

MANAGING INTELLECTUAL ASSETS: THE IDENTIFICATION, CAPTURE, MAINTENANCE, AND USE OF THE RECORDS OF FEDERALLY SPONSORED SCIENTIFIC RESEARCH.

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ABSTRACT: Academic organizations, in addition to government and private industry, must begin to regard sponsored research records as vital and integral *evidential* and *intellectual assets*. This essay emphasizes these records' value as a means of risk management for both the researcher and the institution. Establishing a Department of Intellectual Assets (a name chosen to reflect the nature of the records management/archives program) under the jurisdiction of the University's Controller's Office, where the vital records of all research being performed at the university are maintained, is the primary goal for ensuring adequate evidence and accountability of these activities. The paper points out that the records which emanate from scientific research activities are discipline specific and, as a result, archivists and records managers must work together to develop programs that will reflect this diversification. The goal of what this essay is suggesting is to transform the focus of records professionals off of *information* and onto *evidence*—evidence of fiscal, administrative, and legal transactions, as well as providing evidence of laboratory proceedings.

The proliferation of scientific research after World War II has made it increasingly apparent that attempts to schedule and maintain access to meaningful and evidential research documentation have become disproportionately inadequate given the explosion of such documentation, partially attributed to the increased use of computing for both the administration of, as well as conduct of, modern scientific research. Academic institutions, along with government and private sector organizations, must begin to regard these records as important *intellectual assets*—not only for the benefit of scholarly research, but, perhaps more importantly, to provide a means of ensuring project accountability both fiscally and ethically. Records managers and archivists must pursue creative avenues for motivating institutions to establish records management programs designed to work cooperatively with institutional archives to ensure that those

records that fulfill administrative, fiscal, and legal requirements are scheduled for retention, in addition to records that may enable researchers to explore the biographical and sociological aspects of science. Documentation selected for retention must reflect the totality of the research process and be regarded as a vital resource for intellectual property and risk management. It is imperative that institutional decision-makers understand that these intellectual assets ensure the efficient administration of, as well as the continuation and validation of, scientific research at an institution. Through examination of the totality of the scientific record, with some emphasis on the administrative aspects of this process, this essay proposes the establishment of a records management program working cooperatively with an archives program, under the direction of an *Office of Intellectual Assets*, as a solution for ensuring the identification, capture, maintenance, and disposition of these records, in an attempt to not merely reduce duplication of effort, but to *guarantee* accountability and compliance.

Because the scope of scientific research is so vast, this essay limits its discussion to sponsored projects funded by federal agencies, primarily the National Institutes of Health, to conduct basic, experimental, research science in an academic institution. More specifically, this essay uses the Department of Pharmacology in the School of Medicine at the University of Pittsburgh as a case study from which the life-cycle of these records can be traced. Pharmacology was selected as being representative of typical problems encountered in academia when considering the identification, capture, and maintenance of scientific research records.

Evidence Based Administration

All sponsored project funding in the Department of Pharmacology is administered through a business office that is responsible for overseeing government and private industry grant and contract¹ submission and awards, fiscal reporting, procurement and reimbursement, and asset management. Human resource documents, as well as records originating from the Occupational Safety and Health Administration (OSHA) office, are administered and maintained by the staff of the Executive Administrator for the department. Graduate theses and doctoral dissertations are bound and housed in the Chairman's Office (additional printed copies are maintained by the School of Medicine and microfilm copies reside in the school's library). Actual research documentation and personal papers are the only records that pose a real problem because they are generally dispersed between a Principal Investigator's office, lab, and home. None of these records are maintained under the jurisdiction of an established records management program within the School of Medicine or within the University as a whole.

Aside from the obvious reason of documenting worthwhile research, development of an effective and efficient institutional records management and archives program would ensure evidence of organizational accountability and compliance and reduce duplication of effort and encourage maximum quality, use, and value of information as a strategic objective. In other words, the goal is to transform the focus of records management and archives programs off of *information* and onto *evidence*—evidence of fiscal, administrative, and legal transactions, in addition to providing evidence of laboratory proceedings.

To achieve this change of focus the necessity for building a strong working relationship between records management and archives programs must be emphasized. Operating together, these programs ensure the provision of long-term storage of important records.² The life cycle of these records cannot be administered in the absence of a concern for both current records and archival records without running the risk of losing evidence, weakening accountability, and undermining corporate memory.

So how does one design a program that will not only encompass readily accessible administrative records, but will also attempt to incorporate multiple formats and dispersed records, as well as those aspects within the evolution of a research project that frequently remain undocumented, such as the formulation of hypotheses? What do we need to know about a project? What functions generate which records? Are the by-products of these functions really records or are they data—what are their characteristics? How well do these records reflect the research process? What do they tell you and what do they leave unanswered? How does one contend with scientists who traditionally resist the encroachment of additional administrative demands on their research, as well as individual departments that frequently harbor territorial tendencies toward their records? With these questions and more in mind, endeavors to integrate a new records management/archives program should proceed with an awareness of, and a realistic strategy for, dealing with the variety of documentation involved in scientific research and a sensitivity toward the various departmental cultures existing within an institution or an individual school.

Identifying Significance

In developing strategies for scheduling the records of scientific research, a set of criteria has to be established to distinguish between those projects that deserve full documentation and those for which a final published report along with an accounting summary will suffice.³ Disciplinary committees within the institution should be formed to determine which projects warrant full documentation based on the project's significance to the disciplinary community (i.e., was it a pioneering endeavor, did it unearth startling new results, were new techniques developed), its ability to enhance the prestige of the academic institution, and its influence on the generation of graduate theses, thereby encouraging the development of new courses and/or disciplines.⁴ Such committees are best composed of both the creators and users of scientific records, as well as those individuals who are responsible for administering them.⁵ Their inclusion is critical because:

By their participation in the appraisal of their records for historical purposes, scientists and high-level administrators would become conscious of the potential value of their records, and experience increased morale from this recognition of the importance of their efforts. More immediately, their identification of significant R&D events, programs, and facilities will make possible the destruction of a great quantity of unneeded and bulky R&D records.⁶

Once a project has been deemed worthy of enhanced documentation, it should then be subjected to the process of determining what materials produced by that project are

considered to be records and which are non-records, the objective being to retain only those materials with the most evidential value. If the goal of the records management and/or archives program is to be as meticulous as possible, it should schedule for retention grant and contract proposals and specifications, award statements, correspondence between the researcher/university and the funding institution, progress reports, accounting statements, and closing reports. In addition, a comprehensive program has the right to glean laboratory notebooks, data files,⁷ logbooks, and diagrams for apparatus from the laboratory, assuming that these records are no longer necessary for ongoing research.⁸ A concerted effort should also be made to acquire the personal/professional papers of the Principal Investigator and to integrate these into the other materials. However, these materials should not be treated as a separate manuscript collection. Overall, the surest way to decide exactly which records to schedule can be attained by studying the actual scientific research process.⁹

Realizing Scientific Research Dynamics

Understanding the sociology of scientific research begins with a recognition of the research process as “the pursuit of curiosity into the physical environment producing new understanding and new arrangement of physical matter.”¹⁰ Investigators begin by formulating a hypothesis based on a gap or inconsistency in the known knowledge base. Agencies, responding to national or special-interest priorities, frequently dictate the direction of an investigator’s research.¹¹ In addition, new projects often piggyback off ongoing research being conducted in the investigator’s own laboratory or that of a collaborator.

After a hypothesis is formed, the investigator begins to conceptualize the research methods that will be employed—the goal being to either prove or disprove the validity of their theory. Responsibility for carrying out these methods is then distributed accordingly to various members of the laboratory, who then begin the cycle of experimentation and analysis. Their goal is to establish procedures based on existing theories and to accumulate testable evidence to support their theory. Once initial experimentation indicates that a project is plausible, the Principal Investigator will write and submit a grant proposal to request the necessary funding. If the proposal is funded, then the investigator is presented with the task of completing the research in a specific time period, usually between two and four years depending upon the award. However, this may vary from discipline to discipline. During that time, the investigator must submit annual progress reports and file noncompeting renewals for funding.¹² At this point, it should be noted that the initial hypothesis can often change midstream. The nature of ongoing experimentation and analysis is based on trial and error, which results in a rather amorphous process. In the end, breakthroughs, as well as failures, can be equally valuable in their contribution to the base of scientific knowledge. Investigators are frequently sharing information about their results through publications, poster presentations at conferences, lectures, informal conversations, and correspondence. Once a funding period ends, the investigator is left with the option to either terminate the project, if it hasn’t already run its course, or submit a competing renewal.¹³

Product Reflecting Process

The scientific research process leaves in its wake a long trail of documentation: the hardware (apparatus, specimens, slides), the raw data (laboratory notebooks, logbooks), and the written printed word (administrative records, such as grant proposals, procurement, and human resource records).¹⁴ For the most part, records management and archives programs will be unable to obtain the actual hardware used because it is frequently cannibalized for other projects. However, attempts should be made to either schedule any relevant documentation regarding its procurement, design, assembly, maintenance, and use or, if possible, to document it through the use of photographs or video. Logbooks are frequently good sources of insight into the importance of a particular instrument or piece of equipment.

The Raw Data

The raw data recorded in laboratory notebooks presents the records manager and/or archivist with a slight dilemma. Although the data reflects choices made by the investigating team, it must be maintained in context, otherwise it cannot be interpreted and is rendered meaningless.¹⁵ To determine what amount is necessary to be preserved, one must consider what kinds of data are being produced, who uses it, and in what ways. In addition, contemporary research is frequently subject to federal audits. As a result, notebooks have held key roles in data disputes. It is no longer uncommon to find the following information recorded in these notebooks: the title of the experiment, the experiment's number, the date it was performed and by whom, a paragraph or two explaining why this experiment was run, and the materials and methods used. Notebooks maintained as such offer researchers invaluable insight into the genesis of scientific discoveries, as well as provide the institution with a valuable source of evidence.¹⁶ On the other hand, some archivists feel that if a summary of the data has been published in journal articles or reports, or if the data results from experiments that can be easily reprised without consuming excessive time, money, or effort, then the data can be destroyed without future repercussions.¹⁷

Administrative Records

The written printed word comprises the bulk of scientific documentation. Administrative records are primarily form driven and are more easily adaptable to retention schedules. They have fiscal and legal value for both the investigator and the academic institution, as well as research value based on the record's uniqueness, credibility, understandability, time span accessibility, user demand levels, and types of usage.¹⁸ Activities, such as grant and contract submission, procurement and reimbursement, and human resource transactions are the primary impetus for the creation of administrative records. Grant applications provide evidence of the rationale, methods, budgetary restrictions, division of responsibility, and accomplishments behind a given research project.

For active federal grants and contracts, the Department of Pharmacology's Business Office retains a copy of the entire completed grant application, along with any

correspondence (copies or originals), financial reports, and materials authorizing the use of recombinant DNA, blood-borne pathogens, radioactive materials, or other biohazardous materials, as well as animal and/or human protocols,¹⁹ for seven years—covering the four years the award is active plus an additional three years following closure of the award.²⁰ Pending applications, if they are not funded, are only maintained for approximately one year following submission. However, if a proposal is not funded, but there is a prospect of resubmission, the application will be retained for two to three years. Outside the department, the Office of Research maintains records of the pre-award process and Research Accounting retains post-award records.²¹ Unfortunately not all of the accounts managed by the Business Office are this clearly delineated. For example, the laboratory of one of the department's primary faculty members is housed in facilities maintained by the Pittsburgh Cancer Institute (PCI), an independently operated research institute affiliated with the University of Pittsburgh, but housed in facilities owned by the University of Pittsburgh Medical Center (UPMC).²² Therefore, indirect costs, which pay for purchasing, library maintenance, and building maintenance, are paid to the UPMC. However, the Principal Investigator has chosen to use the University of Pittsburgh's support facilities and have all paper work maintained in the Department of Pharmacology. This situation has resulted in a documentation quagmire that has yet to be resolved.

Sponsored research money is awarded to an institution, as opposed to the Principal Investigator. As a result, if a Principal Investigator leaves one academic institution for another, the grant or contract is transferred to the next institution. Although all formal reports and correspondence are transferred, copies are usually maintained by the former institution. With subcontracts,²³ all original documents outlining the terms of the subcontract should be maintained by the primary awardee. One unfortunate side-effect of subcontracting is that it can lead to fragmentation of the record because often collaborations are multi-institutional, multi-disciplinary, or even, at times, multi-national.²⁴

Procurement and reimbursement records offer additional cursory insight into the research process. However, their accuracy as a reflection of products consumed by a given project is questionable at best. In theory, only those supplies/materials intended for use in a specific project can be charged to that account. Despite this, situations arise under which laboratory staff do not accurately identify the appropriate projects that these supplies/materials are to be charged to. Therefore, they are initially charged incorrectly, only to be transferred to the proper account when the error is discovered. On the other hand, there are times when an account number for a new award is not released in a timely fashion, thereby forcing expenditures onto the department until the time that the account number is released and these costs can be transferred to the appropriate project. Regardless, purchase requests will not reflect these transfers. To compensate for this inconsistency, many research departments within the School of Medicine maintain monthly level reports that do accurately reflect both the initial purchase and, if applicable, subsequent transfer of supplies/materials purchased with sponsored research funds.

The Business Office of the Department of Pharmacology retains the hard copies of these records for a period not to exceed seven years.²⁵ Hard copies are also maintained by Service and Records for seven years, in addition to microfilmed copies that are

retained indefinitely.²⁶ For the most part, only the records of equipment purchases are of great concern because they reflect departmental assets. If the Principal Investigator leaves the University, any equipment purchased with sponsored research funds may follow that individual. Records reflecting the tagging, maintenance, transfer, and retirement of all departmental equipment are maintained for an unspecified time by the department. In addition, Asset Management retains capital equipment records for the duration that the equipment resides on University property.²⁷

Personnel records of staff members working on sponsored research projects are equally as ambiguous as purchase requisitions. Few labs have unwavering daily routines. Although Principal Investigators try to respect human resource allocations as they are reflected in the grant proposal, it is virtually impossible to adhere exactly to the percentage of effort allocated to each lab member in that proposal. In addition, there is really no way for the administrative staff to audit this. As a result, laboratory personnel are on their honor regarding the percentage of effort they devote to a given project. It should be noted that federal auditors representing the United States Public Health Service reserve the right to walk into any NIH funded laboratory and request verification from a researcher that they are giving the appropriate percentage of effort to a given project.²⁸ The Department of Pharmacology maintains all personnel records in the department indefinitely. At this point in time, no personnel records have ever been destroyed. In addition, microfilmed copies of all personnel and payroll records are maintained by Service and Records indefinitely.²⁹

Personal/Professional Records

On the fringe of this discussion lie personal and/or professional records.³⁰ These records generally reside in either the Principal Investigator's office, lab, or home and their form is dependent upon the style of that individual. The quality (i.e. intellectual content) of these records varies extremely depending upon their perceived relationship to future research. Such records may consist of materials from professional societies or committee work, or they may be reflective of a teaching component (e.g. lecture notes, syllabi, and student papers). Preprints, offprints, and reprints, both their own and those of colleagues, are frequently disbursed throughout an investigator's personal papers. Sometimes even those elements of the scientific research process that would normally go unrecorded, such as the formulation of a hypothesis, may be discovered among these files. However, the latter generally only occurs if a Principal Investigator suspects that their research may involve a patent discovery, and, therefore, documents their thoughts for proprietary reasons.³¹ By no means is this an organized process, rather, it may consist of either formal *notes to the file* or more informal notes jotted down in a laboratory notebook. While the consistency and thoroughness of such documentation is dependent upon that individual's habits, for the most part, investigators tend to be more apt to document in detail when a discovery is potentially patentable. Generally, although not necessarily as a rule, investigators recognize that their personal papers, so to speak, are not necessarily their property. However, it is not unusual for these records to leave the academic institution along with the investigator. Minimally, the Investigator will opt to make copies of their records to carry away with

them. Unfortunately, without an established records management and/or archives program, it is extremely difficult to wade through the morass of ownership and accountability issues applicable to these types of records—never mind compliance to any university or federal policies and/or procedures.

Research Results

The dissemination of research results occupies the final stage of naturally occurring documentation. Throughout an investigator's research, this dissemination of information provides a continuous process that refines one's research through informal means, such as telephone conversations and e-mail correspondence, as well as more formal progress reports and publications.³² Interestingly enough, the majority of investigators, as well as research administrators, view the general body of formal publications as their archival record.³³ However, published materials on their own do not necessarily accurately reflect the actual sequence of events for a given experiment. They do not specify exactly who was accountable for what research assignments, and do not address such equipment related concerns as design and construction, nor do they indicate funding sources or any policies or procedures governing decision making. More importantly, any setbacks are rarely reported in the formal literature. Published materials only fulfill the investigators' need to communicate their work to their communities and, at the same time, claim any discoveries made as their own.³⁴ Nonetheless, in an attempt to provide the whole picture, so to speak, it should be acknowledged that "while archives may not house the journal and technical report literature, the selection of manuscript and archival sources should complement the body of published material."³⁵

Regulatory Records

Records, such as those mandated by OSHA, are vital for the appropriate regulation of radioactive materials, recombinant DNA, animal/human protocols, biohazardous materials, and the handling of blood borne pathogens. Within the Department of Pharmacology, compliance with OSHA requirements conjures up an interesting issue that affects the efficient expedition of these records. Pharmacology is housed within the University's School of Medicine. However, the department is physically located in a University of Pittsburgh Medical Center (UPMC) facility and, therefore, is obligated to appear to UPMC's OSHA headquarters. To complicate matters further, the department is primarily allied with the School of Medicine because only the University can grant faculty appointments. However, any clinical research conducted in the department must be done under the auspices of UPMC. As a result, some administrative functions that may touch on federally sponsored research projects must be processed through the hospital. Needless to say, this causes some degree of record entanglement.

Research administrators rely on a variety of sources to keep them informed of their requirements for maintaining the records of federally sponsored research projects, whether they are grants or contracts. For the most part, administrators look to those regulations outlined by the National Institutes of Health (NIH) as a general guideline. At the same time, there are several services available such as Washington FAXTM, which

consists of former Washington reporters who specialized in the life science area. These individuals report on congressional hearings and prowl the agencies and then condense this information into a weekly fax sheet. In addition, there is the *Federal Grants Management Handbook*, produced by the Grants Management Advisory Service, and the *Guide to Record Retention Requirements in the Code of the Federal Regulations* published by the Office of the Federal Register. However, the latter has been found to possess limited usefulness and questionable accuracy. The NIH also administers the NIH GrantLine, which is an electronic information service that includes the *NIH Guide for Grants and Contracts*, NIH extramural program guidelines, and organizational listings from the NIH Telephone Directory. Administrators also frequently make use of the following professional organizations, which can function as watchdogs: The Society of Research Administrators (SRA), National Council of University Research Administrators (NCURA), the Association of American Universities (AAU), the National Association of State Universities and Land Grant Colleges (NASULGC), and the Council on Governmental Relations (COGR). Finally, several world wide web home pages are beginning to surface, such as the National Institutes of Health's, that may provide guidance to those lost in the ever increasing complexity of grant and contract submission and administration.

Developing Strategies And Contemplating Methods

Given the inconsistent nature of this voluminous body of records, what possible strategies are plausible to improve the scheduling and preservation of these documents? First, records managers and archivists must lobby for the implementation of record keeping standards for scientific documentation. Such standards must incorporate allowances for the diversity of this body of records (ie. exceptions to the rules), yet agree on some basic series elements that must be maintained. Standards need to be explored for the arrangement and description of those records that will eventually be transferred to an archives program. In addition, collaborative scheduling proposals must be explored, in anticipation of dealing with the records of an awardee's collaborators and subcontractors—both of which may be located in other laboratories, departments, institutions, or even countries. However,

...before pressing Universities and other institutions to take care of their scientific archives we should ourselves have a much clearer idea, in terms of space, staff, time and money, of what we are asking them to take on.³⁶

Clarification of what is being asked of academic institutions would have to consider location, staffing, and budgetary considerations. Ideally, records management and archives programs should be kept out of the university's library system and be given their own department and budget. At the University of Pittsburgh, a records management and subsequent archives program to document research activities should be allied somehow with Research Accounting under the auspices of the Controller's Office. This location would afford the program the ability to supplement post-award records, maintained under the jurisdiction of Research Accounting, with previously unscheduled records from the various research departments. The program should then be renamed to

reflect the nature of the program, for example *Office of Intellectual Assets*, a name that is in tune with its mission to manage intellectual resources, risk, and accountability.³⁷

To ensure the effective scheduling of research records at the University, subspecialty programs would have to be developed that would be tailored to fit the nature and type of school in question. For example, a record keeping program developed to document research activities being conducted in the School of Fine Arts would not be entirely applicable to the School of Medicine. Records managers and archivists must seek a middle ground that aspires toward goal integration between the nature of the records produced by each school within the University and the needs of the Records Management and Archives Program.³⁸

Once standards are in place, one of the more effective strategies would be to encourage the federal government, working together with academic institutions, to either impose or empower the university to introduce incentives to meet record keeping practices. Such incentives could take the form of programs designed to teach good record keeping practices to doctoral students that could be incorporated into a department's or school's seminar program. In addition, programs should also be developed to target the investigators themselves, as well as support staff. Another strategy could be to implement audits carried out by and/or fines given by the federal agency, that would either be deducted from the current year's award monies or withheld from the subsequent year's award. Just as there are penalties for financial mismanagement, so should there be for records mismanagement. If audits prove that the situation is chronic, then punishment is non-renewal; after all, these are taxpayer dollars.

If fines are to be considered as penalties for ignoring record keeping standards, then methods for auditing these records need to be explored. The following is an example of one method that could be adapted for this purpose. The Department of Pharmacology implemented a program intended to measure a laboratory's compliance with OSHA regulations. First, the department published an internal OSHA manual. The laboratories were then given a predetermined period to read the manual and correct any known violations. Following this initial grace period, the department elected to have a representative from the OSHA office perform a mock audit of each laboratory. A listing of any overlooked OSHA violations was presented to the Principal Investigator of each laboratory along with a summary of fines that would have had to have been paid out of the Principal Investigator's laboratory monies had this been a genuine audit. Needless to say, this approach had the desired effect on most of the laboratories in the department.

Funding agencies need to be more specific in the proposal application packet or in the award statement regarding ownership and anticipated scheduling of records that will result from that award. This statement would need to delineate responsibility for the scheduling and retention of research-related records, as well as those of administrative, fiscal, and legal practices. Increasingly there is a demand for guidance from the federal government in navigating the changing nature of grants and contract administration. Research administrators, as well as investigators and one hopes records managers and archivists, are aware that:

One of the results of the complexity in federal assistance management has been a tendency toward decentralization and devolution of authority. A primary example in the area of grant administration has been a marked shift in emphasis over the past 15 years from transaction control to systems oversight and from central to local responsibility. Where the federal government maintained centralized control of decisions affecting financial accountability through line item budgets, agency approvals, and detailed fiscal reporting, such control has given way to more local autonomy in decision-making and to systems oversight.³⁹

Decentralization of authority increases the pressure on academic institutions to assume responsibility for the preservation of sponsored research records.

The final report of the Joint Committee on Archives of Science and Technology (JCAST) specified that the ideal situation would be for research records to remain with the academic institution to which they were awarded. However, the report also suggests that if there is not a records management and archives program in place at that institution to oversee the disposition of these records, then custody should revert to the awarding agency upon completion of the project.⁴⁰ This is not necessarily a reasonable solution. Instead, federal agencies should consider withholding grant monies from institutions that refuse to comply with retention regulations. Of course this is contingent upon these agencies specifying—clearly—what those regulations are. Records pertaining to contract research, because they are clearly under the jurisdiction of the federal government, would be the responsibility of the awarding agency and, therefore, handled differently.

It is unlikely that the awarding agency will earmark additional funds for records retention. Expenses incurred from the maintenance of research records should be the responsibility of the academic institution. If the schools within that academic institution want to obtain a certain caliber of researcher, they offer salaries that are attractive to these individuals. Ergo, the institution should not begrudge the funds necessary for preserving the records of these prized researchers. This would ensure that the records remain at the institution, thereby enhancing the prestige of that institution's research collections.

In the end, if an institution is unable or unwilling to maintain these records, and the federal government does not choose to acquire them, the option of transferring them to a discipline-based history center or petitioning other organizations to create a specialized data-gathering archives may provide a solution. The latter should only be pursued as a last resort for those records documenting a pioneer endeavor or a particularly controversial form of research.⁴¹ Data-gathering archives tend to only glean easily accessible information, omitting valuable administrative and other contextual records. Frequently these materials are gathered without respect for their provenance: order is manufactured as materials are accumulated. Discipline-based history centers would be the ideal alternative solution. Existing centers, such as the American Institute of Physics (AIP), can provide leadership and advice on how to get programs started.⁴²

Conclusions

Perhaps the most pressing recommendation that needs to be made for improving managed access to scientific research records concerns the development of electronic record keeping systems that would have the ability to glean metadata regarding the identification, capture, maintenance, and use of research records and manufacture audit trails. E-mail is already becoming the preferred method of correspondence among researchers and administrators. Furthermore, the data accumulated by scientific research is generally maintained electronically and the use of electronic lab notebooks, particularly in pharmaceutical research environments, is becoming the preferred method of recording research results.⁴³ In addition, by the end of this century, the means by which federally sponsored research projects are administered will be changing dramatically. The National Institutes of Health are currently in the process of developing the Electronic Grant Application Development (EGAD) project, a process for enabling the electronic submittal of grant and contract applications. Moreover, academic institutions are seeking ways to streamline administrative functions through electronic means. The University of Pittsburgh has recently contracted with Oracle to develop a system to bring the requisitioning and purchasing functions at the university online, as well as to enable electronic monitoring of committed or encumbered budgetary monies—all of which is aimed at paperwork reduction. However, electronic record keeping only compounds the problem rather than offering a solution. As has already been shown, the archives and records management professions are not doing particularly well with paper records, so how can they really do much better with electronic record keeping systems?

Perhaps the fundamental question plaguing the struggle to document contemporary research science is: *how do you control knowledge that is fractured, frustrating, protracted, and vague?* Every researcher stands on the shoulders of their predecessors, thereby adding to the ever widening body of scientific knowledge. As this base of knowledge expands, increasingly specialized disciplines evolve. Accordingly, the individuals and methods employed by records management and archives programs need to begin to reflect this diversification.

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NOTES

1. Grants are defined as "an award given for a sponsored program that contains a broad scope of work defined by the Project Director..." and contracts are defined as "an award given for a sponsored program that contains a scope of work that is specified by the Sponsor." Office of Budget & Administration, "Sponsored Projects," *Policy and Procedure* (Pittsburgh, PA: University of Pittsburgh, January 15, 1988), p. 8; "...grants are given to those perceived to be most able to make a significant contribution to the body of knowledge, and contracts are awarded to those most capable of producing the desired results at the most reasonable cost." Joan K. Haas, Helen Willa Samuels, and Barbara Trippel Simmons, *Appraising the Records of Modern Technology: A Guide* (Cambridge: Massachusetts Institute of Technology, 1985), p. 27.
2. Important records, in this context, are those records that are evidence of either a research related or administrative transaction (i.e. information sent or received in the conduct of an official activity or communicated to a person or database as part of such an activity). Evidence is the result of a record's data, structure, and context.
3. Helen Willa Samuels, *Varsity Letters* (Metuchen, N.J.: Scarecrow Press, 1992), p. 110.
4. Ibid. p.114; Bruce V. Lewenstein, "Preserving Data About the Knowledge Creation Process: Developing an Archive on the Cold Fusion Controversy," *Knowledge: Creation, Diffusion, Utilization* 13 (September 1991): 302.
5. Helen W. Samuels, "Documenting Modern Chemistry: The Historical Task of the Archivist," chap. in *Chemical Sciences in the Modern World*, ed. Seymour H. Mauskopf (Philadelphia: University of Pennsylvania Press, 1993), p. 242.
6. Joan N. Warnow, with Allan Needell, Spencer R. Weart and Jane Wolff, *A Study of Preservation of Documents at Department of Energy Laboratories* (New York: American Institute of Physics, January 1992), p. 14.
7. Ideally, one would want to preserve "...a selection of the data, perhaps less than 1% overall, that will attract scholarly scrutiny by helping to document representative research or major links in the chain of scientific progress." Clark A. Elliot, 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: Distributed by the Society of American Archivists, 1983), p. 35.
8. Ultimately, because funding is awarded to the institution, not the investigator, these records are the property of the recipient institution.
9. "When scientific ideas are discussed without reference to the concrete technical problems against which they were forged, what results is a decidedly misleading notion of the way in which scientific theories develop and impinge on their extra scientific environment." Thomas S. Kuhn, "Relations Between History and History of Science," *Daedalus* 100 (Spring 1971): 276-78, quoted in Clark A. Elliot, "Experimental Data as a Source for the History of Science," *American Archivist* 37 (January 1974): 28.
10. Allen B. Wagner, "Unique Ownership Issues in Biomedical Research," *Research Management Review* 2 (Spring 1988): 5.
11. Haas et al., 30.
12. A non-competing renewal indicates that the investigator has already been awarded the funding, but still must submit a revised annual budget and update any procedural or staff changes.
13. Competing renewals are not automatically funded, rather they are treated in the same manner as new project proposals.
14. John Spink, "A Scientist's Appraisal of Laboratory Records or 'Tribophysics in Transition,'" *Archives and Manuscripts: The Journal of the Australian Society of Archivists* 15 (May 1987): 14.
15. "Unintelligible experimental research data... should, of course, never be accessioned except in small quantities when they constitute a species of memorabilia." Paul Lewinson, "Toward Accessioning Standards: Research Records," *American Archivist* 23 (July 1960): 305; Elliot, "Experimental Data," 29.
16. Chauncey D. Leake, "Responsibility for Science Archives," *ISIS* 53 (1962): 145.
17. Maynard J. Brichford, *Scientific and Technological Documentation: Archival Evaluation and Processing of university Records Relating to Science and Technology* (Urbana-Champaign, IL: University of Illinois, 1969), p. 17; Elliot, *Understanding Progress as Process*, 60; Spink, 11.

18. "...fiscal value is closely related to legal value in that many fiscal records are retained for purposes of compliance..." Schwartz, 77; Elliot, *Understanding Progress as Process*, 32.
19. Animal and/or human protocols outline *specifically* what procedure(s), surgical or otherwise, that will be carried out on what specific type of animal, or, in the case of humans, it outlines the criteria for selection and specifically what procedures will be performed.
20. "...the decisive factor in determining the length of record retention for federal awards is the identification of the award as a grant or contract." For federal grants, "records shall be retained for three years from the date the final expenditure report is filed" and for federal contracts "records shall be retained for three years from the date final payment is made... If any audit commences prior to the expiration of the above periods, the records shall be retained until the completion of the audit and resolution of any audit findings." Office of Budget & Administration, 43.
21. Research Accounting is ultimately responsible for records retention of all sponsored projects. Records of the current fiscal year are maintained on campus, while records of previous years are housed in a remote storage facility.
22. Despite its name, the UPMC is not a part of the University. It is an entirely separate institution.
23. A subcontract refers to a situation where an investigator is contracted by the primary awardee of the sponsored research monies to perform a specific component of the overall research.
24. Joan Warnow-Blewett "Historical Documentation Research," *Chemical Sciences in the Modern World*, ed. Seymour H. Mauskopf (Philadelphia: University of Pennsylvania Press, 1993), p. 257.
25. The length of time that these records are maintained within the department is entirely dependent upon available storage space.
26. Records for the current fiscal year are maintained on campus, preceding years are transferred by Central Business Services to a remote storage facility.
27. The University of Pittsburgh regards any equipment valued over \$2000 with a life span of two years or more as capital equipment.
28. USPHS is the umbrella agency overseeing the NIH. Because NSF funding is also *technically* federal monies, they too reserve the right to audit investigators.
29. Only those records for the current fiscal year are maintained on campus, previous years are transferred by Central Business Services to a remote storage facility.
30. "While some records can easily be classed as 'official' and others as 'personal,' there is a gray area which we can call 'professional' files. For some DOE scientists, for example those whose impact on science policy extends to a national or international level, these professional files are extremely valuable." Joan N. Warnow et al., *A Study of Preservation Documents*, 6.
31. It should be noted that oral histories can also be obtained as a means of capturing the motivations behind a given research project.
32. "Unlike many of the written records of the laboratory, informal discussion provide material which has neither been corrected nor formalized." Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Princeton, NJ: Princeton University Press, 1986), 168.
33. Elliot, *Understanding Progress as Process*, p. 26; Helen W. Samuels, "Sci-Tech Archives and Manuscripts: An Overview," *Science & Technology Libraries* 9 (Summer 1989): 4.
34. Haas, et al., 69-76.
35. Samuels, "Sci-Tech Archives," 5.
36. Roger H. Ellis, "The Historical Manuscripts of Science and Technology," *Journal of the Society of Archivists* 4 (October 1970): 93.
37. Patents are viewed as *intellectual property* that is governed by the Office of Intellectual Property. So it stands to reason that, if research records are to be considered *intellectual assets*, they should be maintained by the Office of Intellectual Assets.
38. Howard L. Smith and Wanet C. Tuttle, "Managing Research Scientists: Problems, Solutions, and an Agenda for Research," *Journal of the Society of Research Administrators* 20 (Summer 1988): 147-148.
39. William S. Kirby, "Toward a Model Policy for Federally Supported Research," *Journal of the Society of Research Administrators* 21 (Spring 1990): 8.
40. Elliot, *Understanding Progress as Process*, 46.
41. Lewenstein, 80.

42. Refer to Larry J. Hackman and Joan Warnow-Blewett, "The Documentation Strategy Process: a Model and a Case Study," *American Archivist* 50 (Winter 1987), 12–47 for an in depth discussion on establishing a documentation strategy followed by a case study on the development of the AIP initial documentation strategy. In addition, consult Helen Willa Samuels, "Who Controls the Past," *American Archivist* 49 (Spring 1986), 109–124 for further information of documentation strategies.
43. For perhaps the most thoughtful and carefully laid out strategy for implementation of an electronic record keeping system for the pharmaceutical industry, refer to: Ulf Andersson. SESAM: Philosophy and Rules Concerning Electronic Archives and Authenticity. (ASTRA: Sweden, February 28, 1996). <http://www.sils.umich.edu/e-recs/Sesam>.

