

36 Joanna Whalley, "Faded Glory: Gemstone Simulants and Enhancements," *Studies in Conservation* 57 (2012): 313–21.

37 Compare Zhao, "Reverse Painting on Glass, fols. 39v–40r," and the annotation by Emilie Foyer, "Gold without gold on silver." Both Zhao's and Foyer's reconstructions called for gilding.

38 Broecke, *Cennino Cennini's "Il Libro,"* 168.

39 Zhao and Foyer record in their field notes our humble attempts to learn gilding in a few days. This experience prompted Foyer to do further research for her annotation on gilding in the early modern period. Susie Nash, *Northern Renaissance Art* (New York: Oxford University Press, 2008), 182, notes the requirement that apprentices "train in gilding for two extra years on top of the basic

two-year training period because of the delicate and costly nature of the task." Foyer's findings and the following account by Cennino Cennini supported Zhao's emerging understanding "that there was much more to 'painting' in the early modern period than today" and of the "fluid boundaries between the professions of painter and goldsmiths, and the common knowledge shared by them." Zhao, "Reverse Painting on Glass, fols. 39v–40r."

40 Broecke, *Cennino Cennini's "Il Libro,"* 138. Broecke notes (p. 2) that Cennini's claims might have been exaggerated, as notarial accounts for Florence attest to one to eight years of apprenticeship (journeyman years not included, however).

41 Ibid., 226–28.

42 Quotations from Broecke, ibid., 228.

43 Ms Fr. 640, fol. 39v: "trasseras naifvement sur la doreure du verre."

44 Ms Fr. 640, fol. 39v: "tu descouvriras le fonds & ce qui doibt estre vuide avecq une aleine dacier bien poinctue."

45 Ms Fr. 640, fol. 39v: "resuivras nettement les traicts."

46 Zhao, "Reverse Painting on Glass, fols. 39v–40r."

47 Broecke, *Cennino Cennini's "Il Libro,"* 226.

48 The following paragraph and all citations are drawn from Zhao, "Reverse Painting on Glass, fols. 39v–40r."

49 Zhao refers to the work of Sienese painter Lucas di Vieri and his brother, the Sienese goldsmith and enameler Ugolini di Vieri, suggesting that knowledge of reverse painting on glass and *basse taille* enameling circulated between their workshops.

50 Zhao argues for a historicized understanding of "art" as *ars*. Only recently have scholars called for an acknowledgment of a historical moment "when the cultural identity of the professional painter was not necessarily defined by the application of pigment to panel but ranged fluidly across varied activities, and when likewise oil painting did not have a definitive role in the visual culture of elite society." James J. Bloom, "The Role of Painters before the Rise of Painting: The Master of Frankfurt's Festival of the Archers," *Nederlands Kunsthistorisch Jaarboek* 59 (2009): 70–89.

51 See Bart Ramakers, "Art and Artistry in Lucas de Heere," *Nederlands Kunsthistorisch Jaarboek* 59 (2009): 164–92, for scholars' neglect of versatility in the study of sixteenth-century art practices.

52 Baker, "Epilogue," in Smith, Meyers, and Cook, *Ways of Making and Knowing*, 409.

53 Call for a PhD candidate for the project "Rethinking Early Modern Media," affiliated with the larger research project "The Cabinetization of Art and Knowledge in Early Modern Europe," carried out by Nadia Baadj and the Groningen Research Institute for the Study of Culture research group, "The Objects of Art & Architecture" (http://www.rug.nl/research/arts-in-society/expertisedomeinen/artandobjects). See also on this point Ulinka Rublack, "Matter in the Material Renaissance," *Past & Present* 219 (2013): 41–85; and on understudied aspects of material culture in art history, see Michael Yonan, "Toward a Fusion of Art History and Material Culture Studies," *West 86th: A Journal of Decorative Arts, Design History, and Material Culture* 18 (2011): 232–48.