Patterns of Organization and Records Creation in Scientific Research: The Work of the American Institute of Physics

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AIP Study of Multi-Institutional Collaborations: Final Report. AMERICAN INSTITUTE OF PHYSICS. College Park: American Institute of Physics, 2001. 320 p. No ISBN.

AIP Study of Multi-Institutional Collaborations. Phase III: Ground-Based Astronomy, Materials Science, Heavy-Ion and Nuclear Physics, Medical Physics, and Computer-Mediated Collaborations. AMERICAN INSTITUTE OF PHYSICS. College Park: American Institute of Physics, 2000. 209 p. No ISBN.

AIP Study of Multi-Institutional Collaborations. Phase II: Space Science and Geophysics. AMERICAN INSTITUTE OF PHYSICS. College Park: American Institute of Physics, 1995. 287 p. No ISBN.

AIP Study of Multi-Institutional Collaborations. Phase I: High-Energy Physics. AMERICAN INSTITUTE OF PHYSICS. New York: American Institute of Physics, 1992. 310 p. No ISBN.

RÉSUMÉ L'article porte sur l'étude menée de 1989 à 2001 par l'American Institute of Physics sur les collaborations scientifiques multi-institutionnelles. L'auteur analyse cette étude dans le contexte de la recherche en stratégie de documentation et en évalue la pertinence pour l'évaluation des documents créés au cours de la recherche scientifique. Il conclut que le travail de l'AIP offre aux archivistes un éclairage précieux sur les formes d'organisation et leurs effets sur la création et l'accumulation de documents.

ABSTRACT The author reviews the study on multi-institutional scientific collaborations conducted by the American Institute of Physics (AIP) from 1989 to 2001. He puts the study in the context of documentation strategy research and its relevance to the appraisal of the records of scientific research. The AIP reports offer archivists much valuable content regarding patterns of organization and their effects on records creation and accumulation.

This study is the most recent in a series of efforts undertaken since the late 1950s by the American Institute of Physics (AIP) to ensure the preservation of adequate documentation on the history of twentieth-century physics. The Institute pioneered the archival approach that was to become known as documentation strategy.[1] Early studies concentrated on pre-war physics, but by the early 1970s it became clear that post-war physics, and scientific research in general, were going in new directions. Organization and methods, as well as their implications for documentation, were markedly different from the pre-war situation. More documentation research was obviously needed, so the AIP conducted a major study of the United States Department of Energy (DOE) laboratories from 1977 to 1981. Those institutions were built after the Second World War to provide access to large, expensive facilities that neither universities nor corporations could afford. In the course of that study, the authors realized that science was being conducted more and more in the context of collaborations involving scientists from several institutions, often from different countries, gathered around a major research facility. For instance, experiments in particle physics could bring together hundreds of physicists in order to use large accelerators. That organizational and institutional framework was clearly different from the more traditional situation of an individual scientist or even a small team working together under an informal agreement. For people aware of the importance of documenting collaborations, there was cause for concern. Collaborations are transient organizations: they are brought together in order to conduct an experiment or a series of experiments, and disband afterwards. Furthermore, participating institutions often do not have an archival programme or do not collect the records of collaborations. The AIP therefore set out to research collaborations, which the investigators also saw as an increasingly important organizational model in other fields of activity besides science.

The study, begun in 1989, was led by Joan Warnow-Blewett (who was also involved in the DOE study), with the assistance of Spencer R. Weart; the project also called on several historians, archivists, and sociologists as staff and consultants. The work was conducted in three phases, corresponding to different scientific fields, and each phase concluded with a separate report. The final report was published in 2001. These reports are available in hard copy from the AIP, and some are available on their Web site.[2]

Project members studied some sixty collaborations, most of which were ini-

1 Larry J. Hackman and Joan Warnow-Blewett, "The Documentation Strategy Process: A Model and Case Study," *American Archivist* 50 (Winter 1987), pp. 12-47. See also the AIP's Web site <http://www.aip.org> (current as of 7 December 2002). The AIP's work on documentation eventually gave birth to the Center for History of Physics, a formal part of the Institute.

2 See Brien Brothman's review of the Phase I reports, *Archivaria* 37 (Spring 1994), pp. 150–153.

tiated between the late 1960s and the late 1980s. They interviewed close to 450 participants (scientists, managers in universities, research facilities and funding agencies, engineers, graduate students, and archivists); performed numerous site visits to universities, laboratories, and archives; and conducted in-depth investigations on certain experiments. The project concentrated on collaborations involving three or more institutions. Most of these were universities, but government agencies were involved, as well as a few corporations. High-energy physics, the first field studied and the one with which project members were the most familiar, received the most attention. Geophysics and space science were also studied in-depth, in Phase II. During Phase III, researchers studied more briefly five other fields (ground-based astronomy, materials science, heavy-ion and nuclear physics, medical physics, and computer-mediated collaborations) in order to broaden their understanding and get a glimpse of new trends apparent in more recent projects. Although several collaborations involved scientists and teams from different countries, most of the study concerns collaborations based in the United States or the experience of American teams.

This is a massive study by archival science standards. The reports offer a wealth of results, which the authors have taken pains to summarize and present in different ways. Readers in a hurry will be tempted to start with the final report, which provides a detailed summary of findings and recommendations. However, that report is short on the specifics of experiments, so those less familiar with the fields of inquiry studied will want to refer to the other reports, notably for the case studies.[3] It would be difficult to summarize properly the findings of such a large study. Instead I will attempt to provide the reader with a sense of what the AIP study has to offer archivists, especially with respect to appraisal. Other readings of the reports are also possible, from the points of view of the history or sociology of science, or of records management.

Multi-institutional collaborative projects are an integral part of the rise of "big science" after the Second World War. One common denominator of most collaborations is the use of expensive facilities, such as particle accelerators, space probes, oceanographic vessels, earth-observation satellites, or astronomical observatories. Another is the necessity of external funding, most often from governments, hence the important role of funding agencies. In some cases, the complexity and cost of experiments brings scientists together. High-energy physicists will collaborate to develop a detector, to which each institutional team contributes a component. Space science projects centre

3 Several Web sites also serve as good starting points to gather information on scientific research. See for example the AIP's own site <http://www.aip.org/history/web-link.htm>, the Echo Science and Technology Virtual Center <http://echo.gmu.edu/center/>, and the CISTI Virtual Library <http://www.cnrc.ca/zone/cisti/special/hotlinks/index_e.shtml> (current as of 7 December 2002).

around the building of a space craft, into which instruments built by different teams of scientists are integrated. Geophysics projects tend to fall into two categories. "Technique-importing" projects are formed in order to apply costly instruments or techniques developed in government or the private sector, such as seismic reflection profiling and deep-sea drilling, to academic research. "Technique-aggregating" projects, on the other hand, bring various techniques to bear on the study of a single site or a single phenomenon of global interest to geophysicists. The World Ocean Circulation Experiment, in which institutions in Atlantic Canada took part, is an example of the latter.

Compared with scientific research conducted in more modest settings, multi-institutional collaborations involve a whole new layer of organization in order to initiate a project, prepare proposals for funding, choose participants, divide responsibilities, balance competing interests, allocate access to facilities, coordinate work, impose standards, manage internal communications, and regulate the publication of results. The AIP study focusses on these organizational issues and how they affect records creation and accumulation. It reveals an impressive diversity of arrangements. For instance, teams in high-energy physics are very dependent upon each other, since they must collaborate in building a detector; their interactions tend to be more egalitarian and participatory. At the other extreme, collaborations that must allocate resources among autonomous, competing teams tend to favour a more formal organization and a strict hierarchy.

The authors have chosen to present their archival conclusions in a number of complementary ways in the final report. They extend the organizational analysis into a study of the processes by which records are created and accumulated, in order to help archivists locate important records within the administrative structure. These considerations evolve into a full-blown typology of collaborations, based on formalization, hierarchy, the presence of scientific leadership, and whether the division of labour is specialized or unspecialized.[4]

The results are also presented using a functional analysis, inspired from the work performed at the Massachusetts Institute of Technology (MIT).[5] For each of the major functions that comprise scientific research (establishing research priorities, administration of research and development, research and development, and communicating and disseminating results), the authors briefly discuss which records are created and who keeps them, in the case of high-energy physics, space science, and geophysics.[6]

4 Joan Warnow-Blewett, Joel Genuth, and Spencer R. Weart, *AIP Study of Multi-Institutional Collaborations. Final Report. Documenting Multi-Institutional Collaborations* (College Park, 2001) pp. 99–111.

5 Joan K. Haas, Helen Willa Samuels, and Barbara Trippel Simmons, *Appraising the Records of Modern Science and Technology: A Guide* (Cambridge, MA, 1985).

6 Warnow-Blewett et al., *Final Report. Documenting Multi-Institutional Collaborations*, pp. 115–126.

Besides organizational issues, some attention is given to record types and formats. The authors discuss the growing importance of Web sites set up by collaborations to exchange information and distribute documents; some of these functions were previously accomplished through e-mail. That observation is a useful reminder that the Web is not just a publication medium, but rather a communication infrastructure that can support many uses, including virtual workspaces. The authors also note, in their discussion of a project that served as a test bed for an electronic "collaboratory" between scientists, that the use of digital channels of discussion such as chat generates a "plethora" of records that have to be appraised and selected. Regarding scientific data, they conclude that it is not useful for historical research and that its preservation is the responsibility of scientists.[7]

We are then presented with formal appraisal guidelines, organized by record type. The basic approach is the same as defined by Joan Warnow-Blewett during the study of DOE laboratories.[8] Archivists are advised to keep a small volume of "core" records for all collaborations, as well as more extensive records for collaborations that are deemed significant. The latter category includes collaborations that have an important impact on scientific knowledge, as well as experiments that can be considered representative of an approach or a period.

The authors also studied records management and archival practices in participating institutions. In the authors' judgement, the most important recommendations, are those aimed at ensuring proper record-keeping during collaborations: they argue that funding agencies should include modest, additional overhead funding as part of grants, to support records management and archives at universities; that academic institutions should preserve the professional files of leading scientists who play a key role in collaborations, as well as the records of transient organizations such as collaborations and research centres; and that non-academic institutions housing research facilities should institute proper records management and archives programmes.

One of the hallmarks of documentation strategy is that its scope transcends institutional boundaries. This is particularly well-suited in this case, not only because of the obvious fact that these are multi-institutional collaborations, but because scientific research is inherently trans-institutional. Most scientists, whatever their home institution, participate in a community whose standards

7 With respect to the long-term scientific value of data, the authors refer to: National Research Council, *Preserving Scientific Data On Our Physical Universe. A New Strategy for Archiving the Nation's Scientific Information Resources* (Washington DC, 1995). That report is the most complete reference on the topic that I'm aware of, and is currently available on the Web <http://www.nap.edu/catalog/4871.html> (current as of 7 December 2002).

8 Joan N. Warnow, *Guidelines for Records Appraisal at Major Research Facilities. Selection of Permanent Records of DOE Laboratories: Institutional Management and Policy, and Physics Research*, rev. ed. (New York, 1985).

are defined essentially by other scientists through a number of institutions such as universities, journals, and funding agencies. The trans-institutional scope here is not part of a thematic approach that would encompass unrelated records creators; it is coincident with the scope of the societal function studied.

While organizational issues are well covered in this study, readers will not find an analysis of the conceptual and technical aspects of the scientific research process per se, or its attendant records creation and accumulation. Most often the analysis operates at or above the level of the "teams" of scientists (usually made up of scientists from the same institution) and their leaders, which gives the strange impression that such an important dimension is treated as a "black box." In this respect, the authors rely on the MIT study and on earlier work by the AIP.[9] This nevertheless leaves us with an incomplete picture, from an appraisal point of view. The organization of work and communications, the types of instruments used, the degree of computerization of research, and the work habits of scientists and technicians all affect which records are created, and in what form. These factors vary widely between disciplines, teams, and scientists.[10] It also bears mentioning that much of the activity studied by the AIP is in fact research and development (building instruments) rather than fundamental research, and it is likely that this distinction would affect records creation or appraisal.

For the majority of archivists who will not be appraising the records of a space mission anytime soon, the value of the AIP study resides in its approach rather than in its precise results, notwithstanding their value. Even archivists who are responsible for appraising the records of a multi-institutional scientific collaboration should be wary about applying the results of the AIP study literally, because they may not apply as well to other circumstances. After all, the study highlights the diversity of organizational and documentation arrangements at work in scientific research, even in related fields. The authors also point out that over the course of the study, changes were perceptible so that the high-energy physics "model," for example, was losing some of its uniqueness. It is to the authors' credit that they provide us with a fine analysis of the processes at work in collaborations and the resulting patterns of organization and documentation. Archivists undertaking an appraisal of scientific records can use these results to steer their research; others will come out of reading these reports with much food for thought.

9 Haas et al., *Appraising the Records*; Warnow, *Guidelines for Records Appraisal*. See also Clark A. Elliott (ed.), *Understanding Progress as Process. Documentation of the History of Post-War Science and Technology in the United States. Final report of the Joint Committee on Archives of Science and Technology* (Chicago, 1983).

10 This has been my experience appraising records of research institutes within the National Research Council of Canada. The work of archivists in France's Centre national de la recherche scientifique <http://www.cnrs.fr/Archives> (current as of 7 December 2002) has also been interesting in this respect.