

Science and/as work: An introduction to this special issue

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Abstract

This brief essay introduces a special issue dedicated to exploring two themes: “science and work” and “science as work.” Following a brief overview of these two themes, it briefly describes the other contributions to the special issue.

Keywords

history of science, labor history, science and labor, science and political economy, historiography

Two years ago, we began organizing a conversation between historians of science and labor historians, convinced as we were – and continue to be – that their interaction could shed revealing light on the twin themes that inform this special issue: “science and work” and “science as work.” Together, these themes invite a reconsideration of who and what are involved in the full gamut of work that science entails, the extent to which scientific work was and continues to be entangled with other sorts of labor, and – thereby – science as inextricably embedded in political economy. To get things started, we secured the generous support of the Science History Institute in Philadelphia and circulated a Call for

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Papers that laid out the challenges and goals we hoped to approach.¹ The response was overwhelming; over 160 abstracts arrived from scholars working in history, science and technology studies, historical sociology, labor studies, media studies, and of course, history of science.

Proposals clustered around six themes that we used to organize the June 2022 conference: “(Un)making labor invisible”; “Reconsidering material and knowledge production”; “Labor: What counts and what can be counted”; “Laboring bodies, embodied labor”; “Labor takes place: Workscapes, topography, and infrastructures”; and “Materials, nonhumans, and the turn toward global history.” In the months leading up to the conference, participants involved in each of these clusters engaged in various forms of online collaboration (brainstorm sessions on Zoom, cowritten position papers, group bibliographies, etc.). We were lucky enough to recruit several prominent scholars to join these discussions as “super commentators” who kept an eye on the big picture. And then the meeting took place – an “un-conference,” as such gatherings are sometimes called, when twenty-minute research papers are banned and panels are encouraged to maximize their engagement with the audience and with one another. Amidst a sea of post-it notes, breakout discussions, and “reverse q&a” sessions, the engaged enthusiasm was palpable, further reinforcing the sense that we were involved in a project of great significance.

Instead of a traditional conference volume, we have channeled the energy and insight of our meeting into a set of coordinated publications spread across three journals. In addition to this special issue, readers can find preliminary results in an *Isis* Focus Section and a special issue of *Labor: Studies in Working-Class History*.² Collectively, these publications speak to the realization that labor history and the history of science, which have seen sparse interaction in the past, have much to offer each other. Strikingly, these fields are already moving in similar directions, striving for greater inclusivity as they look beyond recognized scientists and industrial workers to recover the historically crucial presence of women, unpaid and unfree workers, and others whose labor has been effaced either by historical forces or historians’ biases. Exploring a broader range of worksites and the networks connecting them across the globe, scholars in both fields have come to vastly expand prevailing understandings of what science entails and what counts as labor. And although historians of science have shown more sensitivity than labor historians to the historically active role played by nonhumans and materials, both communities see the importance of tying their research to the examination of environmental history and the challenges of anthropogenic climate change.

Labor historians and historians of science have the potential to build on these similarities in fruitful ways. At present, however, when most labor historians consider science as an area of research, they think primarily of the history of scientific management or skip it in favor of focusing on technology as a blackboxed intermediary.³ Actively drawing on

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1. The Call for Papers can be found at https://www.academia.edu/49668253/Call_for_Conference_Papers_Bringing_Labor_History_and_the_History_of_Science_Together.
 2. Alexandra Hui, Lissa Roberts, and Seth Rockman (eds.), “Focus Section: Let’s Get to Work: Bringing Labor History and the History of Science Together,” *Isis* 114 (2023); Seth Rockman, Lissa Roberts, and Alexandra Hui (eds.), “Joining Forces: Labor History and the History of Science,” *Labor: Studies in Working-Class History* 21, no. 1 (2024).
 3. Alina-Sandra Cucu and Edward Jones-Imhotep, “Labour and Technology,” in Dagmar Schäfer et al. (eds.), *Cambridge History of Technology*, Vol. 2, chapter 6 (Cambridge: Cambridge University Press, 2025, forthcoming).

the insights provided by historians of science can help them recognize the ways in which science's wide-reaching practices, products, and (disputed) claims of authority are implicated in virtually any topic they might choose to investigate. For science has come to play a fundamental role in shaping the imaginaries that direct the organization of labor and modes of production. And, as historical studies of 'technopolitics' have spelled out, science, technology, and politics are mutually constitutive, which has enormous consequences both historically and for our global future.⁴ Similarly, when historians of science, who tend to privilege knowledge in their accounts, choose instead to examine science *as* work, they cannot unsee what that reveals about the maintenance of and challenges to the distribution of sociocultural, economic, and political power – whether looking at sites that can easily be identified as housing scientific production or the wider world in which science plays an integrated role. In sum, bringing science and labor together can work to draw attention to the macroscale structures (such as those associated with capitalism and state socialism) that organize work and science at a given time and place; enable deeper scrutinization of scientific work at the mesolevel of management and intermediation; and open the analytical space to ask more pointed microscale questions about motivation, exertion, and bodily experience.

Realizing these promises will require years of hard collaborative work and dedication. As said, this special issue and its counterparts in *Isis* and *Labor* offer a first step, along with an invitation for others to take this project further. To help orient further conversations, the first article in this special issue, cowritten by the three of us, addresses historians' past, present, and future engagement with science and/as work.⁵ It begins by considering how both historical actors since the seventeenth century and historians during the long twentieth century erased work and workers from the history of science, elevating science to the lofty position of knowledge and casting labor as a mute and mindless vehicle of production. As it recounts, perspectives had begun to change by the 1970s–80s as part of a broader reconsideration of science and its (historical) relation to the growing constellation of socioeconomic, cultural, and environmental challenges facing the world. Researchers endeavored to recover the contributions of 'invisible technicians', as well as to explore previously ignored sites around the world and the networks that connected them where both 'science as work' and 'science and work' were situated.⁶ If current scholarship has made effective strides toward the project of recovery and visibilizing the heretofore invisibilized, the remainder of the essay is devoted to charting future research directions predicated on recognizing science as an unexceptional form of

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4. Salem Elzway and Jason Resnikoff, "Whence Automation?: The History (and Possible Futures) of a Concept," *Labor: Studies in Working-Class History* 21, no. 1 (2024): forthcoming; Timothy Mitchell, *Rule of Experts: Egypt, Techno-Politics, Modernity* (Los Angeles, CA: University of California Press, 2002); Gabrielle Hecht (ed.), *Entangled Geographies: Empire and Technopolitics in the Global Cold War* (Cambridge, MA and London: MIT Press, 2011); Gabrielle Hecht, "Africa and the Nuclear World: Labor, Occupational Health, and the Transnational Production of Uranium," *Comparative Studies in Society and History* 51, no. 4 (2009): 896–926.
 5. Lissa Roberts, Seth Rockman, and Alexandra Hui, "Historiographies of Science and Labor: From Past Perspectives to Future Possibilities," *History of Science* 61 (2023): 448–74.
 6. The term 'invisible technician' was coined by Steven Shapin. See his "The Invisible Technician," *American Scientist* 77 (1989): 554–63.

labor. From this standpoint, investigating the political economic organization of scientific work does not merely embed science in society (a longstanding thrust within the scholarship) but raises the larger issue of who works for whom, on what terms, and to whose benefit – what labor historians call “the labor question” and use to interrogate the broader structures of power organizing a given society.

Next is an article by Gadi Algazi that focuses on Johannes Kepler, an icon of traditional narratives of the scientific revolution.⁷ Algazi begins by asking “what would happen if we thought of science as work?” Noting the tendency to link this question with an analysis of capitalism, the rise of a working class, and industrialization, he seeks to broaden the historical scope of inquiry by considering premodern scholarly practices as work. In doing so, he uncovers the tensions that existed within and between Kepler’s various types of employment, how he and those he worked for hierarchically valued them, and his attempts to negotiate with employers and administrators to gain time for the projects he held most dear, which – despite the labor they entailed – he and others identified with leisure.⁸ Despite the centuries that separate Kepler from current-day science, the labor-infused facets of science as work are immediately recognizable: the need for gainful employment and subsequent struggle to carve out time for personally valued research among all the other tasks that come with the job; the administrative and financial demands that press in upon researchers, requiring them to engage in what they see as onerous ‘busy work’; the negotiations and endless communication (whether at work or at home) required to steal bits of ‘free time’ so as to ‘finally get some work done’. The combined familiarity and strangeness of Kepler’s experiences holds an interesting mirror up for reflecting on the current system in which science is institutionalized as extractive labor.

Duygu Yildirim’s contribution switches our attention to the work of translation, circulation’s “enabling twin” that has historically occupied uneasy and often subordinate relations with other knowledge-producing practices.⁹ Turning to the means whereby seventeenth-century Ottoman nature studies reached foreign audiences, she is especially interested in the contests by which socially differentiated translators (scholar-translators, hired translators, enslaved mediators, etc.) sought to label what they and others did as either intellectual work or ‘merely’ labor – the former worthy of praise for its contribution to knowledge, the latter disdained as rote drudgery. But translation need not entail written or spoken language. It can also be done through the aegis of illustration, as was the case with pictorial representations of Ottoman flora, such as those that accompanied plant-breeding manuals for European audiences. Yildirim discusses them and the work

7. Gadi Algazi, “Kepler’s Labors: Figurations of Scholarly Work c. 1600,” *History of Science* 61 (2023): 475–98.

8. For a complementary discussion of science and leisure, see Harun Küçük, *Science Without Leisure: Practical Naturalism in Istanbul, 1660–1732* (Pittsburgh, PA: University of Pittsburgh Press, 2020).

9. Duygu Yildirim, “Ottoman Plants, Nature Studies, and the Attentiveness of Translational Labor,” *History of Science* 61 (2023): 497–521; Dilip Parameshwar Gaonkar and Elizabeth A. Povinelli, “Technologies of Public Forms: Circulation, Transfiguration, Recognition,” *Public Culture* 15 (2003): 385–98, 392.

that went into their making as triply invisible. To begin, few examples remain in the archives to be studied, a sign that owners did not value them and their makers sufficiently to warrant retention. This has traditionally been compounded by historians' disregard for the illustrations (and their anonymous makers) that do remain as neither meeting the conventional (read: Western) standards of scientific illustration nor falling within other recognizable artistic genres. Moving between these two was the reaction of those European naturalists who originally encountered Ottoman illustrations. In their eyes, the images – and therefore their makers – were not worthy of being taken up into the corpus of naturalist knowledge. They had first to be altered, augmented, or somehow substituted by the work of a sanctioned illustrator.

By highlighting the role of enslaved and other sorts of precarious labor in the eighteenth-century pharmaceutical trade, Zachary Dorner's contribution helps his readers breach a number of conventional boundaries: between free and unfree labor; between visible and invisible involvement in pharmaceutical production; between science and commerce; between domestic, investigative, manufacturing, and commercial settings; and between the types of labor that was pursued in each.¹⁰ But expanding and reconfiguring this history isn't only about being more inclusive regarding who was engaged in productive activities. For laced between such recovery work runs a recognition of the apprehensive tensions that accompanied reliance on the exploited labor of those who lived a precarious or unfree existence. Pharmaceutical knowledge embodied the promises of health and profit, but also the threats of sabotage and poison. To what extent could the enslaved and exploited be constrained to apply their knowledge and skill for ends whose benefits accrued (almost) exclusively to their masters? What dangers lurked behind a system in which productive energies and reward were so extremely mismatched? And how was that mismatch reflected in the historically skewed distribution of care and care work in which pharmaceutical goods and treatments played a part?

The labor history of pharmacy – and chemistry, of which it is a part – fixes our attention on a range of sites and the means of their connections, demonstrating its global character. Habitats around the world were harnessed to the goal of sourcing pharmaceutical and chemically useful substances, their collection and processing often dependent on the enslavement of local and imported populations. The crews aboard ships or working on overland caravans, and later, railroads and planes, transported these materials to domestic workshops and factories where they were transformed into usable commodities. In all these locations, hierarchies of labor were at work, managed for minimum disruption and maximum productivity. Patricia Fara's contribution presents another example of this by exploring the work done by working-class women in British munitions factories during the First World War – work that entailed a good deal of practical chemistry.¹¹ While crucial to the war effort, appreciation of the dangerous – and often poisonous – nature of their work was eclipsed at the time by recruitment campaigns that sought to draw more workers into the factories, as well as by public attention for and

10. Zachary Dorner, "Unnamed Not Unskilled: Toward a New Labor History of Pharmacy," *History of Science* 61 (2023): 522–45.

11. Patricia Fara, "Chemical "Canaries": Munitions Workers in World War One," *History of Science* 61 (2023): 546–60.

post-war legislative prioritizing of men who had joined the military. And, until recently, their invisibility was maintained by historians of science who stuck to the definitional parameters of science as knowledge and had little eye for the travails of socially marginal working-class women who were “bereft of reason, feeling, and all charm.”¹² Even those seeking to increase coverage of women in science generally remained silent as they busied themselves either with recounting the individual heroics of discovery by women or exploring more traditional sites of female activity, such as the home and sites of care. But just as others have drawn attention to the Manhattan Project’s dependence on its extended staff for success, so ought we to attend to the exacting and life-threatening work done by women who worked at the nexus of science and ‘politics by other means’ as they interacted with the poisonous chemicals that went into the munitions they produced. As Fara concludes, “laboratory research, discoveries, and individuals are important” to the history of science, but so too are science’s constitutive “interactions with labor, politics, economics, and colonialism.”¹³

A primary hindrance to grasping the possibilities entailed in looking at science through the lens of labor is the legacy of binary distinctions that accompany conventional discussions. Despite methodological interventions that seek to push us beyond this modern form of discourse, there remains a tendency to distinguish between mind and hand, knowledge and skill, discovery and application, and the like.¹⁴ Chao Ren builds his contribution to this special issue around a concept that suggests how we might transcend the essentializing consequences entailed in such dichotomous divisions while recognizing their historical construction and impact.¹⁵ By exploring the history of working-class oil drillers who traveled from the United States to work in the fields of colonial Burma in terms of their “low-level expertise,” Ren makes an important methodological move. Rather than use ‘expertise’ in an exclusive way that privileges the skill set possessed by specific categories of education-based endeavor such as scientific research or management, thereby projecting them as superior to other types of work, he links ‘expertise’ to social status, modifying it in accordance with the social hierarchy of labor in which it is exercised. Communities of work are thereby made comparable in the fundamental sense that they are all marked by the accrual of expertise through experience and (informal) apprenticeship. This is not to ignore the specific content of various types of expertise, including that which rightfully grants authority to scientific researchers in matters related to their areas of specialization, a point that is especially important to make in an age of heightened political polarization around matters of health, safety, and the environment.¹⁶ It is, rather, meant to draw attention to the ways in which social status has intervened in the recognition of expertise, supporting the maintenance of hierarchies of (in)visibility and power.

12. This paraphrase is based on a quotation found in Susan Kingsley Kent, *Making Peace: The Reconstruction of Gender in Interwar Britain* (Princeton, NJ: Princeton University Press, 1993), p.37.

13. Fara, “Chemical “Canaries,”” (note 11).

14. See especially Bruno Latour, *Nous n'avons jamais été modernes: Essai d'anthropologie symétrique* (Paris: La Découverte, 1991).

15. Chao Ren, “Global Circulation of Low-End Expertise: Knowledge, Hierarchy, and Labor Migration in a Burmese Oilfield,” *History of Science* 61 (2023): 561–87.

16. Harry Collins and Robert Evans, “The Third Wave of Science Studies: Studies of Expertise and Experience,” *Social Studies of Science* 32 (2002): 235–96.

Adding to the global reach of this special issue's concerns, Juyoung Lee's contribution considers the types of preparatory labor that South Korean farmers needed to perform in order to engage with chemical fertilizers and their government's push to modernize the country's agricultural system in the 1960s.¹⁷ Prior to the last few years, studies of modernization and the Green Revolution have focused on government planners, scientists, and the innovations meant to drive progress. Lee turns instead to the mundane lives and work of farmers, whereby she recovers the crucial role they played in preparing and maintaining the material and metaphorical ground in which rural development could take root. Among other things, making their labor, which was previously eclipsed by celebratory tales of techno-scientific innovation, visible has the ironic consequence of showing that 'modern' agriculture was often a hybrid of old and new; manure coexisted with chemical fertilizers, for example, as farmers filled supply gaps with what they knew and trusted. But writing history from this perspective – from the bottom up – also pushes us to recognize what historical movements meant to various communities. From the standpoint of scientists and government officials, the Green Revolution was about harnessing science to increase crop yields and modernize 'developing' countries' agricultural sectors. For local farmers, whose 'low-level expertise' (to borrow Ren's formulation) was largely ignored by outside 'development' experts, it was about having to alter the rhythms and labor practices that governed their everyday lives – often without their consent.

Researching the historical connections between labor and science is undeniably important. But so is teaching, without which historical research risks remaining insular and merely academic. This special issue therefore concludes with a course syllabus directed toward fleshing out the historical details and significance of invisible labor in science.¹⁸ The syllabus is divided into six modules, each with suggested reading and an assignment to encourage depth and further research. "Narrative and methodology" introduces the course by examining various strategies and methods for uncovering invisible labor in sites housing scientific medical practice. It is followed by a module on translation, which asks who was involved in movement of knowledge – not only across geographical and cultural distances, but also between various media of material, verbal, and visual expression. "Geographies of labor" situates scientific labor within sites and systems of skill deployment, management, and exploitation. The fourth module brings an interdisciplinary approach to the study of "care work," without which the more glorified practices and practitioners of science, technology, and medicine couldn't function. "Economies of labor" zeroes in on the historically constructed hierarchies responsible for determining the degree to which various sorts of work and workers have been valued. The sixth module, "Senses and labor," explores the limits entailed in relying on visual terminology such as 'invisibility' to frame historical analysis and draws attention to the role of other senses in scientific work. The syllabus then ends with suggestions for final

17. Juyoung Lee, "Preparatory Labor for Chemical Fertilizer: Rural Modernity and the Practices of South Korean Farmers in the 1960s," *History of Science* 61 (2023): 588–607.

18. Patrick Anthony et al., "(Un)making Labor Invisible: A Syllabus," *History of Science* 61 (2023): 608–24.

projects, encouraging its readers to use the syllabus as a springboard for further research, critique, and inspiration.

We hope that these first published results mark a beginning rather than an end, that they frame the contours of continued conversation, raise as many questions as they answer, and stimulate others to extend these pathways toward new destinations. Fuller, richer narratives will follow, accounts that rectify the injustices of past omissions and that reconceptualize science and labor in ways that mobilize history in the service of a more just future. Straightforward questions may yield transformative answers: What happens when research is examined as a historical and ongoing site of labor conflict? When scrutiny is directed toward the ways in which science simultaneously feeds automation and economic growth, on one hand, and working-class precarity and growing inequality on the other? When labor historians and historians of science jointly move from a focus on innovation to collaboratively explore what maintenance, waste, and recycling can tell us about the challenges of environmental justice and sustainability? These are big questions that deserve – dare we say, demand – our attention.

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