

The *Isis* Bibliography from Its Origins to the Present Day: One Hundred Years of Evolution of a Classification System

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ABSTRACT

The article surveys the evolution of the *Isis* bibliographical classification systems over the past century. Begun in 1913 by George Sarton, the *Isis* Bibliography is continued to this day under the auspices of the History of Science Society. The classification systems have developed and changed gradually over the years, the most recent change being in 2002 when the author took charge of the publication as bibliographer. Changes in both scholarly interests and practice, on the one hand, and digital research technologies, on the other, have guided these most recent revisions. Each citation in the *Isis* bibliography receives two types of subject tagging, an ordered classification into a fixed category and indexing according to an expandable thesaurus. Precisely how these two types of subject tagging work now and how they came to be this way is the focus of this paper.

Keywords:

Classification of knowledge; History of science, as a discipline; Sarton, George (1884-1956); Guerlac, Henry (1910-1985); Whitrow, Magda; Neu, John; 20th century; Bibliographies; Historiography; Subject tagging; Indexing

The *Isis* Bibliography from Its Origins to the Present Day: One Hundred Years of Evolution of a Classification System

In the first issue of *Isis* in 1913, George Sarton explained his reasons for seeking to establish a new scholarly discipline that would focus on the study of the history of science, and he discussed the scope and nature of this new study as he then envisioned it. The journal *Isis* was a keystone of this new field, providing a forum for the publication of specialized scholarship, and it also included an extensive classified bibliography of literature published elsewhere (Figure 1).

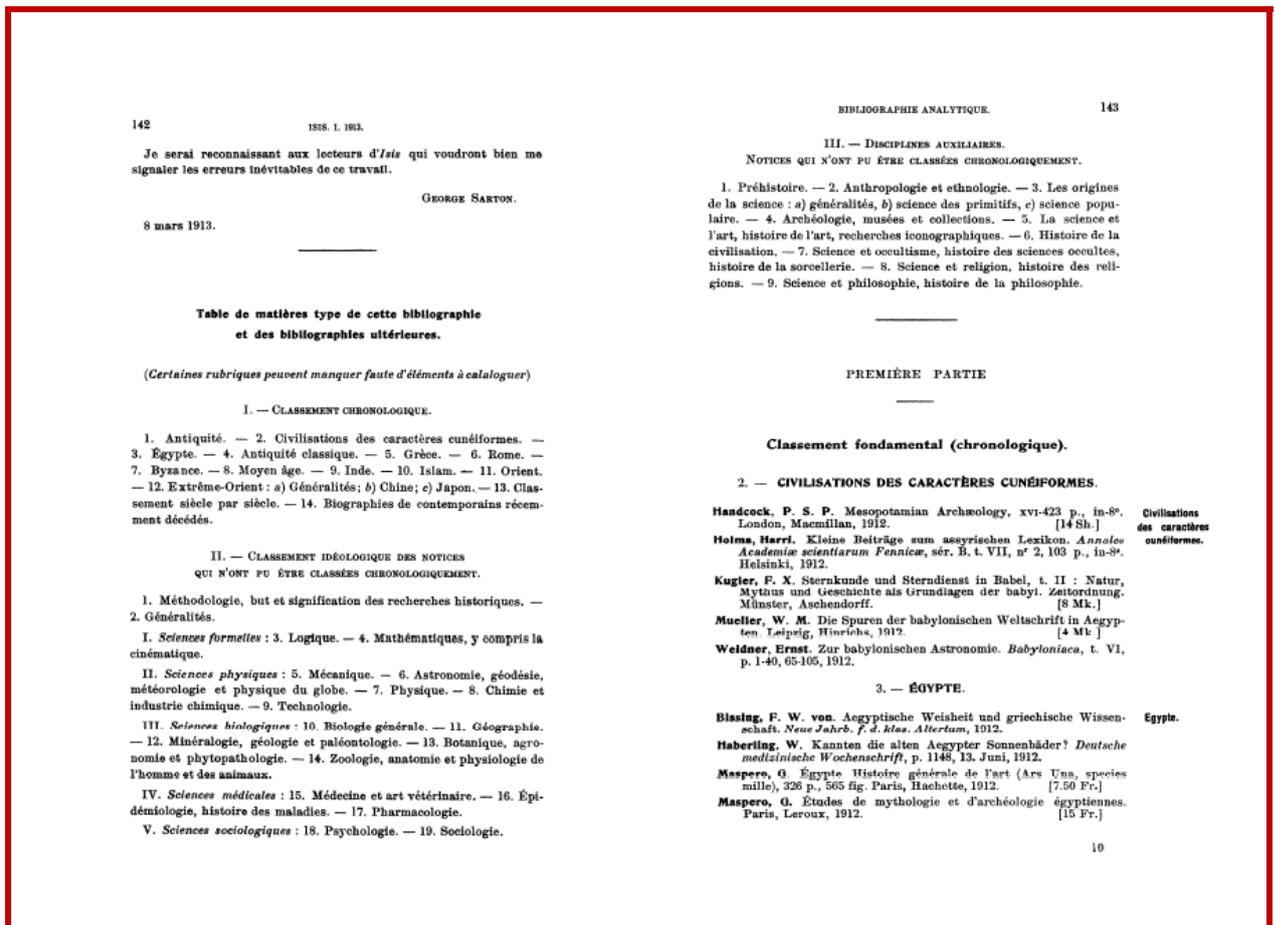


Figure 1: Pages from Sarton's first bibliography of the history of science, "Bibliographie analytique des publications relatives à l'histoire de la science parues depuis le 1er janvier 1912," which was published in the first issue of his new journal *Isis*.

Sarton implicitly understood that in order for a discipline to thrive, scholars must have access to each other's work, and that a bibliography was an essential tool. "For him," I. B. Cohen once remarked, "the major feature of his new journal was the systematic Critical Bibliographies, intended to make other scholars aware of the growing literature of the field, and to provide a place for the correction of errors." Much of Sarton's

professional life was devoted to compiling and editing this bibliography in issue after issue of the journal he founded.¹

During the nearly 40 years that Sarton worked on the bibliography, until his retirement in 1954, he struggled with the classification system in the bibliography. The size of each bibliography—most having a thousand or more items—made it important to have a clear and systematic organizational scheme so that the bibliography was usable for the researcher. The bibliography in Sarton's hands evolved gradually over time, but it always followed a few basic principles that recognized chronology and scientific discipline as the two central axes of organization. Since Sarton's retirement, a number of scholars have been involved in the production of the bibliography, and a few of them have worked on its architecture. I have been the most recent of these architects, and this article is an effort to explain the history of the various classification systems and help people understand how and why the current system is organized as it is.

I made significant modifications to the classification scheme when I assumed editorship of the bibliography in 2002. My efforts were prompted by the need to take account of a half-century of new scholarship that made the existing classification structure less useful for many kinds of scholarship. In addition, two-decades of change in the technology of a scholarly research environment that was becoming increasingly digital imposed other kinds of requirements on classification and subject indexing so that the citations would be more accessible in database format.² Figure 2 shows the bibliographic resources page on the Isis Current Bibliography website as of 2009.³ This site contains information about the current bibliography, but electronic access to the data is currently available only through the University of Chicago press, which has links to recent PDFs of the print versions, and through OCLC's FirstSearch system, which provides subscribing institutions with access to the History of Science, Technology, and Medicine database.

The changes in classification stand out when one looks back over the last century at the *Isis* bibliographies and compares the different systems, starting with Sarton's first efforts and ending with my own recent publications.⁴ Continuity exists as well, however: the principles of classification that Sarton initiated still make their presence strongly felt. Each bibliographer who has worked on this project has modified the tool for new

¹ The quote is from I. Bernard Cohen, "George Sarton," *Isis* 48, n° 3 (September 1957): 292. See also Charles Singer and Dorothea Singer, "George Sarton and the History of Science," *Isis* 48, n° 3 (September 1957): 306-310, and Sarton's introductory essay in the first issue of *Isis*: George Sarton, "L'Histoire de la Science," *Isis* 1, n° 1 (1913): 3-46. On page 12, Sarton discusses the necessity yet difficulty of classifying the sciences as more and more interconnections between them are discovered: "La division du travail scientifique s'est faite simultanément dans des directions très différentes et, par suite, la classification des sciences n'a jamais cessé d'évoluer." ("Division of scientific work is simultaneously done in very different directions, therefore classification of the sciences has never ceased to evolve.")

² George Sarton, "The Critical Bibliographies of Isis," *Isis* 41, n° 3/4 (December 1950): 291-298, gives a good explanation of Sarton's own thinking about the bibliography as he looked toward his retirement a few years away. In her introduction, Joy Harvey gives a short and very useful history of the bibliographies. See Joy Harvey, "Introduction," *Isis Current Bibliography* 92, n° 5 suppl. (2001): v-vii.

³ <http://www.ou.edu/cas/hsci/isis/website/thesaurus/index.html>

⁴ For this article, I did an incomplete survey of bibliographies, two or three each decade, and identified key essays and introductions that are important to understanding the bibliography. In addition, to those essays mentioned above, see Henry Guerlac, "A Proposed Revision of the Isis Critical Bibliography," *Isis* 44, n° 3 (September 1953): 226-228; Magda Whitrow, "Classification Schemes for the History of Science: A Comparison," *Journal of Documentation* 20, n° 3 (1964): 120-136; I. Bernard Cohen, "A Cumulative Critical Bibliography of the History of Science: A Report to the History of Science Society," *Isis* 63, n° 3 (September 1972): 388-392; Magda Whitrow, "A Classification Scheme for the History of Science, Technology, and Medicine," in *Isis Cumulative Bibliography*, vol. 3 (London: Mansell, 1976), 621-632; Magda Whitrow, "Interrelationships in the History of Science: Bibliography as a Guide to Subjects for Research," *Isis* 74, n° 1 (March 1983): 81-85; and Michael Sokal, "The History of Science Society, 1970-1999: From Subscription Agency to Professional Society," *Isis: Catching Up with the Vision* 90, n° suppl. (1999): S135-S181.

generations of historians but the constraints of the past have tempered the changes. I, too, continually felt the weight of the past. The classification structure, though imperfect, needs to have continuity to make the long train of scholarship over the years continually accessible to researchers, and transformations that are too radical can destroy that coherence across time.

Below, I illustrate the changes in various versions of the bibliography. This history illuminates one aspect of the history of the discipline in its own right, this study of the evolution in bibliographic classification is meant especially to help current scholars understand how the current scheme works and how it is meant to meet the demands of scholars in the twenty-first century with their specific scholarly interests and the current research environment of both print and digital media.

Isis Current Bibliography
Bibliographic Resources

Isis CB Thesauri

Classification Scheme
Subjects A-F
Subjects G-N
Subjects O-Z
Personal Names A-B
Personal Names C-E
Personal Names F-G
Personal Names H-J
Personal Names K-M
Personal Names N-R
Personal Names S-Z
Institutions
Geographical Terms
Time Periods

Download files

Other Resources

Isis CB pre-2000 Aspects
Isis CB pre-2000 Subjects
Technology and Culture A-F
Technology and Culture G-N
Technology and Culture O-Z
Forum for the History of Science
History of Science Journals List

Return to CB Main Page

Isis CB History of Science Bibliographic Resources

This website is to be used for searching through the thesaurus that is used by the Isis Current Bibliography. It represents the bibliography as of mid-July 2005. Since the thesaurus is being continually updated this list will not remain current. It will be, however, updated from time to time.

Note that this site includes several lists. The Isis classification scheme is listed here as it is found in the most recent print version of the Current Bibliography (2005). The current list of journals that have had published citations over the last 30 years is also included here. Finally, there are several thesaurus lists. The first group contains all the subject authorities used in the current Isis CB, subdivided into personal names, institutions, time periods, geographical regions, and subject terms. The second list are terms that have been used in the Technology and Culture bibliography. The third list contains terms that were used in the Magda Whitrow classification scheme for the Cumulative Bibliographies. These terms were also used by John Neu when he submitted subject terms to the History of Science, Technology, and Medicine database. Finally, there is a list of subject terms used by the Forum for the History of Science in America.

Included in these lists are also occasional cross references. If you have questions about this list or would like to know more about the Isis CB please contact Stephen P. Weldon at spweldon@ou.edu.

Figure 2: Bibliographic resources page on the Isis Current Bibliography website

The Isis Bibliography Today

The Isis Bibliography is published by the History of Science Society which shares the financial support for the project with the University of Oklahoma, where the office is currently located. Beginning in 1913 as an integral part of the journal *Isis*, the bibliography evolved gradually over the years to become an independent publication, distinct from the journal and edited separately from it, yet continuing to be published as an annual supplement, mailed bound with the December issue of the journal. At the University of Oklahoma, the Department of History of Science and the History of Science Collection in the library provide the resources for the daily operation of the bibliography office, including two half-time graduate student assistants.

The daily work on the bibliography takes place in the Collections in Bizzell Library where my assistants and I locate, enter, classify, and edit several hundred citations each month in order to reach a goal of about 4,000 citations at the end of the year. We scan journals, publisher book catalogues and web sites, book reviews, and dissertation abstracts for items to be included in the bibliography. I accept volunteer entries both by mail and by email from historians from around the world, and I have a board of historians who have agreed to supply me with entries that I am unable to access easily, usually in languages that I am not able to work with. For more complex matters, I have put together an advisory board of experts, most of whom are librarians by training and by profession. They help me

work out problems with citations, classification, and other issues related to the bibliography and its production and distribution.

The Evolution of the Isis Bibliographies

Seven people, over the years, have been mainly responsible for editing the bibliography. George Sarton edited it for four decades from 1913 to 1953. After Sarton's retirement, the job fell to the editor of *Isis* (successively, I. Bernard Cohen, Harry Woolf, and Robert P. Multhauf), who chaired a committee of scholars that collaborated on the production. John Neu, a librarian at the University of Wisconsin–Madison, was eventually hired to edit the bibliography, which he did until his retirement in 1999, producing thirty-one annual bibliographies as well as three ten-year cumulations. Neu's retirement prompted the move of the editorial office from Wisconsin to the University of Oklahoma, where the historian of science Joy Harvey took over as interim editor and produced two volumes of the annual bibliography before I assumed the editorship in 2002. In addition to the editors of the annual bibliography, Magda Whitrow, a librarian at Imperial College, London, was hired in the late 1960s to create a cumulative bibliography that included all of the bibliographies published in *Isis* during its first fifty years (1913-1965; vols. 1-90), a task that took her fifteen years to complete. (The index to the volumes was finally published in 1984).

Subject tagging, the effort to mark citations with classifiers and index terms, has changed periodically in the bibliography, and the type of tagging varies depending upon the publication. The bibliographies published in the pages of *Isis* or as an annual supplement, each have a standard organizing scheme wherein a citation is uniquely classified under the most appropriate heading, but until 2002 these bibliographies did not contain any subject index. The cumulative bibliographies also organize the citations by subject, similar to the classification scheme used in the annual bibliographies but much more detailed and precise; in addition, all of these cumulative volumes include a subject index. Finally, the electronic online database HSTM (“History of Science, Technology, and Medicine”) originally hosted by the Research Libraries Group (now hosted by OCLC), employs the detailed tagging system that originated in the cumulative bibliographies. The nature of this database, which displays records based on parameters supplied by individual users, makes the linear classification schemes of the printed bibliographies less important as an organizing scheme, but the subject tagging remains closely associated with these classification schemes.

George Sarton's bibliographies appeared irregularly in *Isis*, often coming out more than once each year. By the time Sarton retired as editor, he had completed seventy-nine bibliographies over forty years. When the new editors of *Isis* took over—Cohen (from 1953 to 1959), Woolf (from 1959 to 1964), and Multhauf (from 1964 to 1979)—there was an effort to standardize the bibliography and distribute the responsibilities of production to a committee, a move that Sarton had opposed, believing that the bibliographical project was best served by the work of a single individual who could devote time and thought to the entire scope of the project. His essay on the bibliography, published only a couple of years before his retirement, complained specifically of the mediocrity that so often marked committee work that was “automatized, depersonalized, devitalized, devitaminized, and materialized.”⁵ Cohen's biography of Sarton, however, defended the move to production by committee, arguing that the editors, all academics with teaching, research, and multiple professional obligations to attend, worked under constraints that made it impossible for them to emulate Sarton, whose research appointment from the Carnegie Institute of Washington and his relatively light teaching load at Harvard and Radcliff, gave him the ability to pursue the editorial responsibilities of *Isis* more single-mindedly than his

⁵ Sarton, “The Critical Bibliographies of Isis,” 294.

successors.⁶ If the bibliography were to survive Sarton's retirement it had to be as a communal effort of scholars. The committees in the subsequent years did their best to maintain at least some of the personalized and "vitaminized" quality of Sarton's bibliography by continuing to supply the critical annotations and evaluations that had so enriched the pages under Sarton's keen eyes.

As the years drew on, the Society decided to return to a more dependable production system, once again under the direction of a single editor. John Neu's long tenure as the Society bibliographer accomplished this goal, and the committee structure so difficult to coordinate was abandoned. The bibliography changed gradually under Neu's editorship. Not being a trained historian of science, Neu felt unqualified to provide evaluative annotations, so he renamed the *Isis* CB from "critical bibliography" to "current bibliography" to reflect the fact that the tool now featured only descriptive comments.⁷ His position as librarian in the well-supported University of Wisconsin system made it possible for him to build the bibliography to a point at which it exceeded 4,000 classified records annually, larger than it had been at any time in the past, and thus he kept up with the discipline's burgeoning literature during the last quarter of the twentieth century. Neu, further, brought the bibliography into the computer age by working with an academic database provider to help create an international multi-contributor bibliographic database for the history of science, technology, and medicine (HSTM).⁸

Shortly after the Society hired John Neu, it also hired Magda Whitrow in London to produce a cumulative bibliography that would classify and index all of the citations in each of the bibliographies that were produced in the fifty-two-year period from 1913 to 1965.⁹ Over the course of nearly fifteen years she created a six-volume work. Apart from the massive effort at collecting, sorting, reclassifying, and indexing the more than one-hundred-thousand citations in the ninety bibliographies, Whitrow's great contribution was the creation of a much more detailed classification scheme than anything that had appeared before and making explicit a type of faceted structure that Sarton and others had implicitly been using.¹⁰ Her work on this first cumulative bibliography set the standard for subsequent ten-year cumulations. Together with Whitrow's bibliography, John Neu oversaw three more of these, covering the years 1966-1975, 1976-1985, and 1986-1995. Although the print cumulations continued to sell (and libraries still query Neale Watson at Science History Publications about when a new one will appear), the Committee on Publications of the History of Science Society made the decision after John Neu's retirement to publish no more of them, justifying their decision on the widespread use of the HSTM database, which they argued served the same purpose.¹¹

The transition to the University of Oklahoma in 2000 marked a major change in the bibliography. Not only was the long-time tenure of John Neu at an end, but several other forces necessitated changes in the way that the bibliography was produced. The Society once again determined that it wanted a single, dedicated bibliographer to carry on the project and this time found two trained historians of science: first, Joy Harvey, a graduate of Harvard's history of science program, who accepted the position of interim bibliographer to produce two volumes, and then me, a graduate of Wisconsin's program. Neither of us had worked with John Neu on the bibliography before (though as a graduate student at Wisconsin, I had often drawn on his wisdom in the library and, weekly, enjoyed

⁶ Cohen, "George Sarton," 293-294.

⁷ John Neu, "Introduction," *Isis* 80, Current Bibliography 1989 (1989): v.

⁸ It went online in 1993. John Neu, "Introduction," *Isis* 83, Current Bibliography 1992 (1992): v.

⁹ Cohen, "A Cumulative Critical Bibliography of the History of Science," 389.

¹⁰ Whitrow, "Classification Schemes for the History of Science: A Comparison" (1964) and Whitrow, "A Classification Scheme for the History of Science, Technology, and Medicine" (1976).

¹¹ This issue was discussed periodically in the Committee on Publications meetings during my first few years as editor of the journal.

conversations at a local bar where John dependably held the table for graduate students worn out at the end of a hard week). Neu's local database ceased to be functional after he retired, as both hardware and software rapidly dated. Both Harvey and I faced the task of creating a new way to publish the print bibliography as well as upload the citations to HSTM.

The transition, which required a new production system, forced me to consider all aspects of the project, including both kinds of subject tagging—classification and indexing. In addition to revising the classifications as I explain below, I introduced other changes made possible through advances in database software and digital access to scholarly resources. Perhaps most significant, the advanced software allowed me for the first time to include a subject index in the annual bibliography. Although my classification system remains constant, changing only slightly when I periodically institute small changes, my subject thesaurus grows monthly, and this makes it possible to accommodate and precisely tag new subject matter and changing historiographical agendas as I run across them. In both the classification structure and in the thesaurus indexing I have drawn extensively on the hard work and careful thought of previous bibliographers.

Classification Systems

Sarton's System

During the 40-year period that Sarton edited the bibliography, the classification system changed slightly from time to time as Sarton experimented with different ways of organizing the data. Throughout that period, he maintained a three-fold system that classified topics based on the nature of the historical questions being asked. What he called the "Fundamental" classification separated items strictly according to time, based on century-level divisions (and half-century-level divisions in modern times). Within each of those centuries, he separated items by the specific disciplines in science (mathematics, physical sciences and technology, natural sciences, medical sciences, and alia). Sarton thus placed primary importance on the historicity of the subject studied and secondarily to the subject of study. Figure 3 shows the first of George Sarton's three-part classification system, his "fundamental" or strictly time-based, century-level divisions (broken down by half-century intervals in the modern period). The main century level divisions are broken down into five subdivisions corresponding to broad disciplinary areas.

The second major division of Sarton's bibliographies was Historical and Ethnographical—a division that recognized a need to reach across periods of time and group items according to the nature of the period in question. This division allowed him to circumvent the fragmenting tendency of the century-level breakdown. The sections within this division collected topics bounded by geographical and cultural areas. The main effort was to collect coherent traditions within particular civilizations and ethnographic regions. (Figure 4).

The third major division was the Systematic division, which covered the individual disciplines without regard to location or time. This part of the bibliography contained subdivisions based on more precise distinctions among the disciplines and subdisciplines in the sciences. Sarton created eight primary divisions (Science in General; Formal Sciences; Physical Sciences; Biological Sciences; Sciences of the Earth; Anthropological and Historical Sciences; Medicine; and Education), and each of these he divided into several narrower fields (the Physical Sciences division, for example, held Mechanics, Astronomy, Physics, Chemistry, and Technology) (Figure 5).

Main divisions	Sub-divisions
9 th Century, B.C.	A. Mathematics
8 th Century, B.C.	B. Physical Sciences and Technology
7 th Century, B.C.	C. Natural Sciences
...	D. Medical Sciences
19 th Century, second half	E. Alia
20 th Century, first half	
20 th Century, second half	

Figure 3: George Sarton’s three-part classification system

I. Antiquity: including Egypt, Babylonia, Greece, Rome
II. Middle Ages: including Middle Ages; Byzantium
III. Oriental Science and Civilization: including India, China, Japan, Israel, Iran, Islam
IV. New World and Africa

Figure 4: The second of Sarton’s three-part system, his historical and ethnographical division, which focused on larger culturally specific and often historically bounded regions.

I. Science in General	III. Physical Sciences
II. Formal Sciences	22. Mechanics (including Celestial Mechanics)
III. Physical Sciences	23. Astronomy
→	24. Physics
IV. Biological Sciences	25. Chemistry, Physical & Industrial Chemistry
V. Sciences of the Earth	26. Technology
VI. Anthropological and Historical Sciences	
VII. Medicine	
VIII. Education	

Figure 5: The last of Sarton’s three divisions, which he called systematic, covering the individual discipline’s across time and place. Here is shown, as well, the breakdown of one of the eight subdivisions.

Overall, Sarton's mature system reflected a sophisticated understanding of the various ways in which historical research is done. If we fold the Historical/Ethnographical division into the Fundamental (centurial) division for the moment, one of Sarton's primary ideas about the need to study history stands out: he believed that in order for a historian of science to excel, he or she ought to have two kinds of specialties, a vertical one and a horizontal one. The horizontal specialty was a period of time, usually a century, that the historian would specialize in; he would become familiar with the variety of sciences in a particular period so that he could see the interrelations among them. The vertical specialty would be a particular field of science that the historian would study as it developed over time.¹² The breakdown of the bibliographical divisions into chronology and discipline perfectly reflects Sarton's overall view of the discipline.

One other aspect of Sarton's thinking about the nature of the history of science discipline becomes clear in his classification system: his understanding of science as a human cultural phenomenon, not restricted in any way to the West or to the modern period. Sarton recognized aspects of science in cultures all around the world. He urged his students to have a facility in several languages, and he himself could communicate in over ten, ranging from most of the major European languages to Turkish, Arabic, and even a little Chinese.¹³ The history of science was truly an avenue into world history for Sarton.¹⁴

The System of the Guerlac Committee

When Sarton announced his retirement, one of the pressing questions was whether anyone would be able to continue the bibliography. In the end, it was decided that the editor of *Isis* would direct a committee, so that the work could be split among many scholars with a wide range of specialties, each of whom volunteered to scan journals and contribute entries that they accumulated.¹⁵

The classification system also changed at this time. (Figure 6) A separate small committee of historians of science led by Henry Guerlac contemplated how to revise it with two main desires in mind: first, to focus much more tightly on the history of science than had Sarton whose interests had always ranged broadly over the history of civilization as a whole, and second, to simplify the system so that entries were not as widely dispersed throughout the bibliography as they had been. The first requirement had relatively little effect on the nature of classification, except perhaps to reduce the number of entries; the second, however, had significant implications. As they worked to simplify the system, the committee concluded in total agreement with Sarton that a chronological focus should remain primary, since this was a bibliography dealing primarily with historical study. The difficulty was that Sarton had two main divisions that included time, a strictly temporal one as well as a cultural/ethnographical one that included historical divisions such as the middle ages. In the end, the committee decided to merge the two divisions so that while the main thrust of this new division remained chronological, it recognized broad, multi-century, time divisions in all pre-modern categories and included the ethnographical component of Sarton's second division in most of these large categories. They then folded the non-Western categories into this chronological section between Hellenistic science and medieval European science.¹⁶

The final result of the committee's work was what might be called a "3-and-1" framework with the first three divisions containing general works with a single level of

¹² Guerlac, "A Proposed Revision of the Isis Critical Bibliography," 226.

¹³ Cohen, "George Sarton," 296.

¹⁴ This aspect of Sarton's system is highlighted in Lewis Pyenson and Christophe Verbruggen's recent article "Ego and the International: The Modernist Circle of George Sarton," *Isis* 100, n° 1 (2009): 60-78.

¹⁵ Guerlac, "A Proposed Revision of the Isis Critical Bibliography," 226.

¹⁶ *Ibid.*

classification and the last division containing topics of a specific nature with a more detailed two-level classification scheme. The first three categories included tools for the historian (historiography, bibliography, reference materials, etc.), subjects that cut across disciplines of science (such as scientific institutions and the social relations of science), and the histories of the special sciences, a breakdown of scientific fields into thirty-two separate disciplines.

The fourth division that contained a mix of chronological and ethnographical categories contained the bulk of the citations in the bibliography. Any item that could be classified in one of these divisions was placed there rather than in one of the first three general divisions. Each of these period categories was subdivided by discipline, and the committee, like Sarton, created only a few broad disciplinary groupings—seven subdivisions for the premodern periods and ten for the modern periods, a difference reflecting greater specialization in the modern era. This difference can be easily seen by comparing the category Exact Sciences, in the premodern sections with the categories Mathematics and Physical Sciences in the modern periods; so too, the simple premodern Natural History category gives way to the Earth Sciences and Natural Sciences in the modern divisions of the bibliography.

This committee bowed explicitly to Sarton's views on the need to have both horizontal and vertical access, chronology and discipline, though the arrangement differs slightly. The Guerlac structure was more systematized than Sarton's with explicit rules, which were necessary for a large committee to be able to produce more or less coherent classifications. As much as Sarton had resisted bureaucratization, the final product solved some problems of Sarton's system and was perhaps somewhat less idiosyncratic, albeit it was also less personalized.¹⁷

When John Neu took over the bibliography as the sole bibliographer in 1968, he continued to receive help from members of the old committee for a number of years, but his appointment at the University of Wisconsin libraries allowed him as single bibliographer to focus much more effort on the project than had been possible for any one person since Sarton. The Guerlac category system aged over the next three decades, but without professional training as a historian of science, Neu never felt qualified to alter the classification structure. The field of the history of science had undergone dramatic change during that time, both in terms of its practitioners (now mostly trained historians rather than historically interested scientists), and in terms of its historiographical emphases. The technological revolution in digital data manipulation also presented new possibilities and requirements.

Whitrow's System

Magda Whitrow was hired to produce a cumulative bibliography. Coming to the project having already published a paper on the classification systems used by Sarton and his successors, Whitrow developed a unique bibliographic classification tool to serve the specific needs of historians of science.¹⁸ As she studied the systematization of the classification schemes, she proposed an explicitly faceted structure that followed the basic organizational rules that Sarton had used, employing chronology and disciplinary divisions as the main categories for classification. The ordering in Whitrow's scheme followed closely the Guerlac committee arrangement, differing primarily in its greater detail and finer subdivisions.¹⁹

¹⁷ Whitrow, "Classification Schemes for the History of Science: A Comparison," 125, argues that the rules that existed did not sufficiently direct the people working on the committee, and created inconsistencies.

¹⁸ *Ibid.*

¹⁹ Whitrow, "A Classification Scheme for the History of Science, Technology, and Medicine."

A. History of Science: General References and Tools	<ol style="list-style-type: none"> 1. History of Science General Works 2. Bibliographies and Bibliographical Tools 3. Historiography and Historical Method 4. Biographical Collections 5. Encyclopedias and Compendia of General Scientific Knowledge 		
B. Science and its History from Special Points of View	<ol style="list-style-type: none"> 10. Philosophy of Science and Methods of Science 11. Scientific Institutions 12. Scientific Instruments and Special Techniques 13. Scientific Education and History of Education 14. Social Relations of Science 15. Humanistic Relations of Science 		
C. Histories of the Special Sciences	<ol style="list-style-type: none"> 20. Philosophy 21. Mathematics 22. Physical Sciences 23. Earth Sciences 24. Biological Sciences 25. Social Sciences 26. Medicine and the Medical Sciences 27. Technology 28. Pseudo-sciences 29. Ancillary disciplines 		
D. Chronological Classification	<table border="0"> <tbody> <tr> <td data-bbox="494 1019 925 1579"> <ol style="list-style-type: none"> 30. Prehistory and Traditional Societies 31. Ancient Near East 32. Classical Antiquity 33.1 Middle Ages 33.2 Middle Ages: Byzantium 34. Islamic and Related Cultures 35.1 India 35.2 The Far East 35.2 Pre-Columbian America 36. Renaissance and Reformation, 1450-1660 37.1 Seventeenth Century 37.2 Eighteenth Century 38. Nineteenth Century 39. Twentieth Century </td> <td data-bbox="925 1019 1370 1758"> <p>Premodern Subdivisions</p> <ol style="list-style-type: none"> a. General works; philosophy b. Exact sciences c. Natural history d. Pseudo-sciences e. Technology, travel, exploration and geography f. Medicine and health g. Social sciences <p>Modern Subdivisions</p> <ol style="list-style-type: none"> a. General works; philosophy b. Mathematics c. Physical sciences d. Earth sciences e. Biological sciences f. Social sciences g. Medicine h. Technology i. Pseudo-sciences j. Ancillary disciplines </td> </tr> </tbody> </table>	<ol style="list-style-type: none"> 30. Prehistory and Traditional Societies 31. Ancient Near East 32. Classical Antiquity 33.1 Middle Ages 33.2 Middle Ages: Byzantium 34. Islamic and Related Cultures 35.1 India 35.2 The Far East 35.2 Pre-Columbian America 36. Renaissance and Reformation, 1450-1660 37.1 Seventeenth Century 37.2 Eighteenth Century 38. Nineteenth Century 39. Twentieth Century 	<p>Premodern Subdivisions</p> <ol style="list-style-type: none"> a. General works; philosophy b. Exact sciences c. Natural history d. Pseudo-sciences e. Technology, travel, exploration and geography f. Medicine and health g. Social sciences <p>Modern Subdivisions</p> <ol style="list-style-type: none"> a. General works; philosophy b. Mathematics c. Physical sciences d. Earth sciences e. Biological sciences f. Social sciences g. Medicine h. Technology i. Pseudo-sciences j. Ancillary disciplines
<ol style="list-style-type: none"> 30. Prehistory and Traditional Societies 31. Ancient Near East 32. Classical Antiquity 33.1 Middle Ages 33.2 Middle Ages: Byzantium 34. Islamic and Related Cultures 35.1 India 35.2 The Far East 35.2 Pre-Columbian America 36. Renaissance and Reformation, 1450-1660 37.1 Seventeenth Century 37.2 Eighteenth Century 38. Nineteenth Century 39. Twentieth Century 	<p>Premodern Subdivisions</p> <ol style="list-style-type: none"> a. General works; philosophy b. Exact sciences c. Natural history d. Pseudo-sciences e. Technology, travel, exploration and geography f. Medicine and health g. Social sciences <p>Modern Subdivisions</p> <ol style="list-style-type: none"> a. General works; philosophy b. Mathematics c. Physical sciences d. Earth sciences e. Biological sciences f. Social sciences g. Medicine h. Technology i. Pseudo-sciences j. Ancillary disciplines 		

Figure 6: The final classification system developed by the committee of historians led by Henry Guerlac in 1952, which became the basis for the organization of the annual bibliographies from that time until 1999.

1 Prehistory and primitive societies	46 Africa: prehistory, primitive societies; indigenous civilizations
15 Ancient Near East	47 America; North America: prehistory, primitive societies; indigenous civilizations
16 Ancient Egypt	48 Latin America: prehistory, primitive societies; indigenous civilizations
17 Sumer; Babylon; Assyria	49 Ancient and medieval periods combined
25 Classical antiquity	5 Middle Ages
26 Greece	52 Byzantium
29 Early Christian civilizations	58 Middle Ages and Renaissance combined
3 Asia: prehistory, primitive societies; indigenous civilizations	6 Renaissance and Reformation
32 Western Asia	7 Seventeenth century; Renaissance and 17th century combined
34 Iran	8 Eighteenth century; 17th and 18th centuries combined
37 India	9 Nineteenth century; 18th and 19th centuries combined
39 Far East	
4 China	
41 Korea	
42 Japan	
43 South East Asia	
45 Australia and New Zealand; Oceania: prehistory, primitive societies; indigenous civilizations	

Figure 7: Magda Whitrow's civilization and period facet for the cumulative bibliography. This facet followed the Guerlac committee structure that combined the chronological and the cultural context into a major category.

Faceting a system of classifying entries based on different qualities ("facets") of a subject, allows for standardization of subdivisions within a scheme. Whitrow found that Sarton had hit upon a faceted scheme even before such systems became popular, and she readily employed it in her cumulative bibliography. She set out three facets that would, taken together, identify the location of any item in the bibliography: (1) subject and civilization, (2) discipline, and (3) aspect or bibliographic form.

One can understand better how Whitrow worked with both Sarton's and the Guerlac committee schemes by looking at her subdivisions within the chronological and civilization-based divisions. (Figure 7) In this section, Whitrow employed the Guerlac

committee compromise of combining both temporal and geographical/cultural divisions into the same category (or “facet,” as Whitrow spoke of it). In order to be more comprehensive, however, and because the cumulative bibliography so much larger than the annual bibliographies, she added greater detail to the subdivisions, much than either Sarton or the Guerlac committee.

The second facet, that of discipline, generally followed Sarton’s Comtean ordering. Whitrow was adamant that the order of the fields was not meant to reflect any kind of a natural order. It was strictly ordinal, not hierarchical—the layout of the fields was not meant to reflect any inherent relationships between the sciences. (See a selected list in Figure 8).

FZ	Earth sciences	JR	Microbiology
FZ:r	Natural resources	JR:f	Fermentation
G	Meteorology	K	Botany
GA	The atmosphere in general	KC/KN	Plant biology
GB	Winds	KD	Plant chemistry and biochemistry
GC	Precipitations; Floods	KE	Plant vitamins and hormones
GD	Electrical and optical phenomena	KG	Plant evolution
GE	Weather forecasting	KH	Plant genetics; Hybridization
GF	Climatology	KI	Plant morphology; Plant histology
FGA*	Regional climatology	KK	Plant physiology
GG	Geology	KM	Plant cytology
GH*	Regional geology	KN	Plant ecology; Geobotany
GI	Geophysics	KR*	Plant geography; Flora
GJ	Gravitational field; Isostasy	KS	Systematic botany
GL	Geomagnetism; Electrical and radiation phenomena	KT	Flowerless plants
GM	Geochemistry	KU	Mycology
GN	Geochronology; Age and history of the earth; Historical geology	KV	Seed and flowering plants
GO	Seismology and vulcanology	KX	Trees and shrubs
GP	Volcanic eruptions; Earthquakes	KY	Specific trees and shrubs
GPA*	Regional seismology and vulcanology	L	Zoology
GQ	Tectonics; Structural geology	Lza	Applied zoology
GR	Stratigraphy; Petrology and petrography	LG/LQ	Animal biology
GS	Mineral deposits	LG	Animal evolution
GT	Mineralogy	LH	Animal genetics
GU	Gem stones	LJ	Animal anatomy
GV	Geomorphology; Physiography	LK	Animal physiology
GVA*	Regional morphology	LL	Animal embryology
GW	Glaciology	LM	Animal cytology
GWA*	Regional glaciology	LN	Animal ecology
GX	Hydrology and hydrography	LO	Animal psychology and behaviour
GXA*	Regional hydrology	LP	Animal parasitology
GY	Oceanography	LQ	Animal pathology
		LR*	Zoogeography; Fauna
		LS	Systematic zoology
		LT	Invertebrate zoology

Figure 8: A section from Whitrow’s list of subject subdivisions from her cumulative bibliography, indicating the extreme level of detail allowable in this bibliographical system.

The third facet, the aspects and bibliographic forms, ranged widely: aspects encompassed designations of geographical regions, organizational features of science (such as awards or institutions), indications of relationships between the subject and other human activities (such as politics or law or literature), and the bibliographic nature of the work itself (conference proceedings and the like). (Figure 9) The addition of this latter level of classification substantially enriched the indexing of the citations providing others ways of searching for material that were impossible in the individual bibliographies.

Though her alphanumeric notation system came across to most novices as unintuitive, byzantine, and overly complex, the resulting bibliography with its indexes and multiple levels of organization was a stunning achievement in data organization. Intentionally or not, her work prepared the way for the digitization of the bibliography in an electronic age.

The Rationale for Revision in 2002

Faced with the need to develop a database from scratch, I found it necessary to rethink all aspects of bibliographic production, including classification. My training as a historian of science had given me firsthand experience in using the bibliography for research and I understood many of the advantages as well as many of the difficulties of the different schemes. Three forces drove my desire to make changes in classification and

subject tagging: first, there were clear problems in finding suitable locations for subjects that historians were writing about; second, historians questions had changed over the years in ways that made some of the now common methodological or theoretical approaches difficult to classify; and third, widespread access to the HSTM database changed the expectations of users who sought access to data in ways different from researchers using only print sources.

nf	shorthand notations	se	the subject and public opinion
ng	anagrams; codes; cryptographs	sf	the subject and social welfare
nh	terminology; nomenclature	sg	the subject in its relation to economic factors; to industry
nj	eponyms	sh	the subject in its relation to transport
nk	methods of communication	sk	the subject in its relation to politics
nm	speaking; lecturing	sm	manpower and emigration
nn	broadcasting	sp	peace and war
np	writing; reporting; reviewing	sq	refugees
nq	translating; linguistic problems of communication	sr	freedom and secrecy
ns	publishing	st	the subject in its relation to the law
		sy	the future of the subject; utopias
o	the study and teaching of the subject	t	the subject in relation to culture and the humanities in general
ob	study of the subject	tc	the subject in relation to ethics
oc	theoretical aspects of teaching the subject	td	the subject in relation to religion
od	methods of teaching	tf	religion in history
of	examinations	th	the subject in relation to literature in general
og	curriculum	tk	to poetry
om	primary and secondary education	tn	to fiction
on	schools	tp	aesthetic aspect of the subject
op	university and higher education in general	tq	the subject in relation to art
oq	universities	tt	the subject in relation to music
or	teachers and students		
os	social relations of education	u	popular aspects of the subject
ov	adult education; popularization	ud	religious folklore
p	organization of the subject	v	ethnic and linguistic subdivisions
pd	professional or amateur	vb	white races
pe	specialization	vc	Anglo-Saxons
pf	team or single work	vd	Germanic races (Germanic languages)
pg	crown sponsored	vf	Latin races (Romance or neo-Latin languages)
ph	government sponsored, including administrative measures for control	vg	Latin and Greek languages
pq	academically sponsored	vh	Slavs (Slavonic languages)
pr	privately sponsored	vj	Semites (Semitic languages)
ps	sponsored by industry	vk	Aramaic
pv	relations within one country	vm	Hebrew
pw	international relations		
px	prizes and awards		

Figure 9: A section from Whitrow's list of aspect divisions, indicating the varieties of topical and bibliographical subjects that she indexed.

The first two forces arose from the revolutions in historiography that transformed the discipline since the Guerlac system was first introduced. Changes in disciplinary divisions became necessary in areas where historians seriously questioned many of the traditional boundaries. When alchemy and astrology became major foci of interest for historians—as even individuals like Johannes Kepler and Isaac Newton came to be identified closely with these practices—terms like “pseudoscience” ceased to provide a useful grouping of topics.²⁰ Also, historians of recent history were now writing extensively about newly developed twentieth-century sciences and practices like biotechnology and artificial intelligence, subjects unknown or having minor significance to Sarton, Guerlac, and Whitrow.

The questions that historians were now asking also provoked consternation for anyone trying to use the fifty-year-old categories. How did one capture the complexities of the debates about colonialism and non-Western science when there were only a few broad “civilization” categories subsumed within an otherwise strictly chronological system? When the Guerlac committee looked toward simplifying Sarton's system, there were only a few historians turning their sights toward non-Western topics. Joseph Needham was a lonely voice at that time. By the time I arrived at Oklahoma to assume the job of bibliographer, science and colonialism was thriving and new questions about cross-cultural interactions, the relationship of science to commerce and trade, and similar issues

²⁰ Of course the Guerlac committee did in fact group astronomy and astrology together in earlier eras, as they did chemistry and alchemy, but they also had added the category “pseudoscience” in the modern period in a clear bow to positivist conceptions of science.

multiplied. Whitrow's more detailed faceted structure allowed different ways of tagging geographical entries, but even her system had no way to deal with topics on colonialism or imperialism.

Other types of topical questions that spanned disciplines were multiplying as well. Social relations of science no longer seemed to be adequate as a single category to hold all of these historiographical initiatives. The relationship between science and religion, which had long been a prominent aspect of the history of science, was gradually becoming a sub-discipline in its own right. So, too, was science and war. Finally, the study of gender's role in science and its development, wholly unrecognized in the earlier bibliographic systems, had welled up in the discipline, making it almost impossible to use something like "social relations of science" as a container for it.

Finally, the dramatic increase in computing power had far-reaching implications on the nature of scholarship. The digital revolution made new ways of accessing the data not only possible but mandatory. Unless we took advantage of these new technologies our specialized bibliography would be eclipsed by other less specialized bibliographical tools because they offered modes of access that better accommodated the new research methods of historians growing up in the digital age.

For all of these reasons, it was clear to me that without an updating of the classification system, the bibliography would become less and less useful over time. So it was with those problems in mind that I set out to rethink the bibliographical classification system. I talked with scholars around the country and brought together a group of dedicated advisors. My goal was to utilize the strengths of the old schemes and modify them to fit this radically new environment.

My Revised System

At the outset I realized that despite the imperatives of the new, I needed to be extremely sensitive to the project I had inherited and conserve as much of the old system as I could. An entirely radical transformation might be as disastrous as doing nothing. The bibliography is a tool and it works because its users understand how to use it. Careful remodeling of the Guerlac system, then, seemed to be the most prudent thing to do. In that light, I sought to understand the rationale for the various divisions and subdivisions so that I could maintain the overall focus. I ended up utilizing the model of the Guerlac 3-and-1 framework to create a 5-and-2 classification system. While having more components than either the Sarton or Guerlac systems, maintained a structure familiar to users. (See figure 10.) Although I did not conceive of these seven main category divisions as facets when I developed them, they work in the same way. Indeed, I think that it is not inappropriate to consider this revised system as having seven major facets, two of which, the chronological and the cultural, are subdivided.

The first five unsubdivided categories replaced Guerlac's first three categories, having the same purpose, namely to classify items of a broad nature that did not fit into either a chronological or civilizational category: (A) tools and references; (B) philosophical and theoretical approaches to the study of science; (C) thematic studies of science, such as science and gender or science and war; (D) aspects of scientific practice, including instruments, institutions, and education; and (E) scientific disciplines. The innovation here increases the prominence of modes of analysis that fall outside of Sarton's two fundamental categories of chronology and discipline. The many new directions and the greater theoretical sophistication of the work historians were now doing called for special attention. The Guerlac committee's nod to "science from special points of view" just did not do justice to the complexity of the discipline as it now existed.

A. Tools for historians of science	1. General histories of science 2. National contexts 3. Sources of information 4. Reference works 5. Historiography and historical method 6. The profession of history of science 7. Historians of science
B. Theoretical approaches to understanding science	10. Contemporary philosophy of science 11. Sociology of science; psychology of science 12. Studies of linguistic and visual aspects of science
C. Thematic approaches to the study of science	20. Science and society and culture 21. Science and ethics 22. Science and politics, law, & economics 23. Science and literature & art 26. Science and race & ethnicity 27. Science and gender 28. Science and religion 29. Science and war
D. Aspects of scientific practice and organization	40. Scientific institutions 41. Scientific instruments 42. Science education 43. Professional activities of scientists
E. Disciplinary classification	101-4. Occult sciences. Philosophy. Mathematics. Music 110-14. Astronomy. Astrology. Physics. Chemistry. Alchemy 120-24. Earth sciences. Geography. Natural history. Environmental sciences. Paleontology 130-35. Biology. Botany. Zoology. Genetics; evolution. Microbiology; molecular biology. Human biology & physical anthropology 136-37. Neurosciences. Psychology & comparative psychology 140-46. Social sciences. Sociology. Cultural anthropology. Economics. Linguistics. Archaeology. History 150-53. Medicine. Psychiatry. Public health; health; nutrition. Pharmacy 160-64. Technology. Computer & communication technologies. Agriculture. Air & space technologies
F. Classification by cultural influence (sub-divided in categories A to E)	200. Cross-cultural contexts; colonialism 210. Arabic-Islamic contexts 220. Byzantium and Eastern Christian contexts 230. East Asian and Southeast Asian contexts 240. Indian contexts 250. Jewish contexts 260. Native American contexts 270. African contexts 280. Australian and Pacific Island contexts
G. Chronological classification (sub-divided in categories A to E)	300. Prehistory and early human societies 311. Ancient Near Eastern contexts 312. Ancient Greek and Roman contexts 320. Medieval Western European contexts 330. Renaissance contexts 340. Seventeenth century 350. Eighteenth century 360. Nineteenth century 370. Twentieth century, early 375. Twentieth century, late; twenty-first century

Figure 10: Schema of the post-2002 annual bibliographies, showing the seven main divisions, the first five being single-level classifications of general works and the last two providing the more detailed two-level classification scheme.

In terms of theoretical approach, the study of science reflected influences far beyond philosophy of science. These historiographical influences resulted in my development of the facet (B), theoretical approaches. More than ever these days, historians draw heavily on social scientific theories to ground their work, modes of analysis developed among sociologists, anthropologists, and psychologists whose work concerns scientific and epistemological issues. Similarly, the studies of visual representation and linguistic or rhetorical aspects of science have burgeoned, and now incorporate tools from humanities disciplines, art history, and literary studies. Together, all of these fields provide historians a rich foundation for understanding the nature of the scientific enterprise.²¹

Thematic approaches to the study of science, which I have pulled together in division (C), have likewise multiplied. The vertical and horizontal components of chronology and discipline that Sarton believed fundamental to the study of history of science are now joined by some diagonals. The Guerlac system could never be very precise about the classification of these approaches when it included only two general categories, one for social relations of science and one for humanistic relations of science. To remedy this, I added topical categories that reflected specific historical interests, categories that dealt with the way that science interacted with other aspects of the social world: science and society; science and ethics; science and politics, law, and economics; science and art and literature; science and race and ethnicity; science and gender; science and religion; science and war. All of these areas have a vast literature to which historians often need access, and I felt that the bibliography ought to reflect these new historiographical trends. Sarton as far back as 1913 understood the importance of studying the practice and organization of science.²² Different classification systems acknowledged these aspects of science, but never, I thought, did it get the attention it deserved. Whitrow progressed the farthest in this area by providing subject terms that allowed for tagging of such things as teaching, awards, guilds, methods of communication, laboratories, and so forth—all topics which designate institutions or professional activities. I elevated the topic area to a major division (D), however, considering this area to be of signal importance in recent historiography.

Taken together, the two divisions (C) thematic approaches and (D) aspects of practice reflect facets of historical study similar to the old internalist-externalist distinction. Thematic approaches to understanding science (C) cover ways of studying science or scientific disciplines as they interact with things not usually considered part of science, like religion or war. The aspects of practice (D), by contrast, reflects (tirar o s)activities that tend to define sciences, such as instruments and laboratories. Historians are rightly wary of applying a strict externalist or internalist criteria to define any particular aspect of science, so while I notice a resemblance to the internalist-externalist categories, I don't define the categories in this way, preferring them to be used more flexibly.

The facet (E) that covers disciplinary divisions remains similar to the disciplinary divisions in all versions of the bibliography. Mine differ from Guerlac's categories somewhat, but there are many similarities, and both contain just over thirty disciplinary headings to classify the sciences. Some of the changes reflect new historical understandings of science and some reflect actual developments in science itself. For example, I dropped the term pseudoscience, which many younger scholars disliked because it didn't fit historical categories—it was, in a word, whiggish. Beyond that, I added terms for astrology, alchemy, natural history, environmental sciences, neurosciences, computer and information sciences, and air and space technologies, many of these terms derived from Magda Whitrow's more detailed classification list. Some categories have been broadened as well.

²¹ I must thank Joy Harvey for early on pointing out the need for a new category that could differentiate these non-philosophical science studies works from philosophy of science.

²² George Sarton, "Le but d'Isis," *Isis* 1, n° 1 (1913): 195.

The category previously designated as physical anthropology now includes biological descriptions of human beings generally and can be used to categorize such things as eugenics, literature on “the body,” and other topics that deal with human evolution and human nature.

This leads me now to the changes in Sarton’s fundamental classification scheme, the historical scheme. There was always a tension in the way that the bibliographies had attempted to group entities in historical contexts. Sarton clearly had the right idea that a bibliography on the history of science should give primacy to the chronological aspects of the studies, but how best to do this? Historical studies don’t refer merely to time; location and geographical and cultural context play a dominant role in the way most historians think about the world. Sarton had two categories to deal with this, the fundamental (based only on time) and the historical and ethnographical (based on the historical context, a combination of time and place). Because the latter category contained such subcategories as antiquity and the middle ages there was always confusion about whether an item that fit chronologically in one of these time periods would go in the fundamental or in the historical system. The Guerlac system removed this confusion by eliminating the historical division entirely and placing non-Western sciences within the chronological category—located next to the middle ages, but this created another problem by suggesting that non-Western scientific topics were only relevant in ancient and medieval scientific periods.

With the burgeoning of culture studies that focused on the importance of the location of science, I realized that it was important to return to a focus on the historical and cultural context, which I did by adding the category (F). In addition, the closer ties between the field of history and history of science seemed to make it worthwhile to bow to a standard classification tool in history that gives priority to place. The (F) category relocated the cultural categories as distinct from the chronological ones. This has allowed me to treat these (sometimes enormous) non-Western categories as regional cultural topics rather than as chronological ones. The change still reflects a highly privileged place for Western science—which is the focus of the strictly chronological categories—but the discipline as a whole still tends to focus on the scientific institutions that have developed in the West.

The chronological categories remain more or less the same as in the Guerlac system. My main change here apart from removing the geographical-cultural section was to change the way I denoted the subcategories. I employ the same bibliographical, topical, organizational, and disciplinary divisions found in sections (A) through (E) as the main subdivisions in the chronological and geographical-cultural categories. This made the faceted nature of the bibliography as understood by Whitrow more consistent, and it departed from the effort to group citations into just a few broad disciplinary categories such as “exact sciences,” “physical sciences,” or “biological sciences.” The result is that the entries are much more finely classified in these annual bibliographies than they were in others.

Indexing

The classification structure holds a central place in the bibliography, but it can never replace a good index for researchers working on subjects that don’t fall neatly into the built-in categories. The cumulative bibliography made this kind of searching possible by providing a subject index. Moreover, since the citations in the bibliography were included in an electronic database, a precise set of index terms was necessary for subject searching. The Whitrow terminology formed the key element here, providing the basic vocabulary for both print and online indexing. Whitrow had painstakingly developed her terminology in an effort to fill the faceted structure with the many fixed categories that made her system so rich. Neu adopted her system for all of his data as well, and by doing so, the

terminology standardized indexing across the bibliographies. This not only allowed the terms to be properly positioned in the classification scheme of the printed cumulative bibliographies, but it also provided index terms. The terminology functioned essentially as a fixed thesaurus. It standardized the indexing for the cumulative bibliographies as well as the subject tagging for the citations in the HSTM database.

Although I had some qualms with the Whitrow terminology, the consistency that it offered provided an important rationale for its continued use in some form in tagging citations. Strict adherence to the Whitrow system, however, contained too many problems. First of all, the Whitrow class-mark structure when translated into text often proved highly cumbersome. A single descriptor in the database is ungainly, for example: “Social anthropology; Cultural anthropology -- Sexual behavior -- guides; handbooks -- 20th century -- North America: United States; Canada.” Second, the terminology of individual entries had been designed to provide relatively broad topic areas for grouping in a printed format, but that did not work well in digital form. Geographical terms, for example were always grouped together. Works on Canada, for example, were always indicated with the term “North America: United States; Canada.” A similar problem existed in other topic areas as well where phrases linking two different (sometimes widely different) terms existed: “Chemical warfare; Biological warfare” and “Human sciences; Sociobiology” are indicative. Finally, new topics that historians had come to address often didn’t have any appropriate index term available: there was no specific term for nanotechnology, for example. In other words, the Whitrow system, though it provided a standardized thesaurus, was in need of restructuring and updating.

I made two changes in the thesaurus that helped to satisfy the need for more specificity and precision in the tagging of items. In cases where I was able, I applied Whitrow’s vocabulary, or used terms quite similar to those she used. I abandoned the concatenation of the terms that linked different facets of her system, separating all of the index tags. Disciplines, aspects, geographical locations, and time periods are all tagged as separate items, never linked in my entries. Furthermore, I broke up the terms themselves so that they would function more precisely. People searching for Canada as a subject now are able to find just Canada without also getting all of North America and the United States. Second, I established a system that would allow me to expand the thesaurus as necessary when the Whitrow vocabulary was insufficient. I turn first to two sources, the thesaurus in use by the Technology and Culture bibliography and the widely-used Library of Congress Subject Headings. Only when I believe it necessary and where no other acceptable alternatives exist, do I invent new terminology. I now have an easily expandable, but still controlled, thesaurus that can be used for indexing any entry. In practice, the new tagging structure allows much more flexibility in providing multiple terms to citations where needed. Works that include three or four distinct disciplines, for example, can be tagged with all of them. Subject tagging can now be as broad or narrow as the entry requires. These tags, moreover, are used to provide a subject index for each of the annual bibliographies.

Figures 11 and 12 demonstrate how the two systems work in practice in the HSTM database. In these examples I compare two citations dealing with 16th century alchemy, one from data uploaded by John Neu using the Whitrow classification system for the subject index and one uploaded by me using my thesaurus for indexing. The main point that these figures illustrate is that by breaking up the subject terms which were otherwise linked in the Whitrow system, I have made them separately indexable, which gives me much greater flexibility to classify works with much greater precision. The terminology in this case is identical, since I have used the Whitrow system as the foundation of my thesaurus, and as a result, a single subject search brings up citations uploaded both by John Neu and me.

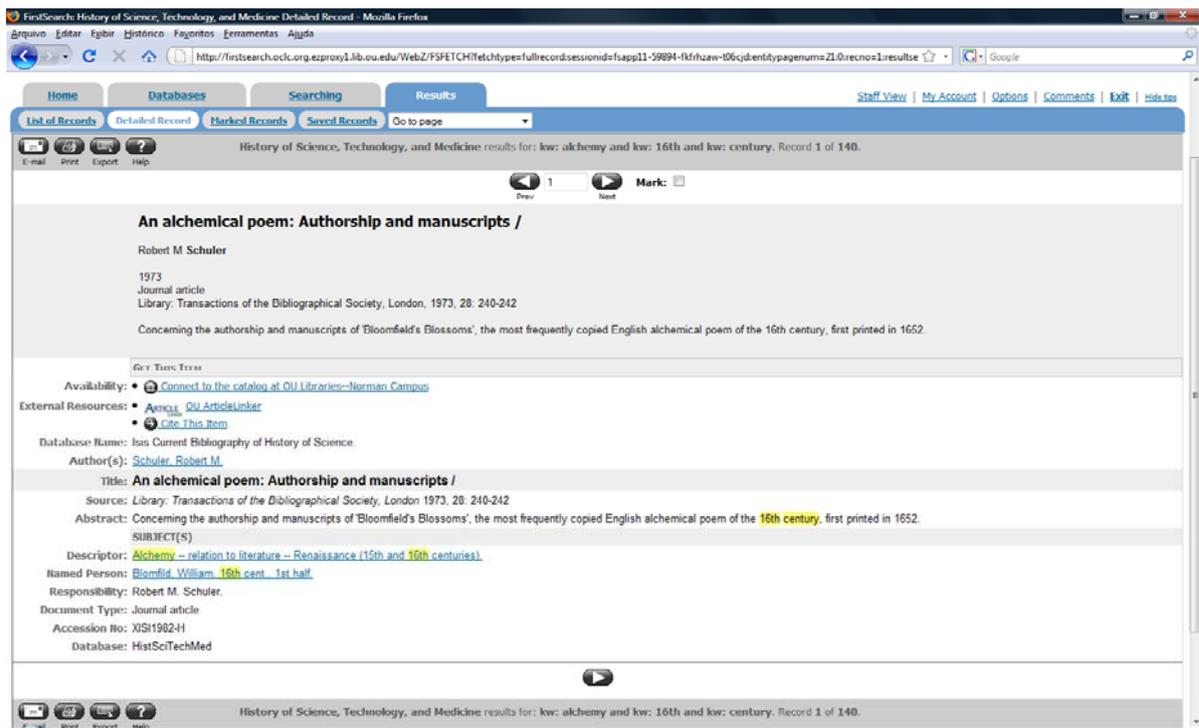


Figure 11: Screen shot of a work in the HSTM database provided by John Neu. The search terms were alchemy and 16th century. Notice that the descriptor here is a single line as formulated in the Whitrow classification system.

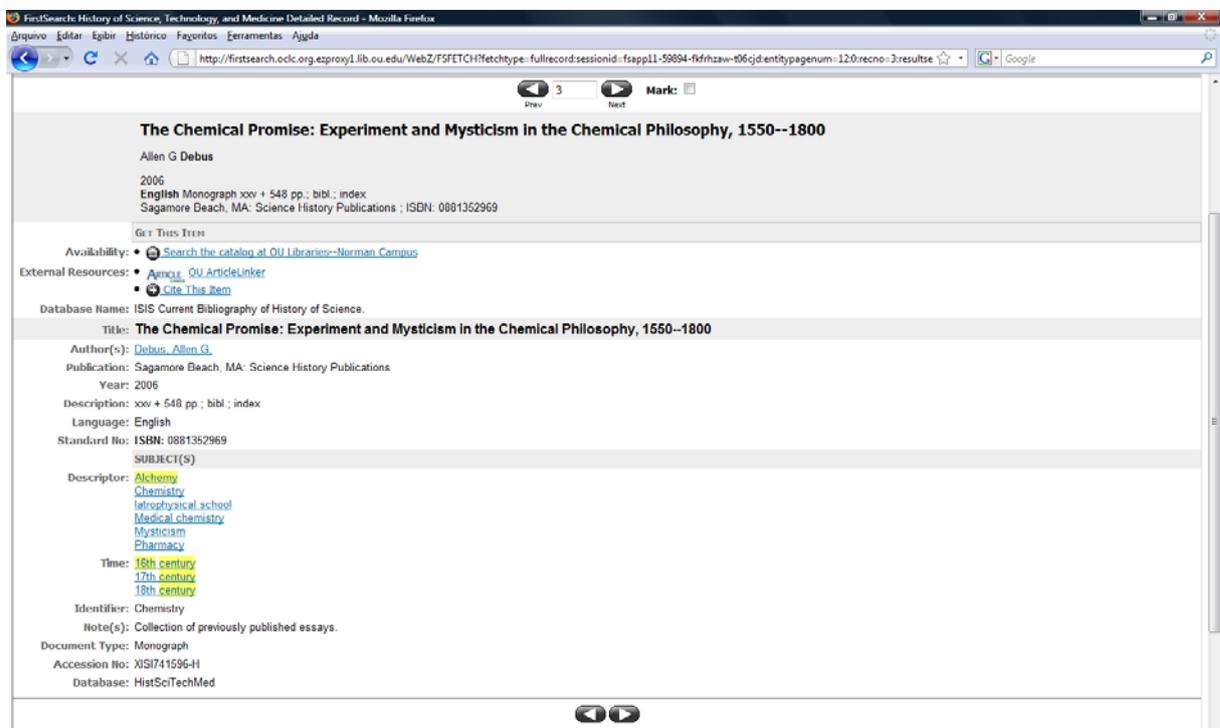


Figure 12: Screen shot of a work in the HSTM database that I provided. As in Fig. 11, the search terms were alchemy and 16th century. Notice that the descriptor contains multiple terms broken up as independent index entries. Though many of the terms are identical to those in the Whitrow classification system, they are used quite differently

Conclusion

In closing let me highlight two main points regarding my work on the classification and indexing of citations for the *Isis* bibliography. First of all, the changes I made are conservative and based on pragmatic, not theoretical concerns. I made changes based on new subjects of study, new questions of historians, and new technologies available. Second, the revised classification scheme is best suited for small bibliographies of about 4,000 entries, but the new subject tagging makes the system work well in today's digital environment. The system therefore has both a clear structure and is easily expandable and updatable.

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