

The *Isis* Bibliography: Information Practices from Sarton's Vision to the Digital Age

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Abstract: The *Isis* bibliography of the history of science has been published continuously since the first issue of the journal in 1913. This essay examines how information practices used to produce the bibliography have shaped, and were shaped by, the evolving discipline of the history of science. We first focus on the intellectual endeavors of George Sarton, who used the bibliography to help define and create a new academic field: the history of science. Next, we outline the administrative struggles of the History of Science Society (HSS) as it tried to continue the project after Sarton's retirement. Finally, we examine the technological aspects of producing a bibliography by focusing on the transition from analog to digital technologies over the last fifty years. In this overview, we show the central place the *Isis* bibliography played in the HSS community and argue that information practices surrounding the bibliography are an underutilized resource for studying the history of the discipline.

Some scholars try to avoid routine work of any kind (and bibliography implies much of it), for which they fancy that they are too good. Nonsense. These people speak of routine as "donkey work"; they are the donkeys.¹

—George Sarton

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¹ George Sarton, "The Critical Bibliographies of *Isis*," *Isis* 41 (1950): 295.

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INTRODUCTION

In last year's December issue of this journal, Bonnie Mak and Allen Renear took readers on an entertaining exploration of how to think about the way that information practices help shape our world. Over a decade earlier, James Secord pointed out that libraries and their information practices remained a largely neglected subject of study. In the following article, we propose to use the history of the *Isis Critical Bibliography*—later renamed the *Current Bibliography* and affectionately known as the *CB*—to reflect on the information history of our own discipline and illuminate its close ties to libraries and the information tools they create. The *CB* has been a fundamental resource around which our discipline has coalesced and developed, and while a detailed history of it remains to be written, we outline below three episodes that exemplify different practices through which “information became information.” Put another way, analysis of the history of the *CB* sheds light on how information practices have shaped, and were shaped by, the evolving discipline of the history of science.²

For the first two decades of the *Isis* bibliography's existence, its form and content were largely determined by George Sarton's efforts to understand what kind of resource it should be. That is, between 1913 and the late 1920s, Sarton spent much of his time engaged with two questions: What was the history of science, and what sort of reference material did this burgeoning but inchoate discipline require? As historians have long known, he drew on a wide variety of thinkers and texts to formulate an answer to these inquiries, ranging from the philosophy of Ernst Mach to the *International Catalog of Scientific Literature*, but his approach to the *CB* was also informed by less august sources. As we will argue, one important—and now mostly forgotten—influence on the evolution of his bibliography project was a similar text by Aksel Josephson, who was then the head cataloger of the John Crerar Library.

The second phase of the *Isis* bibliography commenced when Sarton retired as editor in 1952, prompting the History of Science Society (HSS) community to evaluate the future of the project, including whether it should be continued at all. The *CB* persisted, but this challenging period saw it diverge from Sarton's unique vision for the discipline as numerous individuals strove to reshape and sustain the project. Modifications in the classification schema and production workflow meant that the information presented to historians using the bibliography changed. Simultaneously, while struggling to maintain the annual *CB*s, HSS initiated work on a cumulative bibliography that would consolidate citations scattered across dozens of separate publications into a single reference work, thereby making it more accessible to historians.

The final part of this essay will examine the *CB* from the beginning of John Neu's tenure as editor to the present day. During Neu's tenure, the *CB* was produced by a librarian rather than a historian, a change that brought with it stability for the project. More significantly, Neu's effort to establish online access to the *CB* during the 1990s initiated a seismic shift in how historians interacted with the *CB*. That shift continued into the twenty-first century with Neu's successor, Stephen Weldon, who inaugurated the current online version of the *CB* in 2015: *IsisCB Explore*. *IsisCB Explore* utilized the *CB* data in new ways that transcend the limitations of the printed bibliography. As of this year, the bibliography has now transitioned to an exclusively digital format. It is time, we think, to explore a century of transformation in the *Isis CB*'s information infrastructure amid this changing and growing field.

SARTONIAN ORIGINS (1913–1952)

Although George Sarton (1884–1956) did not invent the history of science, it would be impossible to tell the story of its emergence as an autonomous academic pursuit, replete with salaried

² James A. Secord, “Foreword,” in *Science in Print: Essays on the History of Science and the Culture of Print*, ed. Rima D. Apple, Gregory J. Downey, and Stephen L. Vaughn (Madison: University of Wisconsin Press, 2012), vii–xiii; Bonnie Mak and Allen H. Renear, “What Is Information History?” *Isis* 114, no. 4 (2023): 747–68, <https://doi.org/10.1086/727568>.

chairs, professional organizations, and specialized publications, without him. One of his most important contributions to the advent of the discipline was the creation of *Isis* in 1913. He was also deeply involved in the formation of the HSS in 1924, mainly because he wanted to ensure the continued publication of his journal. He was especially hopeful that HSS would provide a secure institutional foundation for the growth and refinement of *Isis*'s bibliographic content, because he considered the provision of good reference material to be just as essential to the nascent profession's development as the circulation of original research.³ He would spend much of his tenure at the journal's head figuring out what such a project entailed.

Sarton's interest in bibliography had already begun to shine through during his years as an undergraduate in Belgium. Shortly after matriculating at the University of Ghent in 1902, he wrote an impassioned letter to the university's head librarian complaining about the state of the catalog and making suggestions for improvement.⁴ He was not alone in his fascination with the organization of academic texts. Fin-de-siècle Europe and North America were in fact rife with bibliographic initiatives and projects, many of which were connected to the broader intellectual and sociopolitical movements of the period, ranging from pacifism and internationalism to monism and positivism. One of the most famous of the latter was located less than one hundred kilometers away from Ghent in Brussels, where Paul Otlet (1868–1944) and his colleagues at the International Institute of Bibliography were hard at work using decimal classification schemes, printed index cards, and other novel information management technologies to realize the utopian dream of a universal catalog.⁵ A similarly ambitious project was underway just across the channel in England, where the Royal Society had begun production of the monumental *International Catalog of Scientific Literature*. But Sarton's contemporaries were also engaged in less quixotic bibliographic endeavors, including several that aimed to bring order to the unruly morass of information related to a relatively new area of academic inquiry: the history of science.

Many of the first attempts to catalog the burgeoning historical literature on the sciences were restricted to specific fields and disciplines, à la Gustaf Enestrom's bibliographies of the history of mathematics and Karl Sudhoff's bibliographic work on the history of medicine. But by the early 1900s, Enestrom and several others had set their sights on the production of a more general overview of the literature.⁶ This latter group immediately faced two pressing questions: What was the history of science in general, and what sort of bibliography did it demand? Arguably the first to succeed in formulating a practical answer to these questions was Aksel Josephson (1860–1944) of the John Crerar Library in Chicago. Although Josephson's efforts are largely forgotten now, his two most important texts, *The John Crerar List of Books on the History of Science* (1911) and its companion piece, *The John Crerar List of Books on Industry and the Industrial Arts* (1915), quickly became standard reference works for historians of science.⁷

³ George Sarton, "Preface to Volume VI," *Isis* 6 (1924): 4–8; see also John C. Greene, Robert P. Multhauf, Arnold Thackray, George Basalla, Derek de Solla Price, Charles C. Gillispie, and Erwin N. Hiebert, "Fiftieth Anniversary Celebration of the Society," *Isis* 66 (1975): 443–82.

⁴ Marc de Mey, "Sarton's Earliest Ambitions at the University of Ghent," *Isis* 75 (1984): 40–42.

⁵ Following the lead of the Library of Congress, the John Crerar Library and several other American institutions began to use mimeograph and stereotype machines to produce and disseminate printed card catalogs in the late nineteenth century. For more on the relationship between Sarton, Otlet, and the Crerar, see Lewis Pyenson and Christophe Verbruggen, "Ego and the International: The Modernist Circle of George Sarton," *Isis* 100 (2009): 60–78.

⁶ Gustaf Enestrom, "Sur la constitution d'un répertoire bibliographique de l'histoire des sciences," in *Annales Internationales d'Histoire: Congrès des Paris 1900* (Paris: Librairie Armand Colin, 1901), 294–96.

⁷ For contemporary assessments of the *Lists*, see Frederick Brasch, "The History of Science," *Science* 41 (1915): 359; W. T. Sedgwick and H. W. Tyler, *A Short History of Science* (New York: Macmillan, 1921), 458; and George Sarton, "Notes and Correspondence," *Isis* 9 (1927): 114.

Sarton's first "Analytical Bibliography of Publications Related to the History of Science" was therefore not the only work of its kind when it appeared in the inaugural edition of *Isis* in 1913. Nor was it a particularly novel addition to the genre, insofar as it bore many conceptual and formal similarities to Josephson's *Lists*. There were several reasons for this overlap. First, both men saw bibliography as a constitutive but underappreciated element of intellectual life and demanded rigor and objectivity in its practice. Indeed, in one of Josephson's first letters to Sarton, he sought to find common ground with the Belgian by drawing attention to their mutual interest in more fully institutionalizing and professionalizing the production of reference material and lamenting the "frightful" lack of care that their American colleagues exhibited toward such media, particularly in comparison with European scholars.⁸ They also possessed many of the same ideas about what the history of science was, and thus how its literature should be organized. Both were impressed by the evolutionary conceptions of scientific knowledge and research that they found in the work of Wilhelm Ostwald and Ernst Mach, for example, and adopted a broadly Machian perspective on the history of science's value as a tool for coming to a clearer understanding of how and why scientific ideas and problems came to be. Or as Sarton put it, Mach's *Science of Mechanics* had "splendidly illustrated" that analysis of the temporal development of science was essential to assessing and guiding contemporary research.⁹ He and Josephson consequently decided to integrate a chronological component into their respective classification schemes because they felt that it could further that goal.¹⁰

As Sarton continued to refine and expand his bibliographies, however, he made a conscious effort to differentiate them from Josephson's. Crucially, he declared that the rapid and unabated growth of the history of science literature had exposed the "insufficiency" of the *Lists* and other "analytic"—that is, enumerative—catalogs and moved to adopt a more "constructive" and "synthetic" approach that would ostensibly enable his readers to "make a sensible choice between so many titles."¹¹ This transition was already in evidence in the June 1914 issue of *Isis*, which contained a number of notes appended to the entries of various books describing their contents and historiographical relevance. He also broke with Josephson in terms of the texts he chose to include. On the one hand, he became more selective, explaining that there was a direct connection between his decision to exclude publications that did not warrant scholarly attention and his efforts to enhance *Isis*'s functionality as a guide to the literature. On the other hand, he became more inclusive by listing texts on art, religion, and philosophy. One of his goals in cataloging such a wide variety of information was to draw out patterns and connections between different domains of intellectual and practical activity, and ultimately to facilitate the "unity of knowledge and the unity of mankind."¹² As with his emphasis on chronology, his desire to contextualize scientific knowledge and plant the seeds for future epistemic and civilizational unity was indebted to Mach, who had claimed similar unifying motives for his historical work.

While Sarton's critique of the *Lists* was not unfounded, it elided several key differences between his project and Josephson's, including aim and audience. Josephson was first and foremost

⁸ Aksel Josephson to George Sarton, April 26, 1917, MS Am 1803-1803.4, box 14, George Sarton Additional Papers, Houghton Library, Harvard University.

⁹ George Sarton, "The History of Science," *Monist* 26 (1916): 349.

¹⁰ George Sarton, "Bibliographie analytique des publications relatives à l'histoire, de la science parues depuis le 1^{er} janvier 1912," *Isis* 1 (1913): 137–38. This chronological approach stood in stark contrast to the classification schemes suggested by the Library of Congress and Dewey Decimal System, which grouped histories of scientific subjects with scientific works on that subject. For more on the place of chronology in Sarton's tripartite classification scheme, see Stephen Weldon, "The *Isis* Bibliography from Its Origins to the Present Day: One Hundred Years of Evolution of a Classification Scheme," *Circumscribere* 6 (2009): 26–46.

¹¹ Sarton, "The History of Science," 364; and George Sarton, "Synthetic Bibliography, with Special Reference to the History of Science," *Isis* 3 (1920): 159–70.

¹² Sarton, "Synthetic Bibliography."

a working librarian, and he produced the *Lists* to fulfill what he saw as a general bibliographic desideratum among his colleagues and to provide the Crerar's patrons with a means of navigating the library's collections. He also assumed that the main users of these collections would be aspiring or practicing biologists, chemists, physicists, and physicians, because he—and many of the scholars who were involved in teaching and writing the history of science at the time—took it for granted that the field was and would remain the province of scientists.¹³ He therefore consciously omitted data that Sarton considered essential, including entries for texts that were not on the Crerar's shelves, entries for texts that concerned the history of scientific institutions and "movements," and critical notes that provided historiographical information.¹⁴

Sarton, by contrast, intended for his work to help establish the history of science as an autonomous discipline that was the province of a new kind of specialist, hence his focus on providing normative guidance regarding the field's fundamental goals, ideas, methods, questions, and texts. His desire to stake out new disciplinary terrain not only informed the decisions he made related to the *Isis* bibliographies' form and content but also affected his approach to their production, including his conviction that they could not "as a rule, be undertaken by librarians," because the latter ostensibly lacked the historical knowledge and training required to make the relevant sorts of historiographical judgments.¹⁵ This restrictive conception of who was qualified to participate in the project—which was diametrically opposed to Josephson's insistence that librarians should be *more* involved in the production of specialized catalogs—was a factor in his decision to continue doing many of the entries and notes himself, although in 1920 he began to call for other scholars to "help share the burden."¹⁶ This appeal was relatively successful, as the average number of contributors and entries grew throughout the decade, although it remained small compared to contributions by Sarton himself.

In short, by the late 1920s Sarton had succeeded in articulating a distinct vision of what the history of science was and how its literature should be organized. As we have argued, he held that one of the field's primary tasks was to shed light on the contingent and contextually determined evolution of scientific ideas and practices over time, with an eye toward facilitating the eventual unification of knowledge and humanity. These beliefs informed the process he used to produce the bibliography in several ways, including his decision to privilege chronology and to catalog texts on subjects that others considered beyond the purview of the history of science. He had also provided a secure foundation for future growth of the *Isis* bibliographies by establishing an institutional home for them in HSS, expanding their breadth and scope, and growing his network of trusted collaborators. Perhaps sensing that he could afford to turn his full attention to other projects, he set to work on completing the first volume of the mammoth *Introduction to the History and Philosophy of Science*. Although it was a work of history, he nevertheless considered the *Introduction* to be a cumulation of the information collected in the CBs and proposed that each future CB would be "an addendum" to the *Introduction* because the two were linked by various cross references and a shared classification schema. However, Sarton's effort at transforming the information scattered across many CBs into one publication did not meet the expectation of other historians. The *Introduction*'s obsessive cataloging of authors and publications partly explains why

¹³ J. Christian Bay, *The John Crerar Library, 1895 to 1944: An Historical Report Prepared under the Authority of the Board of Directors by the Librarian* (Chicago: John Crerar Library, 1945), 55. See also Aksel Josephson, *The John Crerar Library: A List of Books on the History of Science* (Chicago: John Crerar Library, 1911), 3–5. According to Josephson's Crerar colleague (and eventual HSS treasurer) Frederick Brasch, US university catalogs listed around 162 history of science courses in 1915, all of which were offered through science departments. See Frederick E. Brasch, "The Teaching of the History of Science," *Science* 42 (1915): 46–60.

¹⁴ Josephson, *A List of Books on the History of Science*, 3.

¹⁵ Sarton, "Synthetic Bibliography," 164.

¹⁶ George Sarton, "Seventh Critical Bibliography of the History, Philosophy and Organization of Science and of the History of Civilization," *Isis* 3 (1920): 90.

it received a mixed reaction from contemporaries. According to one reviewer, it was less “a history in the ordinary sense” than an “inspired dictionary.”¹⁷ But as this section has shown, Sarton’s repeated pronouncements about the invaluable and often original contributions that reference works made to knowledge suggests that he would have taken this comment as high praise.

RETHINKING (1953–1967)

Sarton continued to edit *Isis* and produce the *CB* throughout the 1930s and 1940s, but by the 1950s, changes were afoot at the journal and beyond. The Crerar Library, where Josephson published his 1911 bibliography, ceased collecting material on the history of science in 1951. More significantly, Sarton retired from the editorship of *Isis* in 1952, marking the end of a nearly forty-year period in which he curated the bibliography according to his own idiosyncratic vision of the new discipline. In one way, his project succeeded. By 1953, the history of science was well established, with its own society, departments, and an international union. However, in another way, he had failed. The next generation of historians was taking the discipline in a new direction and largely abandoned Sarton’s quest for the “unity of knowledge and unity of mankind.” Given these changes, perhaps it is not surprising that the period that followed was one of rethinking all of the practices used to create the bibliography.¹⁸

Although Sarton dealt with administrative issues during the years he was in charge of the *CB*, they were relatively minor. After his first tumultuous years in America, his professional life settled, and he was able to follow a consistent work routine. Assisted by Alexander Pogo and Francis Siegele, he edited *Isis* in room 189 at Harvard’s Widener Library while composing the *CB* in the evenings at his home.¹⁹ This stability would not last for the inheritors of the project, as administrative tasks soon became their central focus, reshaping the bibliography.

After Sarton’s retirement, the first order of business for his protegee, I. Bernard Cohen (1914–2003), was to investigate whether the *CB* should, or even could, continue without him. As managing editor under Sarton, Cohen was acutely aware of the high cost of producing the bibliography, and he had previously suggested that in order to reduce expenses, it should not be as extensive. He also knew that if the *CB* were to continue to be published, a new approach to producing it would be necessary. To explore these issues, the Society’s Council appointed a committee headed by Cornell University historian of science Henry Guerlac (1919–85). Ultimately, the committee found that the bibliography was “widely held to be one of the most valuable features of the Society’s journal [and] every effort should be made to continue it.” Consulting it was a required task for PhD students around the country, for example, and for many historians it was a starting place for new research or teaching and for keeping up with new literature.²⁰ Based on those findings, the *CB*’s survival was ensured, but Guerlac’s committee also recognized that the *CB* needed to be transformed from the pet project of one man into a community tool that was kept alive by the combined efforts of many people.²¹

¹⁷ Arnold Thackray and Robert K. Merton, “On Discipline Building: The Paradoxes of George Sarton,” *Isis* 63 (1972): 473–95.

¹⁸ Thackray and Merton, 473–95.

¹⁹ I. Bernard Cohen, “George Sarton,” *Isis* 48, no. 3 (1957): 296.

²⁰ In addition to anecdotal evidence on the uses of the *CB*, there is also research by librarians and surveys conducted by Stephen Weldon during his tenure as the bibliographer. Margaret F. Stieg, “The Information Needs of Historians,” *College & Research Libraries* 42, no. 6 (November 1981): 549–60, https://doi.org/10.5860/crl_42_06_549; Helen R. Tibbo, *Abstracting, Information Retrieval, and the Humanities: Providing Access to Historical Literature*, ACRL Publications in Librarianship, no. 48 (Chicago: American Library Association, 1993), <https://openlibrary.org/books/OL1393860M>; Matthew Goldberg, “Searching for the Past: Historians’ Information-Seeking Behaviors and Needs,” *Kentucky Libraries* 82, no. 3 (Summer 2018): 11–14.

²¹ Marie Boas, “History of Science Council Meeting 4 April 1952,” *Isis* 43, no. 4 (1952): 390–91; I. Bernard Cohen, “Report of the Managing Editor of *Isis* to the Officers and Council of the History of Science Society, 1951,” *Isis* 43, no. 4 (1952): 392–93; Henry Guerlac, “A Proposed Revision of the *Isis* Critical Bibliography,” *Isis* 44, no. 3 (1953): 226–28.

Sarton had used the bibliography as an instrument to try to shape the history of science, and its classification schema and scope reflected his vision of the discipline. However, since younger historians generally did not share Sarton's vision, the bibliography had to change to better represent and serve the newly professionalized community. Guerlac's committee took on the task of making those revisions. Their new classification system altered the grouping of citations into categories, and while it still favored Sarton's chronological classification for more recent periods, it adopted broader temporal divisions for earlier eras and separated studies of Western and non-Western cultural contexts. This reorganization abandoned Sarton's approach of categorizing studies into half-century intervals regardless of topic—a strategy he believed would illustrate the “unity of knowledge and unity of mankind.” In addition, the new system introduced a category titled “Science and Its History from Special Points of View.” This category—while recognizing the significance of investigating science in relation to government, religion, and other sociopolitical and cultural aspects—segregated these works into their own section, thus presenting them as *other* and set aside from works on the discrete disciplines, the histories of “sciences” such as physics or biology. Finally, the classification reflected a sharper positivist outlook on modern science by expelling post-seventeenth-century astrology and alchemy from “proper” science and placing them together under a new heading: pseudoscience. All of those changes represent a notable shift in how the *CB* would represent historical research to the history of science community.²²

Once the new classification schema was established, the committee's focus shifted to re-evaluating the practices used for surveying thousands of publications, selecting relevant citations, organizing them, and preparing a manuscript for print. From the outset it was clear that neither I. B. Cohen, who succeeded Sarton as editor, nor any subsequent editor could continue Sarton's practice of managing both roles. As a result, the responsibility of collecting materials for the bibliography was dispersed among a group of volunteers—including professional historians, amateurs, and scientists—with the *Isis* editorial office taking on the job of compiling the final bibliography.²³ It was an approach that defied Sarton's insistence on having just one editor to maintain consistency of method and vision, albeit for good reason: there was simply no one willing to undertake the task of creating the bibliography alone; while many historians recognized the usefulness of the *CB*, none of them shared Sarton's passion for the project. More importantly, the new editors believed that the *CB* should simply reflect what was being published in the field rather than project any specific vision of it. With this approach, it mattered less that the bibliographic work was distributed.²⁴

Of course every bibliography does reflect the perspective of its creators, and the *Isis* editor still had an outsized role in shaping the *CB*, even with many tasks outsourced to the community. When the relatively young historian of science Harry Woolf (1923–2003) took over as editor of *Isis*, he prioritized the publication of articles and reviews over editing the *CB*. This shift in priorities, combined with the waning of enthusiasm from contributors, resulted in a significant decline in the number of citations published under his editorship and signaled to the *CB*'s next editor, the Smithsonian historian of science Robert Multhauf (1919–2004), that it was once

²² Guerlac, “A Proposed Revision”; Weldon, “The *Isis* Bibliography from Its Origins to the Present Day.” On using classification to remove literature from the mainstream, see Hope A. Olson and Rose Schlegel, “Standardization, Objectivity, and User Focus: A Meta-Analysis of Subject Access Critiques,” *Cataloging and Classification Quarterly* 32, no. 2 (2001): 61–80, https://doi.org/10.1300/J104v32n02_06; Melissa Adler and Joseph T. Tennis, “Toward a Taxonomy of Harm in Knowledge Organization Systems,” *Knowledge Organization* 40, no. 4 (2014): 266–72, <https://doi.org/10.5771/0943-7444-2013-4-266>.

²³ Dorothy Stimson, “The Editing of *Isis*,” *Isis* 44, nos. 1/2 (1953): 3–4; I. Bernard Cohen and Katharine Strelsky, “Eightieth Critical Bibliography of the History of Science and Its Cultural Influences (to 1 January 1954),” *Isis* 46, no. 2 (1955): 111.

²⁴ Sarton, “The Critical Bibliographies of *Isis*.”

again time to reevaluate how it was produced.²⁵ When Multhauf took over in 1964, he was thoroughly disappointed to discover that the practice of distributing the work of collecting citations among many individuals resulted in large gaps in coverage. To revive the bibliography, he and the editorial office took a more active approach in collecting citations. One result of this was that the *CB* now reflected Multhauf's ideas of what should be included; for example, he believed that the *CB* should include more historical works published in scientific journals. Another consequence was an increase in the amount of time and effort spent by the editor on the project: in addition to dedicating 1.5 full-time editorial assistant positions to the task, Multhauf found himself spending as much as half his time on the *CB*.²⁶

Although the 1950s and 1960s were marked by a number of serious challenges for the editors of the *CB*, they coincided with an explosion of interest in bibliographies in general. This time period saw multiple high-profile conferences on the future of bibliographic work as well as a proliferation of new bibliographies in history of science-adjacent fields, general history, and beyond.²⁷ The increased interest in bibliography meant that many institutions were willing to financially support the *CB*'s production, and over the next two decades, the *CB* received support from over a dozen institutions. The influx of funds was especially welcome since they at times helped to cover HSS budget deficits, making the *Isis* *CB* helpful in overall fundraising. In this milieu of new digital computers and information systems, the HSS's information tool brought in financial support to the Society.²⁸

In addition to administrative challenges, the *CB*'s stewards had to figure out how to make the bibliography more usable as a research tool. In fact, most of the new funding support was appropriated toward solving this problem. Initially, the *CB* was published within the pages of *Isis*, appearing irregularly every issue or two. Later it became an annual feature and a stand-alone issue. This publication timeline created serious problems for researchers. By the time Sarton retired, there were already seventy-nine separate bibliographies scattered across forty-three volumes of *Isis*. Despite the publication of author and person indexes every few years, the effort needed to search through dozens and dozens of these lists was, in the words of the historian Allen G. Debus, "one of the most unpleasant tasks" and undertaken only when absolutely necessary.²⁹ The information contained in the *CB*s was becoming information that was inaccessible to historians.

²⁵ Harry Woolf, "Annual Report of the Chairman, 22 Dec 1960," Record Unit 7474, History of Science Society Records, circa 1930–1993, box 25, Smithsonian Institution Archives; John C. Greene, "Administrative Documents," *Isis* 53, no. 3 (1962): 433–35.

²⁶ "Report to the Editorial Committee," December 1964, Record Unit 7474, History of Science Society Records, circa 1930–1993, box 15, Smithsonian Institution Archives; "Report to the Editorial Committee," December 1967, Record Unit 7474, History of Science Society Records, circa 1930–1993, box 15, Smithsonian Institution Archives.

²⁷ Notable meetings included the 1965 INTREX conference, which explored the future of bibliographies in the age of computers, and the 1967 conference "Bibliography and the Historian" at Belmont University. Two significant new general history bibliographies that began publication during this time period were *Historical Abstracts* (1955) and *American History and Life* (1964). In addition, many bibliographies directly relevant to historians of science were launched, most notably: *Relations of Literature and Science* (1949), *Current Work in the History of Medicine* (1954), *Bibliography of the History of Technology* (1964), *Bibliography of the History of Medicine* (1966), *Philosopher's Index* (1967), and *International Medieval Bibliography* (1967).

²⁸ Institutions providing financial support included the US Steel Corporation, the NSF, the NEH, the American Council of Learned Societies, the British Academy, the British Library, the Royal Society, the Wellcome Trust, and Imperial Chemical Industries. John C. Green, "Administrative Documents," *Isis* 52, no. 1 (1961): 129–31; John C. Greene, Robert P. Multhauf, Arnold Thackray, George Basalla, Derek de Solla Price, Charles C. Gillispie, and Erwin N. Hiebert, "Fiftieth Anniversary Celebration of the Society," *Isis* 66, no. 4 (1975): 443–82; Magda Whitrow, "Interrelationships in the History of Science: Bibliography as a Guide to Subjects for Research," *Isis* 74, no. 1 (1983): 81–85.

²⁹ Allen G. Debus, review of *ISIS Cumulative Bibliography: A Bibliography of the History of Science Formed from ISIS Critical Bibliographies 1–90, 1913–65*, by Magda Whitrow, *Library Quarterly* 43, no. 1 (1973): 89–90.

To tackle this challenge, HSS hired British librarian Magda Whitrow (1914–2011) to reconceptualize the over 100,000 citations published between 1913 and 1965 in a way that would make them practically accessible once again. Whitrow and her team not only had to retype and double-check all of the information but had to place it in the context of Whitrow's new classification schema. The two classifications used previously, Sarton's and Guerlac's, were designed so that a user had to read whole sections of the bibliography to identify relevant information. This was sufficient for organizing the relatively small bibliographies of a few hundred or thousand entries but was impractical considering the sheer size of the cumulative bibliography. Instead, Whitrow used a sophisticated classification system and a detailed subject index to allow for locating relevant citations with greater precision through multiple access points. Even though this system resulted in some citations appearing in multiple places across the volumes, it made it possible for users to easily identify relevant information, whether they were searching for a particular individual, subject, time period, or even historical method used.³⁰ It was an ambitious effort, and it has been suggested that Whitrow—who had worked at Bletchley Park during World War II on the Allied code-breaking operation—was especially disposed to building an information organization system of this complexity.³¹

After over six years of initial preparation, the five-volume set containing the entire 1913–65 *Isis Cumulative Bibliography* started appearing in 1971, culminating in the fifth and final volume thirteen years later. The *Cumulative Bibliography* project was deemed so useful and important that the subsequent cumulations were published in ten-year intervals through 1995 and were considered to be a regular part of the bibliographer's job. The citation information that previously required tedious labor to extract was now easily accessible and primed to inform the work of the next generations of historians.³²

Overall, during the fifteen years after Sarton retired, the bibliography remained a central undertaking of the Society at a considerable expense and effort by the various editors, administrative staff, and volunteers. How it was produced and presented changed considerably. The new classification schema excluded or marginalized some works, and the changing attitudes of *Isis* editors and CB contributors resulted in varying levels of coverage. Most significantly, Whitrow's work, supported by grants from outside institutions, made information that previously was hidden easily accessible. In the end, the changing realities of academic work and library practices meant that producing the CB could no longer be a side project for the editor of *Isis*. By the late 1960s, the Society decided to shift the production of its bibliography to a library-trained bibliographer, John Neu. Under his efforts, the CB would again thrive.

INTO THE DIGITAL AGE (1968–PRESENT)

When the Society ultimately decided to outsource the production of the CB ten years after Sarton's death, they passed it not to a historian of science, but to a librarian. Answering a call for solicitations, the University of Wisconsin Memorial Library agreed to absorb the cost of a bibliographer by incorporating the production of the CB into the responsibilities of one of their

³⁰ This system was based on a faceted schema developed by the Indian mathematician S. R. Ranganathan in the 1930s.

³¹ Magda Whitrow, "Classification Schemes for the History of Science: A Comparison," *Journal of Documentation* 20, no. 3 (1964): 120–36; Whitrow, "Some Aspects of Descriptive Cataloguing in International Bibliography," *J. Documentation* 21, no. 4 (1965): 291–95, <https://doi.org/10.1108/eb026381>; Frank James personal email communication to Stephen Weldon, February 17, 2011; Stephen P. Weldon, "Bibliography Is Social: Organizing Knowledge in the *Isis* Bibliography from Sarton to the Early Twenty-First Century," *Isis* 104, no. 3 (2013): 540–50, <https://doi.org/10.1086/673273>.

³² Whitrow, "Classification Schemes for the History of Science"; Magda Whitrow, "The *Isis* Cumulative Bibliography," *The Indexer* 13 (1983): 158–65; Whitrow, "Interrelationships in the History of Science: Bibliography as a Guide to Subjects for Research," *Isis* 74, no. 1 (1983): 81–85, <https://doi.org/10.1086/353178>; Roger H. Stuewer, "News," *Isis* 65, no. 2 (1974): 244–48.

librarians. John Neu, a librarian by training, not a historian, was hired to curate the library's history of science special collections and work on acquisitions for the History of Science Department.

The bibliography changed in two important ways under Neu's editorship. First, he never included any critical notes on content of the sort that Sarton regularly composed. (It was a change that prompted Neu to retitle the project from *Critical Bibliography* to *Current Bibliography*.) With only library training, Neu had no basis for giving commentary on any of the works he entered, even if he had wanted to. Second, Neu never felt qualified to make any alterations in the classification system that had been devised in 1953 by the committee of historians. As a result, it remained mostly unchanged throughout his tenure. Unlike Josephson at the beginning of the century, Neu tried "not to make any waves" and focused on producing the bibliography as it was imagined by the historians who had edited it before him. During Neu's tenure, the technology of production became an especially important part of the *CB* project, as information technology was undergoing massive changes, transitioning from paper to digital computers.

Sarton had recorded the citations for the *CB* on index cards. In the early years of the twentieth century, index cards filed in long narrow drawers in cabinets—what we call a card catalog—proved to be an ideal system for storing and retrieving bibliographic data. The cards could be arranged in any order suitable to its user, they could be duplicated, and they could be annotated. However, a printed bibliography lacked all of these advantages. The printed version presented citations in one order, chosen by the bibliographer. Sarton had used that ordering to compel users to scan citations in a way that would lead, he hoped, to making connections. The disadvantage was that users had to wade through entries that they had little interest in. That said, Sarton anticipated that some readers would clip citations out of their annual volumes in order to add them to their own personal filing systems. At one point, Sarton even explored the possibility of printing the *CB* on only one side of the paper so as to allow readers to cut out relevant citations and paste them onto cards or make it possible for users to buy offprints of the *CB* for cutting up.³³

The index card and typewriter were two technologies that made the *CB* possible between the years 1913 and 1974. By the 1960s, however, digital computers were beginning to supplant these paper-based technologies. History of medicine was one of the pioneers in this field. By 1965, the National Library of Medicine was producing bibliographies on the newly created computerized MEDLARS database (a precursor to MEDLINE). Since the *CB* editors collaborated with the National Library of Medicine librarians, a subset of those records was included in the *CB*, but it would be ten more years before the production of the *CB* itself was aided by computers.³⁴ Starting in 1975, Neu began using a computer to process the *CB* citations. Despite a computer's advantages, Neu described himself as computer-illiterate and considered the device a source of frustration; it made him dependent on technical support from the operators of the library mainframe. Eventually, Neu transitioned to working on a personal computer and, by 1988, with the assistance of University of Wisconsin graduate student Peter Sobel, Neu was able to produce camera-ready copy for the press.³⁵

³³ George Sarton, "Ve Bibliographie Critique de Toutes Les Publications Relatives à l'Histoire, à la Philosophie et à l'Organisation de La Science," *Isis* 2, no. 1 (May 1914): 249; William Jerome Willson, *Exhibit in Honor of George Sarton Displayed during December 1952 at the Armed Forces Medical Library, Washington, D.C.* (Washington, DC: Armed Forces Medical Library, 1952), <http://resource.nlm.nih.gov/56210560R>.

³⁴ Robert P. Multhauf, "Report to the Editorial Committee of *Isis*," June 16, 1965, Record Unit 7474, History of Science Society Records, circa 1930–1993, box 15, Smithsonian Institution Archives.

³⁵ John Neu, "One Hundred Thirteenth Critical Bibliography of the History of Science and Its Cultural Influences," *Isis* 79, no. 5 (1988): 16.

But the world was moving quickly into the digital age, and the culture of scholarship was changing. Historians of science began working on computers and recognizing the advantages of having access to a database. For a few years, between 1993 and 1996, the Society offered the CB on a computer diskette, but internet access in 1993 was the game changer. The Research Libraries Group (RLG), a nonprofit consortium of libraries, hosted a new database built from *Isis* bibliographical data as well as data from three other related bibliographies. This new collaboratively created resource, the History of Science, Technology, and Medicine (HSTM) database, became a centerpiece of history of science research for so many HSS members.

After Neu retired in 1999, the Society hired Stephen Weldon (one of this article's coauthors) to replace him.³⁶ That transition marked a significant moment in the Society's relationship with the bibliography. First, Weldon was not a librarian or bibliographer. He was a graduate of the Wisconsin History of Science Department and was hired with the expectation that his familiarity with the scholarship, rather than any library or information science training, would allow him to successfully edit the bibliography.

Weldon, who had worked as a computer programmer in the late 1970s and early 1980s, viewed bibliographical data—and digital information in general—in ways quite different from his predecessors. This background enabled him to rethink the nature of bibliographical citations, and he began to work with the bibliographical data as information for historians. The organization of that information would drive him to make significant changes to the database structure. In printed form, items needed to have classification schemas that rigidified the ways in which they were related to each other. Even Whitrow's classification schema, which was a more flexible tool than a standard hierarchical list, required complex rules for placing citations into context with one another. The existing linear and hierarchical systems with their complex rules were showing their age after nearly fifty years of use. They were inflexible and lacking in specificity.

To help solve these problems, Weldon introduced a subject index to supplement the classification hierarchy. By tagging records with a flexible set of descriptors managed in a thesaurus, searches through the data could be more precise. These subject descriptors included such things as disciplines, place names, time periods, historical objects, ideas and theories, historiographical terms, and other elements that could more broadly characterize the work being cited. The indexes were helpful for readers of the printed CB, but the tagging system turned out to be most useful when implemented as a database-finding aid because it could transcend the limitations of the linear classification hierarchies used by the bibliographers.

By far the most important transformation during these decades was the creation of the IsisCB Explore service, an open access database that made the entire collection of entries going back to 1974 accessible to anyone with an internet connection. Just like the financial support provided to HSS in an earlier era, which funded the *Cumulative Bibliography*, an Alfred P. Sloan Foundation grant in 2014 and 2015 made that development possible. IsisCB Explore is radically different from the HSTM database. Subject terms and keywords are used to build lists of related citations with much greater precision than the printed categories of the past.

As we have discussed, George Sarton had been inspired by Paul Otlet's efforts to catalog and interconnect all of the world's knowledge. Sarton had hoped that his bibliography along with his other works (especially the bibliography-rich *Introduction to the History of Science*, with its 400 pages of indexes) would be the tool to help users find precisely the information they sought, presented in the context of other historical research. The limited technologies available to Sarton and Otlet, however, prevented their projects from achieving their ambitious goals. The twenty-first-century information infrastructure makes the advanced features of IsisCB Explore possible,

³⁶ Joy Harvey edited the 2000 and 2001 CBs as an interim bibliographer.

approaching Sarton's grand vision, connecting bibliographical material in complex and useful ways and linking it to content elsewhere online.³⁷ What it does not do, however, is force readers to scan the wide variety of literature organized broadly within its period, or attempt to shape the discipline in the way that Sarton did with his classification system.

In addition to this technological transformation in the way that the data were stored and presented, Weldon also began to expand the ways in which the bibliography was created. His conception of the *CB* was influenced by the sociocultural understanding of history of science, which helped him see the *Isis* bibliography as itself socially constructed. He saw the *CB* at its root as a form of community-building, and that vision of the *CB* as a social technology drove much of his thinking. Over the years, he built a network of colleagues, advisors, and volunteers to help him accomplish the tasks at hand.

If we are to reflect on how the history of printed information becomes a history of digital information, the print-to-digital shift in the technology of the bibliography had especially far-reaching implications. In Mak and Renear's terms, this shift illuminates how bibliographical information in the *CB* was changing in the twenty-first century. The same citations were now doing different work than they did before. Information was becoming information in new ways, which had implications for the people creating the bibliography as well as for the users of it.³⁸

CONCLUSION

We hope that the few episodes from the history of the *Isis* bibliography analyzed here demonstrate the many possible avenues for research to fully examine how the processes of creating and sustaining this information technology have interacted with the intellectual, institutional, and social history of HSS and history of science community at large. Today, we are acutely aware of how information technologies such as algorithms create our newsfeeds, and of how machine learning underpinning AI chatbots can transform the seemingly infinite amount of online information into information that shapes our actions. We argue that older information technologies, such as bibliographies, did the same: they took the information contained in libraries and converted it into information that augmented the work of historians.

The practices of producing the *CB*—how information scattered through libraries and digital networks became information supporting teaching and research of historians of science—have changed dramatically. The consequences of those changes to our field are yet to be examined despite the fact that the *CB* has been a central feature of our discipline as it evolved over the last century. We believe that investigating the history of this information resource can shed light on this evolution.

³⁷ "IsisCB Explore," <https://data.isiscb.org/> (accessed November 19, 2023).

³⁸ "Ah, Aspasia, we have found it! The process by which information becomes information is through a practice, a *technê*. The function or *ergon* of that practice is the creation, organization, preservation, dissemination, and use of information. And these practices are the subject matter of information history!" (Mak and Renear, "What Is Information History?" 763).