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Ambiguity and legitimate peripheral participation in the creation of scientific documents

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Abstract

Purpose – The purpose of this paper is to report on a qualitative study of data management and recordkeeping in the research sciences and their roles in information creation and professional identity formation.

Design/methodology/approach – The study uses ethnographic fieldwork data in an academic laboratory to examine documentation practices as a part of the trajectory of scientific professionalization. The article examines ethnographic fieldnotes and medical records as cognate areas that provide insight into the topic.

Findings – The paper argues that scientific recordkeeping is essential for learning to balance professional standards and personal knowledge, establishing comfort with ambiguity, and can be a process marked by ritual, anxiety, and affect. The article does this by discussing the creation of record from data, tacit knowledge as part of that process, and the process of legitimate peripheral participation (LPP).

Research limitations/implications – The qualitative nature of the study suggests the need for similar studies in other environments.

Originality/value – The article emphasizes recordkeeping as a part of documentation studies by taking an interdisciplinary, ethnographic approach that is still emergent in information studies. The article is written primarily for fellow researchers.

Keywords Records management, Ethnography, Knowledge creation, Professional education

Paper type Research paper

Introduction

Studies of information behavior have generally given short shrift to the creation of information. As Trace (2007) points out, information creation focuses on the processes by which people create information and the context in which they do. Attention to these processes can only enrich the information profession and discipline, as well as those areas of information behavior that have been traditional foci of research and practice: seeking, organizing, and use. Interest in the practices of documentation and their contexts has found resurgent interest in information studies (Buckland, 2007)

One arena in which the study of documentation is particularly intriguing is research science. The inscriptions of science – data and records, for starters – should be regarded as one of the key repositories and sources of power, knowledge, and enrollment, by which actors recruit others to their own interpretations (Latour and Woolgar, 1986; Latour, 1987). Most of the sociological work in this arena looks at data and records as external sources of memory, and the power that memory confers upon the scientist. Still other studies, in information science and other disciplines, consider the contributions of information and communication technologies to the

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professionalization process. As Frohmann (2007) as noted, there has been extensive research on the nature and role of documents as constitutive forces in the development of epistemic communities (Knorr-Cetina, 1999) and scientific knowledge. Similar studies have shown how institutional, professional, and personal identities are also constructed through documentary practices (Bowker and Star, 1999; Lamb and Davidson, 2005).

However, while much of the focus of sociotechnical studies of documents has been on published documents, the primary and perhaps most prolific form of scientific documentation is the daily laboratory record. This is the log of research kept by researchers and other technical staff in performing their research duties. For the sake of completeness, these research notes must be clear, complete, signed by the author, witnessed by another member of the group, and legible. The notes should be dated and kept in date order. While the maintenance of such records is mandatory for all experimental scientists, it has been noted by many teachers of recordkeeping practice that most budding scientists are left to their own devices to learn recordkeeping (Macrina, 1995; Kanare, 1985; *inter alios*).

The assumption seems to be that scientists will always understand the importance of the lab notebook and thus will always create the most reliable records in that notebook, even though such understanding is usually acquired passively. Instead, research suggests that learning to create reliable records in any institutional or disciplinary setting is a form of craft knowledge in which members of a community participate through learning what seem like low-risk and minute activities – what Lave and Wenger have called "legitimate peripheral participation" (Lave and Wenger, 1991). In the scientific setting, I suggest that researchers learn to create scientific knowledge in ways that are acceptable and useful to the larger community through legitimate peripheral participation – the creation of their own laboratory records.

This account of documentary practices in the science laboratory draws from an ethnographic study that explores how the creation of these primary documents – the daily records of science – socializes new researchers into the discipline and profession of scientific practice, and how that knowledge allows participation and engagement with the craft of research. Themes of ambiguity in the creation of the document and the trajectory of legitimate peripheral participation for new researchers are explored.

Research design

The research design and choice of fieldsite was dictated by pragmatic and theoretical choices. The choice of setting was constrained by appropriate size and membership (too small, and the identity of members would be too obvious; too large, and there was often no physical room for me). I chose to work in an academic laboratory, where there would be a range of professional experiences, relative ease of access to people and documents, and a spirit of open inquiry. The first step in this study was to learn more about people and practices in the environment in question, and this portion of the study relied heavily upon observation of public behavior. I spent eight months, in 2001 and 2002, in an animal neurobiology laboratory. Most research projects took place entirely within the laboratory, although some students (mostly undergraduate) did research outdoors on regular field trips with the chief of the laboratory. Philip was the director of the laboratory and principal investigator; his postdoctoral researchers, Michael and Susan, were in the early stages of their academic careers. There were also several

graduate students and undergraduate researchers doing research rotations. More reflections on research design, can be found in Shankar (2004, 2007).

Although researchers often collected data from digital instruments, researchers chose most often to cut and paste these results into paper notebooks. Each researcher kept his/her data files and laboratory notebooks close at hand, although notebooks and files of students and postdoctoral researchers who had left the group were stored on open shelves. At the time of this study, there were no collaborative notebooks or files, as each researcher was working on a discrete project. One postdoc, Susan, did use some of the files generated by a researcher who had left the laboratory.

The results of the study are of course reflective of the research method and the population under study, and thus I include some caveats. This particular group under study did not use specialized data archives or data collection tools beyond word processing and spreadsheet software, which would have changed the nature of the study and interactions with recordkeeping technologies. Secondly, because many of the scientists were professionally junior, it proved to be particularly fruitful to focus on the development of craft knowledge.

The observation phase, as I had suspected might happen before entering the setting, did not generate much data about the record keeping practice itself, apart from some rudimentary knowledge about what kind of materials are used for writing records, where they are stored, and how they are used. However, what this phase did do was lay the groundwork for understanding the academic and social interactions that characterize the particular group under study.

Based on my initial observations, the next step was to generate in-depth interview questions that I administered in an extended interview format to members of the laboratory who were willing to speak to me. All five regular members of the laboratory (as opposed to several students who were in the laboratory for one university term or less) were willing to talk with me, and interviews lasted approximately two hours with each member. The interviews delved more closely into the scientists' motivations for their behavior and their personal practices. During the interviews, I asked my respondents to show me their records and explain how they created and used them. Primarily, the purpose of these interviews was to understand how the individuals in the group perceive and explain their own behaviors, how their own record keeping practices have evolved, and how they think about their relationships to the other members of their group and their profession. I also asked them about previous training, their relationships with mentors in science, and their use of various information technologies.

By using observations and interviews, I obtained a rich picture of the significance that the scientists themselves ascribe to their behaviors, and verified my own insights with those of my respondents. Marshall and Rossman note that "combined with observation, interviews allow the researcher to check description against fact" (Marshall and Rossman, 1989). The second means was to obtain, with the permission of the scientists I worked with, examples of documents from the lab. I copied portions of documents both of current researchers and ones from the past who had worked in the lab as students or as postdoctoral fellows. Analyzing documents for form, structure, function, and pattern, in conjunction with interviews about the records I examined, surfaced more concrete connections between the production of texts and the production of work. I used textual analysis in concert with observations and interview to integrate multiple sources of information.

My observation and interviews suggested documents that I should be examining, and with the permission of the principle investigator and the records creators, I collected examples of lab notebooks, data files, and other records. I searched for themes in the structure and content of the records themselves, with respect to standardized record forms, notebooks, and practices. I used open coding and analytical memoing (Emerson *et al.*, 1995) to integrate the interview and documentary analysis data and expand upon them.

Open coding was used to analyze fieldnotes and all interview transcripts. I also wrote summaries of the external documents, primarily copies of data files and laboratory notebooks that I had collected, and coded them as well. Once these were constructed, I shared them with the respondents for member checking. Only one responded with changes, and I incorporated these suggestions.

Literature review

Assuming (or acquiring) an identity – whether it is professional, racial, cultural, or other – is embedded in one's multiplicity of relationships with others (Turkle, 1997). The ways in which people create identity in organizational settings in particular have been the work of many researchers concerned with work practices and the role of information and communication technologies. Ranging from the "organization man" of Whyte (1955) through the erosion of group identity in recent years (Putnam, 2001), the trend towards professionalizing everyone has been a common theme in the sociology of work (Wilensky, 1980). Abbott (1988) sees professionalization as an important structuring force in society since a professional identity carries with implications for conferring power, autonomy, status, and gatekeeping. Lave and Wenger (1991) and Wenger (1998) have suggested that these practices are learned in what they term "communities of practice", which share characteristics of form, function, and, most importantly for documentary practices, a shared repertoire of resources that members agree upon over time.

Although that shared repertoire goes well beyond technical skills, it does include the development and use of information technology and tools. The integration of technologies (networked or otherwise) into the workplace has, not surprisingly, reconfigured the very nature of professions and the character of the work they do. Researchers have sought to examine the system of professions through microstudies (Walsham, 1998), focusing on the relationship with artifacts that are created by and as part of the work. Artifacts, including documents and information and communication technologies (ICTs) are somewhat easier to study than conversations – they stay put (relatively speaking) and are as amenable to multiple kinds of textual and interpretive analysis as other forms of practice and text (Lynch, 1985; Klein, 2001). Two disciplines where records have been important to the professionalization of the field include ethnography and medicine. While these two disciplines are very different in their societal roles and respective paths to professionalization, the genres of primary records they create and use have been important to constructing those roles and paths.

Ethnographers and fieldnotes

The history of ethnography as a method parallels the professionalization of anthropology, and the creation of ethnographic texts has been extensively documented. Bronislaw Malinowski's construction of the "professional stranger" and

his disciplined process of taking notes have been cited as an integral move towards the credentialing of anthropological fieldworkers (Agar, 1996). Franz Boas, who devoted much of the last half of his life to the furthering of anthropology as a formal profession, was in favor of creating a scholarly society that would exclude the "interested" amateur and support the publication of ethnographic monographs. Both, he wrote, would improve the rational organization of American science and the scientific merit of anthropology as a discipline (Boas, 1902, quoted in Stocking, 1960). Boas felt that this move would further demarcate ethnographic study, in which the observer describes theoretically grounded and replicable descriptions of social life, from the amateur's "travel narratives".

While there has been quite a bit of literature reflecting on the finished ethnographer's texts and how they reflect and shape the ethnographer's identity as a fieldworker (Coffey, 1999), there has been less reflection on fieldnotes as text and process. There is often a taken-for-granted quality to fieldnotes. The process of writing fieldnotes is seldom discussed as part of pedagogy (Emerson *et al.*, 1995), notes themselves are seldom, if ever, shared among fieldworkers, and there is even less discussion of issues of ownership and data as intellectual property. Jean E. Jackson, in her study of anthropologists and their attitudes towards their fieldnotes, broadly calls them a "kind of literary genre, capable of being compared to other kinds of writing" (Jackson, 1990). Some of her respondents referred to fieldnotes as an interstitial place between "reality and a finished piece of writing" (Jackson, 1990). Emerson *et al.* (1995), in their guide to the writing of fieldnotes, cite a recent inventory by Sanjek in which ethnographers talked about many different kinds of fieldnotes, such as "headnotes" (i.e. the fieldworker's memory), "scratch notes", "fieldnotes proper", "fieldnote records", "journals", "diaries", "texts", and "letters, reports, papers". Researchers seem to write formal fieldnotes in very different ways – as logs at the end of each day in the field, topically organized essays, elaborate records, or less detailed accounts that are filled in upon leaving the field. Many researchers thus see the fieldnote as a personal and highly idiosyncratic documentary forum, so much that they feel the process cannot be taught to new ethnographers.

In the ethnographic community, one could surmise that many ethnographers hold that the highly personal, idiosyncratic nature of fieldnotes precludes the discussion of fieldnotes technique (with some notable exceptions) with student trainees or perhaps fellow ethnographers. Some anthropologists that Jackson interviewed, for example, said that they themselves had never been taught how to keep fieldnotes and defining a procedure or rubric for their students would be tantamount to imposing their own philosophical views as gospel upon their students (Jackson, 1990).

Although there is much more that can be written about ethnography and the fieldnotes, I intend this brief discussion to be just an introduction to a particular set of perspectives on the creation of documents and professional identity. Historically, the move away from art and towards science was often articulated as the need for replicable research, best expressed or proven through genres of texts, particularly the ethnographic monograph or scholarly article. However, when discussions surface, they are often part of a period of reflexivity and interpretation in the discipline. Interestingly, there is no discussion of how fieldnotes are related to ethnographic accountability to one's colleagues, respondents, or the profession, although these issues are peripherally addressed.

Medicine and the patient record

The medical profession and its relationship to "the record" are at the other end of a spectrum of normative form and practice. Patient records are highly structured, legally mandated documentary forms that illustrate the power of the record and recordkeeper. Nevertheless, constructing the narrative form is a learned process. Berg (1997a) in his summary of post World War II history of medicine argues that many different formal tools – the decision support systems that make medical practice look replicable and thus scientific – came out of these narratives.

The formalization of the medical chart or the patient record is only one example of this move of medicine from craft to science. But creating, maintaining, and reading it are learned and taught explicitly. Because the chart is multi-authored and is an acquired skill, it mirrors the hierarchy of medical learning and professionalization (Weiss, 1997). Medical records have also been constructed, particularly in the move towards digitizing them, to minimize certain kinds of conflict that could reflect badly in lawsuits and insurance claims (Weiss, 1997) and to maintain the authority of doctors over nurses who are responsible for much of the medical work that is performed in hospitals (Ngin, 2001; Bowker and Berg, 1997). In Weiss's ethnographic study of recordkeeping by doctors and Ngin's study of nurses, both acknowledge their respondents' acceptance of the medical record as one source of their authority and power. The "scientific" knowledge captured within it is transmuted by the structure and form of the record into a rationalized narrative. As much as environment constitutes systems of recordkeeping and its practices, the uses to which systems are put are also responsible for shaping the environment. In other words, records create context as much as they are products of context. Bowler (1995) provides another example of the power of records and forms to construct difference in authority and expertise. In a study of intake forms and maternity care of south Asian women in a British hospital, Bowler found that the "closed nature" of questions on the standard medical intake forms generated inaccurate and incomplete answers. For example, when the form asked for a "country of origin", the health worker would write down "Indian" even though many of the women were British (though of Indian ethnicity). The different standards and expectations of the health care worker and the patient obscured the "motivational transparency" of the recordkeeping process, but the structure of the records themselves and their contributions to negative results never came up during the course of the study. It could be argued, although Bowler does not go that far, that the structure of the interactional document structured the relationship as much as the speech that was exchanged did.

Professional identity and scientific information

The laboratory record occupies an intermediate position between the ethnographers' fieldnotes and the medical record in terms of accountability and standardization. In science, the trail of discovery and scientific integrity is predicated upon the maintenance of written records that detail the mental and physical activities of the researcher (Holmes, 1990). Generally, the bound, paginated laboratory notebook in which a researcher records the methods, results, and other pertinent information related to the daily conduct of research constitutes the most basic document generated by a scientist. The replicability of research results from the ability of one researcher to continue building upon or refuting the results of another.

Unlike the ethnographic fieldnote, which many ethnographers seem to consider so individualized as to defy prescription, the laboratory notebook structure (if not content) seems to be considered so prescribed, there exists little need for explicit teaching (Macrina, 1995). And yet, there are some voices within both communities that articulate a need for formal training and some level of standardization so that "good" notes are produced. And unlike the medical record, legal standards for the maintenance of scientific records are inchoate and relatively unimportant to the daily maintenance of them.

But there has been little acknowledgement of the multiple and often conflicting roles played by scientific notes and data. In an article on recordkeeping in the sciences, Rayl (1991) quotes a neurophysiologist who tells him, "The primary reason for keeping good notes is scientific, and being able to prove what you've done, actually, should be secondary." While this quote seems self-evident, it suggests perhaps that scientists, or at least some who have written about it, see the laboratory notebook as an objective record that properly does not and should not reflect the individual scientist's subjectivities. And yet, Macrina notes that recordkeeping is an individual process that evolves during the working life of the scientist and that there is no prescription for taking proper notes.

Similar to the world of medical records, data ownership and intellectual property worries are prevalent in science where the products of research are commodities. The artifacts of science, including the data and records, are assets to the institution that produces them. This development has been decried as antithetical to the spirit of open communication and inquiry (Macrina, 1995, p. 46). The issues of property, ownership, evidentiary value, and control over data are still not clear-cut issues, which suggest conflicted roles for the laboratory record as commodity and "recorded truth". Perhaps the problem is, as Macrina opines, "when even fundamental expectations about scientific recordkeeping are not communicated, there is little hope for appreciation of the related deeper issues". In short, data and records are instantiations and exemplars of what Geoffrey Bowker (2006) terms "memory practices": the toolset and infrastructure by which people and institutions remember (and forget).

Although the emphasis of this article is on the creation of paper records, for reasons noted in the research design (namely, minimal emphasis on digital data collection and capture for the particular field site in question), digital tools for generating and analyzing data are standard techniques employed across the scientific disciplines and provide another useful entree into understanding how documentary practices are learned and used. In what Palmer (2005) terms the "cycle of scholarly communication", scientists are both consumers of and contributors to digital data repositories and collections. Scientists using these technologies argue that they enable the next generation of scientists, most of whom are familiar with using information technology for other purposes, to become comfortable with the integration of computation into science (Burrage *et al.*, 2006; Sarini *et al.*, 2004). Covi (2000) has argued that graduate students are often instrumental in introducing novel practices into research science. Electronic notebooks are still not widespread in the academic science laboratory for a number of reasons, including concerns for licensing and ownership of the software, a lack of sustainable solutions for long-term maintenance, and lack of integration with flexible workflow (Taylor, 2006).

Findings

Crafting recordness

Representing "reality", for the scientist, requires representing the objects of his/her study and the conditions under which that object has been manipulated. Philip's laboratory focuses on animal, auditory structures and processes, and in some cases, the context in which these animals are heard – the jungle or desert. The objects of study in Philip's lab are simultaneously visible and concrete – such as frogs, their middle ears, and nerves – and invisible and intangible – concepts called vibrational velocities and the unique calls of frogs in the wild. The "result" of the experiments and observations are both directly seen (the structure of the frog's middle ear in the microscope) and not seen (the wavy line produced on the oscilloscope that reflects how vibration affects the middle ear, but is not a "vibration" itself). How do the members of the lab grapple with the messiness of the material world and document it? The records these scientists create to explain and document phenomena rest in an intermediate space between the material world that is perceived through the senses and the scientific "fact" recorded in the publication.

Students and junior scientists interviewed for this study commented that making this translation is not often discussed but is an essential act of their learning to "be scientists". They are given guidelines and some structure in the form of scientific publications, textbooks, and professors who lay out a set of standards to which individual scientists are expected to adhere, but that an individual scientist must still find a way to make his/her documentary practices fit the specifics of local and personal accounting. This work of making this translation happen confers freedom as long as one remains within the bounds of professional responsibility. In short, the record becomes yet another entity that must be controlled, explained, and ultimately, managed.

Numerous sociologists of science have shown that because many of the objects of scientific research are invisible (atoms, DNA, microbes), it is not the objects per se which are (or can be) studied directly, but the visual traces they leave behind in the form of tracks on plates, autoradiographs, and stains on gels (Latour and Woolgar, 1986; Amann and Knorr Cetina, 1988). The researcher must then employ a system of human readable symbols to "fix" or freeze those visual traces of material reality at chosen moments in time. Moreover, it is not sufficient for him/her to do this once – the experiment, and the way in which it is recorded, must be made replicable by the practice of recording specific conditions in a reusable document. The process by which the record is created must be continually refined so that the scientist produces a record that is understandable by him/her for the duration of the project, and potentially for many years hence if others read the record. The scientist learns to accomplish these goals successfully through classroom learning, socialization to professional practice through participation in research projects, but most of all, through trial and error and the development of a personal style of recording.

The record appears to occupy a transitional state between the capture of instrumental data and physical observations and the formalized narrative represented by a publication of some form. One feels that one can recognize at a glance the differences between data, record, and formal paper, but when one actually becomes the other can be surprisingly blurry. We can argue that the record is actually somewhere between the data and formal paper – but where? The final paper is of course released into the world to stand on its own merits. If the validity of the formal paper is

questioned, however, one must delve into the "records" to re-create the argument and ascertain its validity, or lack thereof.

Even the raw data may be called into question – but the scientists argue that those data sets are not records. They are generally not interpretable unless one has the more structured accompanying documents and formal papers at hand to make sense of the plethora of numbers found in most data sets. Each succeeding layer of annotation, augmentation, deletion, and imposed structure adds "recordness" to the raw data, increasing the amount of tacit knowledge it represents (Botticelli, 2000). Introducing this kind of formalism introduces tension – the record remains a reflection of one's personal choices even while it evolves to conform to the professional norms of "good" scientific recordkeeping.

"Good recordkeeping" in the science laboratory and its reflection of personal preferences versus readability by others rests somewhere on the continuum of the documentation practices of the ethnographer and the structure of the medical records (where "personal preferences" and individual need for documentation are still problematic *vis-à-vis* the formal structure, where one may not serve the other (Harper *et al.*, 1997). In the medical arena, training in recordkeeping is one way in which these tensions are managed. I asked several of the members of the laboratory if they had received any formal training or participated in discussion on these issues in their own discipline. Susan said that in a scientific ethics class they had taken as doctoral students, the topics of what constituted "good" records and records ownership were brought up, but in a somewhat perfunctory way. Michael, however, who had received his doctorate in another country, noted that he had been given no information on the subject of records retention or recordkeeping, which he felt was particularly problematic as he had come from a country where science was not funded or managed in the same way as in the USA. In his words:

> I only found out, in casual conversation, that I was supposed to leave the lab notes behind when I left the lab. If I'd known that, I would have done everything on computer. As it is, I'll have to photocopy eighteen notebooks to take them with me.

Linking these observations back to the earlier discussion regarding ethnographic and medical records.

Documents and affect

Scientific records, particularly in academic science, occupy a curious niche. On the face of things, they are organizational documents that fulfill the expectations of the scientific community, the immediate laboratory group, the university, and the individual scientist. But in that last role, they are also profoundly personal documents, a diary of learning, expertise, and meaning. They are created by human beings, but act back upon them in complex ways, documenting the interactions and intersections of memory, knowledge, space, and time. But asking more complex questions – how are records created, what meanings ascribed to them by their creators, and how do they interact with those creators- yields, not surprisingly, a more complex set of insights into the role of records as external memory. Complexity also yields ambiguities and tensions. To explain them, I rely on the concept of legitimate peripheral participation (LPP).

According to LPP, learning is not just an individualized practice, but instead a process of membership. In this trajectory, the participant has attained a new and stable

state of being, and is thus expected to behave in accordance with certain norms and ethical standards. These states are marked by symbol and ritual, and can be quite dramatic in their presentation to the world. A scientist transitioning from one stage of learning to the next goes through a marked set of rites of passage. Each of these introduces the scientist to the norms of his/her profession, socializes him/her, and makes him/her a greater part of the system, but the intermediate state of learning is transitional. In the new state, as a doctoral student, postdoctoral fellow, or professor, the scientist does not stay in his/her new state, but instead faces new expectations and new anxieties (Delamont and Atkinson, 2001).

For the scientist, the act of engagement with the record is not just a mental ritual. It is also physical, in that the act of recordkeeping engages the body. It is in the engagement of the body, and the record's physical manifestation as document, that the ritual of scientific work is captured and established and knowledge created. The act of sitting down every day and "writing up" the previous day's data, reduced to essential elements, in a form that can be comprehended by others or oneself at a later date is a ritual for many scientists. It is through engagement in creating a singular record from disparate data sources that the scientist connects his/her work with the norms of the larger scientific society – by putting dates, times, graphs, and charts of data into a hardbound laboratory notebook or a computer file the scientist becomes part of a larger group because s/he is participating in the rituals that are the norm for the profession. While I have argued that the record is primarily crafted to establish for oneself that one's ideas and experiments are conducted in accordance with one's own understanding of scientific method and knowledge, the record is linked by the conventions embedded in it to the larger scientific community. The choice of a lab notebook (or other recordkeeping technology), the time and place one chooses for writing one's notes, and the management of one's personal information sources are marked by ritual processes that give continuity to the personal process of research, connect one to the larger community, and make the learning and socialization processes concrete. The rituals of engagement with objects of scientific study, and documentation of that engagement are marked by emotions – satisfaction in a job well done and for the quantity of unknowns and problems confronted, often frustration at the process.

The ambiguous status of the record is both a resource and a source of contention, mirroring the transitions the junior scientist undergoes. Laboratory notes and data seem to produce a certain amount of ambivalence in those who create and work with them – pride in the creativity of one's system (and even volume of records produced), sadness and conflict at having to leave the original documents behind when moving to a new lab, even anger at the institutional rules of ownership. Scientific journals, websites, and professional newsletters are rife with stories of students or other researchers removing their records from the laboratories of supervisors with whom they have fallen out, or even destroying documents. Discussions with students and more senior investigators suggested that on more informal and less destructive level, many scientists tend to feel a sense of ownership of the documents in their custody, at least while they are still working in that laboratory. As Susan told me, "Yeah, I know [the lab notebooks] belong to the lab, but it will be hard leaving them behind." At the end of my fieldwork, when I asked Michael if I could have copies of his laboratory notebooks when he was finished his research, he said yes, as they did belong to the lab – but that he appreciated being asked.

The mobility of the record, like the anthropologist's fieldnotes, allow it to mediate between places – field and laboratory, the laboratory and home (Jackson, 1990). Records mediate between states of profession as well – the postdoctoral fellow, for example, is not a student, but is not yet accepted as a full-fledged member of the scientific community in the way an assistant professor is. For example, result, a postdoctoral fellow's laboratory supervisor may assume, because the postdoc has finished the formal component of his/her educational experiences, that the postdoc "knows" everything there is to know about the creation and subsequent ownership of records. However, that postdoc may fall through the cracks anyway because his/her education may have taken place in a different context where less emphasis may have been placed on records custodianship.

The "betwixt-and-betweenness" and ambiguity of the record notwithstanding, records must be perceived to be trustworthy and reliable for science to build upon itself. Scientists trust their own records and those of others for different reasons. One's own records can be trusted if one is sure that the research processes that are documented in them are reliable, and of course, if the records are complete and legible and clear. These metrics are not sufficient for trusting the validity of someone else's records. After all, records could be beautifully clear and well-organized, but fraudulent. Knowing the reputation of the laboratory or the individual who wrote a paper, and thus could be expected to have generated the data and records behind it, increases the confidence with which one might approach the records (if one needed to do so).

Discussion and conclusion

Returning to the earlier discussions of ethnographic and medical records, commonalities and differences are surfaced. Although ethnographic fieldnotes and medical records are far apart on multiple spectra of strictness of form, regulation, and ownership, those who analyze them as documents suggest several themes that have been worth exploring in the context of scientific recordkeeping. For one, both literatures suggested that information creation is closely tied to form and function of the record itself, and that learning to create records is not always articulated as an explicit form of professional practice or information creation. Ethical and professional conduct is intimately connected with the technical recordkeeping infrastructure in medical work; it is less clearly so in ethnography. Research science rests somewhere in between. As a result, clashes between accepted practice and personal style, while real and important, are capable of bringing up professional and personal anxieties. The budding scientist, in the process of crafting the record of his/her activity, learns the content and form of the discipline, what is worth remembering and what can be forgotten.

Although it is not evident in the individualized kind of research projects that are the norm in Philip's group, formalization and the sharing of records may have other effects. In the medical recordkeeping arena, as electronic records systems (and even the introduction of new paper-based recordkeeping systems) often privilege one set of actors and make invisible (or at least de-center) the work of others (Berg, 1997a; Ngin, 2001). In ethnography, it can be argued that even the act of documenting the practices of others in a private notebook distances those being studied. Further studies in the laboratory and fieldwork would be required to understand how recordkeeping acts on privilege and power, particularly as electronic recordkeeping systems are introduced.

Through learned processes, recordkeeping becomes disciplinary and professional infrastructure. Infrastructure does not just encompass particular practical tools, but

also the practices and concepts associated with them. The technologies used by Philip's laboratory are fairly standard and straightforward: hardbound notebooks, pens, graph paper, binders, and computers. However, the members of the laboratory use these technologies with particular understandings and rituals. On a mundane level, for example, one is expected to keep notes in pen, because it cannot be altered as readily as pencil can. At a more abstract level, disparate sources of data are integrated through repetition and reduction into a kind of narrative that documents one's daily work. The students interviewed in the focus groups, however, are using new technologies to both document their work and obtain membership in the scientific community. The rituals and understandings have yet to develop, and indeed, are often at odds with those who are charged with inculcating these novices into the profession. The students in the focus groups noted that the technologies that they use to manage the data and information they create on a daily basis vary greatly from those of their mentors, often much to the dismay and displeasure of those mentors. To some extent, these fears could perhaps be attributed to technologies have even more potential to disrupt narrative, or make it too easy to modify it. This needs to be further explored, though these initial results suggest that the use or rejection of particular technologies in the laboratory is also a way of establishing independence from one's mentoring.

The scientist has great leeway in how s/he chooses to create information, a kind of freedom that owes as much to the demands of expediency of the moment as it does to academic freedom and the privileged nature of scientific inquiry to establish its own standards. This is certainly true of the ethnographer as well. In both cases, the ways in which one accomplishes the task of recording one's work are part of a larger scientific system: the laboratory, the institution, the funding agencies, and the public that funds science and thus scrutinizes it. The scientific record, the processes that create it, and the norms that govern those processes, constitute the edifice of scientific memory and the building of scientific careers and discoveries, but do so (in general) behind the scenes. Records do more than create scientific memory – they also inscribe trajectories of experience and history for individual scientists and the laboratory in which they are instituted. In short, the infrastructure of scientific recordkeeping is not just the documents and tools that create records. It is also a set of concepts and rules that include the regulations that govern the disposition of funded project records, institutional practices and rules, and the practices of the scientists that create them and the professional codes under which they operate. Thinking about specific records as boundary objects in an informational infrastructure gives us a second framework to consider ambiguity in recordkeeping. In the laboratory, the record captures the tacit meanings and knowledge of craft inherent in their creation and use. Disciplining this knowledge and creating methods to do so structures the way scientists think about their own records and establishes their jurisdiction over them. The members of the laboratory establish and rank, however unconsciously, the relative importance of the different records within their domain through their use and potential re-use of them. How such records are kept, and where, and why, constitute some other factors that determine the importance and embeddedness of any given records. To the scientists within a laboratory, the records may be just an aide-memoire that captures the daily labor and processes of personal learning. In short, keeping "good" records and "good" data is part of a trajectory of learning where these scientists become part of the core of their profession.

However, these digressions wander far away from the day-to-day concerns of Philip and the members of his laboratory. Not surprisingly, these scientists do not concern themselves on a daily basis with what the funding agencies expects with respect to their recordkeeping practices, and allegations of fraud do not haunt them, and I did not intend to suggest that they should. Instead, what I intended to illustrate was that part of the process of becoming an active research scientist requires that the individual mesh his/her personal ways of working with the modes of work demanded of his profession – work that is rich, embodied, often tacit, and as such often anxiety-producing. Learning to create scientific documentation is an important, often overlooked component of socialization to the scientific profession, and more broadly, suggest that the information sciences need more studies that situate documentary practices in trajectories of learning. McGinn and Roth (1999, p. 229), in their discussion of educational researchers and LPP, write the following, that could just as well be written about science students and their documentation practices:

> To understand and participate in it, they have to adopt current standards of the community in which it exists. On the other hand, they have a stake in the development of the practice so that they can establish their own future identity. This means they have to establish their own ways of doing research, thus transforming the available practices in the research and therefore the entire community.

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