Seeds, Dams, and Khipus: Latin America's Eclectic Recent History of Technology

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Seeds, Dams, and Khipus: Latin America's Eclectic Recent History of Technology

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ABSTRACT: Scholarship on Latin America's history of technology has expanded significantly in recent years. By reviewing articles in English- and Spanish-language journals from 2012 to the first half of 2023, we illustrate the emerging themes, geographies, and methodologies in this literature. The four main themes we identify are industrialization, institutions and policies, infrastructure, and moving beyond technological adaptation. We also highlight two emerging themes: Indigenous technologies and the circulation of knowledge. We conclude that the scholarship has generally moved in three directions: the study of technologies associated with traditional economic activities in the region (e.g., monocrop agriculture), national industrialization and modernization processes, and cases that demonstrate alternative ways of knowing the world and how communities use these types of knowledge. We suggest that deepening the connections between these three lines of research could be fruitful for future work.

KEYWORDS: Latin America; industrialization; policy; infrastructure; adaptation; ancestral technology; Indigenous Knowledge

Introduction

In 2014, Michael Lemon and Eden Medina published a review essay examining scholarship on the history of technology in Latin America published in five English-language journals from 1970 to 2011.[1] They found that few articles had appeared in history of technology journals—seven in *Technology and Culture* and five in *History and Technology*. However, broadening the review parameters to include multidisciplinary journals on

1. Lemon and Medina, "Technology in an Expanded Field."

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APRIL
2024
VOL. 65

Latin American studies and a more expansive definition of technology and history increased the number of articles under analysis. It also illuminated differences in how academic communities were writing about technology in the region. Using these criteria, the authors identified twenty-seven articles in *Hispanic American Historical Review*, twenty-four in the *Journal of Latin American Studies*, and thirty-seven in *Latin American Research Review*. These data pointed to conversations that were taking place outside of the history of technology journals.

Three themes emerged from this newly identified body of literature: technology's relationship with development, dependency, and modernization; histories of labor and technology; and the adaptation of technology to local needs and conditions. Journals focusing on Latin America, however, emphasized how technology fit into broader economic structures, dependency relations, and Western hegemony. In contrast, history of technology journals focused on the social construction of technologies and technological systems, specific technological artifacts, and the role of technical and political elites within modernization projects. Journals on Latin America also paid more attention to the relationship between technology and labor, including slave labor on agricultural plantations and workers in Latin American factories. Both sets of journals featured the many ways those in Latin America modified technologies and technical practices to suit local conditions.

The 2014 literature review was motivated by a desire to push back against views that diminished both the value of technology for understanding Latin America and the region's significance for understanding technology history. The review also reflected an urgent recognition within the history of technology community that it needed to move away from its focus on certain parts of the world, notably the United States and western Europe, and toward creating a more globally representative scholarship. Also prompting the review were the new networks of scholarly exchange forming in anticipation of the 2014 joint meeting of the Society for the Social Studies of Science and the Latin American STS society, Asociación Latinoamericana de Estudios Sociales de la Ciencia y la Tecnología (ESOCITE), in Buenos Aires.

Much has happened in this expanding field in the decade since the 2014 review. In 2024, the annual meeting of the Society for the History of Technology (SHOT) will take place in conjunction with the International Committee for the History of Technology (ICOHTEC) in Viña del Mar, Chile, the first to be held by either society in South America and the first to be conducted in English and Spanish. The journal *History and Technology* published special issues edited by historians of the region on topics such as "development interventions" and "thinking with the world" that included scholarship on Latin America. In 2018, the new journal *Tapuya: Latin American Science, Technology and Society* was launched. As an open-access, English-language journal that "elicits conversations within Latin America, between Latin America and Euro-American cultures, and across global peripheries," *Tapuya*

publishes all article abstracts and keywords in Spanish, Portuguese, and English.[2] It provides an important forum for scholars working in the North and the South to engage in broader conversations.

With so much recent scholarly activity, it seemed timely to update the 2014 review with a review of articles between 2012 and 2023, with a specific cutoff date of July 2023 to include articles we deemed relevant in that year. It also seemed necessary to include articles in Spanish. While we could not identify a dedicated history of technology journal in Spanish or Portuguese, we did identify two Spanish-language journals publishing articles that we consider to be history of technology.

We structured our quantitative and qualitative analyses to show how historical studies of technology have evolved since 2012 in terms of their linguistic, geographic, methodological, and thematic diversity. Building on the method for the 2014 review, we adopted a broad definition of history of technology scholarship. We also developed a three-pronged test applied across the journals to determine which articles to include, opting for inclusivity in borderline cases. First, articles had to address technology (understood broadly), such as technological artifacts; technical processes and practices; the creation and deployment of technical knowledge; and individual, collective, or institutional actions that involved mobilizing technological artifacts, infrastructures, or expertise to achieve specific goals. Histories of technical management, how people developed and used various tools and techniques, technology policy, technical education, technical practices in industry and agriculture, techniques for recording and classifying, and technical practices of Indigenous communities all qualified articles for inclusion.

Second, articles had to use humanities and social sciences methods and make an argument that made changes over time, as well as how choices and events affected those changes, a central part of the analysis. While we required methods and source materials common to historical analysis, our desire for inclusivity motivated us to include articles not traditionally considered history. For example, we included articles that primarily used ethnographic methods but also contained a history section that was based on original research and went beyond secondary sources. This allowed us to consider a broader range of methods, including quantitative ones, that historians may use or that contribute to our understanding of the technological past.

We did not include articles on topics primarily set in the twenty-first century, but with some flexibility because historical methods can be productively applied to more recent topics. More often, we found articles that began their analysis in the twentieth century and traced the topic up to the present. We also included articles about a contemporary event that used historical analysis to explain its origin and significance. For example, Felipe Fernandes

2. "What Does Tapuya Mean?," Tapuya: Latin American Science, Technology and Society, accessed March 4, 2024, https://tapuya.org/about-us/wdtapuyamean/.

APRIL
2024
VOL. 65

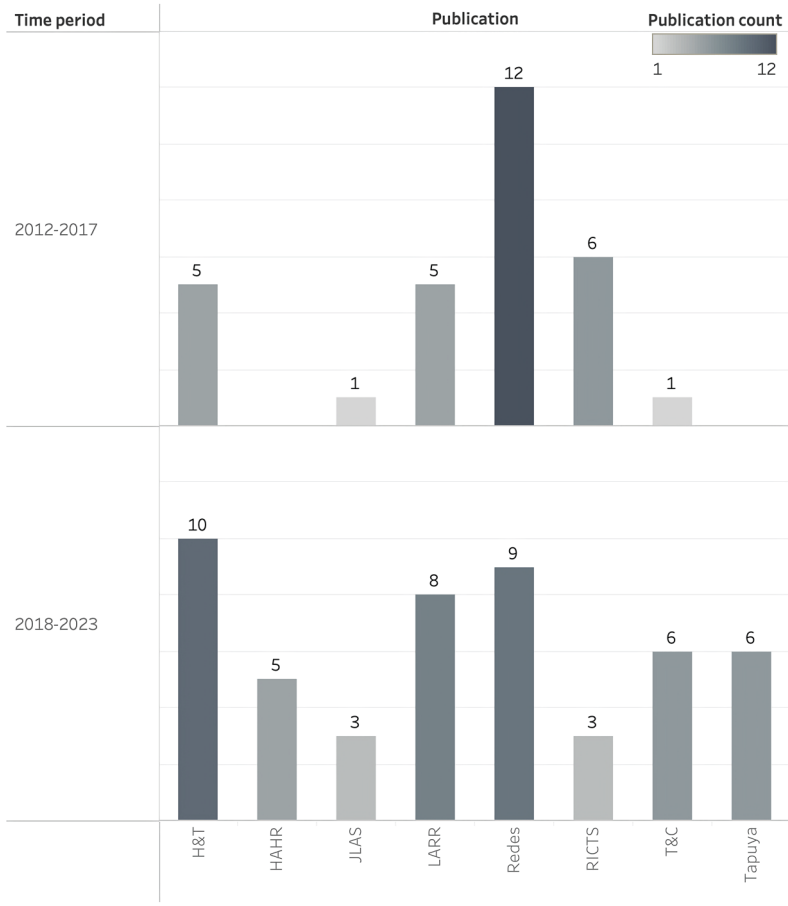

FIG. 1. Charting Growth. This figure tracks the number of articles published between 2012 and 2023 in eight journals dedicated to history of technology: *History and Technology* (H&T); *Hispanic American Historical Review* (HAHR); *Journal of Latin American Studies* (JLAS); *Latin American Research Review* (LARR); *Redes*; *Revista Iberoamericana de Ciencia, Tecnología y Sociedad* (RICTS); *Technology and Culture* (T&C); and *Tapuya*. It highlights a significant rise in scholarship concerning Latin America technology history. Notably, special issues contribute substantially to this growth, with nine of the fifteen articles from H&T featured in this essay being sourced from special issues published between 2018 and 2023. (Source: Figure by Pedro Reynolds-Cuéllar.)

Cruz's 2021 article in *Technology and Culture* describes how members of balloon workshops initially constructed hot air balloons from paper and glue and how these practices evolved into sophisticated forms of technological expertise. Drawn from Cruz's fieldwork in the 2010s, this development serves as a starting point for studying hot air balloons as a historical example of how marginalized communities created new forms of technical knowledge.[3]

We surveyed eight journals based on those analyzed by Lemon and Medina, which included *Hispanic American Historical Review*, *Journal of Latin American Studies*, *Latin American Research Review*, *Technology and Culture*, and *History and Technology*.[4] In an effort to expand to other languages representative of the region and to publications based in Latin America, we included the new journals *Tapuya*, *Redes: Revista de Estudios Sociales de la Ciencia y la Tecnología*, and *Revista Iberoamericana de Ciencia, Tecnología y Sociedad (RICTS)*. They are led by editors based at Latin American institutions; *Redes* and *RICTS* publish exclusively in Spanish. Admittedly, this review falls short in terms of linguistic representation, notably by not including journals published in Portuguese. While the reviewed journals published six special issues relevant to our review, we did not include the six introductions to these issues in our analysis. However, they are important for showing how scholars described work in the field at different times.[5]

This review offers a representative rather than exhaustive overview of the literature, as history of technology scholarship on the region has appeared in journals other than the eight that we surveyed.[6] We also acknowledge that this type of review is inherently biased toward academic and written forms of knowledge production. We therefore encourage scholars and practitioners working at the intersection of history, technology, and Latin American studies to help us bridge these gaps.

Our selection criteria identified eighty articles for analysis. Figure 1 provides a detailed breakdown of the journals in which these articles appeared. Clearly, the number of articles has increased steadily. What the figure does not show is that this increase is partly related to the launch of *Tapuya* in 2018 and the publication of special issues. For example, nine of the fifteen *History and Technology* articles in our pool came from special issues. These

3. Cruz, "Hacking Airspace."

4. Lemon and Medina, "Technology in an Expanded Field."

5. Mateos and Suárez-Díaz, "Development Interventions"; Velho and Ureta, "Frail Modernities"; Matharan, "Introducción al dossier"; Soto Laveaga and Gómez, "Introduction"; Rieznik, "Introducción"; Hernández, Arvanitis, and Vinck, "Circulación y vinculación mundial de conocimientos."

6. Special issues of three journals make important contributions that we did not review: the 2019 *History of Technology* issue on Latin America, edited by David Pretel, Ian Inkster, and Helge Wendt; a collection of articles on the history of computing in Latin America in the Argentine journal *Pasado Abierto* in 2022, edited by Karina Bianculli and Ariel Vercelli; and the 2015 special issue of *IEEE Annals of the History of Computing*, edited by Ivan da Costa Marques.

APRIL
2024
VOL. 65

covered Latin American history in relation to nuclear policy, development interventions, different approaches to studying technology history in the region, and nation building.[7] Thus, this review shows the important role of special issues in shaping the literature published since 2012.

Table 1 presents each journal's distribution of articles in Spanish and English and the departmental affiliation of the authors. The table demonstrates that our broad approach to the history of technology has shaped the pool of articles analyzed here. We coded multidisciplinary programs and coauthored works representing more than one departmental discipline as multidisciplinary. While department affiliation only provides a proxy for an author's primary discipline, it does highlight where conversations about technology's history are taking place. Forty-six of the articles are in English, and thirty-four are in Spanish. This breakdown highlights the activity in Spanish-language journals and the importance of including Spanish-language literature in studies of the region.

The Argentine journal *Redes* published the most articles about the history of technology in Latin America, making Argentina the most-studied country in the region. Figure 2 shows the representation of Latin American countries in the literature. Argentina, Brazil, and Mexico have received the most scholarly attention, while Paraguay, the Caribbean, the Andean countries, and the rest of Central America remain underrepresented. We now turn to the four main themes that we identified: industrialization, institutions and policies, infrastructures, and moving beyond adaptation. Space restrictions prevent us from discussing every article that we identified as part of this literature.[8]

7. On nuclear policy: Mateos and Suárez-Díaz, "Atomic Ambassadors." On development interventions: Peyerl and Fernanda de Mendonça Figueirôa, "Applied Geophysics in Brazil and the Development of a National Oil Industry (1930–1960)"; Mateos and Suárez-Díaz, "Creating the Need in Mexico." On historical approaches to technology in Latin America: Soto Laveaga, "*Largo Dislocare*"; Saraiva, "Anthropophagy and Sadness"; Gómez, "Caribbean Stones and the Creation of Early-Modern Worlds"; Cañizares-Esguerra, "Bartolomé Inga's Mining Technologies"; Schulze, "In Search of El Dorado." On nation building: Soto Laveaga, "Building the Nation of the Future, One Waiting Room at a Time"; Mateos and Suárez-Díaz, "'We Are Not a Rich Country to Waste Our Resources on Expensive Toys.'"

8. Articles from the eight journals that we identified as part of the history of technology literature, but do not discuss further, include Beatty, Pineda, and Sáiz, "Technology in Latin America's Past and Present"; Daniel, "Observar, medir, comparar"; Delgado, "El laboratorio de ensayo de materiales e investigaciones tecnológicas del ministerio de obras públicas de la provincia de Buenos Aires"; Favelukes, "El país en un libro"; Grossman, "Mining Engineers and Fraud in the U.S.–Mexico Borderlands, 1860–1910"; Mazzitelli Mastricchio, "Mapas sin cero"; Otremba, "Inventing Ingenios"; Ramírez Llorens, "Empresarios, católicos y estado en la consolidación del campo cinematográfico en Argentina"; Rieznik, "Los ojos de los pilotos bombarderos"; Torres Vásquez, "Revolución de los papeles"; Wilde and Takeda, "Tecnologías de la memoria."

Publication	Languages	Department affiliation	Total
H&T	English	History	13
		Multidisciplinary	2
HAHR	English	History	4
	Spanish	History	1
JLAS	English	Economics	1
		History	3
LARR	English	History	6
		Multidisciplinary	2
		Political science	2
	Spanish	Anthropology	1
		History	2
Redes	Spanish	Anthropology	1
		Economics	1
		History	8
		Multidisciplinary	5
		Sociology	3
		STS	3
RICTS	Spanish	Development studies	1
		Economics	1
		History	4
		Multidisciplinary	2
		Sociology	1
T&C	English	History	6
		Multidisciplinary	1
Tapuya	English	Anthropology	1
		History	1
		Multidisciplinary	2
		STS	2

TABLE 1. Cross-Disciplinary Dialogues. This table categorizes articles by journal, language, and academic affiliation of the authors, highlighting multidisciplinary collaboration where authors hail from various disciplines or multidisciplinary programs. The analysis reveals greater departmental diversity among authors in Spanish-language journals compared to in English-language journals. This diversity suggests that discussions on the history of technology engage a broader spectrum of disciplines in Latin America.

APRIL
2024
VOL. 65

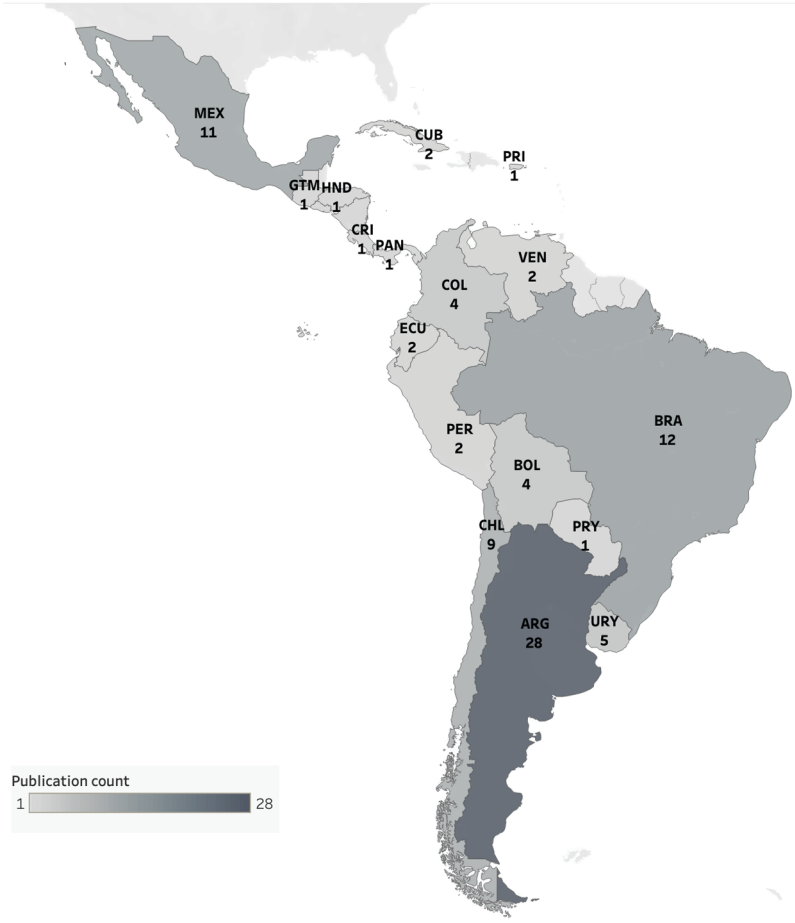

FIG. 2. Geographic Voices. This visualization presents the distribution of Latin American countries featured in the articles reviewed from 2012 to 2023. Notably, the journal *Redes*, located at the National University of Quilmes in Buenos Aires Province, contributes to the prominent representation of Argentina in the history of technology scholarship. (Source: Figure by Pedro Reynolds-Cuéllar.)

Industrialization

Historically, industrialization has served as a barometer of progress, and Latin American peoples have experienced the effects of state industrialization efforts in myriad ways. Not surprisingly, industrialization is a common theme in our literature review. Often, articles show how plans for industrialization are intertwined with other forms of specific economic activity. For example, Jennifer Eaglin describes the history of sugar-based ethanol in twentieth-century Brazil, tracing the origins of ethanol promotion policies and how this energy source was linked to national aspirations to create distinctly Brazilian ethanol-powered automobiles.[9] Teresa Cribelli traces connections between agriculture, industrialization, energy, and nationalism back to the colonial period, highlighting the specificity of Brazil's industrialization experience.[10]

Specific land ownership structures also shaped agricultural industrialization efforts. Alcides Beretta Curi and Leticia Mederos show how late nineteenth-century innovations in soil science (Beretta Curi) and nineteenth- to twenty-first-century veterinary technologies (Mederos) were linked to the importance of large-scale agriculture and ranching in Uruguay's economy.[11] In contrast, Otilia Margarita G. Schiavoni looks at how the prevalence of small-scale producers shaped the industrialization of yerba mate and mandioca in northern Argentina.[12]

The scholarship's focus on agricultural and ranching technologies should not be taken to imply that these industries are the only or most important industries in the region. Articles on "Peronist technologies" developed in mid-twentieth-century Argentina under President Juan Perón provide the clearest counterexample of diverse technological initiatives that were part of state-led industrialization projects and achieved larger state goals. Yamila Cáceres and Facundo Picabea, as well as Marc Alsina, highlight how Perón's government connected national security to the promotion of shipbuilding and aeronautics.[13] Diego Hurtado's article on the nuclear sector looks beyond the Peronist government, but it also examines this link between security and modernization.[14] Regarding civilian-oriented technologies, Facundo Picabea's article on the Rastrojero—an Argentine-designed farm truck built from imported tractor parts—sheds light on how the production of technological artifacts became entangled with ideas of national progress in Peronist

9. Eaglin, "'More Brazilian Than Cachaça.'"

10. Cribelli, "'These Industrial Forests.'"

11. Beretta Curi, "Terratenientes, nueva agricultura e inicios de la ciencia en el Uruguay de la modernización (1870–1900)"; Mederos, "Confianza y desconfianza como impulsos y frenos a la constitución de espacios interactivos de aprendizaje."

12. Schiavoni, "Entre organismos y artefactos."

13. Cáceres and Picabea, "Tecnologías estratégicas para países en desarrollo"; Alsina, "Aviation for the People."

14. Hurtado, "Cultura tecnológico-política sectorial en contexto semiperiférico."

APRIL
2024
VOL. 65

Argentina. Picabea shows that, even under precarious conditions, the Peronist government pushed industrialization as a national project.[15]

Articles about industrialization collectively evidence the active role of the state, its agencies, and its policies in shaping economic activity. One example is the article by Herbert Klein and Francisco Vidal Luna on the pulp cellulose industry in Brazil, Chile, and Uruguay. They show that decades-long government action was key to making these countries top exporters by the early twenty-first century.[16] This emphasis on the state is even more evident in the literature on the role of institutions and policies in technological development, which we discuss in the next section. For now, it suffices to say that industrialization projects and policies have been central in how we understand the region's history of technology.

Institutions and Policies

Technology policy debates appear frequently in the literature reviewed, often concerning the connection between national development and government decisions. Several articles describe government policies aimed at promoting specific economic activities. Cecilia Gárgano examines how Argentina's Instituto Nacional de Tecnología Agropecuaria promoted ties between scientific research in seed development and agriculture during the military dictatorship (1976–83).[17] José Buschini and Mariana Eva Di Bello analyze how the government of President Raúl Alfonsín promoted technology transfer from academic and scientific circles to Argentine industries after Argentina's democratic transition.[18] Articles about industrialization also commonly discuss policies to promote specific industries.

Studies about government science and technology agencies feature regularly in the scholarship. They document histories of the National Council of Scientific and Technical Research (Consejo Nacional de Investigaciones Científicas y Técnicas) in Argentina; the Administrative Department of Science, Technology, and Innovation (Departamento Administrativo de Ciencia, Tecnología e Innovación) in Colombia; and the Central American Institute of Research and Industrial Technology (Instituto Centroamericano de Investigación y Tecnología Industrial). These articles trace key actors and ideas that shaped twentieth-century technological policies.[19] Others show

15. Picabea, "Aircraft without Wings."

16. Klein and Luna, "The Development of a Modern Cellulose Industry in South America."

17. Gárgano, "Semillas, ciencia y propiedad."

18. Buschini and Di Bello, "Emergencia de las políticas de vinculación entre el sector científico-académico y el sector productivo en la Argentina (1983–1990)."

19. Aristimuño and Aguiar, "Construcción de las políticas de ciencia y tecnología en la Argentina (1989–1999)"; Svampa, "Gobernanza en el sistema público de investigación"; Jaramillo, "El papel de las ideas en ciencia y tecnología en los primeros años de Colciencias";

how multilateral organizations have influenced—or attempted to influence—government science and technology policies.[20]

The theme of policy appears more frequently in the Spanish-language literature than in the English-language literature.[21] Historically, policy has been an important site for studying science, technology, and society in the region. This can be traced in part to studies in the 1960s and 1970s that closely examined the relationship of science, technology, politics, and policy, which in the 1980s gave rise to a school of thought known as Pensamiento Latinoamericano en Ciencia, Tecnología y Sociedad (Latin American thought in science, technology, and society; PLACTS). Its history is documented elsewhere, often framed as a separate Latin American trajectory for what is now STS, a view that scholars such as Pablo Kreimer and Hebe Vessuri find overly simplistic.[22] However, those credited with this early conceptual work saw science and technology as tied to Latin American realities, possibilities for development and social transformation, and economic dependence. Policymaking was thus significant for understanding the relationship of science, technology, and society, while policy studies show how government actions shaped national science and technology capabilities and the quality of life for Latin Americans.

Policy remained important for the study of the history of technology of the region, as seen in journals such as *Redes.* The continued prevalence of policy in the Spanish-language literature suggests the ongoing influence of PLACTS, as demonstrated in an article by Juan Martín Quiroga, María Nevia Vera, and Manuel Lugones.[23] They analyze nuclear, satellite, and radar technologies in Argentina, which they describe as *tecnologías soberanizantes* (sovereignizing technologies). Sovereignizing technologies grant countries greater autonomy in making decisions about national development by reducing their dependence on other countries. This idea extends Jorge Sábato's concept of *tecnologías tecnologizantes* (technologizing technologies), technologies that,

Gutiérrez Pérez and Albornoz Barriga, "Un análisis de redes de política"; Viales-Hurtado, Sáenz Leandro, and Garita Mondragón, "Estructuras de implementación de las políticas CTI en América Central (1979–2020)."

20. Aguiar et al., "La influencia del Banco Interamericano de Desarrollo en la política de ciencia y tecnología de Argentina"; Aguiar, Davyt, and Nupia, "Organizaciones internacionales y convergencia de política en ciencia, tecnología e innovación"; Abarzúa Cutroni, "Partículas universales"; Mateos and Suárez-Díaz, "'We Are Not a Rich Country'"; Mateos and Suárez-Díaz, "Creating the Need in Mexico"; Mateos and Suárez-Díaz, "Atomic Ambassadors."

21. Fourteen of twenty articles on policy are in Spanish.

22. Arellano Hernández and Kreimer, "Estudio social de la ciencia y la tecnología desde América Latina"; Dagnino, Thomas, and Davyt, "El pensamiento en ciencia, tecnología y sociedad en Latinoamérica"; Kreimer and Vessuri, "Latin American Science, Technology, and Society."

23. Quiroga, Nevia Vera, and Lugones, "Tecnologías tecnologizantes y políticas pendulares."

APRIL
2024
VOL. 65

once developed, enable the development of other new technologies.[24] Drawing on this conceptual insight of Sábato, whose writings are considered one of the foundations of PLACTS, Quiroga, Nevia Vera, and Lugones describe how policies for national technological capabilities in radar and space were derived from earlier policies to develop the nuclear sector. The state viewed these technological capabilities as a way to increase Argentine autonomy. The authors reiterate the importance of the state in developing Argentina's scientific and technological capabilities, a claim they link to PLACTS.[25] This approach of studying policy history to guide future interventions, including those that increase national sovereignty and reduce dependency, appears more frequently in Spanish than in English.

Infrastructure

Because infrastructure studies feature regularly and are diverse in both approach and focus, we grouped the articles into five categories. We identified two themes, the socio-technical relationships involved in building infrastructure and the impact of infrastructure projects on people and communities, that cut across all five of these categories. We also linked the emerging theme of infrastructure repair and decay to a *Tapuya* special issue in 2019.

Articles about hydraulic infrastructure such as dams make up the first category. Some focus on projects pushed by the state in collaboration with other actors, as well as how these projects have affected the local populations. Matthew Johnson writes about the spread of malaria in areas surrounding the three large dams built by the Puerto Rican Irrigation Service to efficiently irrigate sugarcane fields.[26] Sarah Hines's study of the Misicuni dam in Cochabamba, Bolivia, emphasizes that the push for water access came from local residents who believed that the project would bring a new, water-rich modernity to their country.[27] Robert Andolina's study shows how an irrigation project in Ecuador affected relations among peasant communities, pushing them toward a market-driven society.[28]

The second category encompasses articles on energy infrastructure. This includes histories that overlap with those in the first category, such as studies of hydraulic infrastructure and the processes to bring hydroelectric projects to fruition.[29] However, the energy category also includes Agustín Piaz's

24. Sábato, "El comercio de tecnología."

25. Reference to PLACTS also appears in Quiroga, "Capacidades dinámicas en la producción de bienes intensivos en conocimiento."

26. Johnson, "Swampy Sugar Lands." We include Puerto Rico in recognition of its history, geography, and Hispanic heritage.

27. Hines, "The Power and Ethics of Vernacular Modernism."

28. Andolina, "The Values of Water."

29. Waiter, "Capacidades de la ingeniería nacional y tomadores de decisiones"; Hernando-Arrese and Tironi, "Worlding Hydropower."

recent history of resistance to nuclear infrastructure in Argentina; Diana Montaño's study of informal electricity connections in Mexico City and those who used them without paying; and Tatiana Acevedo-Guerrero's study of poorly maintained electricity networks, blackouts, and repairs by residents in Barranquilla, Colombia.[30] These articles represent the diverse approaches to studying energy infrastructure, documenting the construction of state-led projects and studying how people informally used and maintained them, even outside of state oversight or control.

The third category is communications infrastructure. Samuel Martland examines how the telegraph was key to military control of the Indigenous Mapuche land in southern Chile in the late nineteenth century.[31] Mariana Rieznik analyzes the intersection of astronomy practices, time standardization, and the laying of telegraph cables across Argentine territory.[32] Lila Caimari traces how the construction of the transatlantic telegraph cable between South America and Europe shaped news reporting practices in Buenos Aires.[33] Christiane Berth looks at how Mexicans in the mid-twentieth century experienced "infrastructural discontent" with their telephone service.[34] Shaozeng Zhang, Mariana Ribeiro Porto Araujo, and Ana Carolina de Assis Nunes tell the story of a digital network known as Baobáxia that built on earlier networks created by *quilombos* (remote communities formed by runaway slaves since the seventeenth century) in Brazil.[35]

The fourth category is transportation infrastructure. Kyle Harvey examines the role of engineers in the construction and regulation of the Transandine Railway.[36] Donald Kingsbury traces the history of the Caracas Metro from its early planning in the 1920s to its significance as a public space for political unrest in the 2010s.[37] Rieznik's article on telegraph cables also highlights the role railways played in the expansion of this infrastructure in Argentina. Cruz describes how Indigenous communities in the Amazon worked with the Brazilian government to create airfields that allowed for new air routes. These new flight paths created "aeronautical frontiers" that helped the government access Brazil's interior.[38]

The fifth category is urban infrastructure. Frederik Schulze writes about the 1960s plans for Ciudad Guyana in Venezuela, a promised modernization

30. Piaz, "Acciones de resistencia a la tecnología nuclear en la Argentina"; Montaño, "Ladrones de Luz"; Acevedo-Guerrero, "Light Is Like Water."
31. Martland, "Standardizing the State While Integrating the Frontier."
32. Rieznik, "Tiempo eléctrico en la Argentina del siglo XIX."
33. Caimari, "El mundo al instante."
34. Berth, "Interrupted Conversations."
35. Zhang, Araujo, and Nunes, "A Terrestrial Internet from the Quilombos."
36. Harvey, "Engineering Value."
37. Kingsbury, "Infrastructure and Insurrection."
38. Cruz, "Napalm Colonization."

that never materialized.[39] José Gómez-Urrego tells the story of Yachay, a planned "city of knowledge" in northern Ecuador.[40] Finally, Pilar Egüez Guevara delves into the history of urban infrastructure in nineteenth-century Havana and the attempts of urban elites to modernize Cuba.[41]

APRIL
2024
VOL. 65

Beyond Adaptation

Lemon and Medina's 2014 review identified adaptation—or how people modified technologies and systems to suit local conditions—as a dominant topic in the scholarship between 1970 and 2011.[42] Our review of the literature since 2012 shows that this is still a highly discussed topic. Francisco Garrido and Ricardo Paredes's history of radio and television in Chile from 1928 to 1973 describes how established technologies were redesigned to reflect national narratives of progress.[43] Gisela Mateos and Edna Suárez-Díaz explain how Mexico shifted its nuclear research program away from the weapons discourse advanced by the United States between 1950 and 1975 and toward narrow applications of nuclear energy that could be pursued peacefully, demonstrating that nuclear weapons need not play a central role in the development of Latin American nations.[44]

We also found that scholars are now approaching Latin American forms of knowledge production and technological creativity in ways that go beyond local adaptation. David Pretel's study shows that between the late nineteenth century and the first half of the twentieth, communities in remote jungle forests produced commodities and developed sophisticated production and mechanization processes that were central to making chicle and rubber available globally.[45] Other articles similarly explore how technologies and processes developed in Latin America shaped technological change in other parts of the world.[46] Such approaches turn previous studies of adaptation on their head by framing the rest of the world as adapting technologies and processes from Latin America.

Other authors reflect on what Latin American technologies represent in the societies that produced them. Alejandra Osorio uses the example of

39. Schulze, "In Search of El Dorado."

40. Gómez-Urrego, "The Intersections between Infrastructures and Expectations."

41. Egüez Guevara, "Manuales de urbanidad y discursos sobre el ornato en Cuba en el siglo XIX."

42. Lemon and Medina, "Technology in an Expanded Field."

43. Garrido and Paredes, "Modernizing a Nation through Its Radio and Television Industry."

44. Mateos and Suárez-Díaz, "'We Are Not a Rich Country.'"

45. Pretel, "Hidden Connections."

46. Cañizares-Esguerra, "Bartolomé Inga's Mining Technologies"; Guerrero, "The History of Silver Refining in New Spain, 16c to 18c"; Pereira, "The Rise of the Brazilian Cotton Trade in Britain during the Industrial Revolution."

chuño, a type of freeze-dried potato in Peru and Bolivia, to question what counts as technology in the history of technology literature. As she observes, the chuño preservation method represents a sophisticated "complex food production system without the use of machinery," achievements that have been ignored in the histories of technology in Latin America.[47] Picabea's article on the Argentine Rastrojero truck illustrates how the advancement of local technology can enable a Latin American country to steer its own development agenda.[48]

Articles such as those on Brazil's grassroots balloonists and the Baobáxia network, Bolivia's modern khipus (a string and knot recording system developed by Andean Indigenous Peoples), and khipu reading boards explore the meaning of knowledge and who produces it, depending on the conditions in specific regions.[49] The technologies discussed often involve historical information passed down in culturally specific ways, both written and nonwritten. Together, these articles point to the emergence of studies that explore what Pedro Reynolds-Cuéllar calls "ancestral technology," or forms of knowledge and action that support cultural cohesion, are rooted in bounded geographies, and have histories that live through collective memory.[50] While ancestral technologies may overlap with Indigenous technical practices, the category of ancestral technology is broader and can include technical practices in non-Indigenous communities.

The localization of methods to fit cultural, political, or social dynamics demonstrates a form of adaptation beyond the study of technological modifications. Indeed, several authors use the specificity of Latin American contexts to move to new historical framings. Cruz places the history of Brazilian hot air balloonists in the larger context of national identity across class lines. He sees the balloonists' local workshops as a "deep multilayer archive" and develops methods for incorporating these stories into the historical record.[51] Gabriela Soto Laveaga proposes to connect microhistories in new ways to uncover how people, ideas, and objects forged new paths.[52] She does this by studying the role of Indian scientist Pandurang Khankhoje in developing hybrid seeds in Mexico, telling new stories about the "Green Revolution." Eden Medina studies how Chilean forensic scientists used computer technology to identify the remains of those who disappeared during the civil-military dictatorship. She uses Chile's history of human rights crimes, as well as the subsequent push for truth, to show the value of telling technology histories in

47. Osorio, "Why *Chuño* Matters," 809.

48. Picabea, "Aircraft without Wings."

49. Cruz, "Hacking Airspace"; Hyland and Lee, "Indigenous Record Keeping and Hacienda Culture in the Andes"; Hyland, Bennison, and Hyland, "Khipus, Khipu Boards, and Sacred Texts"; Zhang, Araujo, and Nunes, "Terrestrial Internet."

50. Reynolds-Cuéllar, "Ancestral Technologies as Cultural Preservation."

51. Cruz, "Hacking Airspace," 31.

52. Soto Laveaga, "*Largo Dislocare.*"

areas where technology has limited overall significance, which she describes as the decentering of the computer in computer history.[53] Taken together, these articles signal that the historical study of technology in Latin America is pushing scholars to expand the field's methods and frameworks of analysis.

APRIL
2024
VOL. 65

Emerging Areas

We have identified two emerging areas of value for future work. First, a growing body of literature decenters the state as the primary unit of analysis and focuses on the complex and varied ways in which expertise, practices, and artifacts travel. Several articles examine how information and expertise about nuclear technology moved between the United States, Mexico, Argentina, and Brazil.[54] Mateos and Suárez-Díaz analyze how diplomatic initiatives led to "the movement of technologies, materials, and experts to every corner of the world," and especially across Latin America.[55] Milagros Rocío Rodríguez extends this examination to public and private institutions' role in formulating the nuclear policy of nation-states, and Guillermo Foladori examines the impact of cooperation between different government institutions in Mexico and the U.S. military.[56]

Other studies demonstrate that this circulation of knowledge extends to a wide range of contexts. Guillermo Martín Santos and Hernán Thomas document the transatlantic networks of knowledge transmission that emerged around smallpox vaccination in the eighteenth century.[57] Thales Zamberlan Pereira examines the relationship between specific cotton crops grown by farmers in Brazil and the mechanization processes that developed in the British Empire during the eighteenth century.[58] This body of work is complemented by studies that use the movement of knowledge to reframe the history of academic fields, such as anthropology in Mexico (Karin Alejandra Rosemblatt) and the intersection of Latin American studies and STS (Hugh Cagle).[59] Soto Laveaga's *largo dislocare* approach aims "to dislocate known histories not just geographically but also chronologically to better understand the motion of people, ideas and objects" and documents exchange networks

53. Medina, "Forensic Identification in the Aftermath of Human Rights Crimes in Chile."

54. Dunlap, "Rethinking Nuclear Cooperation in Argentina's and Brazil's Competition for Prestige, 1972–1980"; Domínguez Martínez, "Los orígenes de la física nuclear en México."

55. Mateos and Suárez-Díaz, "Atomic Ambassadors," 100.

56. Rodríguez, "El rol de las empresas privadas en la encrucijada tecnológica nuclear"; Foladori, "Participación militar estadounidense en la ciencia y tecnología de México."

57. Santos and Thomas, "Inoculaciones y procesiones y cuarentenas."

58. Pereira, "The Rise of the Brazilian Cotton."

59. Rosemblatt, "Mexican Anthropology and Inter-American Knowledge"; Cagle, "Objects and Agency."

not tied to North-South relations. Her article disrupts more familiar historical narratives and directs attention to those that foreground other actors and movements.[60] As the field of Latin American technology history shifts to a place "beyond adaptation," local histories of knowledge and technology become increasingly relevant. We see an opportunity to develop new approaches and narrative forms that account for the multiple ways in which knowledge and expertise travel.

Previous reviews of histories of technology in Latin America have highlighted the paucity of scholarship on the experiences of Indigenous Peoples and their knowledge.[61] As Osorio notes, "Few historians of technology in Latin America have dealt with indigenous knowledge at length."[62] We agree, but the literature reviewed does show new scholarly activity. In addition to Osorio, Robert Andolina looks at the various impacts of water infrastructure projects on Indigenous Peoples in Ecuador's Cañar Province.[63] Luis E. Cárcamo-Huechante focuses on Mapuche groups in Chile that use community radio as a tool for agency and self-determination, while Sabine Hyland, Sarah Bennison, and William P. Hyland examine Indigenous accounting tools and economic development practices in Peru and Bolivia.[64] Sabine Hyland and Christine Lee refer to ethnographic field notes from the mid-twentieth century that show the use of khipus for recordkeeping as late as the 1940s.[65] Pretel sheds light on the role that Indigenous knowledge of botany and taxonomy played in establishing the chemical processes used by local workshops in the Brazilian jungles to transform raw materials for export.[66] In foregrounding this emergence, we acknowledge that Indigenous Peoples in Latin America—as well as throughout the world—are not a monolith. In Colombia, for example, Indigenous histories cross-pollinate with those of rural peasants and Afro-descendant communities. We see the space where these nuances exist as fertile ground for future study. Our hope is that this development will lead to a greater representation of Indigenous scholars in our academic community and an expanded understanding of methods, historical sites, and media beyond the written word for histories of technology.

Our inventory of these emerging fields reveals gaps in the literature. Analyses of technology histories mediated by race are largely absent from our sample, although Rosemblatt's article on race, ethnicity, and social science

60. Soto Laveaga, "*Largo Dislocare*," 21.

61. Medina and Carey, "New Narratives of Technology, Expertise, and Environment in Latin America."

62. Osorio, "Why *Chuño* Matters," 813.

63. Andolina, "Values of Water."

64. Cárcamo-Huechante, "Indigenous Interference"; Hyland and Lee, "Indigenous Record Keeping"; Hyland, Bennison, and Hyland, "Khipus, Khipu Boards."

65. Hyland and Lee, "Indigenous Record Keeping."

66. Pretel, "Hidden Connections."

APRIL
2024
VOL. 65

in the United States and Mexico is a notable exception.[67] Few studies focus on gender or class, with the exception of articles such as Marc J. Alsina's class-based analysis of the use of aviation to improve the socioeconomic conditions of the middle class in Argentina and Christiane Berth's study of gendered assumptions in access to and development of telephone technology in Mexico.[68] We note that factory labor and plantation labor have received more scholarly attention in the earlier literature. While Acevedo-Guerrero discusses the ad hoc repairs undertaken by poor communities to maintain their electrical infrastructure,[69] the experiences of the socioeconomically marginalized deserve more attention. The field also has room for more research on how gender, race, ethnicity, class, citizenship, and other identity categories create intersectional experiences of technology. Egüez Guevara's use of race, gender, and class in her study of etiquette and modernity in nineteenth-century Cuba points us in that direction.[70]

The topic of disability studies is also conspicuously absent from the literature we reviewed, both as a perspective for analyzing technology and as a perspective for examining how histories of technology and disability have unfolded in the region. Future studies could pay more attention to the role of nonexperts in creating various types of expertise. Building on recent work in the history of science, we also see possibilities for new historical studies on quantification and data.[71] One example is the article by Oriana Bernasconi, Jefferson Jaramillo, and Marisol López on how state institutions and nongovernmental organizations quantified the victims who disappeared in Chile and Colombia.[72]

Finally, we wish to draw attention to Soto Laveaga's observation that starting points and chronologies shape the narratives we tell and whose stories get told.[73] Added to this is the consideration of who we read and who we cite. We hope that greater inclusion of Spanish-language scholarship in English-language literature will offer new ways of telling stories that focus on Latin American technological experiences and analyze them on their own terms.

Conclusion

We consider the scholarship reviewed as an interlocking three-part puzzle, with each piece represented in our title, "Seeds, Dams, and Khipus." The first element, seeds, points to the body of literature that looks at how

67. Rosemblatt, "Mexican Anthropology."
68. Alsina, "Aviation for the People"; Berth, "Interrupted Conversations."
69. Acevedo-Guerrero, "Light Is Like Water."
70. Egüez Guevara, "Manuales de urbanidad."
71. Special issue of *Osiris* (2017) on data histories.
72. Bernasconi, Jaramillo, and López, "The Number of Disappearance."
73. Soto Laveaga, "*Largo Dislocare*."

Latin American nations have traditionally been integrated into the global economy. This includes studies of technologies and technical knowledge in agriculture and livestock industries, as well as industries such as mining that produce raw materials for export.

The second part of the literature, represented by the element dams, looks beyond the production and export of raw materials to examine state-led modernization and industrialization projects, including those associated with import substitution policies of the twentieth century. These histories may overlap with those in the first area, as seen in studies of irrigation or the construction of agricultural vehicles. But they also document industrial processes such as ethanol production, the national production of consumer goods such as televisions, and the construction of new energy infrastructures. They further study policies designed to increase national capabilities in science and engineering and the techniques used by state and nonstate actors to understand and record the world and its complexities. This scholarship tends to focus on the twentieth century, although we found examples that go back to the colonial period.

More recently, however, a third body of literature has begun to emerge, represented by the element khipu. This small but growing body of literature examines alternative ways of knowing and doing, including those of Indigenous communities and those informed by less visible circuits of knowledge production. It shows other techniques and technologies that are part of Latin American history but have received less attention than they deserve. The history of chuño production is one such example.

As we look forward, we see new opportunities not only to contribute to these areas of scholarship but also to build bridges among them. Scholars of Latin American technological autonomy might ask how to extend Quiroga's concept of sovereignizing technologies to ancestral and Indigenous ones. They might also question how Indigenous Peoples have shaped histories of industrial and infrastructural technologies, which in turn have defined relations in Indigenous communities. Cruz's article on the contributions of Indigenous Peoples to new air routes in the Brazilian Amazon is one of the few examples of this approach.

We further see recent history of technology literature as central for understanding the political and economic dilemmas that the region is now facing. Concerns about deforestation in the Amazon are tied to the history of cattle ranching. Current debates about lithium mining in Chile, Argentina, and Bolivia are linked to the histories of imperialism, struggles for autonomy, and power structures that disadvantage resource exporters. Defending and advocating for the rights of Indigenous communities requires learning about Indigenous forms of knowledge production. Emerging scholarship can help expand our understanding of technology, its production, and its meaning. While the literature reviewed helps us to better understand the region's history, it also offers ways to think about its future.

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APRIL
2024
VOL. 65

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APRIL
2024
VOL. 65

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