Reconstructing Early Modern Artisanal Epistemologies and an "Undisciplined" Mode of Inquiry

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Abstract: This essay presents an overview of the Making and Knowing Project and its approach to teaching hands-on history of craft and science through the lens of an early modern manuscript compilation of artisanal recipes. It calls attention to the advantages and challenges of cultivating student skills through an intensive program of problem-based pedagogy, highlights the transformative potential of experiential learning, and introduces the Project's next initiative: a "Research and Teaching Companion" to help users integrate exploratory, question-generating experiments into the classroom and project design.

Within the darkened lecture hall of first-year Art History, in the dying days of film slide projection, the man in the red scarf, Jens T. Wollesen, turned to his incoming undergraduates and said: "An art historian must make art to understand art." With that, he clicked ahead to show us slides of his own paintings, discussing his process and advertising his *bona fides* as both maker and historian. I had a vague sense that there was an important truth to his words, but, for convenience and from hubris, I dismissed the thought to a dusty corner of my mind. It was quaint to think that an art historian should find the time to practice art as well.

Years later, memories of this episode would return to help bookend my student experience. Shortly after defending my Ph.D., I found myself standing next to the historian of science Pamela H. Smith in a chemistry lab at the University of Toronto, turning cochineal insects into lake pigments. Smith was leading a pigment-making workshop as part of a guest lecture series on her research initiative, the Making and Knowing Project at Columbia University.[1] Beneath the hum of the fluorescent lights, metaphoric bulbs were lighting up in my head. An afternoon

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Acknowledgments. My reflection draws on the collective experience of the M&K team, its students, and its many collaborators (https://edition640.makingandknowing.org/#/content/about/credits); it was shaped, in particular, by generous conversations and work with Pamela H. Smith and Naomi Rosenkranz. I also gratefully acknowledge the Project's institutional and private supporters (https://edition640.makingandknowing.org/#/content/about/sponsors).

[1] Project website: https://www.makingandknowing.org/ (accessed 16 Apr. 2020). Smith was the 2016 Distinguished Visiting Scholar at the Centre for Reformation and Renaissance Studies, University of Toronto.

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of crushing, soaking, precipitating, washing, and filtering with Smith gave me a new receptiveness to Wollesen's message and its particular relevance for my work going forward as a historian of early modern art.[2] That brief encounter in the lab soon led to four years of postdoctoral research and hands-on teaching at the nexus of history, art, and science.

By the time I joined the Making and Knowing Project (hereafter M&K or the Project), it was already two years into its six-year core undertaking (2014–2020): to produce a digital critical edition and English translation of BnF Ms. Fr. 640—a little-known manuscript penned by an anonymous artisan working in the environs of Toulouse, likely in the 1580s. The manuscript's 170 folios contain over nine hundred entries, which comprise technical instructions, craft recipes, observations, and pieces of practical advice about a wide variety of subjects ranging from painting, glasswork, casting in precious metals, and the use of heavy artillery to medicine, cultivation, animal husbandry, and sleight-of-hand tricks. The language, illustration, and annotation of the manuscript's entries evince the breadth of the author-practitioner's encounters with other artisans and the depth of his experiential knowledge, which allowed him to push beyond his evident expertise in fine metalwork to posit and experiment with new practical uses for familiar materials. This rare manuscript offers a glimpse into early modern artisanal epistemologies and knowledge exchange at a time when craft making was a mode of scientific knowing.

M&K's research methods, which involved hands-on reconstructions of the manuscript's craft recipes in graduate history seminars held in the Project's wet lab, had already energized Columbia's students, who eagerly explored new questions and ways of questioning that required expertise outside their disciplinary training. Given my own trajectory, I understood their enthusiasm for experiential learning and its potential to broaden one's personal and professional goals. Thus, a second and vital aim for M&K was coming into focus around the time I arrived: to help prepare students for increasingly collaborative and interdisciplinary cultures of work in and outside of academia. As the Project progressed, we refined a suite of hands-on, lab-based seminars and summer workshops in which scholars and expert practitioners mentored students in textual studies (paleography, translation, and encoding), performative research methods, and issues in material, technical, and digital literacy, all the while generating outputs that contributed to our overarching publication goal. In short, we adapted the model of the university STEMM lab to a (digital) humanities project. Our recently released digital critical edition, *Secrets of Craft and Nature in Renaissance France*, demonstrates that this model of hands-on, pedagogy-driven research leads to significant outcomes for scholars and students alike.[3]

Working in the tradition of teaching science history through case studies, we have been reconstructing not canonical historical experiments but a historical mode of exploratory and iterative scientific investigation.[4] This has proved a useful approach toward bridging the "two-cultures" divide—C. P. Snow's well-known and still useful framing of the chasm between

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[2] Regarding the historic indifference of art historians toward materials and making processes see Ann-Sophie Lehmann, "Wedging, Throwing, Dipping, and Dragging: How Motions, Tools, and Materials Make Art," in *Folded Stones: Tied Up Tree*, ed. Barbara Baert and Trees de Mits (Leuven: Acco, 2009), pp. 41–60, esp. pp. 41–48.

[3] Making and Knowing Project, Pamela H. Smith, Naomi Rosenkranz, Tianna Helena Uchacz, Tillmann Taape, Clément Godbarge, Sophie Pitman, Jenny Boulboullé, 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: Making and Knowing Project, 2020), https://edition640.makingandknowing.org/. This publication was the recipient of the 2019 Eugene S. Ferguson Prize from the Society for the History of Technology, with particular distinction for methodological novelty and rigor.

[4] On this case study tradition and its relationship to an experimental mode see Christopher Hamlin, "The Pedagogical Roots of the History of Science: Revisiting the Vision of James Bryant Conant," *Isis*, 2016, *107*:282–308, https://doi.org/10.1086/687217. M&K's approach yields something akin to what H. Otto Sibum describes as "a material-aesthetic approximation to the historical performance," thereby refocusing attention not on outcome but on process: H. Otto Sibum, "Experimental History of Science," in *Museums of Modern Science* (Canton, Mass.: Science History, 2000), pp. 77–86, on p. 81.

literary and scientific cultures.[5] We have designed our seminars and workshops to give humanities and social sciences students firsthand experience of working within an expansive conception of science that sees it as the fundamental human drive both to understand the natural world and to transform it to meet changing needs and desires.[6] This conception allows students to recognize artworks, craft products, and the experiential knowledge of the maker as central to the history and continued practice of science. These insights are greatly facilitated by our object of study, Ms. Fr. 640, which evinces how craft making was a means to investigate nature at a time when there had yet to emerge the ideological and hierarchical divisions that today see modern scientists, humanities scholars, and artists siloed off into discrete disciplines, spaces, and spheres of influence.[7] Accordingly, M&K seeks to recover not only the artisanal epistemologies of early modernity but also its "undisciplined" (in the sense of "nondisciplinary"), exploratory, and collaborative attitude toward material investigation, an approach that can be as instrumental to the production and transmission of knowledge today as it was half a millennium ago.

THE PROJECT

The Project's approach to science history pedagogy was determined by its overarching goal to produce a digital critical edition of Ms. Fr. 640, and the final contours of that edition help convey aspects of our project design. In February 2020 M&K launched *Secrets of Craft and Nature in Renaissance France*, which presents the manuscript's text in four forms: high-definition facsimiles of the manuscript pages, a diplomatic transcription of the original French, a lightly normalized transcription, and an English translation. The edition includes more than thirty introductory essays by invited scholars, over eighty multimedia student research essays, lab notes from recipe reconstructions, text-level editorial comments, a glossary of terms, search and filter features, and links to raw data files for export and analysis. The work of creating this edition has been accomplished by the core Project team and over four hundred collaborators worldwide, including practicing artists, historians of art and science, museum scholars, conservators, materials scientists, digital humanists, data scientists, librarians, and students.[8] In fact, graduate students have been essential to M&K's work, as the transcription, translation, digital encoding, laboratory reconstructions, and digital prototyping have all been performed by students working under the guidance and mentorship of postdoctoral scholars, university faculty, and skilled practitioners.

Work was structured according to four components.[9] Across seven Text Workshops open to participants from around the world, experts taught Middle French paleography and translation skills as well as the skills of digital encoding to over seventy graduate students. These students, in turn, produced and refined M&K's three versions of the manuscript's text for the edition. Over seventy additional students participated in regularly scheduled graduate Laboratory Seminars, "Craft and Science: Making Objects in the Early Modern World," offered through Columbia's Department of History and held in M&K's wet lab. These students performed historical

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[5] Snow first articulated this framing in a 1959 Rede Lecture. See C. P. Snow, *The Two Cultures* (New York: Cambridge Univ. Press, 1998).

[6] This expansive understanding of science arose in the 1960s with the scholarly turn toward social, cultural, and feminist histories and the sociology of knowledge. For the legacy of these movements see Pamela H. Smith, "Science on the Move: Recent Trends in the History of Early Modern Science," *Renaissance Quarterly*, 2009, 62:345–375, https://doi.org/10.1086/599864.

[7] For one history of these divisions and their stakes see Steven Shapin, "Making Art / Discovering Science," *KNOW: A Journal on the Formation of Knowledge*, 2018, 2:177–205, https://doi.org/10.1086/699899.

[8] For more on the Project's various collaborations see "Collaborations," https://www.makingandknowing.org/collaborators/ (accessed 16 Apr. 2020).

[9] See also Pamela H. Smith, "Making the Edition," in *Secrets of Craft and Nature in Renaissance France*, ed. Making and Knowing Project *et al.* (cit. n. 3), https://edition640.makingandknowing.org/#/essays/ann_329_ie_19.

reconstructions of around 120 craft recipes in the manuscript and produced experiment field notes and research essays that form part of the critical apparatus of the digital edition. Annual Working Group Meetings brought experts and practitioners from around the world—scholars, curators, scientists, and makers—to provide critical oversight for the student essays and translation work, effectively functioning as peer review. Finally, Digital Development worked to curate M&K data and develop the online environment for the edition, informed by M&K's two Digital Humanities (DH) seminars at Columbia.[10] Cross-listed between the Departments of History, English, and Computer Science and offered to graduate students and advanced undergrads, these seminars yielded prototypes of the edition itself as well as digital textual analyses that inform M&K's understanding of the manuscript and future plans.

The Project's activities and pedagogy have required significant support.[11] Two National Science Foundation standard research grants (2014–2017; 2017–2020) furnished lab supplies, supported a Project administrative assistant, and maintained regular activities (Text Workshops, Working Group Meetings). M&K's three postdocs were funded by one annual fellowship from the Science History Institute (2014–2017) and two annual teaching fellowships at Columbia (2014–2020); the Gerda Henkel Foundation supported research in French archives by a local postdoc. An NSF conference grant (2017–2018) facilitated encoding-focused Text Workshops, while a National Endowment for the Humanities scholarly editions and translations grant (2016–2020) supported our digital consultant and designer-developers.

Importantly, M&K was an inaugural research cluster in Columbia's Center for Science and Society (CSS), also founded by Smith in 2014. CSS's mission to "break down traditional disciplinary silos and create a new interdisciplinary paradigm of training and collaboration" has helped the Project frame its pedagogical goals.[12] These have led to a Henry Luce Foundation higher education grant (2017–2020) and teaching-focused support from several private foundations and donors. Internally, Columbia's Collaboratory program facilitated work with computer scientists and supported our DH seminars, as did a Provost's Hybrid Learning Grant. This exceptional confluence of funding and institutional support speaks to Columbia's privileged situation. It also speaks to our historical moment, in which higher education is rethinking its mission in the face of significant social and technological challenges. Our course design has tried to keep those challenges in mind.

HANDS-ON WORKSHOPS AND SEMINARS: FEATURES, SUCCESSES, ROADBLOCKS

In order to reconstruct in the classroom something of an early modern artisanal epistemology and its unbounded, experimental, and collective approach to knowledge production, the Project team made some deliberate and consequential decisions. None of our Columbia seminars would require students to arrive with specialized skills in hand; rather, by eliminating prerequisites, we focused our pedagogy on skill building and skill consolidation in the production of a learning artifact—the edition and its components.[13] Our courses and workshops offered students the unusual opportunity to mentor closely with a team of five to seven core Project scholars in traditional research methods, performative methodologies, digital skills, and scholarly

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[10] Particular thanks is due to M&K's DH seminar co-instructors: Terry Catapano (then of Columbia University Libraries), Dennis Tenen (English and Comparative Literature), and Steven K. Feiner (Computer Science).

[11] For a list of the Project's grants and supporters see "Sponsors," https://edition640.makingandknowing.org/#/content/about/sponsors (accessed 16 Apr. 2020).

[12] Center for Science and Society website: https://scienceandsociety.columbia.edu/ (accessed 16 Apr. 2020).

[13] For a recent articulation of problem-based learning see Laura Helle, Päivi Tynjälä, and Erkki Olkinuora, "Project-Based Learning in Post-Secondary Education: Theory, Practice, and Rubber Sling Shots," *Higher Education*, 2006, 51:287–314.

writing for publication, and students produced capstone projects that became credited contributions to the edition.[14] This course design attracted curious and motivated students from a wide range of backgrounds, including history, art history, material culture studies, anthropology, sociology, chemistry, creative writing, comparative literature, and computer science. The collective intelligence engendered by these various backgrounds made for enriched interactions during class discussions and activities. Additionally, we welcomed guest students from Bard Graduate Center, Parsons School of Design, and the universities of Cambridge and Hong Kong; we conducted parallel course modules via teleconferencing with colleagues and students at the universities of Glasgow and Amsterdam; and we invited local artists to join classroom activities. This open classroom concept and the varying range of skills among participants recapitulated aspects of the premodern workshop and guild system: as the lab activities and discussion topics shifted within the seminar, so too the senior scholars, expert makers, postdocs, and students shifted, in turn, in and out of the roles of apprentice, journeyman, and master.[15]

These features of our course offerings—their low barrier to entry, emphasis on skill building and hands-on learning, open crediting of student work, and opportunities for close mentorship, collaborative work, and interdisciplinary knowledge exchange—have led to notable student successes. Some students have worked with M&K team members to develop their Lab Seminar research into independent studies or scholarly publications.[16] Several Ph.D. students have changed dissertation topics to include questions from material and technical history, added hands-on research components to their thesis plans, or even restructured their thesis data in response to our DH seminars. Such changes affirm the power of hands-on methods to raise engaging questions hardly conceivable outside of an embodied encounter with materials and techniques, whether physical or digital. Finally, at a more fundamental level, students educated within a paradigm that prizes theoretical knowledge and the authority of the written word have begun to embrace the messier and less easily articulated value of experiential knowledge, embodied cognition, and materials and craft objects as repositories of knowledge; fittingly, this embrace of alternative modes of knowing and communicating has generated unprompted artistic responses to the Project and its object of study.[17]

Most significantly, the first cohorts of Text Workshop and Lab Seminar students and M&K postdocs have begun their own teaching careers in K–12 and higher education, and they are adapting Project themes and hands-on approaches in their classrooms.[18] The longer-term outcomes for students introduced to an expansive conception of science through early and ongoing

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[14] For a full list of student collaborators and the nature of their contributions see "Credits," https://edition640.makingandknowing.org/#/content/about/credits (accessed 16 Apr. 2020).

[15] This approach mitigates criticism of the apprenticeship model in higher education, particularly its hierarchical power dynamics and dependencies on one "master" advisor. See Thomas Bender, "Expanding the Domain of History," in *Envisioning the Future of Doctoral Education: Preparing Stewards of the Discipline*, ed. Chris M. Golde (San Francisco, Calif.: Jossey-Bass, 2006), pp. 295–310.

[16] See, e.g., Kathryn Kremnitzer, Siddhartha V. Shah, and Wenrui Zhao, "Three Recipes for Historical Reconstruction," *Common Knowledge*, 2018, 24:389–396, https://doi.org/10.1215/0961754X-6939781; Pamela H. Smith, Joslyn DeVinney, Sasha Grafit, and Xiaomeng Liu, "Smoke and Silkworms: Itineraries of Material Complexes across Eurasia," in *Entangled Itineraries of Materials, Practices, and Knowledges across Eurasia*, ed. Smith (Pittsburgh: Univ. Pittsburgh Press, 2019), pp. 165–181; and Smith and Isabella Lores-Chavez, "Investigating, Philosophizing, and Imitating in the Early Modern Workshop," in *The Matter of Mimesis*, ed. Marjolijn Bol and Emma Spary (Leiden: Brill, forthcoming).

[17] These include poems about Ms. Fr. 640 and the experience of cultivating silkworms as well as a song on "terre chimolée," an enigmatic material in the manuscript.

[18] See, e.g., Donna Bilak's hands-on jewelry history courses with Inuit Metal Arts students at Nunavut Arctic College, "Arctic Metal Arts," https://dbilakpraxis.com/arctic-metalarts/, and the resulting web exhibition, "The Frozen Museum," http://frozenmuseum.cngo.ca/ (accessed 16 Apr. 2020).

opportunities for hands-on exploration are as yet unclear; nevertheless, our anecdotal evidence, cited above and gathered through exit interviews, points to stronger, more diverse engagement and greater comfort among nonscience students in *doing* science and studying its histories—a conclusion similar to that reached by other contributors to this Focus section.[19]

Despite these various and ongoing successes, the road has not been entirely smooth. First, the semester cycle makes for very dense and demanding seminars, particularly as we require no prerequisites and structure our courses to have students deliver publication-ready results or significant prototypes within four months. This means that the instructional team must give basic overviews of issues in early modern history, the history of science, the interpretation of historical texts, best practices for documentation of hands-on work, and introductions to *either* historical reconstruction, lab safety, materials sourcing, and hands-on making techniques *or* command line functions, data management, version control protocols, and digital humanities project design. As one student wrote in a course evaluation, M&K seminars are "like drinking from a fire hose." From the instructional and administrative side, many hands are needed to steady that fire hose.

Our particular design and adaptation of the natural sciences lab model to include a team of postdoctoral scholars, project administrators, and student researchers demands considerable organizational effort and funding, as detailed above. Moreover, as a university research project, we have encountered bureaucratic hurdles that impact participation. It has been challenging at times to draw in faculty and staff from other departments and ensure compensation for coteaching, to cross-list courses in other faculties to appeal to a broader range of students, and to schedule lab time within a humanities course-crediting system designed around discussion seminars. Moreover, the time-intensive nature of our courses has limited the number of science and engineering students willing to enroll, as they find it challenging to accommodate our lab time in their schedules, which are already busy with labs for other courses.

The Project has, however, overcome a major institutional barrier in securing a laboratory in Columbia's Department of Chemistry for research and instruction. Shared physical space in the university itself marks a significant step toward overcoming the "two cultures" division and compartmentalization on campus, providing a point of access for humanists into the cultures and environments of science research. Nevertheless, this achievement remains isolated; for now, Pamela Smith is the only humanities professor at Columbia to oversee a wet lab.

THE "RESEARCH AND TEACHING COMPANION"

While our pedagogy-driven research has yielded useful insights into the material transformations, technical skills, knowledge, and knowledge networks of early modern artisans, the Project's methods seem to interest scholars and educators in equal measure. To address this interest and extend the utility of *Secrets of Craft and Nature in Renaissance France*, we are preparing a "Research and Teaching Companion" (Spring 2021). It will encourage teaching with the edition and share our approach to iterative, hands-on experimental history of craft and science, interdisciplinary distributed collaboration, and exploratory analyses in the digital humanities. It will include an overview of our methods and principles, research workflows and management guides, tips for collaborative editing and textual analysis, syllabi, lesson plans, assignments and reconstruction protocols, digital and material literacy competency calculators

[19] See the essays by the Dean College group, Frederica Bowcutt and Tamara Caulkins, and Vivien Hamilton and Daniel Stoebel in this Focus section. See also the conclusions in Hasok Chang, "How Historical Experiments Can Improve Scientific Knowledge and Science Education: The Cases of Boiling Water and Electrochemistry," *Science and Education*, 2011, 20:317–341, https://doi.org/10.1007/s11191-010-9301-8, esp. pp. 335–337.

and modes of assessment, participant testimonials and reports on successful applications of techniques, and answers to frequently asked questions. Our syllabi and select draft assignments are already available on the Project website.[20] We conceive of the "Companion" as an adaptable, scalable design guide and resource set that affirms what many readers of this essay will already know: hands-on history of science can be taught while accommodating various constraints, including restricted budgets, lack of lab space, and limited support staff.

For instance, one relatively inexpensive activity can highlight issues in early modern knowledge transmission, material improvisation, and intermediary craft processes. Ms. Fr. 640 includes two recipes on folio 140v that use freshly baked bread as a mold material, with the model pushed into the warm innards of the bread and molten sulfur cast into the impression. Each cohort of our Lab Seminar students has sourced early modern bread recipes, learned to bake bread at home from a sourdough starter, and tried "bread molding," casting together in class with either molten wax or, in the fume hood of our lab, sulfur. This activity prompts them to consider why so few early modern bread recipes are recorded, what kind of embodied knowledge bread baking requires, why and how quotidian materials might have been used in artisanal workshops, why bread molding is almost entirely unattested elsewhere, and what it could have been used for.[21] While we teach bread molding to build critical and hand skills that our students will use in later recipe reconstructions, this activity can be taught as a stand-alone module that requires little more than home ovens, flour, wax pellets, and a hot plate.

Our "Companion" will lay out possibilities for scaling and contextualizing various Project activities, including bread molding, for new research and classroom settings. It also aims to encourage novel investigations of Ms. Fr. 640 by sharing examples of work from our collaborators. Take, for instance, the independent study designed by a student at PRISMS high school in Princeton, New Jersey, to assess whether molds reconstructed from the sands and binders described in the manuscript might leave chemical fingerprints in their finished casts.[22] This study shows how the Project's work of transcription, translation, lab reconstructions, and open-access publication offers not only material for new research but a model for exploratory, hands-on history of science. In this way, we hope the "Companion" will continue to encourage users beyond the Columbia community to think about science in a way that makes space for alternative and inclusive ways of learning, thinking, and creating knowledge.

CONCLUSION

The Making and Knowing Project is modeling a new take on a centuries-old apprenticeship-based and constructivist pedagogy at the nexus of the humanities and the sciences, one that stresses the value of alternative ways of knowing—making, experimentation, hand skills, collaboration, and failure—that can enhance traditions of textual scholarship. We believe that this kind of integrative and hands-on pedagogy has the potential to transform classrooms, workplaces, and even global marketplaces by fostering a culture of curiosity and bold-yet-everyday innovation. Such a claim is at once grandiose in scope and modest in method; it is also in line with the

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[20] See "Lab Seminars," https://www.makingandknowing.org/laboratory-seminars/ (accessed 16 Apr. 2020). For DH syllabi see "Digital," https://www.makingandknowing.org/digital/ (accessed 16 Apr. 2020).

[21] See Emma Le Pouésard, "Pain, Ostie, Rostie: Bread in Early Modern Europe," in *Secrets of Craft and Nature in Renaissance France*, ed. Making and Knowing Project *et al.* (cit. n. 3), https://edition640.makingandknowing.org/#/essays/ann_046_fa_16; and Min Lim, "To Shrink an Object: Bread Molding in Ms. Fr. 640," *ibid.*, https://edition640.makingandknowing.org/#/essays/ann_076_fa_18.

[22] Roxanne P. Spencer and Yingyi Liang, "Recipe for Developing High-School Research Projects Illustrated by a Student's Interpretation of Historical Metal Casting," *Journal of Chemical Education*, 2019, 96:1117–1123, https://doi.org/10.1021/acs.jchemed.7b00917.

findings and recommendations of a recent consensus study report on STEMM in higher education by the National Academy of Sciences, as well as mounting case studies detailing experiments in problem-based learning, design thinking, and hands-on STEAM curricula in K–12.[23] A broadened and firsthand understanding among students of how knowledge and objects are created and by whom gives underrepresented demographics a foothold in STEMM fields—fields that, as Frederica Bowcutt and Tamara Caulkins also note in their essay in this Focus section, stand to gain new collaborators with alternative and complementary experiences, expertise, and cultures of communication and work.

M&K's pedagogical approach offers an expansive notion of science that encompasses the creative and the quotidian. It thereby familiarizes science—not as a rarefied set of processes confined to restricted-access laboratories but as a means of exploring, experimenting, and making in the world. Hands-on engagement and historical reconstruction help students to see their place in the shared human endeavor to transform, through contingent performances, the stuffs of nature into knowledge objects—experimental proofs of concept, materialized traces of process, and, ultimately, works of craft and art. These methods of investigation are not only for budding historians of science but for those students who find themselves scrolling through articles in online repositories, sifting through texts in archives and libraries, and sitting in darkened lecture halls and longing for a better grasp of how materials and making matter.

[23] National Academy of Sciences Consensus Study Report, *The Integration of the Humanities and Arts with Sciences, Engineering, and Medicine in Higher Education: Branches from the Same Tree* (Washington, D.C.: National Academies Press, 2018). Rather than being limited by the "dearth of causal evidence [i.e., from randomized, controlled, longitudinal study] on the impact of integrative courses and programs on students" (p. 170), the NAS recognizes the value of multiple and other forms of evidence (e.g., narrative, anecdotal, case-study, and quasi-experimental), supporting the claims of educators, employers, and students themselves who value outcomes of integrated learning. For reports of such work in K–12 settings see, e.g., Tamarah Gal Henderson, Peter Vogel, and Meghan Campagna, "MakerSpace to Capstone: Plans and Progress towards an Integrated K–12 Design Thinking and STEAM Curriculum," *International Journal of Designs for Learning*, 2017, 8(1):22–38, https://doi.org/10.14434/ijdl.v8i1.22664; and Michael Gettings, "Putting It All Together: STEAM, PBL, Scientific Method, and the Studio Habits of Mind," *Art Education*, 2016, *69*(4):10–11, https://doi.org/10.1080/00043125.2016.1176472.