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DISCIPLINARY DEVELOPMENT IN CULTURAL CONTEXT:

The History of Science, in North America

by

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1. Introduction

Social Studies of Science as Social Phenomenon

It is not difficult to find indicators of a rapidly-burgeoning interest in social studies of science and technology, throughout the industrialized world. The successful launching of 4S and its growth to encompass over five hundred individuals in the months before its First Annual Meeting come immediately to mind, for obvious reasons. A preliminary, partial inventory of other indicators might include:

journals (e.g. Minerva, Social Studies of Science)

newsletters (Public Conceptions of Science, STPP News, Philosophy and Technology)

conferences (citation analysis; quantitative methods in the history of science; retrospective technology assessment)

guides (the Cornell Guide to Science, Technology and Society programs; Derek de Solla Price's Guide to Science Policy Studies; Paul Durbin's Guide to the History, Philosophy and Sociology of Science, Technology and Medicine)

other publications (the Wiley-Interscience Series in Science, Culture and Society; Toward a Metric of Science; Science Indicators 1974)

patrons (the NSF, with its new Office of Science and Society; the NEH, with its commitment to scholarly study of the Ethical and Human Value Implications of Science and Technology; the Rockefeller Foundation Humanities Program)

committees and consortia (The International Council for Science Policy Studies; the British SISCON

project; the SSRC Sub-Committee on Science

. Indicators)

programs and departments (Social Analyses of Science Systems at Cornell; Science Studies at Edinburgh; Histoire et Sociopolitique des Sciences at Montréal; History and Sociology of Science at Pennsylvania; Values, Technology and Society at Stanford to give only a few examples)

The list is imperfect, incomplete and heavily biased to Britain and North America. However it should establish the point that social structures now exist in sufficient number and variety to carry the weight of serious, scholarly work in the area of social studies of science and technology.

Social Studies of Science as Intellectual Program

The very number and variety of institutions, interests and disciplinary perspectives make it intrinsically unlikely that social studies of science will ever be captured by one paradigm. The most we can hope for may be to "help to convert an impressive congeries of disparate programs of research on science into an even more impressive composite field of disciplined inquiry." Nonetheless, I take it that there is one set of intellectual issues around which the research agendas of the field are likely to be formed, at least in the immediate future. That set of issues has to do with how--if at all--ideas and social structure inosculate. Answers may be constructed in many different ways and have been so constructed by analysts as varied as Barry Barnes, Joseph Ben-David, Jürgen Habermas, Mary Hesse, Imre Lakatos, Thomas Kuhn, Robert Merton and

Stephen Toulmin to give only a partial, alphabetical listing of the names that come quickly to mind. It is not difficult to discern nor controversial to say that the direction of movement in recent argument has been away from positions which see high scientific ideas as free of social gravity toward articulations that consider such ideas as no more (or less) privileged than any other intellectual activity of interest to the sociologist of knowledge. I take this observation as applying equally to the philosophically recondite arguments of Paul Feyerabend and to the sociologically exact studies of scientific specialties with which much of the rest of this meeting will be occupied.

The Concerns of a Historian

Looking from the perspective of the historian, I can only applaud this movement toward--inter alia--a more complex multi-causal analysis of the phenomena under investigation. The interaction of the ideas of research scientists in various specialties with the particular, insulated professional structures in which they are located is obviously one subject of considerable interest to the historian. However, as a subject it is far from fully capturing let alone exhausting the possible content of social studies of science, even when viewed from within the context of a research program focussed on ideas and social structure.

One might for instance wish to enquire not only about 'high science' as practised in research institutes but also about 'low science'--that is, about the ideas, values, assumptions and beliefs in those broader communities that sustain, permit and encourage, or at the very least tolerate and make possible, the existence and activities of people in elite institutions. More significantly, one might wish to know about the diachronic dimension, about how, when and where

the quantitative has become qualitative, transforming the meanings, rhythms and purposes of those myriad items we so freely lump together under the title "science". To state the same issue in concrete terms, I am firmly persuaded

that the intellectual work, social arrangements and cultural locations of the 100 New York men who constituted the American Chemical Society in 1876 cannot and should not be understood in the same terms as those of the 100,000 people scattered about the globe who today also constitute the American Chemical Society.

To put the matter differently again, I hope for social studies of science which will help us understand the cognitive activity of both heroic individuals and bounded social groups in the context not only of their immediate social experience but also of those short (10 to 50 year) and long run (half century or more) trends which constitute the warp and woof of cultural change. That warp and woof are in their turn essential if we are to comprehend even our most vaunted scientific achievements as anything more than isolated dramatic moments.

To talk of centuries, cyclical changes and secular trends is to run the risk of suggesting that any "new" history of science will have little in common with other forms of social study of science. The truth is I believe quite otherwise, for it is at the level of the group and the individual that we see cultural change made manifest and the quantitative trend rendered concrete and explicit in new intellectual and social formations, coalitions, arguments, programs, beliefs and values. The particular historical technique of prosopography offers a powerful way of dealing with the group. Ideas and social experience may be seen in all the complexity of their interaction by careful use of this tool. A focus on the group allows a way of mediating between individual experience and the often imperceptible long-run trend. Prosopography also affords a means of creative interaction between certain historical, philosophical and sociological concerns.

The Reflexivity of Knowledge in Social Studies of Science

In history as in other spheres, a satisfactory social analysis of science must be, at least in principle, reflexive or self-exemplifying and capable of encompassing itself within its own explanatory forms. However it is not my purpose to encourage navel-gazing, but rather to direct attention to events over half a century ago, when a complex interaction of broader cultural trends, more immediate social experience and particular intellectual beliefs and ambitions led to the formation of a new North American society, devoted to the history of science.

I offer the following analysis with three hopes, namely:

- that it will show how a historical account may be constructed, encompassing individual intellectual ^{ambitions} / the common experience of social groups and broader secular trends within a culture
- that you as sociologists, political scientists, philosophers and practitioners of the other several disciplines represented in 4S will give me the benefit of critical responses
- that attention to the earliest enduring institutional venture in "science studies" will help us as, reflexively, we seek to understand the forces to which we are subject and to work out our common program.

2. A Case-study

The Emergence of the American University

The American university, as an institution devoted to scientific and scholarly discovery and teaching and training in that spirit, was a product

of the last quarter of the 19th century. The period was one in which many of the leading figures of the country--in industry and commerce, politics, religion and education--concluded that a new type of society, urbanized and more centralized than the older system, required a new kind of education. Scientific knowledge was one of its central elements. The changed position of the United States in the world also required a system of higher education judged appropriate to a "world power."

The founding of Clark University in 1889, Stanford University in 1891, and the University of Chicago, also in 1891, confirmed and accelerated a trend apparent in such older, slower-moving universities as Columbia, Harvard and Pennsylvania. The newer seriousness was expressed in the desire of many young persons to pursue their studies at the most advanced level available to them. While the number of recipients of bachelor's degrees increased less than fourfold in the forty years from 1876 to 1916, the number of doctorates awarded grew by a factor of more than twenty. In the five years 1876-1880 alone, American universities awarded more Ph.Ds than they had given in their whole previous history (see Table I).

The change in scale was accompanied by major transformations of style and meaning. The period of pioneers, "precursors" and idiosyncratic individualism in graduate study gave way to an era of collective endeavor. By the mid-nineties a "first generation" of American doctors of philosophy had emerged to the world. Some in this initial wave received a certain amount of pre- or post-doctoral training in Europe. In addition an undertermined number of Americans obtained doctorates at European universities. Many of these had also studied in their homeland. Enumeration of the graduate student body is therefore difficult. In any case exact calculation is not necessary to the

TABLE I: Some Statistics on Degrees

A. Degrees Conferred, 1870-1916.

<u>Year</u>	<u>Bachelor's or first professional</u>	<u>Master's or second professional</u>	<u>Doctorates or equivalent</u>
1870	9,370	Not available	1
1876	12,000	835	31
1886	13,100	859	84
1896	24,600	1,480	271
1906	32,000	1,790	383
1916	45,200	3,910	667

B. Doctorates or Equivalent: Five Year Cumulations, 1871-1896.

<u>Period</u>	<u>Number of Degrees Conferred</u>
1871-75	89
1876-80	192
1881-85	276
1886-90	574
1891-95	1150

Source: U. S. Bureau of the Census, Historical Statistics of the United States. Colonial Times to 1970. (Government Printing Office, Washington, D. C., 1976), Series H 751-765. In this and subsequent tables, statistics will be given to three significant figures.

argument. What is important is the emergence of a large group of holders of the Ph.D. sharing a common sense of professional identity, whether American-trained or returning home with European doctorates, widened horizons and stores of foreign tradition on which they could draw in their own specialized teaching and research and in promoting the institutional fortunes of their subjects.

This first generation was quickly active. It helped to reform the American Association for the Advancement of Science in 1882 and the American Chemical Society in 1889, and to establish the American Historical Association in 1884, the American Economic Association in 1885, the American Mathematical Association in 1888, and the American Psychological Association in 1891. The creation of national societies based on the major disciplines was accompanied by changes in the organization of higher education. By the early 1900s, the pattern of departments specialized by disciplines which included within themselves a variety of more differentiated specialties, was well established.

University teaching became an attractive career for intellectual, ambitious young persons. It offered prospects of advancement and it permitted concentration on special fields of interest. Universities increasingly recognized achievements in research and provided facilities and resources for that research. The greater size of the student bodies, both at the undergraduate and the graduate levels, required more teachers and larger departments. (See Table II) Again, the changing statistics reflect the changing values embodied in the University. At Harvard, for example, the number of undergraduates grew threefold between 1870 and 1910. However, the number of postgraduates went from none in 1870 to 429 in 1908, while the number of professors increased from 45 in 1870 to 194 in 1908. Of especial significance was the expansion in

TABLE II: Institutions of Higher Education-Income and Size

A.. Size and income-all Institutions

<u>Year</u>	<u>Total Faculty</u>	<u>Enrollment</u>	<u>Income:</u> <u>All sources, in millions</u> <u>of dollars</u>
1880	11,600	116,000	not available
1890	15,800	157,000	21
1900	23,900	238,000	35
1910	36,500	355,000	76

B. Statistics for Certain Universities

Year	Registration-all Departments			Graduate School Enrollment		Teachers of Profes- sional Grade	Other Teachers and Research Fellows
Institution	Harvard	Yale	Columbia	Harvard	Johns Hopkins	Harvard	Harvard
1870	1,320	755	776	-	-	45	14
1880	1,370	1,300	1,530	43	102	70	65
1890	2,270	1,650	1,670	132	233	90	108
1900	4,290	2,540	3,180	353	168	134	277
1910	4,120	3,280	5,120	429*	187*	194	416

*Figures for 1908 +Figures for 1868, 1878, 1888, 1898 and 1908

Sources: A. Historical Statistics, H 689-699, H 700-715, H 716-727.

B. Henry James, Charles W. Eliot (2 vols, Houghton, Mifflin, Boston, 1930) 2, appendices C and D.

"other teachers and research fellows" from 14 at the beginning of the forty year period, to 416 toward its end. Similar patterns could be observed at the other major universities of the country. The income of universities grew rapidly. The enlarged departments permitted more specialization in the teaching of particular subjects, and this was a great help to teachers committed to the values of and ambitious to make progress in their research.

The First Generation of Ph.Ds.

This, in rough outline, was the institutional setting of the heroic age of American science. Henry Rowland's "Plea for Pure Science"³ was but one evidence of awakened sensibilities, albeit of sensibilities focussed on an unusually percipient program for the new age of academic professionalism. The closing of the frontier seemed to symbolize both the achievement and the promise of American technology. Spokesmen for scientific research found everywhere at hand what was to them persuasive evidence of how that technology grew out of a loftier science. Steam engines, the generation of electric light and power, the miracle of the telephone--all testified to the same end. Thomas Edison's laboratory at Menlo Park, which was founded in 1876, provided early evidence of the new faith in scientific research apparent among industrial leaders. The same faith led to organized research being taken up by the General Electric Company in 1900, by Dupont in 1902, and by the American Telephone and Telegraph Company in 1907, among others.

The care of health offered similar opportunities for scientific work. Rapid city growth and massive immigration together created the need and context for the public health movement. "Scientific" procedures and scientific knowledge provided the answers; the prestige of science, both as a method of

thought and organization as well as a body of knowledge, was greatly reinforced. Further fuel was added to the flame of research by the growing triumphs of the new "scientific medicine" increasingly practiced in the pace-setting hospitals if not in the proprietary medical schools.

The prestige of scientific medicine, the potentialities of scientific research and the moral power believed to inhere in the progressive virtues of scientific method together constituted a triumvirate appealing to the philanthropic dispositions of some rich men. The Carnegie Institution of Washington, the Carnegie Corporation, the Rockefeller Institute and the various Rockefeller-controlled boards, come to mind. In the years immediately before and following World War I, their directors, their staffs, and their grants added a powerful new ingredient to the forces shaping the directions and meanings of the natural sciences.

The scale of expanding resources exemplified in this munificence was reflected in countless lowlier enterprises. The profession of science grew proportionately, and the number of scientific societies increased to accommodate its members (see Table III). Until 1881, the American Association for the Advancement of Science arranged its annual meeting in two divisions; in that year it reorganized into nine separate sections. In 1889 it belatedly recognized the new realities of scientific life by creating the category of "affiliate societies"; by 1916 its vastly expanded program was jointly sponsored by forty-three such societies, each specialized in a particular discipline. The size of the American Chemical Society indicates the transformations occurring, in the case of a single discipline. In 1906 its membership was 3,000; by 1916 it had almost tripled. In the latter year, more doctoral degrees were awarded in chemistry alone than in all subjects combined three decades earlier.

TABLE III: Scientific and Learned Societies

A. Rate of Formation

<u>Organized</u>	<u>General Science</u>	<u>Specialist Science</u>	<u>Professional Associations</u>	<u>Teachers Associations</u>
1860-69	7	4	4	9
1870-79	15	7	13	4
1880-89	18	21	20	9

B. Membership in the A.A.A.S.

<u>Year</u>	<u>Number</u>
1875	807
1900	1920
1910	8010
1920	11,500

C. Membership in the American Chemical Society

<u>Year</u>	<u>Number</u>
1890	238
1900	1710
1910	5080
1920	15600

- Sources: A. Ralph S. Bates, Scientific Societies in the United States (3rd ed., M.I.T. Press, Cambridge, Mass., 1965) 121.
- B. Proceedings of the A.A.A.S. for the years listed.
- C. Herman Skolnick and Kenneth M. Reese (eds.), A Century of Chemistry (A.C.S., Washington, D. C., 1976), 456.

This pattern of growth in the numbers of scientists and in knowledge, prestige and technical skills in the various disciplines, formed the setting and generated the atmosphere in which the scientific members of the "first generation" of American Ph.D.'s fashioned their careers. A Robert Wiebe has characterized the acclaimed values of this period in the history of the United States as those of "continuity and regularity, functionality and rationality, administration and management". Such values found clear expression in the lives of the "first generation" of American Ph.D.'s in science. By the time the United States was drawn into World War I, a small elite from among them had become famous and influential, not only in pure science but also in scientific medicine, in "governmental science," in the administration of new and old universities, in the creation of learned societies, and in the development of philanthropic institutions.

Four illustrations must suffice. David Starr Jordan, who gained a master of science degree at Cornell in 1872, and a Ph.D. at Butler University in 1878, had a distinguished career as ichthyologist, and was president successively of Indiana and Stanford Universities. He declined the secretaryship of the Smithsonian Institution in 1906, but served as president of the American Association for the Advancement of Science in 1909 and of the National Education Association in 1915. J. Playfair McMurrich, who graduated from the University of Toronto in 1879 and took a Ph.D. at Johns Hopkins in 1885, taught anatomy at Haverford College and in Cincinnati, in Michigan, and at Toronto, where he eventually became first dean of the Graduate School from 1922 to 1930. He was president of the American Society of Naturalists in 1907 and the American Society of Anatomists in 1908 and was simultaneously president of the American Association for the Advancement of Science and the Royal Society of Canada in

1922. Although he took a medical degree rather than a Ph.D. at the University of Louisville in 1889, Simon Flexner nevertheless went on to a major scientific career. He served as president of the Society of Experimental Biology in 1906, director of laboratories at the Rockefeller Institute from 1903 to 1935, trustee of the Carnegie Institution from 1910 to 1914 and the Rockefeller Foundation from 1913 to 1928, and as president of the American Association for the Advancement of Science in 1920. John Campbell Merriam became a bachelor of science at Lennox College in 1889 and then a Ph.D. at the University of Munich in 1893; he rose to be professor and chairman of the newly founded department of paleontology at the University of California at Berkeley in 1912. He was subsequently chairman of the National Research Council in 1919 and dean of faculties at the University of California in 1920. He resigned this last position to become president of the Carnegie Institution of Washington. In Washington he also became chairman of the Committee on Government Relations of the National Academy of Sciences for many years, and he concluded his administrative career by membership on the Science Advisory Board of President Franklin D. Roosevelt.

These four men were gifted, ambitious, and successful. As such they were distinct in a minority in their generation, but they were representative of some of its dominant ideals. They were also members of the organizing committee of the History of Science Society, in 1924. In this latter role their gifts, ambitions, and successes were representative.

The History of Science as Intellectual Program

The history of science first emerged as an identifiable activity in the United States in the 1890s. A complex of causes may be discerned. Though the

number of doctors of philosophy wholly trained in the United States was growing apace, many of the best-educated, most able and most affluent students still journeyed to Germany either for the doctorate itself or for some post-graduate training. Some American students at least thus became aware of the idealistic implication in such works as Ernst Mach's Die Mechanik in ihre Entwicklung, historisch-kritisch dargestellt, which was published in Leipzig in 1883, and in the writings of Wilhelm Ostwald. The reflective historical arguments of these works provided a tradition to which members of the "first generation" recurred in order to develop their own offensive against the grossly hedonistic and utilitarian outlook of some of the spokesmen for American culture and science.

The major American universities conducted their first serious, systematic, and sustained classes for graduate students in the 1890s. The obvious danger that these seminars might breed a race of narrow "technicians" was perhaps most keenly perceived by the scientists who taught them. The scientific disciplines were still somewhat defensive in the face of the criticisms, explicit and unspoken, coming from the older academic disciplines such as classics, philology, and moral philosophy. University scientists increasingly sought to provide a humanistic rationale that could both meet these criticisms and help to establish the higher justification for science. And this, it appears, helped lead to regularly offered courses on the history of the various scientific disciplines, sometimes for graduate students and sometimes for advanced undergraduates. Appropriately enough, it was the leader in technical education--M.I.T.--which took the initiative. In 1887 William Thompson Sedgwick began lecturing on the history of biology and Charles Robert Cross on the history of the physical sciences. By 1905 their two courses had been combined into a regular series

on the history of science, given by Professors Sedgwick and H. W. Tyler. A similar pattern was manifest at Harvard, where Theodore W. Richard's lectures on the history of chemistry--first given in 1890--led to L. J. Henderson's launching in 1911 of his survey of the history of the physical and biological sciences. Stanford from its very beginning provided teaching in the history of chemistry, while the University of Chicago in 1892 offered courses in the history of astronomy and chemistry and later attempted "a very unique and ambitious plan for the fostering and development of the historical courses in science." At the University of Pennsylvania, Edgar Fahs Smith began in 1896 by lecturing in the history of chemistry; while historical courses in one or other fields of science were also given at the University of California at Berkeley, and at Cornell, Illinois, Michigan, Northwestern, and Yale Universities.

By the early 1900s, it became common to discuss explicitly the aims of such teaching. The purpose most often avowed was "the much desired humanizing of science." That aim was simply and unself-consciously linked with the recruitment and induction into science of undecided students, the development of bold claims regarding the place of natural science and "scientific method" in modern culture, and the desire to reintegrate the increasingly differentiated scientific specialties. Understandably no attention was given to the history of science as an academic discipline in its own right or to the problems inherent in the application of historical methods to the natural sciences, to whom the past was less important than the future.¹⁰ Instead, it was taken as self-evident that the fortunes of history of science were auxiliary to the fortunes of American science. The educational needs of students of science and the moral and cultural concerns of scientists together

defined the proper criteria that should govern the growth of this subject.

The developing discussion of the importance of science and scientific method was accompanied by a slow but steady attempt to broaden perspectives from the history of particular sciences to the history of the sciences or perhaps even the history of science. In 1914, as international conflicts became aggravated in Europe, this last possibility took on special urgency. In November of that year, Walter Libby, one of the emergent band of enthusiasts, published an article adumbrating the by-then familiar themes, but with a new twist:

"In conclusion one must recognize that science is international, English, German, French, Italian, Russian, all nations cooperating in the interests of racial progress. Accordingly a survey of the sciences tends to increase mutual respect and to heighten humanitarian sentiment. The history of the sciences can be taught to people of all creeds and colors, and cannot fail to enhance in the breast of every young man or woman, faith in human progress and good will to all mankind."

The message was taken up by F. E. Brasch. In 1915 he published in Science a sixteen-page plea for "The Teaching of the History of Science." In it he argued that

"The final message of the history of science is to show the high plane of science--that which has given life, stability, truth and wealth--in its universal activities and its established international character as the arbiter of the future of man and of peace."

By 1915 Brasch was also urging that a section of the American Association

for the Advancement of Science be devoted to history of science. The same year saw the arrival in America of George Sarton, a young Belgian, as an idealistic refugee who was committed to a secular faith in science as the highest form of human activity and a guiding thread of history. Behind him in Belgium, Sarton had left his home, his library, and his fledgling journal, Isis: Revue consacrée à l'histoire de la science. Before him lay hope and uncertainty. The prospect of America's involvement in the war foredoomed any rapid action on his plans for a full-scale institute for the history of science as also on Brasch's more modest ambitions. However, American wealth and American convictions about the value of science were sufficient to keep Sarton in the country; American experience in the war also strengthened Brasch's case.¹¹

The Scientific Elite and New Legitimations for Science

The First World War was a catalyst of certain potentialities in American society and American science; it was also a converging lens. Rapid changes occurred, bringing into focus and sharp relief trends otherwise unnoticed but no less real. For some members of the educated classes, the war brought new meaning to the national experience and led them to see the United States as an organizable if not yet highly organized society. Washington as the seat of national government and national identity began to preoccupy their minds. The natural sciences were assigned great responsibilities in this process of national self-definition. The National Academy of Sciences was stirred to new life, the National Research Council was formed, and many individuals became very active in them. Symbolic of the changes under way was the move from Pasadena, California, to the national capital of the period's greatest enterpriser in pure research, George Ellery Hale.

If Hale's sojourn in Washington during the years of the war symbolized the new sense of national identity among American scientists, his return to California in 1919 displayed the problems of acting on the basis of that identity under peaceful conditions. While the leading personalities of the sciences felt a common identification with their disciplines and with one another, the political realities of American life remained obstinately rooted in local, regional, ethnic, and class attachments. Together, these attachments forbade centralization and favoured pluralistic, dispersed, and loosely federated forms of organization and control. It was not realistic to believe that all could be centered in one city; the affairs of science could not be conducted from Washington. It was not a creative center. If the scientists were to form a community co-terminous with the national boundaries of American society, there would have to be the regional sub-centres, able to deal effectively with a great variety of interests--university teaching staffs, the trustees of foundations, wealthy individuals; directors of industrial research laboratories; officers of government bureaus; national, state, and local politicians. New roles had to be assumed by the leaders of the scientific community.

The ten years following the war were years of exultant self-confidence and callow optimism, coupled with apprehension about the new phase of America's existence. There was uneasiness about having departed from the "faith of the fathers," about the perils of an urbanized life, amidst entanglements with other countries and other cultures. A small and generally unregarded group of literary intellectuals, radical and liberal, denied the value of the prosperity, the hedonism, and the still persisting piety of American society and culture. Their criticism, made from the periphery of the circles in which the leadership

of the country moved, added, nonetheless, to a sense of need to restate the rightness of America's course. One ready answer lay in the affirmation of the value of science. In this affirmation science was seen not only as sustaining the technology which makes America progressive and thus promises to relieve mankind of the evils of poverty and the pain of illness. Science would also guide the country in the realms of ideals, goals and values.

The continued prosperity in higher education during this period was of a piece with this condition and mood. Professional education thrived. Four undergraduate years became the prerequisite for admission to medical school, with consequent effects on enrollment in courses in the natural sciences. The number of new doctorates in those sciences increased rapidly (see Table IV).

The expanded scale of operation of academic science was not an unmixed blessing. It implied new financial pressures and new organizational problems for the leaders. As spokesmen for their intellectual domains, they had to enlarge the public appreciation of science as a distinctive strand in modern culture. They had to seek out wealthy and powerful patrons. They had of necessity to mobilize additional arguments with which to rationalize their own, their patrons and their followers commitments to the natural sciences. The conflicting interests of the patrons, the producers and the consumers of scientific knowledge had to be integrated, or at least harmonized. For these among other reasons, many academic leaders found themselves in agreement with other significant sectors of American society that a new, secular faith was the answer to the problems of the times. The object of faith was science. Belief in science was celebrated by meta-science, which included both a more popular philosophy of science and a more active history of science. The latter could, among other things, cement the link between the timeless laws of nature and

TABLE IV: Institutions of Higher Education-Further Statistics

A. Degrees Conferred

<u>Year</u>	<u>Bachelor's or first professional</u>	<u>Master's or second professional</u>	<u>Doctor's or equivalent</u>
1918	38,600	2,900	556
1920	48,600	4,280	615
1922	61,700	5,990	836
1924	82,800	8,220	1,100
1926	97,300	9,740	1,410

B. Doctorates in the Sciences

<u>Year</u>	<u>Chemistry</u>	<u>Zoology</u>	<u>Psychology</u>	<u>Physics</u>	<u>Total: all sciences</u>
1914	71	28	12	23	241
1916	115	34	19	35	332
1918	75	33	30	17	293
1920	97	38	38	19	323
1922	153	39	29	54	442
1924	251	42	51	58	611
1926	257	55	60	76	748

C. Total Income

<u>Year</u>	<u>Income: All sources, in millions of current dollars (A)</u>
1920	200
1930	555
1934	486

Sources: A. Historical Statistics, H 751-765.

B. National Research Council, Reprint and Circular Series no. 42 (Washington, D.C., 1923), p. 6 and no. 95 (Washington, D.C., 1929), p. 1.

C. Historical Statistics, H 716-727.

the historical idea of progress. Within that idea, science was the source and seed-bed of the age to come. The faith was shared by people in quite disparate fields--Herbert Hoover comes to mind--but it found its guardians and spokesmen among the elite of the first generation of American Ph.D.'s in natural science.

By the 1920s, that minority of the Ph.D.'s of the "first generation" who had risen with science were at the peak of their collective power. For them organizing science, speaking for science, making representations for science before government officials and businessmen and exercising judgment about sciences and scientists had long since replaced active research. To them, the history of science became valuable in a variety of ways at once wider and more focussed than those known to the less remarkable rank-and-file members of their generation who also drew upon the subject. The new interest displayed by the scientific elite was to prove decisive in facilitating the forms, and shaping the content, of the history of science as an organized activity.

For one thing, the history of science was a record of the success of science. It displayed the heroic achievements of great scientists of the past and made contemporary scientists and those who admired science confident of its achievements in the future. The history of science was an argument on behalf of science; it showed that it was not simply a momentarily useful set of devices but was one of the most grandiose of all the undertakings of the human race, with an illustrious past and limitless promise for the future. In addition to this, knowledge of the classics of science and a discriminating bibliophilia were a bridge to the world of the patrons--to those rich businessmen who were amateurs of learning, to educated politicians, and to the trustees of foundations. The history of science also had other utilities

for the scientific elite. It offered an acceptable medium to the new type of high administrator in universities and government who was not himself any longer a specialist but who needed a broad scientific culture. George Sarton said as much in 1921:

The history of science is an encyclopaedic discipline. It will stand or fall as we accept or not the possibility of encyclopaedic knowledge....It would not be unreasonable to expect university presidents to be encyclopaedists....The president to whom the intellectual leadership will in the future be entrusted (will) need possibly an encyclopaedic education, and in any case a scientific one....The encyclopaedic training would be the ideal one for a college president and for any man whose scientific duties are not specialized.

Sarton's words were almost a description of William H. Welch. Since the time of Benjamin Franklin, no one had ever occupied a place more central to the life of science in America. Welch's positions included the presidencies of the American Association of Physicians in 1900, of the American Association for the Advancement of Science in 1906, the American Medical Association in 1911, of the National Academy of Sciences from 1913 to 1916, and the acting presidency of the Johns Hopkins University in 1914 (he refused to accept a permanent appointment to the post). He also found time to serve as trustee of the Carnegie Institution from 1903 to 1934 and president of the board of scientific directors of the Rockefeller Institute from 1901 to 1933. He was a member of the council of the subsection on the history of science of the American Association for the Advancement of Science (1920), and he was successively a member of the council (1924-26; 1927-29), vice-president

(1930), and president (1931) of the History of Science Society. Very fittingly, his final academic role was to be the founder and director of an institute devoted to the history of science and medicine.

The career of Edgar Fahs Smith also illuminates the commodious utilities of the history of science. Smith came from an obscure Pennsylvania-Dutch background. He graduated from Gettysburg College in 1874 and received a doctorate from Göttingen, in 1876. He went on to become provost (i.e. president) of the University of Pennsylvania from 1910 to 1920. He was president of the American Philosophical Society for six years. He was three times president of the American Chemical Society: in 1895, 1920, and 1921. He declined to stand for the governorship of Pennsylvania, but was on intimate terms with the leading circles of the Republican Party. He served as president of the state's electoral college in 1925. He was also a connoisseur of the history of science and a noted bibliophile. He created the history of chemistry division of the American Chemical Society in 1923 and was^{successively} a member of the council (1924-26), vice president (1927) and organizing committee and fourth president (1928) of the History of Science Society. David Eugene Smith provides one last example. He earned his Ph.D. at the University of Syracuse in 1887, and went on to become professor of mathematics at Teachers College, Columbia University, and president of the international commission on the teaching of mathematics, from 1908 to 1920. As author or co-author of more than 150 textbooks, he became a man of considerable fortune. Smith was the moving spirit in the organization of the History of Science Society. He served as its secretary (1924-25), vice-president (1926) and president (1927). Smith was also a bibliophile--his library of 10,000 volumes in the history of science is now at Columbia University. He linked the worlds of high science, high culture, and great wealth. Through him, plans were drafted to persuade George Kunz, vice-president of Tiffany and Company, and Archer M. Huntington, cousin^{-in-law} stepson, and brother-in-law of Henry E. Huntington

and multi-millionaire philanthropist in his own right, to supply the financial support for a research institute in the history of science. Through him, George Plimpton, chairman of Ginn and Company, trustee and treasurer of Barnard College, trustee of the World Peace Foundation and president of the trustees of Amherst College, was persuaded to join the History of Science Society and to become a member of its council.

The history of science served the bibliophilic tastes and the encyclopedic aspirations of certain influential sections of the elite of American science in the 1920s. It also did far more. Its peculiar power in that decade lay in its combination of these functions with an outlook which was congenial to far wider groupings in that elite and the audiences which they encountered. The ideology of the history of science was progressive, idealistic, internationalist, and patriotic. It appealed to the expert; it invoked objective truth; it implied the desirability and inevitability of progress; it was a paean to the role of science in contributing to the good of mankind. It seemed to say that science could aid in the achievement of the highest ideals of politics while remaining apolitical. These features made it very attractive to many educated, public-spirited and wealthy Americans. Yet despite this powerful support in intellectual curiosity and in ideals, wealth and influence, the history of science had great difficulty in establishing the cognitive and professional identities which mark a secure academic discipline.

The History of Science Society

There is rich, persuasive evidence available, showing that the history of science very easily achieved the kind of "imperfect institutionalization" which was to characterize it between the Wars. In April 1919 a formal call

to organize was published in Science. By the end of the following year a "History of Science Subsection" was established in Section L of the American Association for the Advancement of Science. Sufficient communal energy was available not only to sustain this sub-section but also to engender the creation of the History of Chemistry Division of the American Chemical Society (1923) and the American Association for the History of Medicine (1924), in addition to the History of Science Society itself. A prosopographical analysis of those who organized, shaped and governed this last group is especially rewarding. It displays how acceptable modes of intellectual activity were patterned by values, ideology and prior social experience, and also why "imperfect institutionalization" was the lot of this new discipline.

The letter of December 1923 announcing the formation of the History of Science Society was signed by an organizing committee of thirty-seven persons. If to their number we add the ten officers appointed in the first five years who were not among the original committee, the resulting group of forty-seven persons may be seen as constituting the "organizing group". That group may quite naturally be divided into three subgroups (see Table V). The largest subgroup, containing an extraordinary combination of talent and power, was that of the "patrons". Its twenty-six members--all scientific administrators and researchers from the "first generation"--were all in their mid-fifties or older. They had extensive European experience as students--21 of 26--strong and explicit commitments to peace and internationalism--10 of 26--and enormous influence within and outside the academic community. Thirteen of them were in the National Academy of Sciences, one was a Nobel-laureate.

The thirty-four presidencies of national scientific societies they had severally held included the American Association for the Advancement of Science, the

Table V

The Organizing Group of the History of Science Society

Subgroup	No.	Age Range in 1924	No. with foreign birth or educa- tional experience	No. of members of Nat. Acad. of Sci.	Presidencies of other national societies, pre-1924	Active commitment to inter- nationalist politics
Patrons						
Administrator	9	55-74	8	7	24	6
Researcher	17	54-73	13	6	10	4
Total	26	54-74	21 (81%)	13 (50%)		10 (38%)
"Proto-historians of science"	9	40-57	5	0	3	0
"Sympathizers"	12	35-55	6	2	2	0
	21		11 (52%)	2 (9%)		0 (0%)
Total	47	35-74	32 (68%)	15 (32%)		10

Sources: Information derived from the DAB, The Biographical Memoirs of the National Academy of Sciences, American Men of Science, the National Cyclopaedia of American Biography, obituary notices in Isis, etc.

National Academy of Sciences, the American Chemical, Mathematical, Philosophical, Physical, and Psychological Societies, the American Societies of Anatomists, Naturalists, and Orientalists, the American Neurological Association, the American Council of Learned Societies, the National Research Council, and the Royal Society of Canada.

A clear difference in age, prestige and cumulative advantage separates this sub-group from the next, that of the nine "proto-historians" of science. The "proto-historians" of science were relatively young--five of the nine were in their forties--, they had less experience of Europe and they did not enjoy eminence in learned societies. They were however all directly connected to the history of science by publication, by their roles as editors and enthusiasts, and by more or less exiguous academic positions. Frederick Barry provides one illustration. Born in Massachusetts in 1876, Barry trained as a chemist at Harvard (A.B., 1897; A.M., 1909; Ph.D., 1911). He spent one year as research assistant chemist at the Carnegie Institution, before moving to Columbia University as an instructor. He apparently failed to gain tenure as a chemist and "for six years after 1917 he continued researches in Columbia laboratories, but as an independent scientist." In 1923 he rejoined the Columbia faculty, teaching the history of chemistry. By 1928 he had gained the title of "associate professor of the history of science," though he had little else to show by way of claim to ^{academic} power and authority. The differences between the patrons and the producers of history of science were to some extent softened by the scattering of "sympathizers" (physicians, young "mainstream" historians and others) who together constituted the final sub-group. However the social space between patrons and practitioners--exemplified in the distance between Barry and, say, Edgar Fahs Smith--helps to account for the contrast between the lofty expectations of the former sub-group and the difficulties of the latter in establishing their subject in the universities.

Social facts of this kind contributed powerfully to the shaping of

American history of science. Another example is provided by George Sarton's determined but never-realized ambition to create an Institute of the History of Science and Civilization. The Institute would be dedicated to pure research of the most enacting, scholarly variety. Despite or possibly because of its European nature, the vision was perfectly in keeping with the aspirations of American academic life at this period. Two other members of the organizing group obtained endowed institutes in which to pursue their intellectual ambitions. However they came from the sub-group of patrons, and as such enjoyed power and reputation. Sarton's personal dream might have corresponded more fully with the aims avowedly represented by the founding elite of the History of Science Society. In 1924 it was more important that he was an emigré, that he was employed in a marginal position and that he was the youngest of the struggling "proto-historians."

Continuous, systematic, detailed historical research was not of primary value to the most powerful among the patrons of the history of science. At best such research could only confirm the veracity of a vision deriving its power from quite other sources. One of those sources was internationalism. The forms taken by that internationalism were many and complex. By the 1920s the forces nourishing it included not only the traditional belief in a "republic of letters" beyond the boundaries of nationality but a desire to extend war-time links and disappointment born of the failure of Woodrow Wilson's internationalist exports. Traditional American politics offered no easy road for expressing the European ties and cosmopolitan experiences characterizing the sub-group of "patrons" in the founding elite. The "apolitical" politics of scientific internationalism did. American wealth and improved trans-oceanic communications both fostered an unfamiliar international role for American scientists.

Rockefeller fellowships brought brilliant young men of many nationalities to American shores. Rockefeller programmes in medicine and public health sent American men of science to all parts of the globe. A belief in the international and progressive character of scientific truth which transcended the boundaries of particular cultural traditions was congruent with the routine experiences of administrators like Welch and Flexner at this time. Equally, the establishment in Europe of international bodies devoted to the history of science and medicine served to concert certain intellectual interests which were emerging on both sides of the Atlantic Ocean. The objectivity, progressiveness, and internationalism of science were widely proclaimed at this time; the history of science was regarded as capable of bearing witness to them. But an appreciation of these functions of the history of science did not generate a strong will to make provision for sustained research into their history.

The values at stake were exemplified in the case of another member of the organizing committee of the History of Science Society. George Ellery Hale was educated at the Massachusetts Institute of Technology and at the University of Berlin and, after a period at the University of Chicago, served as director of the Carnegie Institution's Observatory at Mount Wilson, California. He combined, in extraordinary degree, high scientific achievements, administrative zeal, political acumen, and an internationalist outlook. He collected about a dozen gold medals from institutions including the French Academy of Sciences, the Royal Society of London, the Royal Astronomical Society, and the National Academy of Sciences. He founded and edited the Astrophysical Journal. He played a major if not the major role in creating the California Institute of Technology, the Henry E. Huntington Library and Art Gallery and the National Research Council. He raised the funds for a permanent building for the United States National Academy of Sciences. Amid

these scientific and administrative activities, he also found time for other ventures. "Always an internationalist by nature," his position as foreign secretary of the National Academy of Sciences from 1910 to 1921 gave him a firm base. From it, he helped to launch the International Research Council, later to become the International Council of Scientific Unions and the International Astronomical Union. To Hale, it was self-evident that the history of science was the history of progress, of the cumulation of objective knowledge and of an internationalism immune to the corruption of nationalistic politics. Science, unfolding successively deeper truths about nature, was also moving forward to greater economic prosperity and future moral progress for mankind.

The power of such assumptions was reinforced by the way in which they could help unify and consolidate the scientific enterprise by providing common ground to otherwise antagonist elements. A commitment to the progress of science and to the grandeur of its history was compatible with the main strands in academic political belief, from a devotion to socialism to a championing of liberal private enterprise.

J. McKeen Cattell, who was another of the patrons, for example, was a socialist. He was a founder of the American Psychological Association, of the Psychological Review, of American Men of Science, and of School and Society. He took over and transformed Science and Popular Science Monthly and was president of the American Association for the Advancement of Science in the year the History of Science Society was founded. For Cattell, belief in the significance of the history of science and the possibilities of moral progress went hand in hand with his belief in the merits of democratic socialism. At the same time, these beliefs about the values demonstrated by the history of science could equally well be linked with a more cautious, conservative temper

as in the cases of John Merriam and Edgar Fahs Smith. As a trustee of the Carnegie Foundation for the Advancement of Teaching, Smith severely criticized Cattell regarding his views on politics and economic policy. The "thirty-third degree Free Mason" and the forthright socialist held markedly different political beliefs. However, the history of science provided a platform of commitment to progress on which they could comfortably stand together, regardless of their political differences.

That platform also allowed its occupants to appreciate the continuity of their own achievements in science with the previous pattern of European triumphs. By the 1920s, Americans (in large numbers) no longer went to Europe for graduate training. They did, however, find precedent and legitimation for their own work in earlier European endeavours; they regarded themselves as sharing a common tradition and extending it jointly with European colleagues. In its early years the History of Science Society moved quite naturally from one annual meeting wholly devoted to colonial American science to another completely concentrated on Isaac Newton. This internationalist vision also encouraged concern with science outside Western civilization. Such concern was helped by a stress on the antiquarian and esoteric aspects of the history of science. It was, moreover, perfectly compatible with a definite belief in the superior merits of the "Anglo-Saxon" tradition. George Sarton was deeply convinced of the importance of the achievements of Islamic science, but he also easily admitted that:

"My chief reasons for choosing English [as the sole language for Isis, after the First World War]...are my faith in the Anglo-Saxon conception of life, and also my love of and my hope in the younger civilizations of the world: first of all this United States, then also Canada, Australia, South Africa, and New Zealand...I believe

that as far as the diffusion of common sense in politics and the spirit of fair play are concerned these young nations are the hope of the world. They are, on the whole, less trammelled by precedent and by prejudice, and more capable of working out radical ideas in a conservative way. I trust that the ideal of the New Humanism--that is, the reconciliation of science and art, truth and beauty--will find a more appreciative audience among them."

The Execution of the Program

Sarton was of course the most active among the various propagandists on behalf of the history of science, as he was also the most tireless organizer of its necessary intellectual apparatus. He created Isis, the journal which the History of Science Society sustained. He produced the long succession of "critical bibliographies" in the subject. He worked on what was designed to be the definitive Introduction to the History of Science. He produced a stream of arguments for his chosen field. His formulations of the importance of the subject, and of the moral worth of science, took on power and resonance precisely because they coincided with the ideology pervasive among the patrons of the activity. This was true when he argued for the importance of science and of encyclopaedic knowledge, or for the merits of the Anglo-Saxon tradition, or that

"The true internationalism toward which the unity of knowledge and the unity of mankind are steadily driving us, will constitute an immense progress. This progress will be largely due to the development of positive knowledge and scientific methods..... whatever happens at the surface, the essential unity of mankind is a

reality which will be attested in the future as it has been in the past by a small elite of scientists. These will pursue their sacred task, undisturbed--even as bees pursue theirs--in spite of wars and other cataclysms. Thus, thanks to them, the secret advance of mankind may go on indefinitely."

Just as resonance between the intellectual orientations of patrons and practitioners helped shape the work of the latter through patterned approbation and applause, so a lack of resonance could be powerful in shaping by indifference and neglect. By way of example, one of Sarton's ambitions was "to carry on simultaneously research on ancient science and on nineteenth century science." His first intention blossomed while the second quietly withered. Scientists and administrators spoke of the pervasiveness of science and its historic role in shaping the modern world, but as patrons of the history of science, their interests were rather in history as a cultural adornment, a source of bibliophilic delight and as a fount of communications about "esoteric subjects." (Table VI) Despite the affirmative declarations

TABLE VI: Contents of Isis, volumes 3-12 (1920-1929)

Articles on:

<u>Scientific Disciplines</u>		<u>Culture</u>		<u>Period</u>	
Mathematics	27	Arabic	9	Ancient	15
Chemistry and alchemy	12	Indian	4	Medieval	19
Physics	9	Chinese	2	16th Century	16
Medicine	6	Muslim	2	17th Century	20
Astronomy	2	Egypt	2	18th Century +	15
Geography	1	Italian	2		
		American	2		
		English	1		

Note: Totals do not agree as, for instance, an article on "Arabic science" is counted only under Culture, while one on "seventeenth-century astronomy" appears under Scientific Disciplines, and Period.

regarding the virtues of the modern world, the research reported in Isis ran rather into a different direction.

In the days in which the history of science was being organized and Sarton was seeking to define his own intellectual tasks, he often spoke of "my book on nineteenth century physics." In practise, far more remote problems and periods were to occupy his scholarly energies. The history of science avoided the recent past; its actual conduct had something in common with the humanism of those writers like Irving Babbitt and Paul Elmer More who denounced the modern world and who saw nothing good in its "scientism." There was, indeed, a defensive humanism to be found within the organizing group, in the persons of the Egyptologist James Breasted and the medievalist Charles Homer Haskins. It is thus understandable that Sarton and Lynn Thorndike, who were the two most gifted, energetic, and productive of the "proto-historians" of science in the organizing group, should have done their work so far from the type of scientific activity which the patrons united in praising as the epitome and model of modern life.

It is not difficult to find further evidence of the organizing group's ambivalence towards the progressivistic scientism that they so often enunciated. It happened that the Social Science Research Council came into being at the same period as the History of Science Society; it was progressivistic to the hilt; it sought the benefits of applying the scientific approach to the problems of modern society. It seemed, therefore, to have much in common with the affirmative and progressivist view of the founding elite of the History of Science Society. The founding twenty-five members of the Social Science Research Council contained not one person in common with the organizing group of the History of Science Society.

The History of Science Society was based on a rhetorical affirmation of the supreme value of modern science and scientific method. At the same time the values and interests of its patrons inclined it away from modern periods and scientific approaches to modern problems, towards an alliance with the most defensive forms of humanistic scholarship. If this were not paradox enough, its espousal of the need for a "new humanism" brought an uneasy alliance with certain methodologically radical historians. The rationale for history of science as a "new humanism" could indeed be interpreted as a denial of the value of the traditional humanistic disciplines. Sarton certainly did not hide this intention.

"To focus the system of education upon scientific method and knowledge is....to replace a one-sided vision of the world which no longer corresponds to the available knowledge of our time by one which is more adequate; to replace incomplete humanities by complete humanities; to replace an ignorant and insecure idealism by one which is....solidly anchored on all the reality we have yet been able to grasp."

He concluded from this that "the center of gravity of historical studies must be displaced." The old historian's "absurd pretense to control historical studies" must necessarily give way before the claims of that new humanism which found its centre and meaning in the history of science.

This disparagement of the traditional humanities as studied in the modern university did not gain the sympathy of the traditional political historian or classical scholar. It was more acceptable if not entirely welcome to those concerned with such peripheral fields as oriental history and Egyptology,

which were not as internally specialized or differentiated as the humanistic studies of European cultures. On the other hand, it did find sympathy and a warm response among those general historians who were in revolt against what they thought was the dominant academic tradition.

James Harvey Robinson's emphasis on history as the history of the progress of the rational mind would embrace previously neglected social groups and realms of thought. As early as 1912, one of his students was writing her Ph.D. dissertation on The Role of Scientific Societies in the Seventeenth Century. Robinson's rhetoric was highly congruent with the scientism of the organizing group. His The Mind in the Making and especially The Humanizing of Knowledge, both written in the early 1920s, might have been taken for manifestoes for the History of Science Society. Together with his disciple--Harry Elmer Barnes--and two of his pupils--Preserved Smith and Lynn Thorndike--Robinson formed an articulate clique within the organizing group. Barnes was eloquent about the importance to the historian of science and technology, while Smith wrote a major work of intellectual history adumbrating by three decades themes which Herbert Butterfield was eventually to bring into prominence. Thorndike proved to have the greatest persistence as historian of science, perhaps because his theme of Magic and the Rise of Experimental Science demanded most attention to more remote periods.

Despite these efforts, the history of science found no secure place on the agenda of academic historians. No doubt this was in part because the "new historians" were themselves a very minor if vocal grouping within the historical profession. But it was also in part because of imperatives intrinsic to the history of science.

The historiography of science is no new arrival on the American academic

scene. The society devoted to the history of science is significantly older than the organizations devoted to musicology, architecture, aesthetics, metaphysics and economic history. Already in 1924 textbooks were being written and a plethora of courses flourished. Four historians of science held appointments in universities in their capacity as historians of science. The discipline had some powerful patrons in the academic world. The organizing group of the History of Science Society included academic deans from Harvard, Columbia, and Toronto Universities; departmental chairmen from the California Institute of Technology and Northwestern University; presidents of foundations and academic administrators.

Why did a field so well placed make so little progress? Why was it able to sustain but not to develop a prestigious learned society, and unable to command the regular academic forms of teaching positions, seminars, fellowships and departments? Perhaps its patrons did not think that the demonstration of the internationalist objectivity and centrality of science to human progress really needed the support of specialized historical research. Perhaps they found a focus on great scientific personalities and remote and heroic events sufficient for their purposes. Perhaps the preoccupations of the Depression and the Second World War explain much. Perhaps it was inevitable in the departmentally organized university that this small subject would have to choose either science or history as its patron and would decide to look to the sciences for legitimation and support. Perhaps the sort of imperfect institutionalization experienced by the field is less

anomalous than it first appears. Perhaps it is also less surprising than it seems at first sight that there is to this day still no satisfactory historical-survey of nineteenth or twentieth-century American science and that the Manhattan project and the hydrogen bomb have not yet been studied by persons holding academic appointments in the history of science. Perhaps it is understandable that historians of science still debate "The Relations Between History and History of Science."

The 1920s saw the early stages of institutional establishment of the history of science in the United States. Within that imperfect institutionalization, George Sarton and Isis were provided with the means to play the central role. Sarton remained an impassioned propagandist for the importance of science in history and a dedicated prophet of disciplined research. Perhaps the final irony is that he incarnated better than he ever knew the themes, the limitations, and the possibilities inherent in a subject caught between the exigent demands for scholarly standards and the traditions and the imperatives of university departments organized according to their disciplinary jurisdiction, on the one side, and patrons who were more interested in the legitimacy of science than they were in the scholarly study of its history, on the other.