

8 The Making of Empirical Knowledge: Recipes, Craft, and Scholarly Communication

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The making of empirical knowledge is, broadly speaking, regarded today as the result of research carried out by social and natural scientists, while the arts and humanities are considered to employ a different type of methodology, form a separate realm of inquiry, and produce insights that are sometimes complementary, but not equivalent, to objective facts. Yet, the empirical techniques of experiment and observation employed in the natural sciences have their origins both in the creative labors of Renaissance artists' workshops and in the empirical methods pioneered by Renaissance humanists and historians.¹ At the beginning of the Scientific Revolution in the sixteenth century, the craft workshop was understood to make knowledge about nature, as artisans codified material processes in technical recipes and "how-to" texts. The earliest European scientific societies avidly collected technical recipes from craftspeople in order to study and advance natural knowledge. Over the course of the seventeenth century, collaboration and experimentation that had taken place within the craft workshop became integrated into the practices of the natural sciences. However, in the eighteenth and nineteenth centuries, when the new sciences cohered as distinct disciplines, these shared origins became obscured, and since then, the divisions between the natural sciences and the arts and humanities have grown ever wider. Studying the premodern workshop provides an opportunity to bridge the modern communities of artists, historians, and scientists by fostering scholarly communication and collaboration around materials and the techniques of engaging with the material world.

As one of several "case-study" pieces in this volume, this essay first discusses the genre of how-to texts as a platform for a new type of communication of knowledge in the past as well as their role in the development of the massive infrastructure that we know today as "modern science." It then

turns to document a large collaborative research and pedagogical initiative, the *Making and Knowing Project*, which explores historical and methodological intersections between artistic making and scientific knowing. The Project examines the structure of the “technical recipe book” or “how-to text” as a type of sociotechnical system that played a central role in the reconfiguring of older systems of knowledge about nature. In order to undertake this research, the Project has constructed a physical and virtual infrastructure for collaborative scholarship and pedagogy, and for interdisciplinary, open scholarly communication. In doing so, the Project is itself employing new technologies to reconfigure one of these historical how-to texts for new uses and as a platform for dissemination and collaboration. This essay thus deals with an important development in the history of scholarly communication; introduces a project that is dedicated both to understanding this development and to creating a platform for disseminating the knowledge it has created and the methods it has developed; and finally, makes a case for experimentation with material practices as an important site for open scholarly communication in the future.

The *Making and Knowing Project* explores the complex of scholarly practices and infrastructure by means of sharp focus on a well-defined object of research that is investigated using techniques from the laboratory, art studio, museum, and archive. From 2014 through 2020, the Project created a digital critical edition of an intriguing anonymous sixteenth-century artisanal and technical manuscript now held in the Bibliothèque nationale de France, Ms. Fr. 640. To achieve this, the Project brought together a network of over 400 collaborators in the humanities, arts, and natural sciences at institutions worldwide to undertake interdisciplinary research, teaching, and knowledge exchange on this manuscript. Thus, both the process of creating this digital critical edition as well as the resulting product (i.e., the digital critical edition) together compose the platform for the collaboration and dissemination referenced above.²

The Project’s collaborative approach, combining text-, object-, and laboratory-based research with digital humanities tools, challenges the separation of pedagogy from original research and the division between scientific and humanistic inquiry. It brings to the fore methodological consideration of historical evidence and, like other recent collaborative humanities projects, indicates the important strengths of large-scale collaborative research in historical and humanities scholarship. The *Making and Knowing Project* also

considers how training in the hands-on skills of material and technical literacy as well as in emergent digital and open-access technologies can transform the practice of historical research by reinforcing the value of differently encoded forms of knowledge.

The Early Modern How-to Text as a Platform for Knowledge-Making and Dissemination: BnF Ms. Fr. 640

In the last decades of the sixteenth century, an anonymous French-speaking craftsman, most likely from the region of Toulouse, took the unusual step of setting down on paper techniques for a number of processes that we would now classify as belonging to the fine arts, crafts, and technology: drawing instruction; pigment application; dyeing; coloring of metal, wax, and wood; imitation gem production; metal and cannon casting; tree grafting; land surveying; preservation of animals, plants, and foodstuffs; distillation of acids; and much more. The resulting manuscript, now housed in France's Bibliothèque nationale as Ms. Fr. 640, is a unique communicative record of practices that gives rare insight into craft and artistic techniques, daily life, and material and intellectual understandings of the natural world in the sixteenth century. Above all, the manuscript demonstrates the common origins of artistic and scientific experimentation and innovation in the workshops of early modern Europe (ca. 1350–1700). This document is an early example of knowledge (or research) communication.

Ms. Fr. 640's compilation of artisanal techniques, recipes, and experimental notes produced by an experienced practitioner appeared at a pivotal moment in the growth of a new mode of gaining knowledge which we now call "empiricism" and "natural science." The fact that a practitioner recorded these technical procedures at all was part of a seminal development in early modern European history starting around 1400, when craftspeople increasingly began to write down their embodied knowledge in "how-to texts." As new communities of readers and writers grew, these treatises were imitated and disseminated by entrepreneurial printers to a diverse audience, helping to foster a culture that valued practical knowledge. These how-to books thus became a form of conveying both practical and scholarly activity as well as collaboration, exchange, and communication.

Scholars have long identified the period from 1400 to 1600 as one in which attitudes toward nature profoundly changed. New theories, practices,

and materials brought renewed attention to the exploration of nature and to representing it in novel ways, whether through lifelike images and objects, mathematical models, or measuring instruments. Changing attitudes were accompanied by an explosion of printed information that codified and disseminated new kinds of learning to newly literate audiences. Ms. Fr. 640 represents the intersection of two essential developments behind this larger shift in intellectual and material production: the turn to writing down, communicating, and making explicit knowledge that had previously been tacit, embodied, and possessed by skilled craftspeople who learned by making things rather than by reading texts; and the move away from reliance on classical textual authorities toward methodical experimentation with natural materials and the refining of techniques and processes through firsthand experience. These developments occurred as a result of many converging factors—including the growing literacy of artisans and other urban populations, the rivalry among artists for patronage at the increasingly powerful territorial courts, and the important role that art and technology played in maintaining the power of these courts. They produced a new genre of “how-to” texts that included individual recipes, specialized treatises, and comprehensive compilations of procedures. These texts—although not “open access” in the same sense as we use when writing of our own digital age—nonetheless lay bare the knowledge of the artisan, mediating between lived experience and the written word. This “communicative event,” in which practical knowledge came to be set down and disseminated in a new genre of texts, set off a crucial and thoroughgoing reconfiguration of the realms of scholarly knowledge and action, as the natural sciences began their long ascent to their present status as arbiters of method and authority among the disciplines. Certainly, the contemporary focus in the digital space on the open dissemination of new forms of practice-based research—frequently across novel media—has a far longer history than is often acknowledged.

Indeed, recent scholarship on artisans’ knowledge, a domain to which Ms. Fr. 640 belongs, has profound implications for the history of science and culture, as it reconsiders the relationship between exploring ideas and exploring materials to produce new knowledge. In preindustrial societies, the workshop produced knowledge as authoritative and powerful as that of today’s scientific laboratory, but the knowledge-making processes of the workshop privileged objects over words. Craftspeople expressed their knowledge largely in the mastery of techniques and in the objects of their art, but

scarcely in writing until the fifteenth century. Ms. Fr. 640 and similar how-to manuscripts are rare evidence from this moment when craft became literate. This manuscript offers unusual insight into daily life and how natural materials and art objects were made, collected, appreciated, and circulated in a period of burgeoning production and consumption. Its detailed information about plants, animals, and the raw materials of nature provides an exceptional view into attitudes toward the natural world at the dawn of the “new experimental philosophy” out of which modern science developed. The manuscript is unique for recording its author’s immediate, self-reflexive, and iterative notes on various processes for making objects and investigating material properties. It shows the methodical experimentation of the workshop and the ways in which craft was understood as a tool for the investigation of nature. This experimentation would be developed into a self-conscious epistemology and incorporated into the natural sciences as they were institutionalized over the course of the seventeenth through twentieth centuries, first in scientific societies and then in research universities.

The *Making and Knowing Project* as a Platform for Knowledge Creation and Exchange

From the Project’s inception in 2014, ongoing work toward the full transcription of Ms. Fr. 640’s French text, English translation, and the research generated around the manuscript became a platform, or an infrastructure of sorts, for hundreds of scholars and students to take part in active research and extend the Project’s work to their own scholarship and teaching. Moreover, Ms. Fr. 640 is proving to be an important source of evidence across a number of disciplines, from technical art history to literary scholarship to the history of daily life. The publication of the annotated transcription and English translation of Ms. Fr. 640 as a scholarly edition has made accessible an important primary source that significantly enhances the existing body of early modern technical writing and allows readers to understand and analyze the actions of craft making as the creation of empirically tested knowledge about the natural world. As the Project’s initial research and dissemination has already shown, Ms. Fr. 640 will engage readers, whether researchers, students, or broader publics, in a new approach to exploring historical texts, one which emphasizes the importance of the material conditions, interpretations, and outcomes that emerge when the written

word is realized through investigations into materials in the laboratory. The manuscript codifies procedures that were not meant to be reproduced solely through the act of reading but were rather an invitation to imitate and experiment; the research that it communicates mediates the embodiment of this craft knowledge. The critical edition, in turn, through its critical commentary and accompanying videos and visual resources, invites its audiences not only to read and analyze the text but also to explore and investigate the materials and processes detailed within it.

The Digital Critical Edition of BnF Ms. Fr. 640

Secrets of Craft and Nature in Renaissance France: A Digital Critical Edition and English Translation of BnF Ms. Fr. 640 (<https://doi.org/10.7916/78yt-2v41>), hosted by the Columbia University Libraries, makes this unique manuscript freely available to students, scholars, and the general public through open-access publication. It presents the text of the manuscript in French transcription and English translation for the first time and, through the *Making and Knowing Project's* customized encoding, transforms the manuscript's text into a rich and manipulable dataset for advanced analysis, search queries, and visualization. Moreover, *Secrets of Craft and Nature* situates the manuscript's contents within the material and historical contexts in which they were produced. Users of the edition not only read the manuscript as a text but, through the laboratory reconstructions of its recipes, also experience it as a record of material practices. To facilitate this experiential engagement, the edition's critical apparatus harnesses the flexibility and interactivity of tools in the digital humanities in a dynamic, multifunctional, web-based application. It presents traditional archival and paleographic research on the manuscript alongside innovative material reconstructions and analyses of the techniques described in it. In this way, the open-access digital critical edition actually embodies many of the principles that are key to Ms. Fr. 640 itself.

The edition comprises an intuitive user-directed online format for the four versions of the manuscript: (1) high-definition facsimile images, (2) diplomatic (verbatim) French transcription, (3) normalized (slightly modernized) French transcription, and (4) English translation. The digital critical edition presents the option to view the versions of the manuscript as user-directed sets in comparison panes with links to the critical commentary (figure 8.1). The versions are also available as standalone downloadable

PDFs. Comprehensive digital encoding and markup transforms the manuscript text into a database of recipes, materials, and processes, which users can freely search and analyze. The digital critical edition has an extensive search function that allows users to easily find and collect information through various filters, and the raw data, openly available through GitHub, can also be used for further analysis and visualization with existing digital humanities tools. For example, a user can query the data to locate every instance of the material “gold,” and then further refine search results by the process of “gilding” to determine what proportion of gold usage is related to gilding (figures 8.2–8.4). This database and robust search/concordance feature allows scholars, educators, and students to draw new connections among thematic focuses, specific materials, and much more from the manuscript’s contents.

Whether the manuscript is browsed or searched, the user has the option to consult relevant features of the critical commentary in pop-out windows that illuminate specific aspects of the manuscript such as a word or a technique, or the historical and cultural context of its production (figure 8.1).

The edition’s critical apparatus includes multimedia research essays that place techniques and materials described in Ms. Fr. 640 in their textual and historical contexts, editorial comments, a glossary of technical terms, and resources for further exploration. The multimedia essays combine traditional historical research and comparative material (for example, historical objects in museum collections produced using techniques described in the manuscript) with innovative recipe reconstructions. The essays include images, objects, graphic animations, videos, and first-person accounts of processes that cannot adequately be conveyed in traditional print formats. In addition to the research essays that explicate material and technical content, linguistic and paleographic essays also make transparent the editors’ and translators’ interventions and interpretive decisions. The entirety of the critical apparatus is produced through student-scholar teaching-research partnerships, described in detail below.

The Making and Knowing Project: Process and Pedagogy

The *Making and Knowing Project’s* fusion of pedagogy with a focused research program has proven to be a powerful research model. Indeed, it partially adapts the model of lab-based scientific research groups to the humanities

Secrets of Craft and Nature in Renaissance France

A Digital Critical Edition and English Translation of BnF Ms. Fr. 640

/ Folios / **4v**

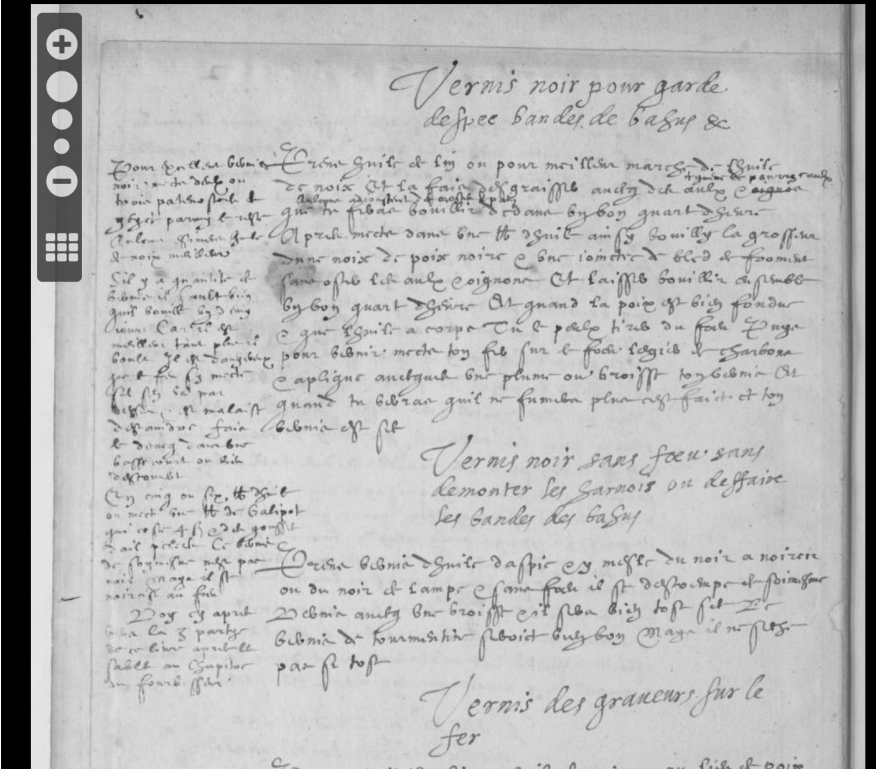


Figure 8.1

Dual-pane view of fol. 4v in the digital critical edition, showing user-directed text comparison panes with pop-out commentary (editorial note at lower left of right pane) and a dropdown research essay (marked with the flask icon) that explains and reconstructs the recipe.

and history, once more playing into the very traditions of scholarly communication and research seen in the how-to texts that are the Project's object of study. The creation of *Secrets of Craft and Nature* included a series of "expert crowdsourcing" workshops and regularly scheduled university courses that involved students, practitioners (such as sculptors and painters), scholars of

For excellent black varnish, add two or three paternoster beads of jet among the rest.

Some consider walnut oil better.

If there is a lot of varnish, it needs to boil for at least half a day, for it is better the more it boils. It is dangerous if it catches fire, if it goes over the top, and is hard to extinguish. Make this therefore in a courtyard or an open space.

In five or six lb of oil, one must put one lb of galipot, which costs 4 sous, & some peeled garlic cloves. This varnish in and of itself is not black, but it blackens over the fire.

See below, around the 3rd part of this book, after sands, in the chapter on furbishers.*

See the entry beginning on fol. 94r, *Fourbisseur* (Furbisher).

Black varnish for sword guard, bands for trunks, &c

Black Varnish for Armor



Historians know little about how armor was made black. This essay starts to fill the lacuna by examining a sixteenth-century recipe, “Black varnish for sword guard, bands for trunks, etc.,” on fol. 4v of Ms. Fr. 640. What was black varnish for armor? How was it made and applied? What ingredients and techniques were used? What purposes did it serve? Using a combination of reconstruction and textual research, this essay suggests that “Black varnish for sword guard” was used as an etching ground, a rust-protection coat, and a finish to impart luster and brilliance to armor and metals. The reconstructions underpinning this essay give insights into the varnish ingredients and show that success (or failure) in making and applying black varnish depended as much on the properties of the ingredients as on an artisan’s knowledge of heat, metals, and tools—as well as the skill of working with them.

Take linseed oil or more cheaply, walnut oil, and rid it of grease with garlic & ^{onions} +hog’s fennel, some also add bread crusts, which you will boil in it for a good quarter of an hour. Next, put in one lb of the oil thus boiled the size of a walnut of black pitch & a double handful of grains of wheat, without removing

Figure 8.1 (continued)

the humanities and social sciences (history, art history, anthropology, and museum scholars), natural scientists (chemists, physicists, and conservation scientists), and specialists from the digital humanities and computer science (computer scientists, AR researchers, and librarians). The research process employs novel methodologies for history, such as large-scale collaboration in cross-disciplinary research groups, historical reconstructions of past techniques, and analysis and dissemination using new digital tools. The Project also provides a model for the preservation of, communication of, and

Summary: There are 643 unique words other than those in the stop list, there are 1631 words other than those in the stop list. There are 3474 words in total including the stop words.

Words	Counts	Words	Counts
	377	Apply	12
Silver	79	Good	10
Cast	33	Sand	10
Color	26	Image	9
Like	16	Work	8
Fine	14	Want	8
Make	14	Use	8
Casting	13	Gild	7
Leaf	12	Enamel	7

TAPoRware Tool Parameter Summary	
Tool name	Find Text -- Collocation (Plain)
Text source	translatedfolio.txt
Pattern	gold*
Context	word
Context length	5
Sorting	Co-occurring words by frequency

Figure 8.2

TAPoRware collocation analysis for the term “gold*.”

interaction with practice-based experiential knowledge by allowing readers to experience historical techniques through text, image, audio, and video.

The Project’s creation of the edition consists of four interrelated and iteratively developed components, described in more detail below: (1) transcription, translation, and encoding of the manuscript; (2) critical commentary, including in-depth, multifaceted research of the manuscript’s “recipes,” notably by hands-on laboratory reconstructions; (3) working group meetings for critical review and oversight; and (4) digital development of the online environment of the edition. Each of the first five years of the Project focused on a single theme to draw together components of the manuscript and provide focus for analysis and activities: Moldmaking and Metalworking in 2014–2015; Colormaking in 2015–2016; Vernacular Natural History and Practical Optics, Perspective, and Mechanics in 2016–2017; Ephemeral Art in 2017–2018, and Making Prints and Other “Impressions” in 2018–2019.

11 co-occurrences found

To ***gild*** with **gold** color and tinsel Once you imitates the basse-taille of **goldsmiths**, ***gild*** the whole glass order to ***gild*** with matte **gold**, one has to pounce so that the composition resembles **gold**. ***Gild*** the day after ***gilding*** after with having applied **gold** color, but wait one ***gild***, and cut your **gold** with a knife near where ***Gilding*** with ground **gold**: Take a coquille of gold ***gild*** your animal with fine **gold**, as much homogenously you can ***gild*** it with gold leaf, and set it
 Removing **gold**: Gold as ***gilding*** goes away
 Removing gold: **Gold** as ***gilding*** goes away if

TAPoRware Tool Parameter Summary

Tool name	Find Text -- Co-occurrence (Plain)
Text source	translatedfolio.txt
Primary pattern	gold*
Co-pattern	gild*
Context	word
Context length	5

Figure 8.3

TAPoRware co-occurrence analysis for the terms “gold*” and “gild*.”

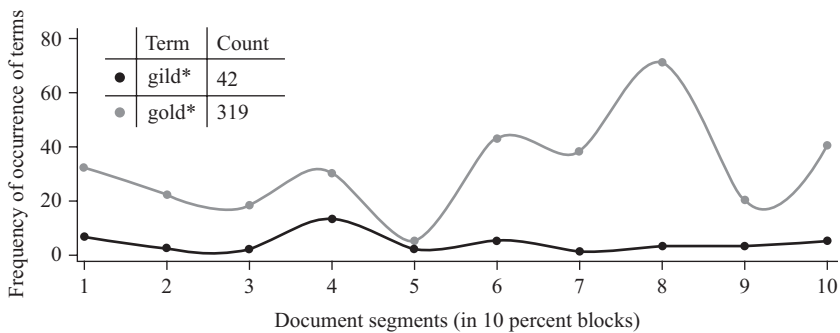


Figure 8.4

Voyant Tools graph showing distribution of terms “gold*” and “gild” across the manuscript.

The first stage of transcription and translation of the manuscript was carried out in a series of three-week paleography workshops that brought together both experts and graduate students. Every year from 2014 to 2018, approximately 15 to 20 graduate students gained skills in middle French script and textual analysis by transcribing, translating, and encoding the manuscript. These workshops resulted in a finalized, accurate, diplomatic transcription, a normalized transcription, and an English translation, all comprehensively marked-up in a custom XML tag set derived from the Text Encoding Initiative (TEI).

Collaborative editing took place via Google's free office software in Google Drive, which enabled the collective work on the manuscript text; multiple paleographers worked simultaneously on the same part of the text and saw edits in real time. Google Drive also crucially permitted all participants (including working group members and visiting experts) to write and view comments on any part of the shared documents. These comments facilitated the collective transcription, translation, and encoding work, and informed the critical apparatus as participants left questions, citations, external research, and most importantly notes about their decisions during all parts of the research and editing process. Throughout the years of Google Drive use, the Project discussed moving to the online software development and version control platform GitHub. While most parts of the Project are now managed there, because of the many collaborators and the limited timespan of grant funding, the Project chose not to manage all collaborative processes with Git.³ The edition infrastructure and content, however, are now fully open-access, nonproprietary, and also adhere to the principles of minimal computing championed by the digital humanities community at Columbia University.⁴

The paleographers' transcription and translation formed the basis for hands-on laboratory research on the recipes carried out by laboratory seminar students in a course offered each fall and spring semester by Columbia's history department (*HIST GR8906: Craft & Science*). Laboratory research focused on understanding materials and processes by means of experimental reconstructions of selected recipes from the manuscript, in which the students comprehensively investigated historical materials, ingredients, processes, tools, and their associated terminology, availability, origin, and scientific significance. Reproducing the manuscript's technical recipes played a crucial role in deciphering this complex text and in understanding the changing

practices of creating, codifying, and transmitting knowledge about nature in early modern Europe. With oversight from course instructors and visiting “expert makers,” the students integrated this research in multimedia essays that now form the historical and material commentary for the digital critical edition of the manuscript.⁵

Each year’s focused research in paleography and laboratory activity culminated in the third component of the Project: annual working group meetings. Each meeting brought together about 20 expert scholars and practitioners with approximately 20 students from the year’s two offerings of the lab seminar to discuss and critique the student-authored research essays. The meetings provided the necessary expert oversight of the digital critical edition and introduced rich new insights from the scholars’ varied disciplines to inform the Project’s research. In the same way, the year’s laboratory research cycle informed the transcription and translation activities of the subsequent summer paleography workshops. The manuscript’s often complex and/or technical descriptions required research of period- or technique-specific terms and materials, and the varied investigations of each component of the Project not only informed one another but also provided a more comprehensive understanding of the manuscript. The interpretation of the manuscript evolved continually in light of the material reconstructions of the lab seminar, the textual and lexical examinations of the paleography workshops, and the knowledge exchange of the working group meetings. This iterative approach is key to the design and methodologies of the *Making and Knowing Project*, because it integrates and enhances student research with critical scholarly consensus. The Project has come to see this approach as replicating the artisanal workshop in its apprenticeship-based learning models.

The final component of the Project was the transformation of the manuscript and the voluminous multimedia research and critical commentary into a public-facing digital environment. The Project is committed to ensuring the sustainability of the edition—an increasing problem in an open, digital age, as other chapters in this volume point out—and thus the functionality of the website and the data it represents were developed using the most durable formats that allow migration and conversion of all digital assets in response to changing technologies. Through the creation of the edition, the Project strives to encourage other digital humanities projects to consider technical debt and preservation considerations early in the development

process. Like the other three components, the digital development followed the Project's methodologies of collaborative research, interdisciplinary knowledge exchange, and pedagogy. This approach began with the encoding and preparation of the text for digital presentation at the first paleography workshop in 2014, and evolved with the addition of new digital staff, collaborators, and course offerings in the digital humanities, including in 2017, when the Project developed and offered its first digital humanities seminar, *HIST GR8975: What Is a Book in the 21st Century?*, which introduced students both theoretically and practically to the concepts and tools relevant to the creation of a digital edition. The seminar equipped participating students with identifiable, measurable, and repurposable digital skills and simultaneously accomplished the research objectives of the Project by prototyping the minimal digital edition, a simplified early model of Ms. Fr. 640. The seminar also encouraged reflection on how the format of texts shapes the production of knowledge in historical and contemporary contexts, an issue also addressed by our collaboration with the Columbia Computer Graphics and User Interfaces Lab (CGUI). CGUI is developing an augmented reality (AR) toolset to complement the digital critical edition, which will enable communication of and interaction with practice-based experiential knowledge, allowing users to experience the process of historical techniques not only through the multimedia critical commentary but also through cutting-edge visualization technology. In many ways, this AR implementation is the perfect twenty-first-century, open counterpart to Ms. Fr. 640's own experimental systems of scholarly communication, once more bringing the "reader" back to the experiential and embodied forms of knowledge in the original manuscript.

This collaboration led to two additional pedagogical initiatives—the integration of historical data from the *Making and Knowing Project* into an existing computer science course in AR and a new advanced cross-listed digital humanities seminar, *HIST/ENGL/COMS GU4031 Transforming Texts: Textual Analysis, Literary Modeling, and Visualization*. The Project's textual, critical, and material data served as the basis for the experimentation with text representation and modes of digital communication by the digital seminars and collaborators, and allowed for the continued exploration of the digital critical edition as a flexible, customizable tool that responds to the needs of students, researchers, and the broader public.

The interrelation of research and pedagogical components proved to be an efficient method of realizing the Project's collective and iterative research

design. Through each cycle, from paleography workshop through lab seminar to working group meeting to digital seminar and prototyping, new insights were gained, accumulating information and generating questions for the next phase in the cycle. The strength of the Project's collaborative research also derives from the fact that the participants not only come together from different disciplinary backgrounds but also possess varying degrees of expertise. Teaching and researching through collective workshops, in which experienced participants overseen by disciplinary experts work closely with novices, has fruitfully facilitated both the training of the novices and the consolidation of knowledge by the more experienced participants.

Dissemination of the *Making and Knowing Project* through a Teaching Platform

The innovative methodologies developed by the Project, partly modeled on the natural scientific research group, have the potential to be applied beyond the study of Ms. Fr. 640. The Project will continue to serve as an incubator of pedagogical and research methodologies and is presently working to go a step further to articulate them in a formal implementation guide: the "Making and Knowing Research and Teaching Companion." The Companion will offer a scalable model with resources that scholars, instructors, and students can use in their own research endeavors or in the classroom, at small or large scales. These resources will include standardized protocols, lesson plans, digital literacy competencies and modes of assessment, templates for research workflows and management, participant testimonials, reports on successful applications of techniques, description of methods and philosophy, and frequently asked questions. The Companion will not provide step-by-step instructions for recreating the *Making and Knowing Project*, but rather will form a resource for others to apply the Project's methodology to their own contexts and needs. It will be freely available on the Project's website and on that of the digital critical edition of Ms. Fr. 640 and will form a platform for dissemination and a demonstration of how experimentation with material practices can provide a site for scholarly communication in the future. The Companion will also ensure that the methodologies employed in the creation of *Secrets of Craft and Nature* are not lost behind the scholarly publication, but instead highlighted and disseminated within the scholarly community and beyond.

Among the most distinctive components of the Project is its exploration of hands-on reconstructions of historical techniques and processes as a form of historical evidence, as well as the integration of this method of inquiry into the classroom. The study of a text from both material and textual perspectives simultaneously—and the challenges of communicating such an approach within textual forms—encourages careful decipherment of terminology and processes in historical making practices. It provides a type of close reading that raises many questions that would otherwise go unasked, questions that often turn out to be crucial for insights into historical practices and attitudes toward the natural world, materials, and processes. Moreover, the challenges of reenacting the skilled material manipulations of an artisan provide valuable, experience-driven understanding of embodied forms of knowledge that cannot be accessed through conventional historical research and pedagogy. Learning skilled handwork, whether in workshop or laboratory, also proves valuable in itself for students and scholars: the process of trial, failure, replication, and extension in both hypothesis and experiment design, as well as the practice of close observation (both of one's fellow worker at the bench and of the material being experimented upon) not only inculcate manual skills but can also enhance cognitive abilities of observation and reflection.

In the process of reconstructing a historical procedure, a participant also gains literacy in and firsthand knowledge of techniques and materials that can only come from engagement with process. Some techniques wholly lost or indecipherable, such as the long-confounding “incuse reverse casting” described in Ms. Fr. 640 and reconstructed in the fall 2014 lab seminar, are only recoverable through the process of attempting to recreate them. These attempts often require repeated trials, improvisation, creative reinterpretation, integration of available complementary sources or information, and a responsive and adaptive approach to unexpected outcomes. This goes against the grain of much contemporary textual scholarly communication, reintegrating an openness to processes and objects into the research lifecycle.

The Project's deciphering of the manuscript's ruby glass recipe, for example, required not only multiple trials in response to unanticipated results but also the collective expertise of historians, material scientists, geochemists, glassblowers, artists, curators, and students. This demonstrates the Project's collaborative and interdisciplinary approach, which facilitates and

relies on collective interaction and knowledge sharing among individuals of varying disciplinary backgrounds who offer unique perspectives, approaches, and skillsets. The range in skill levels forces participants to clearly articulate and communicate ideas, problems, and gaps in information, knowledge, and expertise toward the common goal of producing new and significant scholarship.

Additionally, the sharing of knowledge and expertise among Project staff, collaborators, and students mitigates gaps in skill or experience, frequently following an “apprenticeship” model, as each participant imparts knowledge and trains other Project participants in their specialization—whether as a visiting expert maker leading skill-building sessions (such as teaching lab seminar students how to incorporate pigment into binding media), or as returning paleography students mentoring and training newcomers in the requisite skills as well as the Project’s methodologies and protocols.

These multidisciplinary, expertise-directed, and process-oriented practices undergird the Project’s pedagogy-driven research. Pedagogy is an integral part of every component of the Project (transcription, translation, reconstruction, working groups, and digital development). By making all students active participants in and contributors to core research, the Project provides training and engagement unlike traditional undergraduate and graduate lecture and seminar courses. Following the precepts of project-based learning, the students’ acquisition of skills by generating research content cements their newly gained understanding of both concepts and tools, and allows them to employ these skills and new ways of thinking in other courses, in their own research, and in their future careers.

The *Making and Knowing Project* has been a collaborative and interdisciplinary endeavor since its inception. This has necessitated physical and intellectual openness to allow disciplinary differences to permeate the undertaking. In all aspects of research and development, the creation of the digital critical edition has brought together scholars, researchers, practitioners, and students to interpret the text, to attempt to replicate and understand its recipes and procedures, and to participate in its representation in a digital environment. In conjunction with the Project’s reciprocal, iterative design, this interdisciplinary approach presents a rich and efficient model for collaborative research. Each step of the Project is critically informed by the preceding steps and consequently informs the succeeding steps. The *Making*

and *Knowing Project* Research and Teaching Companion will provide a flexible and adaptable resource for other nascent projects and will allow the Project's impact to expand beyond its own research focuses and timeline.

Results

At root, the Project asks what a book *was* in the sixteenth century, what a book is *for* in the twenty-first century, and what it can *do* for us. Until recently, the form of the book, as printed codex, was taken as a standard for the production and dissemination of knowledge. Current research on the early modern era has disrupted an overly simplified conception of the book, revealing that even in the age of Gutenberg, books were often collectively compiled and the idea of a single author with a proprietary right to the creative content of a text was the exception. Our assumptions that printed books superseded the inefficient and limited communication of manuscript culture have been discredited by a more sophisticated understanding of writing technologies. The medieval scriptorium did not end because of a new technology of “artificial writing”; print and manuscript coexisted well into the eighteenth century, and Ms. Fr. 640 is a testament to this longevity. Early modern knowledge was made through the circulation of many different forms of media (including letters, manuscripts, instruments, and objects—among them printed books). This proliferation of media was not entirely dissimilar to today's blogs, zines, websites, web projects, e-books, minimal online publishing (e.g., [sx:archipelagos](http://sx.archipelagos.com)), digital databases and archives, online exhibits, streaming videos, and podcasts. The “printed book” as a monolithic concept—containing and conveying knowledge seamlessly from author to audience—seems increasingly inadequate to describe the products of the past, let alone where we are going in the present. However, in spite of the discrediting of this narrative, it continues to constrain scholarly and public conceptions of how knowledge is conveyed: we strive to imitate a “reading experience” on our digital humanities platforms. We “turn pages” on our devices. We view the text as if it were simply a sheet of paper, rather than metal, plastic, and liquid crystal; and we naively neglect to consider it as containing proprietary code that can be used to look back at its readers or potentially to censor text automatically.

Drawing upon a deep interest in what it means to make and communicate knowledge (a central concern of the history of science and technology),

the *Making and Knowing Project* rethinks the book as a scholarly object for the twenty-first century from the perspective of the early modern world. To recapture this exciting and highly experimental moment in human history and to allow people today to access it more vividly, the scholars of the *Making and Knowing Project* aim to think creatively with the technologies available to us today. How can we effectively present historical content and analysis in ways that communicate the dynamic and multidimensional nature of texts, especially that of a how-to text? Through the iterative process described above, the *Making and Knowing Project* is disassembling the manuscript's assemblage of written and practiced activity by means of unusual methodologies and pedagogy-driven research, which includes historical laboratory reconstructions and new tools in the digital humanities. The Project's edition combines text- and object-based historical research with laboratory experimentation, computer science, digital humanities, visualization, and design research in order to communicate the results of its investigations in ways that are intellectually rigorous, methodologically innovative, and able to draw in new audiences and participants. One important outcome of the Project's disassembly and reassembly of Ms. Fr. 640 has been to demonstrate that disciplinary divides between science, art, craft, and the humanities can also be dismantled in the research and publication process.

Notes

1. Among numerous works, see the publications of Nancy Siraisi; in particular, Gianna Pomata and Nancy G. Siraisi, eds., *Historia: Empiricism and Erudition in Early Modern Europe*, Transformations (Cambridge, MA: The MIT Press, 2005), especially the introduction; and Gianna Pomata, "Praxis Historialis: The Uses of Historia in Early Modern Medicine," in *Historia: Empiricism and Erudition in Early Modern Europe*, ed. Gianna Pomata and Nancy G. Siraisi, Transformations (Cambridge, MA: The MIT Press, 2005), 105–146; of Pamela O. Long, especially, "Hydraulic Engineering and the Study of Antiquity: Rome, 1557–70," *Renaissance Quarterly* 61, no. 4 (2008): 1098–1138, <https://doi.org/10.1353/ren.0.0320>; and Pamela O. Long, *Artisan/Practitioners and the Rise of the New Sciences, 1400–1600* (Corvallis: Oregon State University Press, 2011); of Gianna Pomata, especially, "Observation Rising: Birth of an Epistemic Genre, ca. 1500–1650," in *Histories of Scientific Observation*, ed. Lorraine Daston and Elizabeth Lunbeck (Chicago: University of Chicago Press, 2011), 45–80; and of Pamela H. Smith, especially, *The Body of the Artisan* (Chicago: University of Chicago Press, 2004). See also the works of Deborah Harkness, Alexander Marr, and Cristiano Zanetti's, *Janello Torriani and the Spanish Empire: A Vitruvian Artisan at the*

Dawn of the Scientific Revolution, Nuncius Series: Studies and Sources in the Material and Visual History of Science, vol. 2 (Leiden: Brill, 2017).

2. The edition is openly accessible as the Making and Knowing Project, Pamela H. Smith, Naomi Rosenkranz, Tianna Helena Uchacz, Tillmann Taape, Clément Godbarge, Sophie Pitman, Jenny Boulboulé, Joel Klein, Donna Bilak, Marc Smith, and Terry Catapano, eds., *Secrets of Craft and Nature in Renaissance France: A Digital Critical Edition and English Translation of BnF Ms. Fr. 640* (New York: The Making and Knowing Project, 2020), <https://doi.org/10.7916/78yt-2v41>. For more information on the *Making and Knowing Project*, including a roster of team members, collaborators, and supporters, see <http://www.makingandknowing.org/>. The Project thanks the National Science Foundation, the National Endowment for the Humanities, the Henry Luce Foundation, the Science History Institute, the Gerda Henkel Foundation, the Gladys Kriebel Delmas Foundation, the Florence Gould Foundation, the Maurice I. Parisier Foundation, and Howard and Natalie Shawn for support.

3. Git is a version-control system initially developed by Linus Torvalds for the collaborative work on his Linux operating system. GitHub is a third-party hosting platform, now owned by Microsoft, that plays home to thousands of projects that use the Git versioning system, allowing large-scale and international collaboration on these efforts. While Git was designed for software development, it can be used in any collaborative working setup where maintenance of versioning is desirable.

4. An example of this minimal computing approach is the Project's 2017 minimal edition: <https://cu-mkp.github.io/2017-workshop-edition/>. Our thanks to Terry Catapano for his contribution to this edition.

5. The *Making and Knowing Project* photo repository from the lab reconstruction experiments can be accessed at: <https://www.flickr.com/photos/128418753@N06/albums>.

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Histories, Infrastructures, and Global Politics of Open Access

Edited by: Martin Paul Eve, Jonathan Gray

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