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In Pursuit of "Useful" Knowledge: Documenting Technical Innovation in Sixteenth-Century Potosí

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This article examines a series of proposals for improving silver refining methods presented to the municipal council of Potosí (in current-day Bolivia) in the late sixteenth century as a means of nuancing current understandings of the Iberian state's pursuit of "useful" knowledge. Historians have argued that the sixteenth century saw the fostering of an empirical culture, one based on experiential and collaborative practices, in the Iberian world. They have stressed that as artisanal experts and royal officials developed a mutually beneficial relationship, this empirical culture became institutionalized in administrative bodies for the pursuit of useful knowledge. This article focuses on the textual production that resulted from the relationship between artisanal experts and royal officials. It probes the motivations of local officials in generating a textual record of artisanal knowledge. Historians have tended to interpret and actors at the time often stated an interest in inscribing, artisanal knowledge as expertise and experience. However, this article demonstrates that what often motivated municipal officials' inscription of such knowledge was an emphasis on administrative knowledge as rule-following, in particular, a desire to demonstrate one's competency as an administrator. This conclusion suggests historians should expand their conception of "useful" to better reflect how early modern actors in the Iberian world viewed their pursuit of scientific and technical knowledge. It also indicates the importance of paying attention to the process of bureaucratic knowledge production when interpreting the written traces of the scientific and technical culture of the early modern Iberian world.

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Keywords: bureaucracy; Iberia; mining; administration; Potosí; technology

On October 17, 1588, the public notary of Potosí (in current-day Bolivia) documented a meeting between an agent of the royal treasury (*procurador*) and the provincial governor (*corregidor*), which related a potentially disastrous financial situation.¹ According to the treasury official, all refining of Potosí's *cerro rico* (rich hill), the immense silver deposits discovered by the Spanish in 1545, had ceased in anticipation of a new refining method held by one of the town's citizens, Garçi Sánchez. Sánchez's new method purportedly produced more silver using less mercury, the crucial ingredient essential in the then-standard method of purifying Potosí's silver ores. Sánchez, however, was unwilling to share his method without a clear mandate from the viceroy, who resided some 2,000 kilometers away in Lima.² The manuscript compilation in which the

¹ I am grateful for the initial invitation to participate in the "Beyond Data" workshop in June 2017, and to the numerous interlocutors at that workshop and subsequent meetings who shaped the direction of the final contribution. An earlier version was shared at the 2019 Spanish History Symposium at UC San Diego. I thank Pamela Radcliff for the invitation and the participants for their comments. Ann Blair provided practical advice and introductions which proved crucial, and Tamar Herzog graciously shared her expertise. Four anonymous reviewers offered insightful feedback.

² BNE Ms. 3040, Descubrimiento de Potosí y papeles de minas (S. XVI), 311r; Bargalló, *Amalgamación*, 234. A partial transcription of the documents pertaining to Sánchez is found in Bargalló, *Amalgamación*, 234–38; Espada, *Relaciones geográficas*, II, CXXXI–CXXXV.

notary's record of the initial meeting appears indicates that all was apparently resolved fourteen days later when Sánchez appeared before the *corregidor* and the same notary and declared the details of his method, which involved combining silver ore, ground sulphur, and quicksilver and heating the mixture until a black crust formed on top.³

This article considers Sánchez's and other proposals for improvements to the refining process made before Potosí's municipal council in the late sixteenth century as a means of nuancing current understanding of the Iberian state's pursuit of "useful" knowledge. The surviving records of these proposals reflect an administrative response that was similar in form and content to that found across the geographical reach of Iberia's early modern empire. Administrative documents and other writings intended for officials often contain a high level of detail regarding technical procedures, frequently accompanied by references to empirical results.⁴ Those making and responding to claims of technical innovation described present or projected ruin in contrast to the potential great fortune such innovations could bring to individuals, local communities, and the Iberian empire.⁵ Historians have noted gaps in the archival record as it is preserved today: inventions that were described and subsequently disappear; investigations that were ordered whose results do not appear in the surviving documents; as well as fragmentary records.⁶ In other instances, the success of the original proposal is indicated by sustained references to the same invention across time and geographical areas, such as the mercury-amalgamation process first developed by Bartolomé de Medina in New Spain, which Sánchez's proposal was designed to improve.⁷

Scholars of science in the Iberian world have relied on documents such as these to counter a narrative of early modern science shaped in part by the Black Legend, one that discounted the role of Iberian actors in the period's intellectual transformations.⁸ According to these revisionist accounts, Spain's empire and institutions promoted scientific knowledge with a utilitarian bent, exhibited a comparatively early reliance on eye-witness reports and often experiment, and encouraged the production of a large quantity of manuscript texts that never made it into print. Such knowledge, furthermore, eschewed questions related to speculative philosophy, had an overwhelmingly visual character, and served the state's interests instead of conforming to the personal inclinations of practitioners.⁹ Key to these narratives has been the notion that the Spanish empire collected and promoted the collection of *useful* knowledge, usually understood as denoting activities with an economic or practical purpose.¹⁰ The implication has been that such knowledge was sought—and therefore inscribed—for its applicability to concrete interventions in the natural world and, to the degree that such inscriptions protected the interests of artisan innovators, for the aim of furthering Spain's imperial expansion.¹¹

Two approaches to the study of knowledge production and institutions guide my approach. First, I build on the insights of Arndt Brendecke, who has argued that the process of generating "more knowledge" for the Spanish Crown often furthered political and administrative ends that were unrelated to the content of the knowledge itself.¹² This article thus shares a preoccupation with the relationship between individuals and local contexts to imperial power found in scholarship on *arbitrismo*, a term often used to describe the activities of reformist writers of the late sixteenth and seventeenth centuries who offered recommendations to buttress what they perceived as weaknesses in Spain's royal government.¹³ It differs, however, in its

In this and subsequent entries BNE Ms. 3040 contains 494 numbered folios with 97 different individual records related to Potosí, cf. Paz, *Catálogo*, 509–16, where printed transcriptions exist, references will be to the printed version with transcriptions omitted. On Sánchez and Fernández Montañón, treated below, as members of collaborative networks of European and indigenous miners, see Bigelow, "Técnica," 58–62.

³ Bargalló, *Amalgamación*, 237.

⁴ Barrera-Osorio, *Experiencing Nature*, esp. 17–23, 27, 60–74; Buechler, *Mining Society*, 86–92; "Technical Aid," 56–63; De Vos, "Science of Spices," 417–26.

⁵ Buechler, *Mining Society*, 81; "Technical Aid," 43; Warsh, "Political Ecology," 538.

⁶ Buechler, *Mining Society*, 83; De Vos, "Science of Spices," 419, 426; Warsh, "Political Ecology," 529, 544.

⁷ Bakewell, "Technological Change"; Bargalló, *Minería*, 134–59; Castillo Martos, "Primeros beneficios"; Muro, "Bartolomé de Medina"; Sánchez Gómez, *Savia del Imperio*, 140–54.

⁸ Navarro Brotóns and Eamon, *Beyond the Black Legend*; Pimentel and Pardo-Tomás, "Paradoxes"; Slater and López-Terrada, "Being beyond."

⁹ Barrera-Osorio, *Experiencing Nature*; Bleichmar, *Visible Empire*; Cañizares-Esguerra, *Nature, Empire, and Nation*; Portuondo, *Secret Science*. With respect to Potosí, cf. Buechler, *Mining Society*; "Technical Aid"; Salazar-Soler, "Alquimia y los sacerdotes"; "Álvaro Alonso Barba"; Tandeter, *Coercion and Market*, 167–219.

¹⁰ Bleichmar et al., *Science*, xxi; De Vos, "The Rare, the Singular," 271–72; Portuondo, "Cosmography," 61.

¹¹ For example, Barrera-Osorio, *Experiencing Nature*, 58, 59, 61.

¹² Brendecke, *Empirical Empire*.

¹³ For a classic discussion on this subject, see Elliott, "Self-perception and Decline." On the relationship between peninsular *arbitristas* and reformers in the Spanish Americas, see Eagle, "Restoring Spanish Hispaniola." Especially close in themes and sources to this

approach. Whereas scholarship on *arbitrismo* has tended to use the content of reformers' proposals as a window into contemporary visions of the imperial project, this article focuses on the administrative practices and accompanying justifications that led to the production of the textual records in which such proposals were recorded.

Second, I rely on Max Weber's typology of bureaucratic knowledge to probe more explicitly the motivations underlying officials' professed interest in refining improvements in Potosí. Weber identified *Fachwissen*, or expertise, as the systematic, coherent, and reliable knowledge that bureaucrats needed to dominate or regulate a specific area of social life. A second type of knowledge drew on expertise collected and made available to other administrators and was termed *Dienstwissen*, or experience: "the knowledge of facts that is acquired by practice and by reading files."¹⁴ While both expertise and experience have received significant attention by historians of science and of archives and information, Weber also mentioned a third type of bureaucratic knowledge only in passing that has often been overlooked. This third type of knowledge is the knowledge of rules, namely "more or less exhaustive rules that can be learned. Knowledge of these rules therefore constitutes a particular theorized art [*Kunstlehre*] (jurisprudence, administrative theory, or commercial science, respectively) that officials have in their possession."¹⁵

As outlined below, Weber's description of bureaucracy and his typology of bureaucratic knowledge do not map precisely onto the Iberian case, but this categorization does elucidate how this article is in dialogue with both the history of science and the history of bureaucratic knowledge. Historians of science in the Iberian world have tended to approach knowledge production in relation to the state as expertise or experience; that is, as knowledge of scientific and technical matters collected for the purpose of managing a scientific or technical resource. Even when it was the artisanal experts who carried out trials or generated reports on behalf of officials, historians have focused on the potential use of the content of this scientific production as the basis for decision-making, or, in Weber's terms, governance. By focusing on the administrative process that instigated the inscription of technical proposals, this article unearths the role that bureaucratic knowledge-as-rules played in generating bureaucratic knowledge as experience and expertise. It suggests that bureaucratic knowledge-production as rule-following was an important impetus underlying the collection of technical information and, thus, that current conceptions of "utilitarian" knowledge should be expanded to better reflect actors' understandings of their activities.

Section 1 contextualizes Iberian administration in the sixteenth century. An analysis of the documents surrounding Sánchez's declaration before Potosí's municipal council (*cabildo*) and that of another inventor, Juan Agustín Rojo, forms the focus of sections 2 and 3, which argue that municipal officials cited a desire to demonstrate administrative competency (rule-following) as a central motivation for inscribing the details of technical proposals. Section 4 considers a wider range of proposals presented before Potosí's *cabildo* and an administrative review ordered by the viceroy to suggest that rule-following shaped what information was recorded in the archival record in ways that make it an imperfect picture of on-the-ground artisanal empirical practice. A final section questions whether "useful" is the most appropriate designation for historical actors' conceptions of their motivations in collecting technical information.

Bureaucratic Knowledge Production in Early Modern Spain

Modern notions of "state" and "bureaucracy" have no direct counterpart in sixteenth-century Potosí. Officials used the term *estado* (state) to describe the general condition of one of the Crown's many different dominions, such as the Indies. *Estado* could also refer to the social estates into which the community was divided. Officials referred to *gobernación* (governance) to describe the decision-making of the king and his councils.¹⁶

Officials and residents in Potosí relied on various words to describe the communities to which they belonged. Individuals were described as *vecinos* (citizens), *residentes* (residents), or *moradores* (inhabitants).¹⁷ Petitioners, witnesses, and officials used the term *republica* ("republic") or *reino* ("kingdom") to refer to the

contribution are Warsh, "Political Ecology"; *American Baroque*.

¹⁴ Weber, *Grundriss der verstehenden Soziologie*, 1:165–166. Cf. Weber, *Wirtschaft und die gesellschaftlichen Organisationen und Mächte*, 157–234. In this discussion of Weber, I draw on the research, translations, and analysis of Christine von Oertzen and Sebastian Felten in an earlier version of their introduction to this special issue.

¹⁵ Weber, *Wirtschaft und die gesellschaftlichen Organisationen und Mächte*, 159.

¹⁶ Brendecke, *Empirical Empire*, 2; Cañeque, *King's Living Image*, 9; Portuondo, *Secret Science*, 126.

¹⁷ On *vecindad* as a category of belonging, see Herzog, *Defining Nations*.

larger kingdom of which Potosí was a part, often in relation to the royal treasury and the king.¹⁸ While period dictionaries define *administrador* in Latin as *administratorius* ("performing the duties of an assistant"), in English as "he that beareth office," and in French as *administrateur* ("administrator"), those in such positions usually spoke of their *servicio* ("service") to the Crown. Demonstrations of "service," which could be achieved while serving as an administrator but also as a soldier, conquistador, inventor, or in other capacities, were understood within the scholastic concept of distributive justice, wherein favors were awarded to those whose actions benefited the common good.¹⁹

Unlike nineteenth-century Prussia, which, as the editors of this special issue note in their introduction, provided the model on which Weber based his ideal notion of bureaucracy, there was no ready collection of rules or laws that detailed the organization of Iberian administration and governed its recording practices or its policies for evaluating and providing compensation for mining innovations. The normative legal structure governing local administration and mining rights in the sixteenth-century Iberian world derived from three sources: custom or communal practices, "doctrine" (or *ius commune*), and, less applicable in terms of the case of mining, canon law and Christian moral theology.²⁰ The *Siete partidas*, the thirteenth-century compilation that introduced *ius commune* to Castile, included only two laws that referred to mining, and these focused on the king's rights to mining revenues.²¹ Sixteenth-century commentaries on these laws discussed this right in more depth, but they did not specify how an inventor in Potosí should petition for compensation for new mining technologies.²² In terms of municipal administration, the *Siete partidas* provided details on the work of notaries and their registers of documents, but it contained little on the mechanics of local governance.²³ Alongside these normative sources, the king and other officials issued legal decisions in the form of *cedulas* (decrees), ordinances, *bulas* (bulls), and other proclamations.²⁴ Sixteenth- and seventeenth-century compilations of these royal decisions did address some aspects of mining and local administration, but they focused primarily on the maintenance of records and the rights and obligations of miners.²⁵ While they made clear the right of residents in Spain's American territories to petition royal officials, they were silent with regard to how such proposals were to be evaluated.²⁶

To understand the administrative mechanisms governing the production of records of mining innovations, it is necessary to reconstruct customary practice from the documents themselves. Antonio Barrera-Osorio has used this approach to uncover how the Council of Indies, which oversaw the administration of Spain's overseas territories, responded to requests for royal licenses. These licenses were agreements between individuals and the Crown, which provided legal protections similar to a modern patent for technical innovations. As part of his larger argument that the emerging relationship between artisans and administrative officials promoted a culture of empiricism in the sixteenth-century Iberian world, he found that members of the Council sought to protect "efficient and profitable technologies and instruments" and often requested that empirical trials be carried out by experts before deciding on the issuance of a license.²⁷ While the practices of the Council of Indies, as a centralized body with which the king consulted, are not directly applicable to the local context of Potosí, Barrera-Osorio's analysis provides a useful comparison for assessing municipal officials' rationales for inscribing technical information in their records.

Rule-following as Impetus for Recording

Surviving documents from Potosí contain not only the details of technical proposals but also introductory and contextual comments that offer clues as to why administrative officials chose to record them. This section and the next examine this introductory and contextual content, or what we might term the "paratext" of the archival record, in relation to two proposals for refining innovations brought before Potosí's municipal

¹⁸ "esta republica y de la hacienda real," "la forma que mejor estuviere al servicio del Rey nuestro señor e bien e aumento desta republica." BNE Ms. 3040, 312r.

¹⁹ Brendecke, *Empirical Empire*, 38–41.

²⁰ Herzog, "Colonial Law."

²¹ Scott, *Siete Partidas*, 369–70, 822.

²² *Siete Partidas*, 1:50v; 2:157v.

²³ Scott, *Siete Partidas*, 759–67.

²⁴ Because prior to the eighteenth century such decrees were understood as attempts to solve particular legal problems by applying norms that theoretically predated their announcement by the king, the applicability of these decisions to local practice is not a given. Herzog, "Colonial Law."

²⁵ Menéndez y Pidal and Manzano Manzano, *Recopilación*, 1:130r, 2:96r–98r, 2:118v–29v, 2:133r–34v.

²⁶ *Ibid.*, 2:75v–79v.

²⁷ Barrera-Osorio, *Experiencing Nature*, 59–74, 140–44; García Tapia, *Técnica y poder*, chap. 9; Warsh, "Political Ecology," 528–29.

council.²⁸ Officials couched their decisions to seek out and record further details of the methods described in the proposals in relation to administrative procedure. Local power dynamics—specifically, municipal officials' perceived obligations in relation to those of viceregal officials—also shaped their responses to innovators' proposals.²⁹

Municipal officials described their attention to Sánchez's case in October 1588 as a response to the crisis of stalled silver production, rather than as an action intended to promote or offer legal protection to a promising technological innovation. The notarial record begins with the treasury *procurador* Juan Castellanos's notification to the *corregidor* Pedro Torres de Ulloa of the cessation of the town's mining and refining operations. Castellanos' report focused not on the potential value of Sánchez's method but rather on the crisis at hand and its management: "The refining of metals is stopped and suspended, in expectation of a new method of working them." Only then did Castellanos come to the subject of Sánchez himself. Instead of emphasizing the promise of Sánchez's method, he discussed Sánchez's role in delaying production: "although there is present in this town Bachelor Garçi Sánchez, the person who has to show the said method, he doesn't want to. Previously he delayed, making absences from the town, because he says that without an express order from the viceroy of these kingdoms, Conde del Villar, he doesn't have to."³⁰

The suspension of work was also central to Torres de Ulloa's response. To address the crisis, he authorized an open meeting (*cabildo abierto*), an established procedure in which the regular municipal council opened its proceedings to a wider assembly, usually to consider matters judged of grave importance.³¹ The persons whom Torres de Ulloa invited to attend, the gentlemen of the mines and mills, played a central role in the town's silver production and likely occupied the role Barrera-Osorio has attributed to the expert artisans the Council of Indies summoned to evaluate innovators' requests for licenses.

In contrast to what Barrera-Osorio has described, Torres de Ulloa did not couch his call for the open meeting in terms of the potential benefit of Sánchez's method. Instead, he emphasized the halt in production as local miners and refiners awaited the new method: "all work on the metals has stopped, which hurts the royal fifths, the king, vassals, and Spain's kingdoms."³² At the meeting, Torres de Ulloa justified his call for the gathering in similar language: he had learned through news (*informaciones*) and letters (*relaciones*) that work on the metals had been halted "almost instantaneously," causing "great harm to this republic and the royal treasury," because people were waiting for Sánchez's new method.³³

As municipal officials debated Sánchez's case over the next two weeks, Torres de Ulloa continued to emphasize that his actions were a response to the crisis of stalled silver refining. This is evident in his response to a petition presented by a group of owners of mines and refineries to begin collecting promises of payments in exchange for Sánchez's method. Torres de Ulloa reiterated the crisis in which Potosí now found itself: "because of having understood ... that the method of the said Garçi Sánchez was about to be released, almost all refining had stopped at once, which is of great harm to the royal treasury and more generally to the entire republic." Understanding the "great inconvenience and harm" that would continue to unfold in waiting for a response from the viceroy, Torres de Ulloa awarded a license to the *alcalde* (municipal officer) Juan de Urquicu and the *contador* (accountant) Martin de Garnica to receive pledges from the townspeople to compensate Sánchez, as agreed in the open meeting.³⁴ Such an agreement between an inventor and community members to share a technological innovation is not unknown. In June 1550, Juan Tetzl, a major player in the fledgling Cuban mining industry, negotiated similarly with residents in Santiago, Cuba. After traveling to Europe and working with master miners in central Europe, Tetzl had developed a new technique for exploiting copper ore, which he promised to teach Cuban locals. Unlike Sánchez, who, the records suggest, avoided sharing his method and sought a license only after the local community pressed

²⁸ Gérard Genette coined this term to describe the verbal and visual accessories, including covers, title pages, and prefaces, which accompany printed texts and mediate between authors, printers, and readers, Genette, *Paratexts*.

²⁹ Warsh has described how local Spaniards developed a regional political ecology that challenged royal policies. See Warsh, "Political Ecology." Whereas Warsh focuses on the content of witnesses' testimonies in response to innovations authorized from above, this article focuses on the local administrators' professed justifications for recording proposals submitted to them.

³⁰ Bargalló, *Amalgamación*, 234.

³¹ Bayle, *Cabildos seculares*, 433–52; Haring, *Spanish Empire*, 159–60.

³² "por estar parado el beneficio de los metales por lo que en ello perdien los quintos rreales de su mag.d y su vasallos y rreinos." BNE Ms. 3040, 311v.

³³ Bargalló, *Amalgamación*, 235.

³⁴ "por causa de aver se entendido en esta villa que por estar a pique de salir este benefiçio del dicho bachiller garçi sanchez an cessado casi todo los benefiços de golpe lo qual es en mucho daño de la hazienda real y generalmente de toda esta rrepublica y atento a esto y a que seria de mucho ynconviniente y daño el aguardar a dar aviso al visorrey destos rreynos dava y dio la dicha licencia para que el alcalde juan de urquicu y contador martin de garnica hagan la diligencia que les fue cometida en el cabildo abierto que ayer se hizo." BNE Ms. 3040, 314r–v.

him to do so, Tetzl reached his agreement with local miners after approaching the Crown in person and receiving a license with numerous incentives.³⁵

The response to the situation by the royal treasurer, Diego de Robles Cornejo, elucidates Torres de Ulloa's justification for taking action in terms of the administrative crisis at hand. In the first place, Robles explained Torres de Ulloa's response to the crisis in similar terms as the *corregidor* himself had: Torres de Ulloa had requested a license to force Sánchez to share his method because "whatever delay occurs results in great harm and prejudice to your royal treasury and the public good ... [because] all people who grind metal to refine and remove silver have stopped [refining]."³⁶ However, in contrast to Torres de Ulloa's pointed focus on the damage caused by the delayed production, when Robles described his own views, he expressed optimism about the possible benefits of Sánchez's method. He justified the mill- and mine-owners' response by explaining that it was "for the great loss that they have with the method and procedure that until now have been used."³⁷ Addressing the viceroy directly, he also explained that Sánchez's method of refining yielded a fourth more silver in three days compared to the six required for the one in use. He praised the improvement as "one of the most important things for your royal service that can be offered at this time given the reduction and failure that the mines and their metals and their refining [are experiencing] at present."³⁸

Robles' concern for the mill and mine owners and his enthusiasm for the benefits of the new method most likely stemmed from his personal investment in Potosí's mining operations. Unlike Torres de Ulloa, he responded with concerns beyond that of a municipal official. Robles is listed in Luis Capoche's 1585 history of Potosí as part owner of a mine and described as the first individual to construct a water mill for grinding silver ore.³⁹ Some also saw Robles as a collaborator in the innovation process. In an administrative review carried out in 1588, Cristobal Maldonado testified that Sánchez and Domingo Gallego had developed a new refining method "by way of a book that the treasurer Diego de Robles Cornejo [had] brought back from Spain."⁴⁰

Torres de Ulloa and Robles put forward their arguments to further their own goals with those who would likely read their accounts. Robles wrote directly to the viceroy as both a local official and a mine and mill owner. Aiming to secure a provision that would force Sánchez to reveal his method, Robles ascribed to the actors involved motives with which he believed the viceroy would sympathize: the bureaucratic plight of the *corregidor* Torres de Ulloa, the dire circumstances of the miners and refiners, and, for the viceroy himself, the promise of a method that would greatly improve silver output in Potosí.

Torres de Ulloa wrote for a different reader as he worked with the notary to document the situation in Potosí and his response to it. His audience was the individual, either his successor or a visiting judge, who would evaluate his tenure as *corregidor* as part of Spain's regular process of administrative review.⁴¹ He justified his willingness to appease Sánchez by appealing to the obligations of his office: the necessity of keeping the mines, mills, and refineries in operation because of their importance to the Spanish Crown and treasury. His repeated explanations of his actions were intended to convey to those reading the records his commitment to his administrative responsibilities.

Rule-following and Administrative Hierarchies

The interactions of Potosí's cabildo with another inventor, Juan Agustín Rojo, offer another perspective on how local officials understood their responsibilities with respect to administrative rule-following as opposed to the pursuit of new technological innovations. In October 1591, the cabildo received a letter (described both as a *relación* and a *memorial*) from Rojo, who identified himself as a man from Genoa.⁴² Initially, the communication provoked considerable excitement. After reading it aloud in an open meeting at the end of October, the cabildo held a closed meeting on 2 November in which officials revisited the subject. Municipal

³⁵ Barrera-Osorio, *Experiencing Nature*, 65–67.

³⁶ "qualquiera dilacion queen esto aya se sigue gran daño e perjuizio a vuestra rreal hazienda y al bien publico mediante que todas las personas que tienen metales molidos en harina para lo beneficiar y sacar la plata de ellos lo an suspendido." BNE Ms. 3040, 315v.

³⁷ "por la mucha Perdida que tenian con el beneficio e orden de que hasta aqui sea usado." BNE Ms. 3040, 315v.

³⁸ Bargalló, *Amalgamación*, 236.

³⁹ Capoche, *Relación general*, 101, 117. On the granting of a license to Robles to refine silver using mercury in 1570, Lohmann Villena, *Minas de Huancavelica*, 54n37.

⁴⁰ BNE Ms. 3040, 331r; Espada, *Relaciones geográficas*, 2, CXXVI. On this collaboration, Bigelow, "Técnica," 67–68. On the role of print in spurring mining innovations, cf. Sánchez Gómez, *Savia del Imperio*, 154–57.

⁴¹ Phelan, *Kingdom*, 215–19; Haring, *Spanish Empire*, 138–45.

⁴² ABNB, CPLA 6, 35v–38r, 40r–41v. On Rojo as part of the larger community of metallurgical practitioners in Potosí, see Bigelow, "Mining Empire," 266–68.

officials reported that the content of Rojo's communication had been approved by the "gentlemen of the mines and mills," who had been commissioned by the town and its citizens to consult regarding what "most suited the good and utility of the ... Republic."⁴³ They claimed Rojo's initial letter did not address "some doubts and difficulties." Since requesting a response in writing usually resulted in "new difficulties and doubts," they all agreed to invite Rojo to Potosí and facilitate his travel there. They reached out to him via the viceroy in Lima to relay their offer of 1,000 pesos to offset the costs of the journey and another 2,000 pesos if needed.⁴⁴

Nothing more was heard from Rojo until the end of December when three letters arrived from Lima, which were read aloud in the *cabildo* and summarized in the body's minutes. Both the viceroy García Hurtado de Mendoza and the *correo mayor* Pedro Balaguer de Salcedo offered less than enthusiastic reports. According to the viceroy, Rojo appeared to be "crazy or a charlatan" because of the exorbitant promises he offered, his tendency to run on at length, his writing, and "his manner of proceeding" more generally. What especially alarmed the viceroy was the compensation Rojo had demanded: "he asked for 500,000 pesos and ... said he wouldn't accept less because he didn't have clothes or a bed to sleep on." He also requested a privilege for his invention prohibiting anyone from using it who did not have a license.⁴⁵ Since such protection for an invention was common for licenses issued by the Council of Indies, it is likely that what troubled the viceroy was the financial compensation Rojo had requested coupled with the description of his impoverished state.

In his communication to the *cabildo*, the *correo mayor* reported the interactions between Rojo and the Crown's *fiscal* (attorney) in Lima. Having appeared before the *fiscal* in a "very thin" condition and "with little health," he had continued to insist on his original request of 500,000 pesos and could not be persuaded to accept the Crown's offer of the customary private, time-limited privilege that restricted the use of his method to himself and those to whom he granted the rights to its use.⁴⁶ After departing with a surly disposition, Rojo later returned to the *correo mayor* in a more contrite state, "with some fear and much diminished," claiming he was now ready to travel to Potosí for only the 1,000 pesos initially offered.⁴⁷

Notwithstanding Rojo's humble entreaties to the *correo mayor* in person and in the lavish letter he forwarded to Potosí that accompanied those composed by the viceroy and the *correo mayor*, town officials became decidedly cooler towards Rojo after reading these missives. Using the same language the viceroy had, the *cabildo* recorded its judgment that Rojo appeared from the said letters "to be a charlatan and swindler and that the *cabildo* took him to be so." In his capacity as treasurer, Robles was tasked with rescinding the *cabildo*'s earlier offer of financial compensation.⁴⁸

The *cabildo*'s abrupt loss of interest reflects the factors that made Rojo's case different from Sánchez's. Rojo and his method were not known personally; there was no production crisis impelling town officials to act; and the viceroy and *correo mayor* had provided their evaluation in writing. With the onus of judgment on the higher-up officials, the municipal officials could dismiss Rojo without fear of being accused of failing to pursue a potential benefit to royal revenue.

Yet, despite the *cabildo*'s reversal, almost two years later Rojo traveled to Potosí, and the details of his proposal were recorded in the council's records. According to the notary's account, in a meeting on 12 January 1594, the then-*corregidor*, Juan Ortiz de Zarate, raised the topic of Rojo's refining method, reminding those present that although it had been discussed in the past, they had never reached a decision about how

⁴³ "mas conbenia al pro y utilidad de la dicha republica." ABNB, CPLA 6, 36r.

⁴⁴ "patento a que en el memorial ... parece no declarar algunas dudas y dificultades ... y si se aguardase ha pedir declaracion por escrito considerado que siempre suelen resultar nuevas dificultades y dudas ... ha parificado a todas de una conformidad que el dicho Juan agustin venga personalmente a esta villa ... le ymbien librança ... para que luego se pueda poner en camino un mil pesos ensaiados de los quales no ha de dar seguridad ninguna ... si tubiere mas neçesidad de plata le de en nombre desta villa otras dos mil pesos ensaiados mas." ABNB, CPLA 6, 36r-v.

⁴⁵ "En lo mucho que ofreçe y su largo discurso y escriptura y en su manera de proceder me a parecido loco o charlatan porque pide por descubrir la nueva ynbençion quinientos mill pesos y dize que no lo hara menos y no teniendo que se bestir ni cama en que dormir sin embargo desto e ofreçido dar el privilegio para el y no otra persona en todo el reino pueda usar de su beneficio sino fuera con liçencia suya." ABNB, CPLA 6, 40r. Rojo appeared again before the viceroy in 1594, Levillier, *Gobernantes*, XIII, 159.

⁴⁶ "se presento su mucha fflaqueza y poca salud ... y dizo no bajaria de los quinientos mil pesos ensayados ... le propuso algunos medios y uno dellos fue dar el privilegio particular por tiempo limitado para que solo el y que en el permitiese pudiese usar de su beneficio como en semejantes cosas sea costumbra de ningun medio se satisfizo." ABNB, CPLA 6, 40v.

⁴⁷ "y con esto el despido con algun desabrimiento a mi parecer con cuidado para disponerle mejor bolbio a mi algo temerodo y mas reduzido ... y que consintiendo en esto tomaria solos los mill pesos." ABNB, CPLA 6, 40v.

⁴⁸ "y se hacordo por todos los dichos capitulares que el tesorero diego de Robles comejo responda a todas tres cartas lo que le pareçiere que combiene a esta Republica que no se le den los dos mil pesos ensaiados ... ni los un mil pesos ensaidos ... atento ha que por las dichas cartas parece ser charlatan y embaidor y este cadildo lo tiene por tal." ABNB, CPLA 6, 41v.

to proceed.⁴⁹ After reaching Potosí, Rojo had sent Zarate a "closed and sealed" communication containing "everything that the said method involves."⁵⁰ After a discussion "among themselves," the municipal officials resolved to hold an open meeting with "the gentlemen of the mines and mills" the following Sunday.⁵¹ The surviving record of the meeting reveals none of the uproar surrounding Sánchez's proposal, stating simply that:

In this cabildo the method of Juan Augustin Rojo was opened, which the royal corregidor had in his possession. And having read it ... word for word, they ordered that it be put in this book and proclaimed publicly so that whoever wished to make use of it could do so.⁵²

Following the transcription of Rojo's letter, the record mentions no experimental trials or evaluation of his procedure, nor is there any indication that he was granted protection for sharing his method.

Rojo's method appears to have been included in the books of the cabildo because he had given his letter to the *corregidor*, who then felt obliged to present it to the municipal body and publicize it. By sharing the method with the wider community through a public proclamation and then recording the details of the method and its mode of dissemination, local officials demonstrated that they had responded as good administrators. While Rojo could be ignored when he was far away and judged a fraud by the viceroy, his presence in Potosí and personal delivery of his letter to local municipal officials impelled them to acknowledge and record his method. These actions, I suggest, reflect administrative thoroughness; the letter needed to be recorded because it was received. The *corregidor* did not want to later be accused of overlooking a method that could have benefited silver refining and thus royal revenue in Potosí.

Rule-following as Determinative of Content

Rule-following not only motivated municipal officials to record technical information. It also shaped the type of information they recorded, leading them to emphasize certain aspects of artisanal empirical practice in ways that make the surviving written record likely an imperfect representation of mining operations on the ground. One feature shared by the proposals of Sánchez and Rojo as well as others recorded by Potosí's municipal council in the late sixteenth century is a focus on the details of their methods and an apparent lack of attention *in the record preserved for posterity* to their effectiveness. The reason for this was not just that administrators tended to entrust the testing and assessment of technological innovations to expert artisans. The pattern of the records indicates a tendency to not record the final evaluation of a proposal's usefulness, even when the cabildo explicitly claimed an interest in it at the outset. Rather than dismissing this pattern as a function of the document's genre, this section interrogates this feature to shed light on the nature of local bureaucratic knowledge production.

One instructive case is that of Juan Fernández Montaña, who promised a new method of refining in 1587. The surviving record follows the pattern Barrera-Osorio described for licenses issued by the Council of Indies. It includes a declaration by Fernández Montaña of the worthiness of his invention, followed by the cabildo's vote on his compensation. The municipal council ultimately agreed that Fernández Montaña should share his method with Potosí's residents in exchange for a sum of 25,000 silver pesos.⁵³ In the final paragraph of the entry, the notary recorded that Fernández Montaña had offered his method so that Potosí's citizens could test it for themselves.⁵⁴ There is no further mention of Fernández Montaña, the money he should have received, or the results of the subsequent testing in the records of the cabildo.⁵⁵

⁴⁹ "se havia tratado por parte de Juan Agustín Roxo un nuevo beneficio y aun que se savia platicado sobre ello nunca se havia resuelto en lo que se havia de hazer." ABNB, CPLA 7, 50r-v. Given the time lapse, perhaps Zarate did not recall the earlier decision, or perhaps the decision not to assess Rojo's proposal further was deemed an indecision.

⁵⁰ "ultimamente lo havia ymbiado a su merced cerrado y sellado todo lo que en el dicho beneficio havia." ABNB, CPLA 7, 50v.

⁵¹ "y haviendolo conferido entre si todos los capitulares fueron de parecer que se haga un cabildo abierto en esta sala con los señores de minas e yngenios el domingo proximo que viene." ABNB, CPLA 7, 50v.

⁵² "en este cabildo se habrio el beneficio de Juan agustin Rojo que el real corregidor tenia en su poder y haviendole leydo ... del verbo ad verbun mandaren se asiente en este libro y se pregone publicamente para que el que quisiere usar dello lo use." ABNB, CPLA 7, 53r.

⁵³ "el declarara la dicha ynvencion con que se le den por los vezinos desta villa por el trabajo que en ello a puesto y gastos que a hecho veynte y cinco mil pesos de plata ensayada y marcada." ABNB, CPLA 5, 90r.

⁵⁴ "E vista la declaracion del dicho Juan Fernandez Montaña ... para que haga mas experiencia dello y vean si les es provecho el dicho beneficio y si lo quieren usar." ABNB, CPLA 5, 91r.

⁵⁵ My emphasis here is on the absence in records produced by municipal officials. Fernández Montaña does appear in other documents. The details of his method, isolated from their administrative context, and discussions of it by witnesses in a *visita* of

On occasions when information about an invention's effectiveness was recorded in municipal records, the purpose often was to demonstrate compliance with administrative rules. Many references to the effectiveness of methods brought before the municipal council were generated as part of the recording process. For example, in the cabildo's entry for Fernández Montaña's method, the justification for the decision to record it was that "it is well known that Juan Fernandez Montaña, resident in this town, has made many trials of the metals of the *cerro* in order to perfect their refining so that [the ores] turn out well and [of higher grade] and use less quicksilver." The notary described Fernandez Montaña's method as being of "certain use" and declared that "it holds for certain that the silver is augmented and the loss of quicksilver diminished."⁵⁶

In some instances, officials attempted to corroborate whether the written record of a method corresponded to how it was employed by refiners. Following Sánchez's declaration, a group of witnesses, including the cabildo notary, *corregidor*, and *alcalde*, visited Sánchez's residence where they claimed they saw evidence that the method recorded was the one being used. The notary recorded that he "saw a little stove holding ground metallic flour to which fire was being applied, in agreement with what was declared above."⁵⁷ This testimony, though it did not validate the effectiveness of the proposal, served both as a demonstration of how to implement the technique and as verification that Sánchez's declaration corresponded with his own refining practice. These statements of apparent empirical success thus served to account for specific administrative actions. References to widely perceived effectiveness as well as the correspondence between a declared method and its observed implementation in the refiner's home justified the cabildo's decision to record the method's details.

Attitudes towards the technical details versus the effectiveness of a method appear to have differed, depending on one's position in the administrative hierarchy. On 21 January 1588, the viceroy of Peru, Don Fernando de Torres y Portugal, ordered an administrative review, or *visita*, in Potosí of inventions developed for the refining of silver. In addition to requesting experimental tests, Torres y Portugal wanted information on their projected effects on the Crown's treasury revenues and the demand for indigenous labor. The appointed *visitador*, Juan Ortiz de Zarate, was instructed to send his opinion in secret to the viceroy so he could determine what was "most suitable to the service of his majesty and to the public good and the conservation and perpetuity of the said mines of silver."⁵⁸ The viceroy's emphasis on secrecy and the range of the information he requested sheds light on why municipal officials understood their duty to be the recording of the details of the proposals rather than evaluating and endorsing their effectiveness. Only Torres y Portugal, as the Crown's representative in Peru, could weigh the multiple factors at play in determining whether mining improvements were beneficial. The viceroy's instructions suggest that officials at different levels within the administration hierarchy sought out different types of information in conformity with their conceptions of their administrative responsibilities.

Yet, bureaucratic hierarchies do not erase another central feature associated with the municipal authorities' approach to mining improvements: the importance of bureaucratic rule-following in generating a documentary record. A careful reading of the records of the *visita* indicates that its instigation was prompted by the viceroy's own attention to bureaucratic rule-following. Though the viceroy described the contradictory and uncertain nature of information he had received about the proposed improvements from Potosí, his decree ordering the *visita* emphasized the lack of proper reporting by the inventors and their failure to obtain the requisite licenses. According to the viceroy, "they still continue forward with these inventions, about which the said people who develop them haven't given me notice, [even though they] must do so before beginning them."⁵⁹ He went on to explain that the licenses were required because the inventions could harm the royal treasury as well as the circulation of quicksilver, whose mines, sale, and distribution were under royal control.⁶⁰ As a result, the royal officials of Potosí, "satisfying the obligation that they have to their offices, were obliged to not endorse nor give a place to such inventions made without

1588 are found in BNE Ms. 3040, 325v, 331v, 340v, 345v, 411r–v; Bargalló, *Amalgamación*, 239–40; Espada, *Relaciones geográficas*, 2, CXXXV–CXXXVI.

⁵⁶ "es notorio Juan Fernandez Montaña rresidente esta villa a hecho muchos ensayos de los metales deste cerro para poner en su punto el beneficio dellos para que salgan y procedan con mas ley y consumen menos azogue y es usa caerta ... se tiene por caerto se aumenta mucho a la plata y diminuye en mucho la perdida de azogue." ABNB, CPLA 5, 89r.

⁵⁷ Bargalló, *Amalgamación*, 238.

⁵⁸ BNE Ms. 3040, 323v; Bargalló, *Amalgamación*, 262. Partial transcriptions of the documents are found in Bargalló, *Amalgamación*, 242–77; Espada, *Relaciones geográficas*, 2, CXXIII–CXXVIII.

⁵⁹ Bargalló, *Amalgamación*, 262.

⁶⁰ Bargalló, *Amalgamación*, 262. Modern historians offer conflicting assessments of the Crown's control of mercury distribution on the royal treasury. Cf. Bakewell, *Miners*, 159; Brown, *History of Mining*, 20–25; Lane, *Potosí*, 83; Robins, *Mercury*, 29–30.

a license and without my approval in order to provide above all what is convenient to the service of his majesty."⁶¹

Within a general ethos that recognized the importance of mining, technological improvement, and revenues for the Crown, officials justified their collection of technical information, be it the details of proposed innovations or testimony regarding their effectiveness, by appealing to standards of correct protocol. Hierarchies within the administration as well as the complexity of factors that determined the treasury's revenue and the continued operation of the mines shaped what individual officials understood as their responsibility to record. The result was a documentary record rich in the details of proposed methods that reflected only partially the underlying empirical work and testing that took place on the ground.

Expertise vs. Rule-following

Documents like Sánchez's declaration have garnered attention from historians of science and technology along two different trajectories. On the one hand, historians of early modern technology have argued that the type of record Potosí's *cabildo* produced regarding Sánchez, an archival document generated as part of routine institutional or administrative work, offers the best window into premodern craft practices. Because these texts were not composed for purposes of sharing artisanal practices with a diffuse readership, historians see them as useful for revealing local specifics rather than describing idealized practices or offering overviews of methods.⁶² On the other hand, historians of science in the Iberian world have used such documents to advance their claim that by seeking to collect and document information regarding knowledge that was useful for governance, the Iberian state encouraged and institutionalized empirical and utilitarian knowledge-making practices. While these arguments speak to different historiographical concerns, both make inscription practices central. For the historians of early modern technology, it is the act of inscription for a circumscribed audience that positions such texts as privileged windows into artisanal practice. For historians of science in the Iberian world, it is the act of inscribing technical information as well as the focus of the inscription on empirical knowledge of apparent utility that has been read as evidence of an interest in science and technology and thus used to justify claims of a scientific tradition in the Iberian world with specific characteristics.

Historians of the book have unpacked the practices and motivations underlying scribal and print authorship and publication. This article suggests that the same must be done with respect to archival documents detailing scientific and technical matters. Similar to the way print publications were the result of collaborations between a named author and other individuals, the fate of Sánchez's and other innovators' declarations in Potosí indicates that the content of the administrative documents was generated by many individuals whose different interests determined what type of information was included in the final product. Examining the contexts in which these records of empirical practice were produced shows that they do not provide a significantly better window into artisanal practice than printed and manuscript works; they provide a different one. The surviving proposals offer specific local details about what individuals, and often the community more generally, believed would be good methods for refining silver, often with precise details about the available raw materials, local units of measurement, and the contributions of indigenous knowledge traditions. However, it is difficult to determine from these records alone the extent to which specific proposals were put into practice, how they came to be viewed (as plausible or not), how their effectiveness was judged, or what the standard practice of silver refining was at any specific time. My point is not that these questions can never be answered: if this were the case, the detailed histories of Iberian mining available today could not have been written. Rather, my aim is to emphasize the context, conceptions, and knowledge-production practices that generated these specific local records on refining innovations.

Putting the articulated motivations of the officials who created these documents in dialogue with their contents allows for an expanded understanding of the purposes the recording of technical information served in the late-sixteenth-century Iberian empire. Historians who have analyzed the Council of Indies from the perspective of written proposals and practices have argued that officials aimed to develop efficient and profitable knowledge and technologies for the Spanish imperial mission. The recording of agreements with innovators, according to this line of inquiry, brought benefits to both the inventor, usually in the form of

⁶¹ Bargalló, *Amalgamación*, 262.

⁶² Smith, "Goldsmith's Workshop," 36. Cf. Bertucci, *Artisanal Enlightenment*; Eamon, *Secrets of Nature*; Long, *Openness*; Smith, *Body of the Artisan*.

compensation and protection, and to officials who received the promise that the new technique would be shared more broadly.⁶³

However, such benefits reflect only imperfectly the written record produced in sixteenth-century Potosí. When textual inscriptions function as licenses to certify an agreement between officials and inventors for their mutual benefit, what is important are the terms specified between the parties. Hence, as Barrera-Osorio describes, royal licenses tended to be succinct.⁶⁴ In contrast, the documents produced in Potosí included copious technical details. These detailed textual inscriptions did not necessarily function as a means of sharing new methods, since the Crown's regulations specified that municipal archives were to remain under the care of a restricted group of local officials who limited access to the documents they contained.⁶⁵ Instead, the dissemination of new technical processes was often carried out through public proclamation and demonstration, as in the case of Rojo described above. The detailed descriptions of technical innovations may suggest an interest in profitable and improved technologies for the good of the state, but such an interpretation would require that the state—that is, other administrators—be the intended audience of these documents. Such a scenario implies that the interest in recording information about effectiveness and use was to make such transcriptions and their meanings legible to readers. Yet, it is precisely this information about the outcome of the proposals that is less emphasized in these records.⁶⁶

What emerges from the statements of municipal officials is an alternative reason for inscribing this information, namely administrative rule-following.⁶⁷ Local officials repeatedly explained their documentation of technical innovation as a response to a bureaucratic crisis, an attempt to force others to comply with bureaucratic rule-following, or their own efforts to follow the rules of the bureaucracy. The act of generating documentation was a chief means of demonstrating one's competency as an administrative official.

These observations suggest that "useful" might not be the best term for describing historical actors' understandings of the information they collected. Period usage indicates the same. Although the Latin term *utilitas* (usefulness) had been employed since antiquity, the corresponding Castilian *utilidad* does not appear in dictionaries until the seventeenth century.⁶⁸ Sixteenth-century dictionaries define the Latin *utilitas* as *provecho*, a term that had connotations of profit and which today is often translated as "advantage" or "benefit."⁶⁹ Another way that writers in the sixteenth century could convey a sense of utility was through the term *para*, a preposition that denotes the purpose or end goal of an action and is often translated in English as "in order to." "Purpose" or "benefit" thus might be more apt than "utility" for understanding the inscription of technical knowledge in sixteenth-century Potosí, terms that capture the range of motivations underlying historical actors' inscriptions of technical knowledge.

Untangling the bureaucratic practices and motivations that led to the creation of the administrative documents considered here exposes the perils of the historian of science's gaze and highlights the benefits of a "bureaucracy as knowledge" approach. The historian of science focuses with precision on traces of natural and technical knowledge and interprets them according to categories that modern scholarship has associated with the production of knowledge: empirical, practical, utilitarian, didactic, economic, speculative, symbolic, and so forth. Scholarship at the intersection of the histories of the book and of science have highlighted how unstable these categories are with respect to textual content; the collaborative nature of textual production meant that the individuals involved were often motivated by interests not shared with the text's primary author and readers. The "bureaucracy as knowledge" approach offers an analogous warning for understanding administrative documents. It has been tempting to read the inscription of technical knowledge as an interest in that knowledge, to code the technical with the designation "useful" and to argue that science in the sixteenth-century Iberian world was driven by the utilitarian interests of the state. Such identifications, however, may not have been shared by those producing the documents.

This article suggests that there was a vibrant culture of technical experimentation and innovation in sixteenth-century Potosí, one that was valued by local practitioners for economic and practical ("utilitarian") reasons. There was a tradition of discourse on the part of administrators that affirmed the importance of silver

⁶³ Barrera-Osorio, *Experiencing Nature*, 59, 61; Cañizares-Esguerra, *Nature, Empire, and Nation*, 19–21; Portuondo, *Secret Science*, 103–40.

⁶⁴ Barrera-Osorio, *Experiencing Nature*, 59.

⁶⁵ Castillo Gómez, "New Culture," 554, 558–59.

⁶⁶ Scott, *Seeing Like a State*, 9–83.

⁶⁷ On this possibility, Portuondo, see *Secret Science*, 140.

⁶⁸ "Utilidad" first appeared in Franciosini's 1620 Italian-Spanish dictionary, RAE, "Nuevo Tesoro." On the discourse of utility in eighteenth-century botanical treatises, see Bleichmar, "Visible and Useful Empire," 297–99.

⁶⁹ Nebrija, *Vocabulario*, LXXXIVv; Percyvall, *Bibliotheca hispanica*, "PR."

yields and profit, and thus of improved refining techniques, to the Crown. Yet, when it came to innovative methods, what motivated their inscription at the local level often was less the value of the technical knowledge itself—what has been coded as “utilitarian”—and more the desire to show compliance with the regulations of accepted administrative practice. Recognition of these varying motivations clarifies what was recorded in these documents for posterity and why. Such an elucidation not only shapes the conclusions historians can and should draw from these and similar documents, but also leads to narratives that, one hopes, hew more closely to the motivations held by the historical actors who participated in their creation.

Competing Interests

The author has no competing interests to declare.

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