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Material Mastery: How University Researchers Use Digital Libraries for Scholarly Communication

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Information and Computer Science

by

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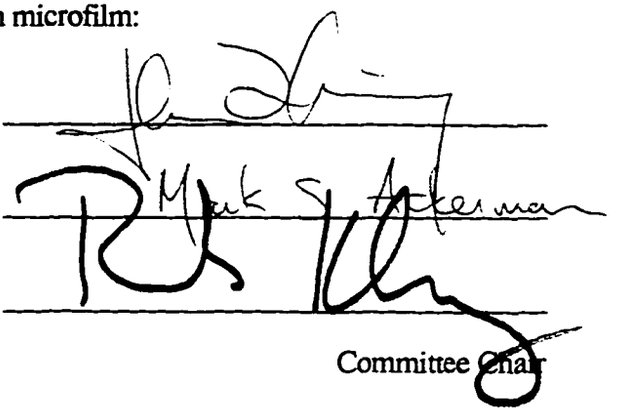

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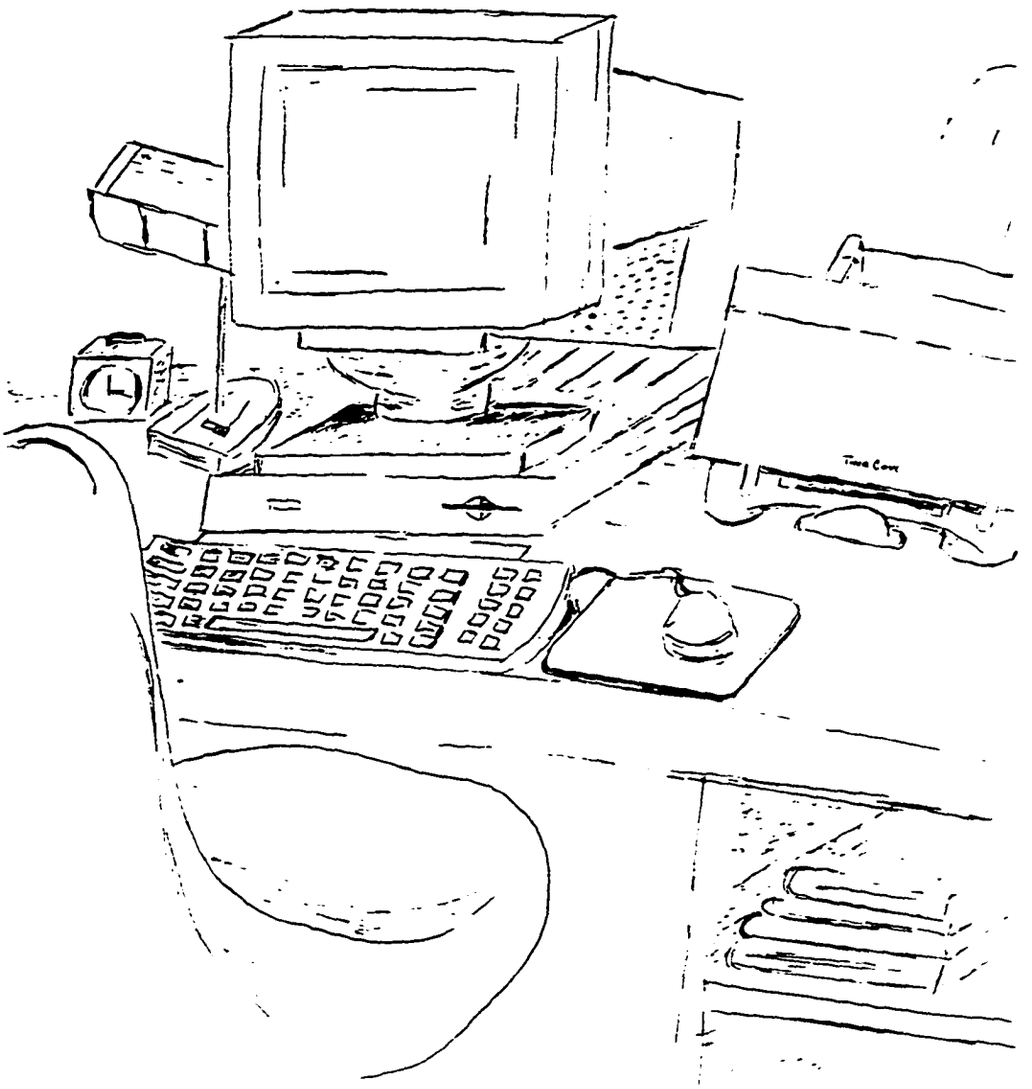

Dedication

In memory of Beverly Ann Covi
who gave me the courage to pursue what would make me happy.

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Abstract of the Dissertation

Material Mastery:
How University Researchers Use Digital Libraries
for Scholarly Communication

by

Lisa Martina Covi
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In the past several years, researchers in library and information science, computer science and management information systems have claimed that knowledge workers will work in new ways due to increased access to internetworked digital libraries. Digital libraries include technologies such as the World Wide Web, shared databases, and bibliographic systems. This study of academic researchers at eight research universities found that the principle of mastery shapes the ways the knowledge workers use both paper and electronic materials. The principle of mastery is the social process by which knowledge workers judge differing "mastery ability" levels according to a "mastery ideal" code of conduct for competency in working with a body of knowledge in specialized work worlds. This study presents data on the principle of mastery in three material use practices; comprehensive searching, browsing and retrieving, and in four research disciplines; molecular biology, sociology, computer science, and literary theory. Mastery ideals differ in each discipline depending on the social processes of work production. Some attributes of mastery ideals

were found: molecular biologists have knowledge of previous and concurrent research projects to make a unique contribution, sociology attain and sustain mastery of bodies of knowledge in multiple subspecialties, computer scientists have a working knowledge of both conference and journal literature in their subspecialties and literary theorists master a particular subgenre of literature and the intellectual discourse about it. The principle of mastery shapes material use practices in the following ways: mastery ability replaces comprehensive searching, mastery ability enables browsing and mastery ability is necessary for retrieving. The principle of mastery helps digital library developers and providers anticipate new ways of working by showing how underlying social processes shape use of both paper and electronic materials.

Chapter 1
Introduction

This study began as an inquiry into what constitutes the "effective use" of digital libraries. I sought accounts from knowledge workers who were highly motivated to make the best use of the resources they had available. I investigated accounts from top researchers at highly ranked U.S. universities who were successful academic professionals with "cutting-edge" access to the latest developments in electronic materials, infrastructure and the means to make use of it. However, as I began to see preliminary patterns in their accounts: literature scholars overwhelmed with the amount of material they try to digest, sociologists without Internet connections and sometimes without private telephone lines in their offices, biologists who spent several hours on the phone each day and computer scientists who rarely visited campus libraries, I began to realize that the findings were not about "effective use" of any one resource such as a bibliographic databases or the World Wide Web. In order to understand how faculty researchers used technological artifacts, I had to look more deeply into what constituted work production in their subspecialty. As I contextualized their use of research materials within the social processes of work production, I discovered what guides their choices of documents, data sets and personal library collections. Aside from individual preference, these researchers all articulated a common theme: in order to participate in the production of research in their specialized work worlds, they needed to evaluate their ability to master materials according to a normative code of competence, a "mastery ideal." This study describes this social process: the principle of mastery. This dissertation describes the principle of mastery in four disciplines and provides evidence of its role in knowledge work production through material use practices.

By "materials" in this study, I refer to the types of documents and data that knowledge workers use for work production. For instance, in libraries, a central resource problem is managing the "materials budget." The corollary in computer services is managing hardware and software maintenance and acquisition which also shapes what types of resources are made available on campus. This chapter describes the motivation for interest in this inquiry and provides an overview of the study as a whole.

1.1 Material Use Practices from Memex to World Wide Web

The fascination with how libraries store the knowledge of humankind dates back to ancient times. The romance with the library of Alexandria and admiration for Gutenberg's contribution to printing endures today in the naming of some of the most contemporary library digitization projects. Accompanying the attraction of these endeavors is the very pragmatic challenge of how to make the best use of these libraries as institutions and documents as artifacts. Vannevar Bush's Memex was one such antecedent.

In 1945, Vannevar Bush published a famous proposal for a new type of "library" to manage the proliferation of scientific information (Bush, 1945). The Memex was a means to facilitate the development of mastery ability in the context of an ever increasing body of knowledge

> There is a growing mountain of research. But there is increased evidence that we are being bogged down today as specialization extends. The investigator is staggered by the findings and conclusions of thousands of other workers - conclusions which he cannot find time to grasp, much less to remember, as they appear. Yet specialization becomes increasingly necessary for progress, and the effort to bridge between disciplines is correspondingly superficial.

Bush's Memex was an early articulation of a desk-top hypertext system based on microfilm representations of research documents. He proposed it as a solution to facilitate access to large numbers of documents. Bush examined three cases of common **material use practices** (what he called "selection" of materials). In the first case, a researcher looks at the entire record of work chosen via **comprehensive searching**. Selection proceeds by examining one by one the result of this frequently large search result. One example of comprehensive searching is a keyword search on an electronic bibliographic database that returns hundreds of results. Selecting materials from a large number of results is extremely labor-intensive and often discouraging. In Bush's second case, the researcher knows so well what he want to find that the selection process simply consists of **retrieving** one item based on a particular unique identifier. The Memex provides more rapid selection and complete dissemination of the material. In the third case, the Memex provides benefit of a new type of searching, "searching by association" which he claims as the heart of the researcher's creative process. "Searching by association" is what we now call **browsing** via hypertext links. Bush described both prepackaged and customized "trails" for following links.

Even today in the fashionable "Wired" magazine, the problem of using a proliferating number of electronic materials has emerged again (Steinberg, 1996). Steinberg surveyed and interviewed people who created different World Wide Web search tools in order to address the following questions:

> How do researchers possibly believe they can organize the rapidly growing Web?
> Have they really solved the problems that have stumped scientists for the last 200 years, or are they just ignoring them?
> And if organizing the Web really is possible, what are the implications?

Although Steinberg concluded that taking the best of the available search tools could yield a useful organization and delivery mechanism for Web information, he also engages a deeper

issue. Because the World Wide Web is not mediated by publishers who make decisions in the print world about what kinds of materials reach mass markets, anyone who has access to the World Wide Web can publish. This increases the search space to include materials not usually collected by traditional paper libraries.

These examples provide points of departure for the exploration of material use practices. Both proposals emerged from a need to organize proliferating information. However, in order to study how people actually use materials, Bush's focus on work production suggests a more tangible context for investigating these issues by pointing out that researchers have high motivation to utilize digital libraries. This study also explores the issue Steinberg raised about how World Wide Web (and other forms of electronic publishing) increases the search space at the same time as it offers the capability to organize it.

1.2 Research Question

This study examines digital library use by examining a broad range of material use practices which enable a body of knowledge to be utilized for knowledge work production. Therefore the study addresses the research question:

How does the principle of mastery shape material use practices for work production?

This research question emerged from the analysis of a study of the use of paper and electronic materials by researchers in situ. The next section and Appendix I describe the

initial approach to this study and the methods of analysis. The findings from this study address the following subquestions:

> What is the principle of mastery?
> How do material use practices relate the principle of mastery to work production?
> How does the principle of mastery shape material use practices?

In order to address the main research question, Chapter 2 defines the principle of mastery in terms of the social focus of this study. Chapter 2 also introduces how material use practices relate the principle of mastery to work production. Chapter 4 through 7 demonstrates how the principle of mastery shapes material use practices in the four cases.

Although there has been much focus on how knowledge workers use materials available in a particular corpus and how the corpus can be accessed by them, there has been less investigation about how a body of knowledge is used in the normal course of work production. Chapter 3 describes findings from studies on material use practices, particularly in information science. Information needs research sheds light on how mastery ideals influence knowledge workers' occasions for using materials and end-user searching behavior research informs questions about how knowledge workers access a body of knowledge on particular occasions. This study will extend results in both areas by relating the principle of mastery, work production and a body of knowledge to identify persistent patterns of material use which can inform digital library design, provision and use.

1.3 Research Strategy

The research strategy was designed to elicit data on digital library perception and use by faculty and doctoral student researchers in diverse universities and in diverse fields to discover how resource arrangements influence researchers' abilities to effectively use digital libraries. To accomplish this strategy, the investigators collected data from a

comparative institutional analysis of the use of paper and electronic materials in eight major Carnegie I research universities[1] (Carnegie Foundation for the Advancement of Teaching, 1994). Site selection was based on a comparative case design with three dimensions (number of library branch facilities, public versus private institutional control, and a institutional investment in libraries and digital library infrastructure). The approach to site selection was based on a standard social science sampling strategy to investigate use of technology in organizations (Danziger et al., 1982). These dimensions were chosen in consultation with expert colleagues about the role\ of resources in researchers' accessibility to paper and electronic materials on their campuses (Kling, 1987; Kling and Jewett, 1994). The sample included four public universities and four private universities to reflect sources of operations funding. These universities were located in the northeast and west coast of the United States. They varied in their library investments (per faculty member) from $3,200 to $37,500. They also varied in the number of branch libraries they operated (from 2 to 76) which reflected the degree to libraries supported distribution of resources, space and personnel. Upon analysis, resource flows did not influence material use practice as much as the principle of mastery. However, these were early days for many of these universities in providing access to network infrastructure and electronic materials. In future studies, simple resource discriminators may yield important findings.

At each university, three faculty researchers were interviewed in each of four fields: a lab science (molecular biology); an artifact-based discipline (computer science); a social science (sociology); and a humanities discipline (literary theory). These fields were chosen because of the different types of materials different disciplines use for their work. The interviews focused on one or more exemplary research projects. When doctoral students were available in each field, they were also interviewed for this study. Doctoral students were included based on the resource discrimination rationale: doctoral students usually have

[1]The Carnegie I classification included 88 United States universities awarding 50 or more doctoral degrees and receiving at least $40 million in federal support each year.

access to different types of resources and sometimes have different work patterns than their advisors. In total, this study includes interviews with 96 faculty and 28 doctoral student researchers.

Interviews were also conducted with 23 key digital library infrastructure providers (several at each campus) such as a university librarian, a director of academic computing, a faculty senate library chair and other senior academic administrators such as a provost. These interviews focused on data about campus-wide patterns of material use, patterns across disciplines, and university investments in library and computer support. During visits to each campus, tours of library and computing facilities were documented to examine first-hand the resources and services reported in the interviews.

The main form of data analysis was theory evolution through grounded analysis of this data (Strauss, 1987). Initially, data analysis focused on how researchers' material use practices were influenced by disciplinary, campus and departmental resource arrangements. However, the informants' accounts instead revealed that disciplinary norms for material use practices were more salient to them than resource provision arrangements. A pervasive theme throughout the data was the importance of attaining or maintaining a minimum level of mastery ability over a body of knowledge in their subspecialty in order to contribute to work production. Disciplinary norms defined what constituted mastery ideals in their subspecialty. The informants drew upon normative notions of mastery ideals in the course of finding relevant materials, selecting which materials they wanted, and managing the materials they collected.

This research strategy is limited in several ways. The study design was initially focused on collecting data on resource arrangements for digital library use and thus site selection reflected a diverse set of resource availability by institution rather than sampling on more

germane variables such as reported mastery ability level or drawing a snowball sample of participants in particular research subspecialties. Gathering data from these alternative designs would have yielded findings about what constituted mastery ability levels in different world worlds or more specific attributes of the mastery ideal in research subspecialties rather than in the research disciplines.

Another limitation arises from the combination of the study design and the analytical approach. Because analysis is data-driven, analysis is limited to the findings present in the data collected. Because the study design narrowed the range of informant selection to faculty and doctoral students at Carnegie I institutions, the data set oversampled faculty researchers who had a high level of mastery in their work worlds. In addition, the selection of these elite researchers at prominent U.S. universities limited consideration of the mastery abilities of the researchers who win the most grants, attract the most highly ranked students and interact with other prominent researchers. The sample does, however accurately represent work practices of highly productive researchers. Another limitation of this data set is the undersampling of doctoral student researchers, particularly in sociology and literary theory. Because it was difficult to locate for interviews students in these disciplines who were in the later stages of their doctoral work, the study's findings do not include a great deal of evidence about doctoral students' use of materials on their different mastery ability levels.

This study was also limited by the schedule for data collection. Because the vast majority of research informants were only interviewed once, the findings reflect a static snapshot of informants material use practices at one particular moment in time. Discussions of the principle of mastery therefore do not take into account the way informants' mastery ability changes over time or the relationship between mastery ability and changing technology. It

is left for future work to examine how differences in accounts taken at different times affect the principle mastery and material use practices.

Finally, this study is limited by the self-reported nature of the data collected. Although the data collected by doctoral students who worked closely with faculty researchers and reports from digital library infrastructure providers on use of campus resources were used to check the accuracy of faculty informant accounts, the data do not always reflect the true behavior of the informants. However, the focus of analysis on perceptions and reported material use practices produce useful results about how researchers approach paper and electronic materials if not how they actually use them. The principle of mastery embodies both actual behaviors and perceptions of norms which shape rather than mandate individual behavior.

1.4 University Research as Knowledge Work

Because there are few studies of sociology of worklife examining faculty researchers, this section provides a brief overview of some general characteristics of knowledge work in university research and a general introduction to university research work production activities.

Faculty conducted research among a mix of diverse work activities. The faculty informants in this study were busy professors juggling teaching loads, administrative meetings and research activities. This 1989 H.E.R.I. survey provides a general overview of faculty workload, albeit over a much broader sample than drawn in this study (Table 1.4.1). However, the tasks are similar to those reported by informants: teaching, preparing for teaching, research and scholarly writing, advising or counseling students, committee work/meetings, other administration and consulting with clients or patients (Astin et al.,

1991). At research universities, the percentage of faculty spending more than 12 hours a week on research may be higher than the 20.1 percent reported here.

Table 1.4.1: Faculty Workloads, 1989-90
(Astin et al., 1991)

	Proportion reporting number of hours per week								
	0	1-4	5-8	9-12	13-16	17-20	21-34	35-44	45+
Teaching	0.3	7.2	26.2	32.0	17.6	10.1	5.9	0.5	0.1
Preparing for Teaching	0.3	8.4	22.9	25.2	17.3	13.8	9.4	2.0	0.7
Research and Scholarly Writing	20.2	27.9	16.4	12.4	7.3	6.7	6.3	1.8	1.0
Advising or counseling students	2.6	56.6	29.5	8.0	2.0	0.9	0.4	0.1	0.0
Committee work/meeting	4.6	68.8	20.6	4.3	1.1	0.3	0.1	0.0	0.0
Other Administration	36.5	38.6	11.5	5.8	3.0	2.3	1.7	0.4	0.2
Consultation with clients or patients	68.8	20.7	6.3	2.2	0.8	0.6	0.4	0.1	0.1

Note: The figures are based on survey responses of 35,478 faculty members at 392 colleges and universities. The survey was conducted in fall and winter of 1989-90 and was limited to full-time professors who spent at least part of their time teaching undergraduates. The response rate was 55 percent. The figures were statistically adjusted to represent the total population of full-time faculty members. Because of rounding, figures may not add to 100 per cent.

Research and Scholarly writing is a broad category that subsumes a variety of activities, participants and materials. Research activities vary among disciplines as well as within them. Research activities in these four disciplines included such tasks as:

monitoring lab instruments
thinking about problems
crafting grant proposals
closely reading rare texts
conducting group meetings
filing research reports for funding agents
resolving conflicting results
assembling presentations
analyzing laboratory data or field notes
organizing research materials, and
obtaining materials not immediately available.

In order to get credit for their contributions, researchers spent a lot of time on publication activities. The publication process included activities such as:

writing and revising one's own manuscripts
editing journals and books
reviewing and critiquing colleagues' research
working closely with publication house editors
serving on conference program committees
soliciting and selecting relevant new work,
organizing workshops or working groups to investigate new areas, and
negotiating with publishers for publication agreements.

Research groups often divided labor among faculty researchers, postdoctoral researchers, doctoral students and undergraduates and other research staff. They also worked with personnel external to their research group and university in the course of their activities. For instance, publication activities brought researchers into contact with editors, peer-reviewers, and publishing houses. Some researchers worked primarily alone in their homes, offices, laboratories or libraries. Others depended on one or more of the following people to help them produce ideas, data and problems to publish: doctoral students, secretaries, work-study students, librarians, computer support personnel, undergraduates receiving course credit and key collaborators. However, even when researchers worked alone on individual projects or single-authored publications, their work constantly connected with and was influenced by other scholars who evaluated the value of their contributions.

Although researchers worked on many of these activities in the locales where they live, other important activities took them away from their offices, families and homes. Researchers often traveled to conduct their work. They attended academic conferences, workshops and advisory panels. Many presentations were by invitation only which routinely required submission of papers selected by peer review. Researchers also visited collaborators, funding project directors, universities or companies who invited them to

speak. At these different forums they exchanged ideas and met potential collaborators and audiences for their work. They often used materials to support travel activities or visits by other researchers. Similar to the way research activities were interspersed with other responsibilities, correspondence, conducted increasingly via electronic mail, divided their attention between a wide variety of activities and responsibilities.

The materials that researchers used for their work and the materials they produced also varied. Common forums for publication included: books, journal articles, conference proceedings, technical reports and book reviews. Researchers collected and used other materials such as newspaper articles, government reports, calls for proposals and colloquia announcements to support and organize their activities. Some materials were classified as archival publication which refers to the type of published documents that librarians have traditionally collected, preserved and made available to researchers. In general, research contributions were expected to become part of the archival publication literature. Although there had been alternative proposals for collecting and disseminating knowledge among researchers, the standard of contribution to archival publication persisted throughout this study.

1.5 Summary of the Dissertation

Chapter 2 describes the principle of mastery and its role in knowledge work production. It also clarifies the level of analyses of this study and describes the organizational focus. Chapter 3 surveys previous research in material use practices. It provides a summary of major findings and outstanding questions particularly in the areas of information needs and end-user searching of information science. Chapter 3 also clarifies how this study differs and yet builds on previous work about the use of both paper and electronic resources.

Chapters 4, 5, 6, and 7 are the cases upon which the major argument rests. Each chapter surveys work production in a research discipline: Molecular Biology, Sociology, Computer Science and Literary Theory and discusses the principle of mastery. Because of the nature of specialization in these disciplines, in each discipline I highlight one subspecialty as a vivid example of the general characteristics of work production in that discipline. Each chapter provides evidence of patterns in three material use practices: comprehensive searching, browsing and retrieving. These chapters clarify which practices are confined to the particular discipline and which cross-cut different disciplines. Chapter 8 summarizes the major findings of this study, discusses limitations and outlines directions for future work. Chapter 8 also provides the conclusions of this work.

Chapter 2
The Principle of Mastery

This chapter provides background on the principle of mastery necessary to understand the findings of this study. Although an individual may possess a particular level of mastery ability, one judges that ability according to a mastery ideal which is socially constructed by university researchers in particular work worlds. The principle of mastery is the social process by which researchers judge differing "mastery ability" levels according to a "mastery ideal" code of conduct for competency in working with a body of knowledge in specialized work worlds. This chapter defines the principle of mastery for use in this study and describes how materials use practices relate the principle of mastery to work production. Then, relevant research in science studies and cultural studies is presented to describe the social construction of mastery ideals which is followed by an explanation of the different social units involved with this study. A brief overview of attributes of mastery ideals in the four disciplines completes this chapter.

2.1 What is the Principle of Mastery?

In this section I define the principle of mastery which is derived from a social mastery of technology in the study of diffusion of innovation.

The principle of mastery is the social process by which knowledge workers judge differing "mastery ability" levels according to a "mastery ideal" code

of conduct for competency in working with a body of knowledge in specialized work worlds. A minimal level of mastery ability includes knowing the scope of the body of knowledge, qualities of materials in the corpus and relationships between materials. Researchers are initially socialized to aspire to mastery ideals within particular subspecialties through doctoral programs and postgraduate preparation. Once they attain a minimal level of mastery ability, they increase and sustain mastery ability through participation in work production, especially feedback from colleagues via peer review of their work. This study provides evidence that the principle of mastery exists in different disciplines and describes how it shapes material use practices in four disciplines.

The principle of mastery was derived from a similar mechanism which shapes use of technology in the study of diffusion of technological innovation (Petrella, 1996). Researchers in the study of diffusion of innovation define the term "social mastery of technology" to mean the ability of a social group to incorporate technology into its community life. They contrast this definition with the definition of industrial mastery which as a necessary condition for social mastery is the ability of a country, society or firm to incorporate technology into its routine operations. The principle of mastery, as defined in this study, departs from this definition in several ways. First, the principle of mastery (in this study) is a social process rather than a diffusion attainment measure. Social mastery is closer to the notion of the mastery ideal: the paradigmatic definition of competence in a subspecialty. Second, this study refers to mastery ability over a body of knowledge rather than mastery ability of one or more electronic technologies. In this way, the principle of mastery differs from the conception of the requirement for an individual to have mastery at the information interface (Zuboff, 1985). Although this study examines the use of electronic materials, the principle of mastery is generalizable to use of both paper and electronic material.

Two findings from the study of social mastery of technology are germane to this study. In his review of assessments of information and communication technology, Petrella observed that attaining social mastery of technology requires a minimal level of public awareness and acceptance. This is true of individual mastery ability over a body of knowledge. Researchers must be aware of the contents of the body of knowledge and also must be in agreement for what constitutes mastery ideals over a body of knowledge in their subspecialty.

A 1991 symposium on social mastery of technology discussed how mastery of technology depends upon "implicit knowledge drawn from experience" in work production (Kirat, 1992). This finding also applies to the findings about the principle of mastery in this study. The principle of mastery reinforces its role as a mechanism for participation in work production through norms for legitimating who participates in academic research. In order to publish papers, win grants and fellowships, gain recognition for contributions and award doctorates to graduate students, faculty researchers must be accepted through a social process that judges their adherence to the mastery ideals of their discipline. The principle of mastery thus depends upon the continued participation in work production and knowledge of mastery ideals drawn from experience. In each discipline, mastery ideals comprised this implicit knowledge and this study identified several attributes of mastery ideals in each discipline.

2.2 How Material Use Practices relate Mastery to Work Production

Chapter 1 characterized **material use practices** in scientific research as selection of relevant work. Chapter 3 describes the three material use practices in this study: comprehensive searching, browsing and retrieving. In this section, I describe the

relationships between material use practices, the principle of mastery, body of knowledge and work production.

This study found that the principle of mastery shapes materials use practices in knowledge work. The evidence for these observations came from research informant accounts in four university research disciplines. Researchers drew upon a variety of materials to produce work. These materials were both inputs and outputs of **work production**: in creating articles and books, researchers accessed each others' production outputs to create their own. The collection of these materials forms a **body of knowledge** for that research subspecialty.

This study found that **the principle of mastery**, the social process by which knowledge workers judge differing "mastery ability" levels according to a "mastery ideal" code of conduct for competency in working with a body of knowledge in specialized work worlds, shaped the ways in which researchers use materials. Norms for mastery ideals were communicated through work production activities such as research participation in graduate school (Berelson, 1960) and peer review which controlled which contributions become what part of the body of knowledge. A minimal level of mastery ability entailed being able to discern the scope of the body of knowledge, the qualities of specific materials in that corpus, and relationships between materials.

Figure 2.2.1 depicts the relationships between the principle of mastery, a body of knowledge, work production and material use practices. The principle of mastery shapes material use practices by which researchers select materials from a body of knowledge for work production.

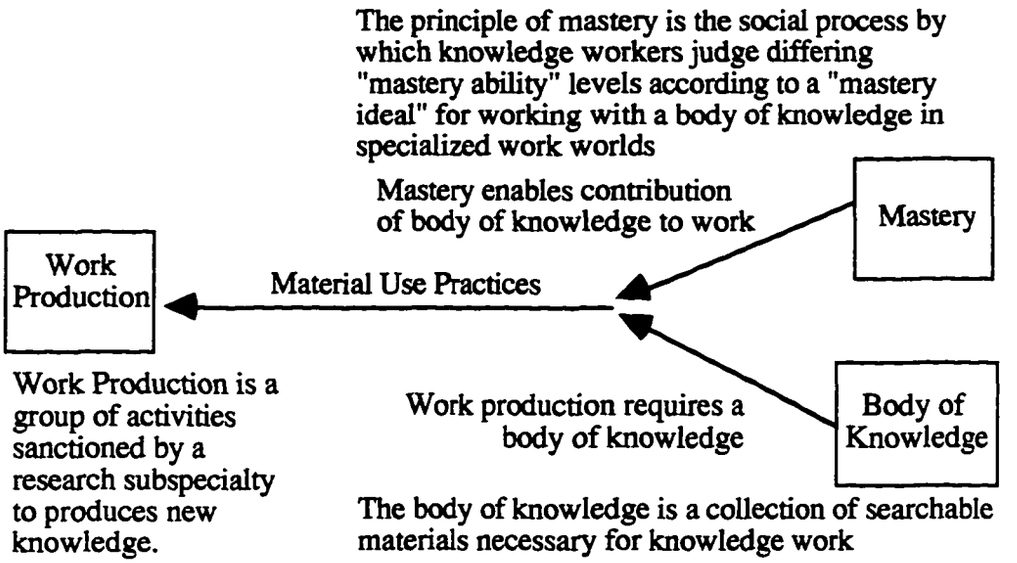

Figure 2.2.1: Essential Attributes of Knowledge Work Production

These essential attributes can be viewed from two perspectives: the mastery ideal and mastery ability. From the point of view of the mastery ideal, researchers produce the highest quality of work drawing on paradigmatic knowledge of the comprehensive body of knowledge of their work world. However, in practice, researchers routinely produce work with some level of mastery ability using some subset of the body of knowledge.

Although this study focuses on how researchers are using some level of mastery ability over a body of knowledge, it also makes the assumption that researchers have other necessary abilities for work production. Necessary abilities in university research include knowing what constitutes a contribution in the field, knowing how to use specific research methods and knowing how to use specialized equipment.. Each disciplinary case in this study (Chapters 4-7) presents some of these necessary abilities to help explain attributes of the mastery ideal in that discipline or subspecialty.

This study does not examine how information technology changes work production, mastery ideals, or the body of knowledge. Instead, this study focuses on how material use practices are shaped the principle of mastery in four different disciplines. Diffusion of innovation relates how technology changes work production, mastery ideals and the body of knowledge over time (Figure 2.2.2).

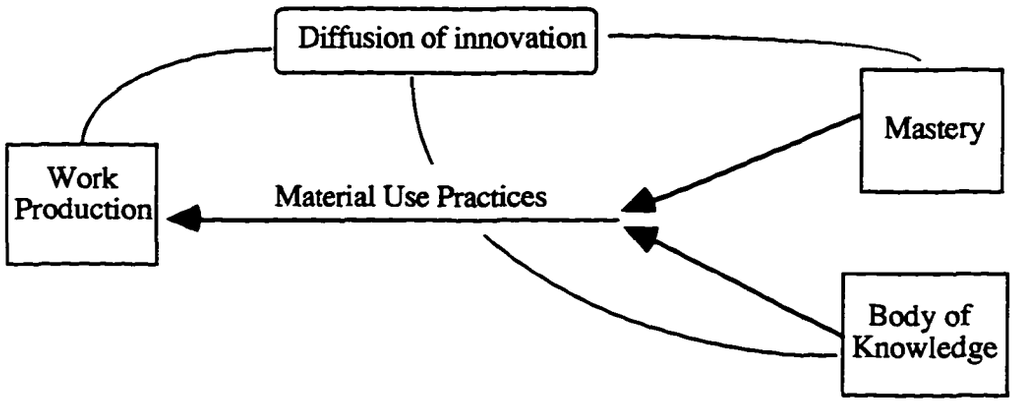

Figure 2.2.2: Relationship between This Study and Diffusion of Innovation Research

2.3 The Principle of Mastery in University Research

This section discusses previous work on the principle of mastery in university research. Data and documents connect individual researchers through social work production activities within research disciplines. Some work production activities within disciplines concern the definition of the mastery ideal and others evaluate the level of mastery ability necessary to produce work in that discipline. These activities provide institutional continuity to the disciplines as they change over time. One source of change is ongoing specialization of research subspecialties within disciplines. Understanding the principle of mastery in university research provides background for understanding findings from this study.

Doty and his colleagues (Doty et al., 1991) investigated issues surrounding norms and the use of electronic scientific networks at Syracuse University. They not only examined the roles of scientific social norms in the production of scientific research, they also found that researchers used networks to facilitate informal communication to gain "craft knowledge" needed to adhere to those norms. Doty's study supports the existence of the principle of mastery in work production of university research by identifying the mastery ideals in norms and how material use practices support the social processes of evaluating mastery ability. This work extends these findings by describing in greater detail attributes of mastery ideals and specifying the mechanism by which the principle of mastery influences material use practices.

Studies from anthropology of science examine social interactions surrounding the use of materials in research. For instance, Knorr-Cetina's study of plant protein researchers investigated how materials embodied specific social processes which guided the "manufacture of knowledge" (Knorr-Cetina, 1981). Social processes such as negotiation about how individuals selected and combined materials, arguments, interpretations and assumptions were represented in scientific results. Materials thus connected individuals through transscientific fields (research subspecialties in this study) and facilitated social interaction between researchers for knowledge work. Latour and Woolgar studied biologists' work production as the social construction of scientific "facts" (Latour and Woolgar, 1986). They examined social processes such as conversation and resolving interpretive disputes in the laboratory. These activities also manufacture scientific facts which created order out of the disorder of work production. This study builds on these results by examining principle of mastery as a social process in comparative cases. It also extends this work by relating conventional ways of selecting materials (creating order) in different disciplines to specific social conventions (mastery ideals).

In her study of high energy particle physicists, Traweek showed how theories from the field of physics influenced their work production culture (Traweek, 1988). The ways that physicists viewed knowledge were shaped by social processes in their research. For example the ways in which physicists made and managed their research contributions were guided by the central role of managing time in work production, particularly the scarce commodity of gaining access to the electron beam for experimentation. Similarly in this study, the social processes of creating knowledge influenced the definition of mastery ideals in each discipline. For instance the mastery ideals defined by literary theory scholars differed markedly from bench scientists in molecular biology.

These studies demonstrated how social interaction and work world culture influences the production of knowledge work in research. The principle of mastery examines a subset of these social process: those surrounding access to a body of knowledge of documents and data required for research production. These studies provide evidence that mastery ability is judged against mastery ideals in different research worlds. Researchers worked with an awareness of social influences and reacted to various incentives to adhere to mastery ideals. One such incentive was scientific competence or legitimacy. Pierre Bordieu defined the notion of scientific competence or authority as "a particular agent's socially recognized capacity to speak and act legitimately" (Bordieu, 1975). As agents of a discipline or subspecialty, researchers worked in ways that demonstrated their competence and authority. Bordieu's examination of competitive social processes within subspecialties which struggle to control this authority illustrate the key incentive for developing and sustaining mastery ability for process of legitimation. This study provides evidence that the principle of mastery, as one aspect of research competence, is dependent upon participation in work production to define and reinforce adherence to mastery ideals through participation and proven competence.

Cultural studies scholars also examine the construction and nature of disciplines which organize social processes and embody different cultures (Shumway and Messer-Davidow, 1991). They call the study of these social mechanisms for producing knowledge "disciplinarity." However, this study distinguishes between the level of analysis of the discipline and the research subspecialty. Lenoir's analysis provides a useful distinction between these two levels: :

> Disciplinary programs are fundamentally institutional in terms of orientation, are concerned more with establishing service roles, facilitating links to other disciplines, and enabling transmission of the techniques and conceptual tools of the scientific field to (potentially multiple) user groups from neighboring disciplines and to persons training for particular types of career. While no less political in character, research programs, for the purposes of this discussion, are characterized less by their concern to organize society than by their problem-oriented focus, through their efforts to dominate the cycles of credit and available resources for extending and legitimating products of their research. (Lenoir, 1993)

These two levels are also important to the social processes of specialization that influence the constitution of mastery ideals in a subspecialty. In an examination of patterns of interdisciplinary research, Campbell observed that "the ego ideal of the scholar calls for competence, for complete knowledge of the field he claims as his" (Campbell, 1986). Campbell claimed that the division of specialists into decision-making units and training programs (disciplinary-oriented departments) encouraged clustering of interests into common specializations. This division creates gaps in research inquiry that fall between disciplines and encourages "exhaustive mastery of a an exceedingly narrow realm within one specialty." The social process of specialization raises the question of what level of analysis is appropriate to examine the principle of mastery in material use practice.

2.4 Analysis of Mastery in University Research

Although the findings of this study were drawn from accounts of individual behavior, the analysis focuses on the social elements that influence that behavior. Figure 2.4.1 depicts abstractions of the elements of this study from Section 2.2.

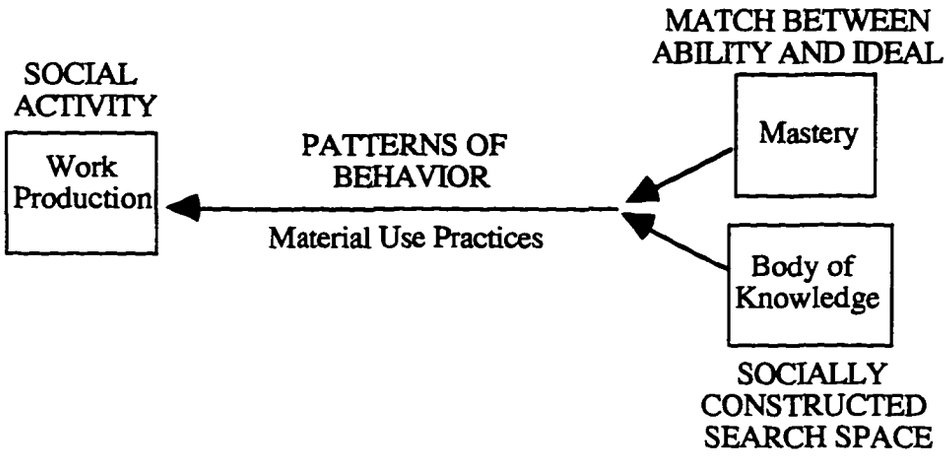

Figure 2.4.1: Abstraction of Elements in Knowledge Work Production

This figure shows that although the evidence of this study is drawn from generalizing patterns of researcher's accounts of their individual behavior, the focus of analysis is on social factors which shape that behavior. In particular, the process of matching mastery ability to mastery ideals shaped individual material use practice through social norms for participation in university research.

Underlying the evidence of this study, is the configuration of several social structures. Figure 2.4.2 illustrates various social structures included in the study. Researchers worked within a subspecialty which legitimated their work production output, socially constructed the body of knowledge and evaluated mastery ability in their work. However, the research subspecialty is more of social identity among researchers trained in a particular discipline,

than a geographical location or corporate entity. Subspecialties may be wholly contained with a particular discipline but often span two or more disciplines. For example artificial intelligence researchers were most commonly trained in the computer science discipline, but attended conferences in computational biology or information theory in addition to their own specialty conferences. For practical considerations, the data for this study was collected by sampling departments at eight different universities, but in each discipline, one subspecialty provided a focal area of analysis to examine specific aspects of research production.

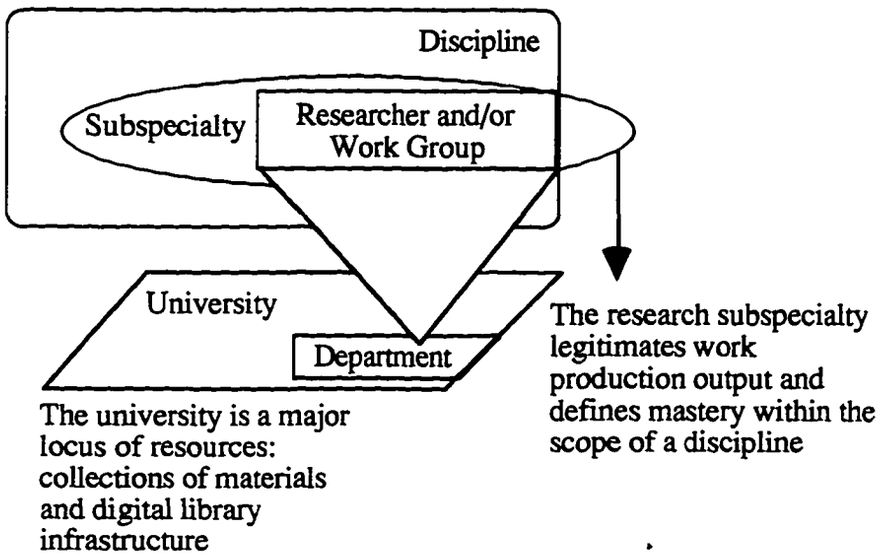

Figure 2.4.2: Social Structures in University Research

Elsewhere, evidence from this study examined local arrangements for provision of collections of materials and digital library infrastructure (Covi and Kling, 1995; Covi and Kling, 1996). In this work, the university was a major locus for centralized resources. Other administrative units such as departments and schools also facilitated access to resources for the researchers. There has been other extensive work to study the allocation of resources from the university to the individual researcher or research group (Cummings

et al., 1992; Green, 1994). However, this study focused on the arrangements between the researcher and the subspecialty relevant for work production. It assumed that resources were somewhat scarce, though they varied among universities, departments and individuals. However, because the scholars selected for this study were working at elite research universities, the level of resources and the arrangements for provision played less of a role than the principle of mastery in their accounts of material use practices. Although the universities chosen for this study were diverse among Carnegie Research I institutions, the materials use practices did not vary significantly by the site selection criteria. Data in this study indicated that resource discriminators may matter, especially for use of electronic materials, but use was not yet widespread enough to produce precise results. Other studies have also suggested that resources will matter. For example, Hesse and his colleagues (Hesse et al., 1993) found that the use of electronic resources among oceanographers was partially shaped by their proximity to scarce data collection points such as off-short laboratories. A study conducted concurrently with this one (McClure and Lopata, 1996) concluded that there were not enough measures to evaluate university resource arrangements for digital libraries at this time.

2.5 Mastery Ideals in Four Disciplines

This section provides characterizations of disciplinary differences and an overview of mastery ideals in four disciplines. The findings of this study relied on generalizing patterns to the discipline level rather than the subspecialty due to the organization of data collection in this study. Most informants identified their work in research subspecialties that embodied these disciplinary patterns. However, the subspecialties which differ from these patterns are also noted in Chapters 4-7.

One well-known study characterizing differences between disciplinary inquiry is Kuhn's study of scientific modes of inquiry (Kuhn, 1962). He proposed that "paradigms, " or conventional examples of a discipline's practices distinguish phases in the history of disciplinary formation. Informants referred frequently to "paradigms" to characterize their work production and material use practices.

Table 2.5.1: The Nature of Knowledge in Disciplinary Groupings (adapted from Becher, 1987)

Disciplinary Grouping	*Nature of Knowledge*	*Nature of Disciplinary Culture*
Hard-pure (Pure Sciences, e.g., **Molecular Biology**)	Cumulative; atomistic (crystalline/treelike); concerned with universals, quantities, simplification; resulting in discovery/explanation	Competitive, gregarious; politically well-organized; high publication rate; task-oriented
Soft-pure (Humanities and Pure Social Sciences, e.g., **Literary Theory and Sociology**)	Reiterative; holistic (organic/riverlike); concerned with particulars, qualities, complication; resulting in understanding/interpretation	Individualistic, pluralistic; loosely structured; low publication rate; person-oriented
Hard-applied (Technologies, e.g., **Computer Science**)	Purposive; pragmatic (know-how via hard knowledge); concerned with mastery of physical environment; resulting in products/techniques	Entrepreneurial, cosmopolitan; dominated by professional values; patents substitutable for publications; role-oriented
Soft-applied (Applied Social Science, e.g., Education, Business, Law)	Functional, utilitarian (know-how via soft knowledge); concerned with enhancement of [semi-] professional practice; resulting in protocols/procedures	Outward-looking; uncertain in status; dominated by intellectual fashions; publication rates reduced by consultancies; power-oriented

Becher's (Becher, 1987) study of common characteristics of disciplines provide some useful distinctions to understand these paradigms. He grouped disciplines (see Table 2.5.1) based of the nature of knowledge in each discipline. The four groupings were hard-pure (e.g., Molecular Biology), soft pure (e.g., Literary Theory and Sociology), hard

applied technologies (e.g. Computer Science) and soft-applied (e.g., Education, Law, Business).

Although these distinctions are broad and do not necessarily apply to each subspecialty within the discipline, they embody important distinctions that mastery ideals in each discipline embodies. One distinctions from Becher's study was the nature of disciplinary culture as embodied in social interaction (collaboration) in the process of conducting research.

Researchers often established the nature of social interaction in the process of conducting research during doctoral training. This differed markedly between the hard versus soft disciplines. In the hard-pure disciplines, faculty researchers closely supervised graduate students and routinely published co-authored papers with them (and other research staff members). In soft pure disciplines, graduate students worked more independently from their research supervisors and publish single-authored papers more frequently. Becher explained this phenomenon as a result of the construction of disciplinary knowledge: if the different researchers can easily work on different parts of the same problem, a cooperative approach is more "sensible." However, if the problems are broadly defined and not easily divisible, there is little incentive for collaborative work. In the hard-applied discipline, there is greater incentive for graduate students to seek industrial positions at the end of their training not only because the applied disciplines lend themselves better to practice, but also because the problems are more dispersed and specific.

Emerging from the sociology of science (Merton, 1973), the study of scientific communities by examining their communication links, has provided one window for understanding scientific growth (Crane, 1972). This set of studies views scholarly communication as a social system and examines such influences of invisible colleges over

research outputs such as publication and social communication (Hagstrom, 1965; Garvey, 1979; Pickering and King, 1992). Invisible colleges are organizations of researchers in a particular discipline (or subspecialty) into an "in-group" that routinely communicates via conferences and circulation of preprints and who controls personal prestige and the fate of new scientific ideas and strategy (Price, 1963; Price 1965). Studies on "invisible colleges" (Chubin, 1983) examine specialization and diffusion of knowledge: how subspecialties come into being and sustain themselves over time. A related program of research examined the flow of communication among engineers in industrial settings (Allen, 1977) and developed extensive measures of the nature, amount and role of communication networks. Reviews of scholarly communication regularly examine specialization, fragmentation of the literature, the possibilities of shifts from print to electronic communication patterns (e.g., Lancaster and Smith, 1978; Cronin, 1982). The study of scholarly communication, in this study refers to how work production shapes what becomes the body of knowledge (Figure 2.5.1).

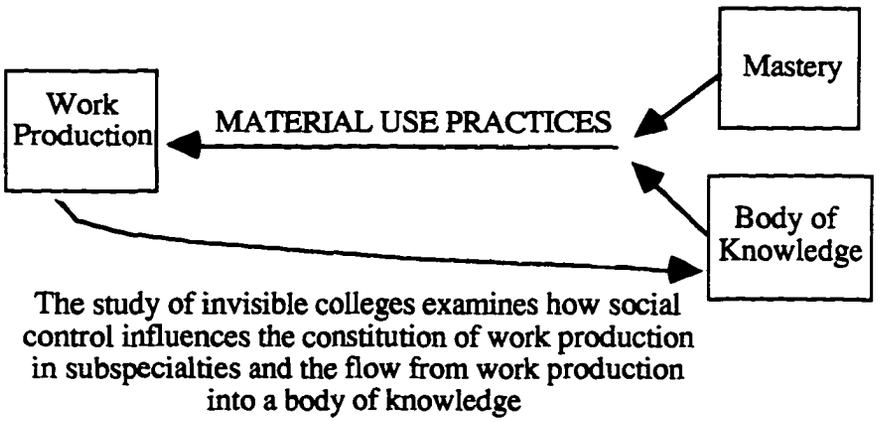

Figure 2.5.1 The Relationship of Invisible College Research to the Principle of Mastery

Scholarly communication patterns of invisible colleges differed between disciplines. In hard-pure disciplines, communication was frequent and fast because there many people

worked on similar problems and therefore depended upon current progress reports. They also depended on frequent conferences, telephone contact and circulation of preprints to help coordinate costly and time-consuming research strategy. In the hard-applied areas, the pace was less frantic and conferences provided an important forum for contact with industrial funding agents and audiences. Paradigmatic status has also been related to publication rates in different disciplines (Lodahl and Gordon, 1972). Lodahl and Gordon concluded that disciplines with more highly developed paradigms fostered more "efficient" communication (frequent publication with fewer delays). Efficient publication helped to stimulate further work in the discipline.

Table 2.5.2: Attributes of Mastery Ideals in Four Disciplines

Discipline	Attributes of Disciplinary Mastery Ideals
Molecular Biology	Molecular Biologists have knowledge of both previous and concurrent research projects to make a unique contribution
Sociology	Sociologists attain and sustain mastery of bodies of knowledge in multiple subspecialties
Computer Science	Computer Scientists have a working knowledge of both conference and journal literature in their subspecialties
Literary Theory	Literary Theorists master a particular subgenre of literature and intellectual discourse about it.

Molecular biology was a recent addition (since the 1940's) to life science research. The discovery of DNA, recombinant-DNA techniques and computational aids to genetic sequencing have introduced new approaches to understanding life. Evelyn Fox Keller attributes changes in twentieth-century biology to the influence of physics on the study of organisms, their relationship to the environment and physical-chemical interactions (Fox Keller, 1993). She claims that molecular biology's exclusive focus on the gene, definition of life as genetic code, and goals of study to be intervention and control over the development of life embody a dream of power of science and its social institution. However, this interpretation of the social forces behind molecular biology research was

only an undercurrent to informants accounts. Productivity in molecular biology depended upon priority of discovery and credit for their work. Therefore, molecular biologists could not rely solely upon current literature to track their collaborators and competitors. Invited conferences, electronic mail and telephone contact helped them keep track of simultaneous work in other labs. Mastery ideals therefore provided incentives for these scientists to sustain knowledge of both previous and concurrent research projects.

Sociologists defined themselves in terms of the sciences, specifically, the social sciences which are their neighboring disciplines. There was a deep sense of malaise about the growth, specialization and lack of coherent focus of the discipline within its professional field and within the university. In a recent special issue of Social Forces, Gove characterized some problems in sociology: "acrimonious interpersonal relationships," "lack of involvement in university affairs," lack of support for grant applications within the discipline and the lack of an "essential core of knowledge" (Gove, 1995). He attributed this last problem to the increasing number of practitioners, diversity, complexity and specificity of the research work. Fuller argued that social science is less powerful than the hard sciences because they are more accessible to ordinary discourse and sociology in particular is not "well constituted as a social unit." (Fuller 1993). Fuller believed that sociologists undermined their contribution in understanding how knowledge is socially determined by the way they classified their own streams of work as by schools of thought rather than "academic lineages." This suggested that similar work can nondeterministically arise from different social settings. However, he attributed the power of the hard sciences to "folk perceptions about the discipline's ability to transform the world, which in turn, serve to define the exemplar of worldly power itself" (another reflexive weakness). If Fuller is correct and sociology holds little authority control over its findings, it explains why material use practices varied widely by research subspecialty. The common thread

among all sociologist informants was that the mastery ideal in sociology involved keeping up with multiple subspecialties.

Computer Science was experiencing some clarification of its identity as a discipline. In 1989, the Association for Computing Machinery issued a final report from its task force on the core of computer science, defining computing as a discipline. This report reflected the dual origins of computer science from mathematics and electrical engineering and defined its areas as: algorithms and data structures, programming languages, architecture, numerical and symbolic computation, software methodology and engineering, database and information retrieval systems, artificial intelligence and robotics, and human-computer communication. This report served not only to define a curriculum beyond computer programming but also to establish its legitimacy. However, three years later, the National Research Council issued a report (Hartmanis and Lin, 1992) calling for computer science to broaden its agenda and address practical concerns thus shifting its paradigm to an applied discipline (Wegner, 1993). The close relationship between computer science research and the problems which arise in the fast-paced computing technology industry have increased the importance of keeping up with conference publication to maintain mastery ability in the field. Therefore, computer scientists sustained mastery ability by maintaining a working knowledge of both conference and journal published material.

Scholars in literary theory gave accounts of controversies and intellectual discourses which persisted and defined the identity of their profession in academic discourse and in society. For instance, literary theorists were concerned about how the discipline should be taught and practiced. Gerald Graff characterized "successive oppositions" over the history of the discipline such as classicists versus modern-language scholars, research investigators versus generalists, historical scholars versus literary journalists, cultural critics versus critics and scholars versus theorists. (Graff, 1987). He explained fragmentation of

research subspecialties in the discipline in terms of the "field-coverage principle." This principle refers to the practice of English departments to hire instructors in different specialized areas (studying literature of a predefined period or field) under the assumption that literature teaches itself and externalizing the framework in which literature and thus the teaching of literature is interpreted. Whether literary theorists supported canonization of works also influenced how materials were disseminated and shared. In contrast with the low diffusion of technology into literary scholarship, there was much greater utilization of technological artifacts and processes for teaching of writing in the curriculum. Instead, literary theorists primarily used materials based on their need to master particular subgenres of literature and the intellectual discourse that surrounds those texts.

2.5 Summary of the Principle of Mastery

This chapter described the principle of mastery as the social process by which knowledge workers judge differing "mastery ability" levels according to a "mastery ideal" code of conduct for competency in working with a body of knowledge in specialized work worlds. This term was derived from work in the area of diffusion of innovation which investigates social mastery of technology. Material use practices related the principle of mastery to work production. The principle of mastery explains how mastery as an individual ability is influenced by disciplinary norms for a mastery ideal. Work in science studies and cultural studies identified the social processes involved in the principle of mastery. Materials use practices operate on different social structures. This chapter also reviewed attributes of mastery ideals in four disciplines. This chapter thus provides the groundwork to understanding the findings of this study. The next chapter examines previous work on materials use practices from information science.

Chapter 3
Material Use Practices and Information Science Research

3.1 Introduction

The purpose of this review is to characterize previous work in information science research that is relevant to the findings of this study. Whereas Chapter 2 reviewed some key findings about the existence and the principle of mastery in university research, this chapter will focus on findings about the existence and nature of material use practices. First, a general framework is presented to contextualize the previous work in relation to this study. Findings on end-user searching and information needs are then reviewed.

Previous information science research has already examined several aspects of knowledge work production (Figure 3.2.1). End-user searching research investigates issues concerning how material use practices make a body of knowledge available for work. Another area of information science research, "information needs," has explored aspects of the principle of mastery influences material use practices for work production. It focuses on communities of practice and conceptualizes material use practices in terms of the values of the communities. This chapter reviews relevant studies in each of these domains.

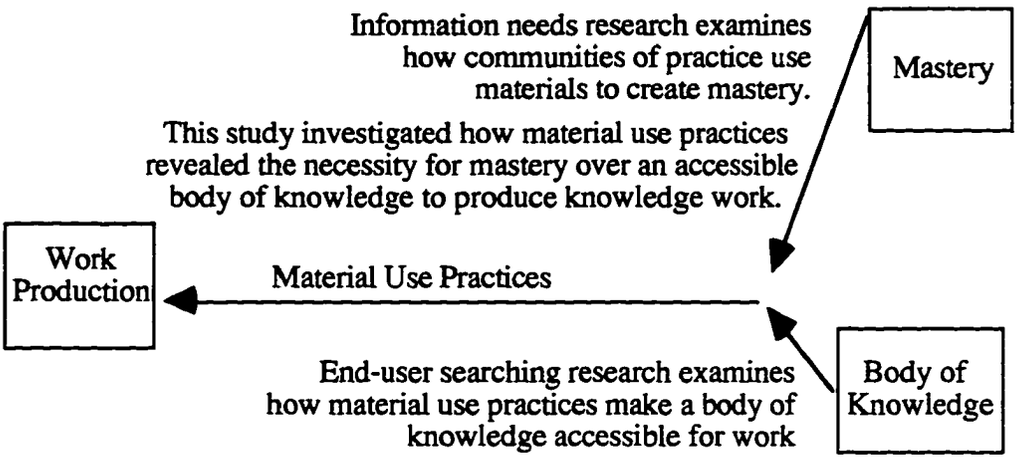

Figure 3.1.1: Framework for Information Science Research

3.2 The Study of Material Use Practices

One starting point to review work relevant to material use practices is Donald King's review of scientific and technical information communication studies (King 1994). He discussed studies of engineers' use of primary communications (interpersonal communications, books, articles, reports) rather than secondary services (databases, libraries, other resources). King makes an important observation that among these studies, the terms "information needs, " information seeking" and "information use" refer to different phenomena. Therefore, please note that this chapter reviews research programs and studies on material use practices, defined as individual behavior for selecting paper and electronic materials. Chapter 2 described the importance of considering the social arrangements surrounding this behavior.

King also characterized five research approaches that have been used to study scientific and technical information communication:

1. enumerate information sources used in a recent R&D task
2. measure information channels within and between organizations and subunits
3. chronicle the lifecycle of information as it passes through communication channels
4. explore a critical incident of authorship, publication, selection, location and storage
5. measure amount and characteristics of information exchanges between informants

This study combined the first and fourth approaches. Interviews examined a critical incident of authorship and then moved to enumerate sources including those not explicitly mentioned in the course of discussing the critical incident. This study differs from those surveyed in King's report by its data collection technique (face-to-face interviews in a field study) and its mode of analysis (data-driven theory evolution). These techniques are discussed in Appendix I.

3.3 Three types of Material Use Practices

Three major types of material use practices are described in this study: comprehensive searching, browsing and retrieving. In this section, I define these material use practices and describe the relevant literature surrounding them.

Bates (1979a; Bates, 1979b; Bates 1989) has conducted extensive inquiry into classifying and studying information searching. I draw upon six common search tactics she identifies that I will use as examples of these material use practices.

Table 3.3.1 summarizes the three definitions for the material use practices in this study. Comprehensive searching is defined as looking into or over the body of knowledge thoroughly in an effort to find and discover something. It chiefly consists of creating a complete list of all materials in the body of knowledge matching a particular search criterion. This method includes a variety of search strategies. For example, citation searching is a form of comprehensive searching. Citation searching consists of beginning with a citation and "forward chaining" to identify all materials in a body of knowledge that cite the original citation. A researcher using citation searching might use resources such as the Social Science Citation Index or the Science Citation Index to produce a list of materials.

Subject or author searches in abstracting and indexing databases (in this study called bibliographic databases) is another example of comprehensive searching. A researcher may connect to a database such as MEDLINE, Sociological Abstracts, Gary Perlman's Human Computer Interaction bibliography or even their own personal database of reprints and conduct a search matching all materials to a particular keyword, title word, author or other database searching field. To be more precise, comprehensive searching refers to the material use practice of creating exhaustive list, rather than simply accessing the database in order to find a call number or title (see retrieving). Another form of comprehensive searching is to use a World Wide Web search engine such as Yahoo or Alta Vista. These engines vary to the extent of what is indexed, how it is indexed and the reliability of accessing search results, but they generally produce at least a partial list of materials matching the search criteria.

In order to use comprehensive searching, a searcher requires access to a bibliographic database relevant to his or her interests. Comprehensive searching is generally used to

obtain a set of possibly relevant materials or to examine the nature of materials which match the search criteria.

Table 3.3.1: Definitions of Material Use Practices

Material Use Practice	Definition (in terms of this study)	Strategies
Comprehensive searching	Looking into or over the body of knowledge thoroughly in an effort to find or discover something **Requires:** Relevant bibliographic database	citation searching subject searching author searching World Wide Web search engine
Browsing	Looking into or over the body of knowledge reading random passages that catch the eye in search of something of interest **Requires:** Bounded subspace to search	area scanning journal run table of contents following hypertext links scanning materials
Retrieving	Getting and bringing back from storage something chosen for a reason **Requires:** Unique material identifier	reference chaining URL ftp electronic mail

This study defines browsing as looking into or over the body of knowledge reading random passages that catch the eye in search of something. Browsing includes several strategies. Traditionally, browsing referred to what Bates called "area scanning:" examining materials which are stored in visual proximity to each other such as books on the same bookshelf. In this study, researchers used browsing to review their own collections as well as those of departmental or campus libraries. Browsing an ordered set of books is not truly random, but often allows researchers to look into materials they may not have previously thought to examine.

Another common strategy for browsing was a "journal run." A journal run is the examination of a series of issues or volumes of a particular scholarly periodical (usually the table of contents and abstracts) to identify relevant materials. Researchers also used browsing when they examined the table of contents of the most recent journal issues each month or week that they arrived. Another strategy for browsing was to use electronic materials, such as home pages on the World Wide Web to follow hypertext links to related materials. In this study, browsing focused on following hypertext links only when researchers were conducting a purposeful search. Scanning footnotes and reference lists to catch materials of interest or read through parts of materials they examine is also another browsing strategy. Using these strategies, browsing preceded and followed retrieving.

In general, browsing is used to select materials or parts of materials that are relevant to a task at hand. Although one can browse without a specific purpose, random browsing is not explored in depth here. Some of these strategies may seem similar to comprehensive searching, but browsing differs from comprehensive searching in several ways. First, browsing generally provides more cues to the materials contents than comprehensive searching which is usually a computerized search. Another difference is that browsing usually is conducted over a much smaller set of materials than comprehensive searching. Browsing requires a bounded subspace which could include a list of materials from a comprehensive search.

Retrieving is defined as the practice of getting and bringing back from storage something chosen for a reason. Researchers used retrieving after selecting materials from comprehensive searching or browsing. Retrieving includes several strategies including "backward chaining" also called reference or footnote chasing. Researchers used backward chaining when they found materials in a reference list or footnotes that they wanted to

obtain. Retrieving is different from browsing because it entails borrowing, making an electronic copy or making a physical copy of the material.

Retrieving has not traditionally been considered a search strategy. However, it was a pervasive material use practice throughout the study. Researchers needed a unique identifier to obtain materials which included call numbers, a personal filing scheme or a URL (universal resource locator) to display an item from the World Wide Web.

3.4 End User Searching

End user searching research explains how material use practices make a body of knowledge available for work. End user searching is regularly reviewed in the *Annual Review of Information Science and Technology* so rather than survey the whole area of work, I will focus on several aspects of this research most relevant to this study.

In a review of online information retrieval systems, Hawkins characterized the study of search strategy to be the study of how a user communicates with a system (Hawkins, 1981). My study takes a different point of view. Although my evidence is based on individual reports of interaction with a system or a body of knowledge, I show how social factors shape how certain individuals accessed the body of knowledge and utilized the materials

End-user searching focuses more on the individual user interaction with a body of knowledge than the social aspects of that interaction. End-user searching includes studies

of online catalog use, software tools, training and other services. The studies of online catalog use have several findings relevant to this study.

> Subject searching is the predominant form of searching
>
> Users approach online catalogs expecting to find enhanced access to a broader field of materials
>
> Subject searches... often produce a large number of citations (Mischo and Lee 1987)

Although this study addresses more than just online catalog use, these findings are relevant to the use of comprehensive searching. The prevalence of subject searching combined with the orientation to using catalogs to find a broader field of materials suggests that the occasions for comprehensive searching are related to occasions when researchers, as experienced searchers, want to gain access to a large number or a broader field of materials. These studies reveal outstanding problems in online catalog: searchers get results which are too broad or nothing at all. My study addresses occasions on which they find online searching useful and not useful.

Bates proposed a model for information searching called "berrypicking" (Bates, 1989). She argued that real search behavior consisted of pursing evolving search needs with a wide variety of search techniques including but not limited to bibliographic database searching. The data in my study support Bates' model and further delineate the patterns and social influences that shape this behavior.

The STAIRS study (Blair and Maron, 1985; revisited in Blair, 1996) was a large scale case study of the utility of retrieved documents in a large corporate database for lawsuits. They found that document retrieval performance declined as document databases increased in size. They found the best case was when a searcher found 20% of documents that they could have found. In fact, they concluded that the immense system was used to manage

personal document collections rather than provide comprehensive lists of relevant materials. These results suggest that for intense environments for work production, comprehensive searching may be less important than retrieving.

In a review of "search failures" in document retrieval systems, Tonta examined studies based on "retrieval effectiveness" (measured by such variables as precision, recall, fallout, and relevance), "user satisfaction" (based on user judgments), transaction logs, and critical incident techniques (Tonta, 1992). Tonta observed that user satisfaction depended on both user, group, and search goals meaning the context of the search. This review provides support for the role of social factors in material use practices. Tonta also concluded that transaction logs provide evidence that users experience search failure because they are not aware that the document retrieval systems depend on access via use of a controlled vocabulary. Catalogs and databases are organized based on indices that are designated subject words, keywords, author names or title words. When a searcher uses his own words and queries did not match what the database can provide, search failure resulted. This finding suggests that both novices and experts in subject areas will experience at least some search failure unless they also understand how the document retrieval system is organized.

Much of the research on browsing in end-user searching studies the use of prototype systems. Cove and Walsh propose a system for browsing as an activity where a searcher only has a partially defined query (Cove and Walsh, 1988). In fact they define three types of browsing: search browsing (highly structured with a clear goal), general purpose browsing (routine browsing of specified sources) and serendipity browsing (random, unstructured). My study focuses on search browsing (such as browsing a research paper) and general purpose browsing (journal run or table of contents browsing). Other work in Human Computer Interaction and Hypertext research communities have examined other

approaches to organizing hypertext materials in new ways through filtering, foraging, information visualization and topological representations (e.g., Pirolli et al., 1996; Card et al., 1996). This study will not directly evaluate the proposals of these approaches, prototypes, or even older, well-known strategies such as intelligent agents (Wooldridge and Jennings, 1995) or information filters (DeClaris et al., 1994). Although at each interview I asked about use of features that embodied some of these approaches in the systems researchers used, there was little awareness let alone use of these features. Instead, my study provides data that will help designers evaluate their proposals in light of this evidence. Although it is difficult to predict the use of technologies which are currently being developed, material use practices change more slowly and may shape adaptation and customization in the short term.

3.5 Information Needs Research

Work on information needs in Information Science is often also called "user-centered" information retrieval or information use studies (Sugar, 1995). Two approaches to this inquiry Sugar classifies as cognitive and holistic. The studies that most inform this study are the holistic approaches which are rather individual-oriented (examines cognitive, physical and affective aspects of users). However, these information needs studies provide a starting point to investigate how the principle of mastery, particularly as social processes embodied in community values influence material use practices for work production.

My study most closely builds on Brenda Dervin's "sense-making" approach (Dervin, 1992; Dervin and Nilan, 1986). The sense-making approach views knowledge-workers as active creators of their own information. This is reflected in the labels for the three material use practices in this study labeled comprehensive searching, browsing, and retrieving to

reflect the active role these researchers take. Material use practices embody more than just the selection of materials. They empower the knowledge workers through the activity of selecting toward creation of their own unique collections which are embodied in work production outputs (papers, articles, reports, etc.).

Another example of how knowledge workers actively create information are organizational memory systems like Answer Garden (Ackerman 1994) in which seekers are accessing knowledge which they themselves create. This context is particularly relevant to my study because university researchers as knowledge workers contributed to the body of knowledge which they searched. They often used their own materials as well as materials of people who are known to them in work production.

Kuhlthau (1993) draws on user values work to produce a holistic study in the affective domain. Her approach is centered around the principle of uncertainty as a starting point for information seeking. Because information seeking occurs when a seeker has "uncertainty due to a lack of understanding, a gap of meaning or a limited construct." She also used a grounded theory approach to discover affective responses to information seeking. This study will extend these findings by examining social influences on information seeking through the principle of mastery as a mechanism to construct and discern meaning.

3.6 Summary of Review

Previous information science research has already examined several aspects of knowledge work production (Figure 3.1.1). End-user searching research has tackled problems concerning how material use practices make a body of knowledge available for work. My study explains why these problems persist, in the world of both paper and electronic

material use practices by identifying how the principle of mastery shapes access to a body of knowledge. For instance, my study provides evidence that highly skilled knowledge workers frequently prefer retrieving to comprehensive searching and browsing when they already have mastered the body of knowledge. My study also takes a user-centered view of digital library use and reframes the previous research from a research paradigm which examines interactions between users and systems to a paradigm which examines how people produce knowledge work in a community of practice. Another area of information science research, "information needs," has explored aspects of how the principle of mastery influences material use practices for work production. For instance, Dervin's sense-making approach (Dervin 1992) views knowledge-workers as active creators of their own information. This is particularly relevant to the study of university researchers who create the works that become part of the body of knowledge they access.

My study combines these two streams of work by investigating how the principle of mastery shaped material use practices. Although digitization of collections make new material use practices possible, it does not change the need for knowledge workers to select materials according to social norms of professional practice. Though the norms may change (this is not studied here), the role of the norms do not. The next four chapters illustrate how the principle of mastery shaped current practice in four research disciplines and identifies enduring influences on material use.

Chapter 4
Material Mastery in Molecular Biology

4.1 Introduction

In this chapter, I describe the first case: how the principle of mastery shapes material use practices in molecular biology. I will discuss the nature of work production in molecular biology, drosophila as a sample subspecialty and the material use practices in this discipline. The major findings of this chapter are that the mastery ideal in molecular biology includes the attribute that participants in active research have knowledge of both previous and concurrent research projects. The nature of biological discovery was so interdependent on sharing previous results that the body of knowledge upon which molecular biologists based their work was highly organized and standardized. All the molecular biologists used the MEDLINE bibliographic database which indexed the vast majority of relevant journals. Publishers and funding agents also mandated contribution of genetic sequences to GENBANK or similar other sequence databases which they widely used. The stakes were high for a molecular biologist to keep abreast of the latest developments in a subspecialty: researchers competed for multi-year grants providing support of at least $100,000 a year to be the first to discover a gene sequence, functions or structures of a particular model organism. Browsing the latest journal issue table of contents was very common (as was continuous communication with colleagues by telephone and electronic mail). Molecular biologists also used retrieving by photocopying articles or exchanging preprints by postal mail. Because articles frequently used graphics

to report results and biologists did not share common formats for exchanging electronic documents, molecular biologists relied primarily upon print materials.

4.2 Work Production in Molecular Biology

This section describes several features of work production in molecular biology: the flow of production, the ways researchers share inputs to production, the kind of output dissemination and how knowledge workers define their specialization.

Molecular biology as a discipline is a more recent subspecialty which grew from the discovery of DNA in the 1940s. This description provides an overview of the topic of inquiry:

> Molecular Biology is a field of science concerned with studying the chemical structures and processes of biological phenomena at the molecular level. Of growing importance since the 1940s, molecular biology developed out of the related fields of biochemistry, genetics, and biophysics. The discipline is particularly concerned with the study of proteins, nucleic acids, and enzymes--i.e., the macromolecules that are essential to life processes. Molecular biology seeks to understand the three-dimensional structure of these macromolecules through such techniques as X-ray diffraction and electron microscopy. The discipline particularly seeks to understand the molecular basis of genetic processes; molecular biologists map the location of genes on specific chromosomes, associate these genes with particular characters of an organism, and use recombinant-DNA technology to isolate and modify specific genes. (Britannica Online, 1996a).

Work production in molecular biology consisted of producing unique research results that were acceptable for publication in a set of molecular biology journals. Molecular biologists worked on biological phenomena building directly on preceding work. They established themselves in specialties through many years of specialized training after a bachelor's degree including positions as technicians, doctoral student researchers, postdoctoral researchers and sometimes experience in industrial labs. Molecular biologists identified themselves in a hierarchy by their doctoral advisor and sometimes spoke of being a member

of a generation of study in a particular specialty. Lab directors usually served as doctoral advisors for the doctoral students working in their labs. Lab directors were faculty researchers who coordinated the activities of the lab and facilitated close cooperation within the lab and with collaborators in other labs. Contribution to work in molecular biology was based on priority of discovery. Together with the temporal nature of biological materials, researchers were very concerned with coordinating their work with collaborators and if possible, competitors.

Molecular biologists shared inputs to work production. As a lab science, molecular biologists worked in lab groups that shared the same facilities and related research pursuits. They trained in laboratories run by faculty researchers who served as principal investigators of multiple grants providing total support upwards of $100,000 each year.

Because these researchers worked with biological materials which change over time, their work centered around access to their lab. They often worked on weekends in their facilities to support their tasks. They needed reliable access to biological, paper and electronic materials in their laboratories to conduct their work. Labs shared biological materials through centers that distributed biological material such as stocks, strains or cultures. They shared documents usually through fax or postal mail. They used electronic mail frequently to order biological materials or request documents but not to exchange documents. Some researchers used electronic mail to send reviews of journal, conference or grant submissions.

The output of work production in molecular biology appeared in a fairly homogeneous set of scientific journals. One set of outputs were short articles published in scientific journals chronicling advances that researcher teams had achieved. Molecular biologists coauthored most work which reflected the contributions of a variety of participants who worked on

different parts of the problem. Usually, the first author was the person who took the lead on the project and the last author was the faculty researcher that supervised the project.

Because molecular biology production builds so much on previous work, crediting previous discovery when reporting a new discovery plays an important role in work production. However, since journal articles are relatively short (see Table 4.2.1), researchers must make choices about how to credit previous work. Another distinguishing feature of publication in molecular biology was its typical frequency. *Nature* and *Science* were both weekly, *Cell* was biweekly and *Genes and Development* was monthly. Although the publication lag was much shorter than in other disciplines, molecular biologists were greatly concerned about coordinating publication with discovery.

Table 4.2.1: Profile of Molecular Biology Journal Sample[1]

Journal	Type of Submissions	Length of Articles	Prescribed Number of References
Nature	Reviews	6 pages	50-100
Nature	Research in Progress	4 pages	50-100
Nature	Research Articles	5 pages	50
Science	General Articles	5 pages	50
Science	Research Articles	5 pages	40
Science	Reports	1 page	30
Cell	Research Articles	3-10 pages	no guideline
Genes & Development	Research Articles	5-12 pages	no guideline

Another set of outputs were contributions to centrally maintained databases such as GENBANK. Publishers and granting agencies required that molecular biologists submit sequencing data to GENBANK before accepting an article for publication or renewing a grant. This public data was often repackaged for use in other specialty databases. The

[1] This data was collected from the following WWW home pages: Nature: (http://www.america.nature.com/Nature2/serve?SID=5115&CAT=Contacts&PG=Author/guide.html), Science: (http://www.sciencemag.org/science/home/con-info.shtml?alt), Cell: http://www.cell.com/cell/cellsubm.html), Genes & Development (http://207.22.83.2:443/cshl/journals/gnd/#d)

sharing of gene sequences was very important to the flow of production among molecular biologists. The following example illustrates how a field grew from the discovery of a homology (a sequence match) between different genes different researchers were studying:

> It's funny, for 5 years [we didn't have any competitors] not at all. And it turned out that this ... gene had homology to some other genes that people were studying. It wound up being very important and so now, it went from a field that had maybe 10 people working on it, to a field that has maybe has 100-150 people working on it which was both a blessing and a curse. It's a blessing in the sense that there's a lot more interest in it and in a way there's more money involved in it. But it's a curse in a sense that constant pressure to get something novel out. So yes, now there are many people working on it because of these genes. I told you it's what's called a transcription factor, it turns on other genes. It turns out that one of the those things it turns on is HIV - the AIDS virus. So this is a protein that controls the replication of the AIDS virus. So right away there's a lot of people interested. [RUMB1]

Conferences provided another forum for the dissemination of research results. Researchers were required to submit an abstract to present at the conference, but acceptance was open since most researchers waited until research articles had been accepted for publication in a scientific journal before announcing their results. There were also smaller invited meetings called "Gordon Conferences" run by a group of senior researchers to encourage open communication between researchers. At Gordon conferences, researchers examined the direction of advances in the field rather than producing results from discussions at the conference. Researchers who lived in metropolitan areas often attended city or regional research seminars coordinated via electronic mail. Some researchers found these meetings to be convenient opportunities to arrange face-to-face meetings with out of state researchers giving visiting talks.

Another key aspect of work production in molecular biology was the way lab directors coordinated specialization of their lab's work. Because of the need to coordinate publication with discovery, and the risk of another lab's result eclipsing their work, lab

directors spent a great deal of time (some reported 50%) communicating with collaborators (and sometimes competitors) on the telephone, over electronic mail and fax.

As a result, lab directors tended to know more about what other labs were doing than their staff members. Conferences (especially the Gordon conferences) supplemented the individual coordination laboratory directors maintained in order to produce contributions in their research subspecialty. Lab directors also coordinated collaborative projects with other labs. They shared biological material as well as paper and electronic materials.

Molecular biologists described their specializations in several ways. The most specific way was the particular problem they were working on such as identifying a structure, sequencing a particular gene, or determining the function of a gene. More broadly, molecular biologists work in research subspecialties focusing on molecular aspects of model organisms. In this study the majority of molecular biologist informants were drosophila (fly) researchers. I also interviewed researchers in other model organism communities including one c. elegans (worm) researcher and several e. coli researchers (see Appendix I, Table I.5.2). Although molecular biologists also identified themselves in terms of biochemistry, genetics, cell biology and microbiology, my analysis examines patterns within the model organism communities since that was the subspecialty to which researchers compared themselves.

4.3 Drosophila Subspecialty

Drosophila researchers as a research subspecialty in molecular biology, were an older subspecialty (than c. elegans), and had developed electronic resources for their work. This

section provides details from this subspecialty that illustrate specific aspects of work production in molecular biology.

> Drosophila melanogaster is a fruit fly, a little insect about 3mm long, of the kind that accumulates around spoiled fruit. It is also one of the most valuable of organisms in biological research, particularly in genetics and developmental biology. Drosophila has been used as a model organism for research for almost a century, and today, several thousand scientists are working on many different aspects of the fruit fly. (Manning, 1996)

Drosophila researchers study the fruit fly as a model organism.[2] They refer to their peers as "fly people" or the "fly community." Biologists have been working with drosophila for many years so as molecular biology has grown in importance, drosophila became a popular model organism. Compared to other model organism work, drosophila work was cheaper. A group at Berkeley was conducting the drosophila genome project to clone all the drosophila genome and then to sequence it. This would provide drosophila researchers a different starting point to focus on more experimental issues without having to sequence it first. This example illustrated how the fly community's work is expected to change as a result of a large scale effort to provide an exhaustive infrastructure for work.

Currently, the inputs for work include the sharing of biological materials through stock centers and documentation of sequence information through GENBANK. Drosophila researchers frequently mentioned using an electronic resource called FLYBASE usually via the gopher client software (it was also available on the World Wide Web). It contained contact information about the drosophila researchers themselves as well as the addresses of the stock centers. It was started in an effort to make a list of cloned DNA sequences

[2]Drosophila is more precisely known as the vinegar fly.

available to all researchers and put the data in the field-defining "RedBook" (Lindsley and Zimm, 1992) online. FLYBASE now includes:

- A bibliography of over 82,000 drosophila citations
- An address book of over 5,000 drosophila researchers
- Information on more than 32,000 alleles of nearly 10,000 genes
- Descriptions of over 12,000 chromosomal aberrations
- Drosophila genetic map information
- Information on the functions of gene products
- Lists of stock center and private lab drosophila stocks
- A listing of over 9,000 nucleic and over 3,000 protein sequence accession numbers
- Lists of over 7,000 genomic clones
- Allied databases
- Berkeley drosophila Genome Project data
- European drosophila Genome Project data
- The bionet.drosophila archives
- Drosophila Images
- Wild type drosophila strains and chromosomes (Flybase, 1996)

Most of the drosophila researchers primarily used the FLYBASE front-end to locate other molecular biologists or order stocks. For gene sequencing, most researchers used other computational resources over the Internet (such as BLAST or GCG) to match DNA and protein sequences in central databases (such as GENBANK, EMBL, FLYBASE data sets).

In terms of disseminating their results, drosophila researchers published in a similar set of scientific journals. Most molecular biologists subscribed to Nature, Science, Cell, Development and sometimes Genes and Development and Genetics. These major journals were also indexed in MEDLINE which was available at all universities in this study. In addition some researchers also used BIOSIS, a database with similar coverage of journals but was based on Biological Abstracts (produced by BIOSIS) rather than Index Medicus (produced by the National Library of Medicine). Both bibliographic databases provided a large percentage of abstracts in addition to citations.

Another means of disseminating work outputs were conference. There was a large annual research conference which they call the "fly meeting." They also attended a variety of annual conferences and often regional seminars. They shared with other molecular biologists materials such as biological indices, supported electronic and postal mailing lists and paper journal publications. In addition, they, like other model organism researchers had developed electronic resources for disseminating research results, reference resources and contact information unique to their subspecialty. In addition to personal electronic mail and regional seminar mailing lists, some researchers, particularly doctoral students, used BIONET newsgroups to discuss techniques, get help with problem solving or read announcements.

> BIOSCI [BIONET] is a series of freely accessible electronic communication forums (i.e., electronic bulletin boards or "newsgroups") for use by biological scientists worldwide. No fees are charged for the service. The system is intended to promote communication between professionals in the biological sciences. All postings to the newsgroups should be made in that spirit. While the general public may "listen in" to the discussions, these newsgroups are intended primarily for communications between researchers. There are other forums on Usenet such as sci.bio for the asking and answering of biological questions from lay persons.(BIOSCI/BIONET, 1996).

Although they sometimes found these newsgroups useful, faculty researchers sometimes found them too repetitive and chatty.

Drosophila lab directors resembled the other molecular biology lab directors in terms of coordinating the work of the lab and defining their specializations. However, one informant described an example of openness on the part of a leader in drosophila work:

> The field as a whole is cooperative - it has had to be and we were lucky that the huge movers and shakers like Jerry Rubin... did something.... In 1981, Jerry and Allen Spradler figured out how to transform drosophila ...absolutely necessary biological research. And it's like harder than hell to do. They figured out how to do it.... So what they did is that they announced it at one of these annual drosophila meetings. And of course, you can image how one might announce this. It's like the coming of the holy grail, you can do it to get everyone on their knees ...What they did was say okay,...Here's a 3X5 card going out. Put your name and address if you want the recipe and the stocks and we'll send them to you. I mean they went out of their way to be open, to be cooperative to be as helpful as they could be. Because they said look! we live on the fact that the fly community has existed and has made these mutations and has done all this work. We couldn't have done what we did without the fly community. We want to share and give back just you do and in so doing, of course, they set the tone which had already - they confirmed the tone. That this is a community that shares. The guy who started that was the guy who started flies and that's Thomas Hunt Morgan. He had a dictum to share views. {BSUMBS]

The drosophila subspecialty was a rather typical example of a molecular biology subspecialty. Although work in model organism communities also relates to cross-cutting subspecialties, these communities provided the locus for the development of mastery ability.

4.4 The Principle of Mastery in Molecular Biology

In order to participate in work production in molecular biology, researchers needed some level of mastery ability that included knowledge of both previous and concurrent research projects to make a unique contribution. Thus the level mastery ability depended upon several factors: credit for previous work, coordination between researchers and development of mastery ability within a lab.

In the following example, a molecular biologist explains his dilemma in wanting to cite a large number of materials:

> I was at the fly meeting, it was said that the first fly citation was 1657 at some monastery. If I could see that I would like to see it. If the library went back to 1657, I'd go look at it [laughs]....I like to go to the primary source, not quoted and requoted in some chain. And it's often said that so-and-so discovered so-and-so. You go back to the paper and you find out that, well actually, they're really taking up the lead for somebody ten years before that and so it's often not very true....I tend to overcite. I have a lot of stuff and editors will throw it out. I [substitute a group of citations with] a review... but if they let me, I'll do it....[HUMB3]

Besides space limitations, crediting discovery was also a political matter. Researchers submitting their work for publication concerned themselves with reviewer's preferences for citations. This researcher described the problem:

> What do you do when four groups claim the same [discovery]? Who do you choose as being the one that gets the credit? So I would like to cite all four because I don't know which one of those four guys is going to be reviewing this paper [laughs]. If I can just make everybody happy, why not? And so the editor turns around and tells me I can't. [HUMB3]

In molecular biology, most journals did not accept references from abstracts of talks presented at conferences, and personal communication citations required documentation for the journal publishers. Thus work production involves the necessary complementary ability of knowing about citation practices for crediting discovery.

In order for molecular biologists to have knowledge of work in progress, they needed to cultivate collaboration and be aware of competition. These tensions are documented even in early accounts of the field (Watson, 1968). The ways that molecular biologists reported their results often depended upon how similar work was progressing. This researcher describes how he handled such situations:

> In a competitive situation, where three years worth of work may become completely worthless, if you work came out 15 days late, ... that happens all the time. Under those circumstance, you try your best to talk it out and see if it wasn't possible to send it to journals in a coordinated kind of way so that things come out at about the same time. So that's a very unpleasant situation usually. Sometimes it can be interesting because you are looking at something from one point of view and someone else is looking at it from a totally different point of view but your points of view coincide at the end and then you do some negotiations to make sure those come out at the same time. [BSUMB2]

The lab directors' role of meeting with other lab directors, funding agents and other colleagues facilitated this coordination. Lab personnel sometimes did not have the access or influence to coordinate publishing activities. The division of labor within the lab allowed the lab personnel to develop wet lab and computer skills to produce discoveries while the lab director facilitated the ability to perform this work. Molecular biologists frequently shared preprints (after an article was accepted for publication) which they used to supplement oral reports of forthcoming findings. Informal as well as formal communication contributes to coordination of work between labs and thus plays an important role in the communication of mastery ideals and the evaluation of mastery ability.

Mastery ability in molecular biology was developed through intense social interaction. Not only did lab personnel all depend upon the lab director to find resources and help them coordinate their work, but they developed mastery ability from the lab director and from others in the lab. Molecular biologists in a lab worked on related projects and thus shared materials, assisted each other with lab techniques, and communicated with each other over the course of the work day in the open setting. Usually a lab included students, researchers and technicians with various levels of experience. This setting provided a variety of skill levels within the group. Even though lab directors tended to do less wet-lab work, they perceived that building a good staff was critical to successful work:

> There's no way you can be competitive in this area without a fairly good cohesive research group [FSUMB3]

One way that lab personnel developed mastery ability with each other was through journal clubs. Here a researcher described how the lab works as a whole to decide on the relevance and direction of their work in relation to published articles:

> I have ... photocopies circulated amongst the people in the lab. And then they chose one or two papers out of those approximately 4-5 papers per month on which we do a journal club. So that's when we get together and discuss the whole paper. So whenever there is something which is very closely related to what we are doing, we, the whole laboratory, all seven or eight or whatever the number of us get together and we discuss that article and decide on the plus and minus points of it and so on and so forth. [BSUMB2]

Although lab directors had their own private offices, they made computer equipment and high-speed network connections available for their personnel in the lab facility. Lab directors often sought personnel with specific computer skills for genetic sequencing or controlling equipment that had been connected to computerized data gathering devices. In fact, many molecular biologists commented that undergraduates in molecular biology had fewer computer skills than expected.

> My one graduate student that I have now... started out computer-savvy and she has taken advantage of everything that has come along so she's probably the best person in the lab in terms of that kind of information. And my postdoc...is also. He's done all the setups... and all the computer stuff there. The person who just came in has a terrible fear of it.... And I have to say, I am shocked by the fact that half my undergraduates also have terrible fear of it. [FSUMB2]

In this following example, a researcher who had a high level of mastery ability in terms of keeping track of what's happening in her field mentioned that her students used the computer resources (meaning MEDLINE) to keep current.

> I wish I were using the computer technology more than I actually am. And I happen to be particularly good at the old method which is keeping a lot of information in this hard disk [motions to her head] and you know it takes some amount of energy to and time to just learn how to use the new methods and sometimes I don't get around to it, but my students do. [HUMB1]

In summary the interdependence of molecular biologists on other labs and previous work combined with the necessity to coordinate that work within and between labs shaped what constituted a mastery ideal in molecular biology. The ways researchers credited previous work, negotiated publication of competitive results and developed skills for mastering materials in molecular biology showed how researchers attained knowledge of previous and concurrent work.

4.5 Material Use Practices in Molecular Biology

In this section, I analyze data about three material use practices and show how mastery ability level shapes them. Informants judged mastery ability against the mastery ideal in molecular biology. One attribute of the mastery ideal that figured prominently in this study was that participants in active research have knowledge of both previous and concurrent research projects. This typical report of material use illustrated a progression: comprehensive searching (via MEDLINE) to create a bounded search space, browsing (of abstracts) to identify which materials in the space are relevant and retrieving a copy of the full article (by photocopying it from the library) to create a highly accessible collection. This informant perceived the benefit of online documents to be the accessibility of the material (retrieving) more than the searching or browsing:

> I'm hooked up through my, in here it's hooked up to the university computer and so I can do MEDLINE searches from here. So I can get up to the abstracts right here. And then I can print the abstracts out right here and most often will just look at that and see whether it is important or not. If it looks important then someone will go to the [Biology Branch] library and Xerox a copy. Having the whole article online would have been very nice. [BSUMB2]

Molecular biologists used bibliographic databases for comprehensive searching, browsing and retrieving. Researchers used bibliographic databases for comprehensive searching when they knew little about the topic for which they were searching. They used browsing extensively for identifying published materials in databases and journals to which they subscribed. Mastery ability enabled browsing by providing researchers an orientation to materials they could move through quickly. Molecular biologists used retrieving to amass collections of reprints and preprints that were easily accessible and more closely reflected their subspecialties than the wider contents of the journals and databases they used. They used bibliographic databases for retrieving materials in their own collections when they needed to find locator information (author, title, date, etc.). Mastery ability was necessary for retrieving since aside from using databases to facilitate locating the material, researchers had to know exactly what they wanted in order to photocopy, request or otherwise obtain the material. Despite good access to computer equipment and high speed networks, there was not yet a common infrastructure for molecular biologists to share electronic materials widely.

4.5.1 Comprehensive Searching

Molecular biologists relied upon comprehensive searching when they were using materials having to do with previous work in areas less familiar to them. For instance researchers described the occasions of using comprehensive searching as times when they were

searching for evidence. This researcher categorized his MEDLINE searches as motivated by a new finding or confirming what they already know to be true.

> [Doing a MEDLINE search] usually has to do with either something interesting, like Hey, we just found something that we never knew about. Let's see if we can find a little bit more. Or there's something incredibly frustrating, like, Hey, we know that this is true. There's got to be a reference for this somewhere. How do we find a reference? [RUMB1]

Another researcher depicted his searching as helping him refamiliarize himself in an area he did not usually work. This report depicted the value not only of producing a list of citations but also implied that the value of the database was to also provide the capability for researchers to browse abstracts encapsulating the findings of the articles.

> I teach better for having a computer because I sit down and think I have to teach a lecture ... and I'll run onions [not his specialty] through MEDLINE and find what was published since I last gave the lecture a year ago. Or get a review out of an review journal, the latest review so that when I walk into the class I am up to date whereas otherwise it would be incredibly hard to give 40 disparate lectures a year be up to date on 40 fields. [HUMB3]

Another important aspect of this report is that the researcher felt that he could reasonably rely on MEDLINE to keep up to date in fields outside of his specialty. Although I have previously pointed out that researchers could not afford to only rely upon tracking publication and indexing to keep up to date with concurrent work in their specialty, MEDLINE did function as a repository for researchers to begin to explore related areas, or develop mastery ability in a different field.

Another occasion for searching is when researchers wrote grant proposals.

> I use my personal library more heavily for manuscripts but for writing grants, I'll use literature searches much more heavily...[because] I'm just making sure that the statements that I make or that the ideas that I have are sound. [TUMB3]

Particularly when junior faculty were applying for their first grants, they had to demonstrate a minimal level of mastery ability to show promise of future findings. This example illustrated how even before this researcher had access to an online database, he used "the old MEDLINE," Index Medicus in paper format to perform this necessary task.

> At that stage as far as projects go, the first grant that I wrote, literature searching, where it was done, manually, the hard way. The librarian searched things out, used MEDLINE, Science Citation Index, Biological Abstracts. At that point - the library -- it still does, has the old MEDLINE on books - quick index form. Also, certain ... key articles served as references to themselves by simply looking at the bibliography there, as well. Then, what we made, as I said, a discovery, around two or three years after that - that light's a requirement [for the process I study], for instance. That sort of opened up a lot because that now we had a phenomenon we could study. [DSUMB1]

Another researcher also reported that she would draw upon her knowledge about relationships between researchers to us comprehensive searching. She also reported using both online database searching and searching reference lists of review articles as complementary techniques. Because lab directors often appeared as the final author in a multi-authored paper, searching by lab director as author provided a history of work that has been conducted by a particular lab.

> I've been in the field long enough now, I would search [Researcher3] ... or [Researcher4]. I wouldn't search [Researcher5] or [Researcher6] because ... [Researcher4] was a postdoc in that person's lab and so they're often doing totally other things... Or [I would go] to a recent paper on the same subject and I'll see what references they have reviewed. [FSUMB1]

Other researchers reported varying results from using comprehensive searching. One molecular biologists characterized his use of MEDLINE as looking for surprises. He said only about 10% of his searches yielded surprises for his work.

Every molecular biologist in this study had used either MEDLINE or BIOSIS for searching but had varying levels of regular use. Several problems reported with MEDLINE were

characteristic of problems with comprehensive search. For instance, one researcher expressed frustration with the problems of finding the indexed keyword in a search. Authors sometimes provided nonstandard or popular keywords to a publisher for their works which made it hard for researchers to locate articles using comprehensive searching Even mastery ability of the most precise keywords would not improve the usefulness of a comprehensive search in this case.

> If you do a number of searches, you can eventually find everything, but it is frustrating because I've known several times that there is an article on this subject and I can find it and eventually I get it. It's because it was filed under some different kind of topic. So you wonder how often you're missing things that would be relevant to my one concern. [FSUMB3]

In summary, the principle of mastery shaped molecular biologists' use of comprehensive searching in several ways. In areas outside of a researchers' subspecialty, comprehensive searching in conjunction with browsing of abstracts provided a way to familiarize themselves with a continuously growing body of knowledge. When they were searching for confirming evidence, comprehensive searching both of online databases and of reference lists in review articles provided a way to locate lesser known materials. Also, the comprehensiveness of the MEDLINE and BIOSIS databases which index the major common journals these informants read and in which they published allowed comprehensive searching to provide a common database upon which they could depend. The mastery ideal in molecular biology included comprehensive knowledge of previous work in their subspecialty. Comprehensive search however, was most useful when researchers had needs outside their subspecialty. Because work production in molecular biology depended upon sharing research advances, comprehensive searching of a multi-specialized body of knowledge provided a frequently used resource to develop mastery ability in a new area through limiting the search space. When researchers attained a high level of mastery ability in a new area, it replaced the need to use comprehensive searching.

4.5.2 Browsing

Molecular biologists used browsing to keep abreast of publications in their specialty. They used browsing to examine table of contents and abstracts of paper journals to which they subscribed. They also browsed abstracts in online databases. In fact, because of the nature of their publications, browsing could be a predominant mode of use of documentary materials since articles were short, and presented data in display format (diagrams, photographs) which facilitated browsing. In addition, because laboratory personnel frequently collaborated, they often helped each other identify materials through browsing which often leads to journal club activities (see previous section). A high level of mastery ability over previous and current research enabled molecular biologists to browse. Because they were familiar enough with their subspecialty, they could move through the search space quickly identifying materials for retrieving.

In the course of the interviews, researchers frequently revealed the means by which they discriminate the quality of work they were browsing. The following example illustrates how one molecular biologist used the scientific value of reproducibility of results and applied it to his evaluation of a search space.

> Interviewer: How do you judge good science?
> It's obviously personal....I think it's based solely on experience. I look at something it looks like the experiments are done well.... does this make sense? There are a huge amounts of papers out there - you got to sort through something some way....[If] a number of people have now started to work on this, it started to be duplicated and more and more people studying something, the likelihood that they're right increases. [RUMB1]

Although some researchers had a difficult time articulating their criteria, in order to produce work in their subspecialty they had developed a high level of mastery ability over the

literature which they applied to browsing tasks. Here is another example that shows how a researcher developed confidence that no one had explored a particular phenomenon before:

> I was pretty sure nobody had done it. [I was sure] because in a previous publication I stated that it was random and then another publication from another group had the same observation. [TUMB3]

Browsing played a key role in molecular biologists ability to work with a body of knowledge which often seemed quite generalized, even to them. For instance, most biologists used MEDLINE which indexed the vast majority of materials they used, but also included much more. Some molecular biologists were unfamiliar with limiting searches to certain journals or set of journals and complained about limitations of the database due to searches that yielded too many results.

The following example shows how the development of a new field of cancer research, cell death came to the attention of one molecular biologist through routine browsing. He contrasted this with the emergence of interest in a new field due to a discovery of a link to something on which an "important person," meaning a person who is well-known and has lots of resources, is also working.

> I wouldn't say that [the increase of interest in cell death] was driven by an important person, though....So there were a lot of journal [articles], it was talked about at meetings a lot of times and was starting to be reviewed a lot, in Nature, News and Views, things like that. There were starting to be a lot of editorials on cell death and why it was important, reviews about the subject so it developed a life of its own [sic] kind of as a field. [RUMB1]

The following example is from a molecular biologist who preferred to work with primary materials and was concerned about citation accuracy. He described how biologists reduced discoveries to popular citations and have a tendency to browse for a citation rather than reading the paper.

> HUMB3: There's for instance this guy, this guy's at [neighboring school], commonly credited with discovering the first [finding] in 1976. Actually in 1975, it was discovered independently in Argentina, published in Spanish. Nobody knows that because it's a long way away and they are politically unimportant - they get no credit.
> Interviewer: And how did you come to find that?
> HUMB3: Because they were honest and cited it in the 76 paper. But if you don't actually read that you can just reiterate - such-and-such was discovered by ([], 76) so that's the paper that he reads. A lot of people don't really read it, just cite it.

Researchers often depended upon lab personnel, collaborators, friends and family to share useful materials retrieved in the course of their browsing practices. This example was a faculty researcher who browsed Usenet newsgroups, a task usually more characteristic of doctoral students (though this faculty member works at a relatively resource-poor research university). He described what he valued in this browsing:

> There's a molecular biology methods newsgroup - that one is always very busy. That gets close to being - every time I've used it - it maintains about a week's worth of messages (250-300 messages there constantly). They're quite useful. People are always saying, I can't get this system to work or this gel working and you look at it. Sometimes I'll participate but other times I'll just scan it to see if there's anything useful and I'll see the same exact problem I'm having and the next person will have solved it. [DSUMB1]

This example is also interesting because it shows the development of mastery ability through intensive browsing of a large body of material. The opportunity to share the development of mastery ability across labs and institutions offered a value to a researcher who didn't have the particular problem-solving skill in his own lab.

In another example, a researcher relied upon her husband who collaborated with her to identify useful innovations into her lab techniques. Here she described how she capitalized on his exploration of new techniques to work with materials.

> I would say I'm not totally [savvy about electronic resources]. It's mostly because my husband is really quite into it and I only take advantage of it once I decide I need something or somebody shows me - this is how I did it. The most recent things where we - these are our gels that we actually took pictures of. Now we scan them in. So this was 8 months ago. We, at the time we did this, we had tried some scanning and it turned out really well and so in the end we decided to go completely.... [FSUMB2]

In summary, molecular biologists aspired to the mastery ideals of their subspecialty and thereby applied their mastery abilities in the course of browsing a variety of materials. They browsed journal articles, online database abstracts, editorials, Usenet newsgroups and results in the papers themselves. They also capitalized on browsing activities among their lab personnel and collaborators. Because browsing was a more intensive use mode than comprehensive searching the combination of examining materials for specific results and the ability to capitalize on human resources helped facilitate effective browsing to keep current on publication in the subspecialty.

4.5.3 Retrieving

Molecular biologists used retrieving to select the vast majority of articles they want to utilize. They used retrieving because they valued accessibility and they needed to be able to examine high quality reproductions of published and publishable data. In addition retrieving in molecular biology was usually drawn from the common group of widely-read publications. Informal communication sometimes resulted in preprint sharing of work under review (read by research reviewers) and work accepted for publication.

Molecular biologists created their own collections of reprints. Sometimes researchers used MEDLINE to identify materials in their own collections. Several informants created their own personal database to keep track of their preprints which they would use for

comprehensive searching. Another means for locating an initial collection of materials was when researchers used their own papers to track down previous references they had used.

In this example of retrieving, the molecular biologist culled articles from his journal subscription, creating his own binders of relevant work.

> I ... go through [articles] as the journals come in. I will scan through their indexes to find articles that seem like they're relevant to what we are doing, and then I photocopy those abstracts. Then I make a little book like this [shows me a binder]. So this has photocopies of whatever I felt was important, according to that month or the two months, or whatever. [BSUMB2]

In effect, the researcher had created a body of literature in his own specialty quite explicitly.

In this example, the molecular biologist started with the manuscripts in his own collection and supplemented his work by using searching (though not comprehensive) to identify a result or a citation to confirm his evidence.

> The way it works with for me - I use my own personal library for the initial sort of creation of the manuscript. And then in the writing of it, I often need to double check statements and so I'll do a literature search recalling a paper that I read but didn't photocopy for myself, just to confirm things. And just to make sure that statements are sound. [TUMB3]

Retrieving activities also ensued from contact that researchers had with each other at conferences and meetings. The previous account of how Ed Rubin disseminated important findings at a fly meeting was exceptional in the way the result was announced, but typical of the way researchers reported obtaining articles directly from authors. Molecular biologists used retrieving to obtain materials from databases besides research results. They used FLYBASE to obtain contact information and MEDLINE to examine the work coming out of a particular lab also sustain work production.

Retrieving required a high level of mastery ability over what the body of knowledge contains. Not only did researchers need to know the nature and relationships between the materials in the body of knowledge, they also needed unique location identifiers to retrieve a document. For instance, they needed to know how a paper would be filed in their reprint collection, a combination of search criteria to locate materials in a database or a particular URL to examine a home page on the Web. Comprehensive searching provided an access mechanism when a researcher did not have enough information to retrieve materials. A referral from a colleague was another type of access mechanism that provided identifiers.

Retrieving also required a minimal level of mastery ability in the sense that researchers did not actually use a material unless they could integrate it into their work. For instance if a molecular biologists retrieved some recent work performed by a competing lab, he or she needed to draw upon mastery abilities to be able to make decisions about judging the work relative to his own such as how to proceed with his own work and publish his results.

Personal relationships between researchers played a role in their willingness to cite one paper or another. Thus researchers favored browsing and exact retrieval of certain researcher's materials (materials coming out of a particular lab) over comprehensive searches of all researchers.

Molecular biologists typically subscribed to between 6 and 10 paper journals in their area. Because they stored these journals in their laboratories, articles were available for immediate retrieval upon demand. When they needed articles from older issues or journals they don't own, the biologists found them in departmental or campus branch libraries (usually located near the laboratories) to which they often had free access to around the clock.

Molecular biologists valued the ability to retrieve abstracts (usually following a MEDLINE search) and they were eager to retrieve to the full-texts of journals online (at that time, there were some preliminary CD-ROM distribution from the publisher). In this example, molecular biologists privileged retrievability over publishing results in color.

> This is the only one [article] that I have a lot of color and I'll never do it again because it costs so much money - it cost $8,000 to publish this paper. Some of the things you can do without color. But in fact, when we all have the ability to bring these things up electronically, so we don't have to have the journal and the problem is that what our method of communication is. We send these articles out, they're in the journals, people Xerox them and give them to their students and read them. And nobody can make sense of them because you can't see poop because this person just Xeroxed this for me and it has these color figures and you can't see anything. I can't tell where anything is. So it sucks. And so anytime you can get away with, in fact, my argument, [indistinct] argued me out of it, I said he should make these gray, these white and those black. Then you could Xerox it. Soon we won't have that problem. [FSUMB2]

Retrieving offered molecular biologists a chance to narrow their field knowledge by collecting articles most relevant to their work. Browsing and Retrieving often overlapped because of the need to identify specific results from a much more general corpus. Retrieving materials offered molecular biologists a reliable access method to work with a specialized set of materials in their specialty.

4.6 Summary of Material use practices and the Principle of Mastery

Molecular biologists worked in a competitive discipline where work production required a minimal level of mastery ability including knowledge of previous and concurrent projects (Table 4.6.1). Researchers developed and sustained mastery ability in molecular biology by working in laboratory groups and keeping in close touch with others in their field through conferences, personal contact (telephone and e-mail) and journal publishing.

Table 4.6.1: Mastery Ideal in Molecular Biology

Discipline	Attribute of Disciplinary Mastery Ideal
Molecular Biology	Molecular Biologists have knowledge of both previous and concurrent research projects to make a unique contribution

The principle of mastery in material use in molecular biology reflected disciplinary aspects of work production. Although MEDLINE was widely used, comprehensive searching was not its chief role. Molecular biologists used comprehensive searching to familiarize themselves with new areas if they were teaching something out of their specialty or if they found a result that spanned specialties. Molecular biologists did not use comprehensive searching widely because attainment of a working level of mastery ability replaces it. However, molecular biologists widely used browsing. They used browsing to examine journal tables of contents when new issues arrived, abstracts obtained after a partial search, and full articles when researchers were scanning for a particular result. Browsing helped molecular biologists sustain their mastery ability through supporting their knowledge of current research issues and published work in their specialty. Researchers also used extensive informal communication channels as well as conferences and meetings to keep in touch with concurrent work. Mastery ability enabled browsing because it allowed researchers to move through a large body of work quickly. Molecular biologists used retrieving to amass collections of articles and preprints which they reported using as reference sources of first resort. They would use databases or trust memory to find articles in these collections. A minimal level of mastery ability was necessary for retrieving since the researcher needed previous knowledge of the relationship of material to work in order to locate it.

Table 4.6.2: Material Use Practices In Molecular Biology

Discipline	Comprehensive Searching	Browsing	Retrieving
Molecular Biology	Researchers searched MEDLINE for grants and in new areas	Researchers browsed tables of contents of subscribed journals to keep up with field	Researchers copied articles and shared postal mail preprints with trusted peers
The Principle of Mastery in Molecular Biology	Comprehensive searching helped researchers gain knowledge of areas outside their specialty	Browsing helped researchers keep current with newly published results	Retrieving helped researchers create a more field-specific corpus to use

Chapter 5
Material Mastery in Sociology

5.1 Introduction

In this chapter, I describe the second case: how the principle of mastery shapes material use practices in sociology. I will discuss the nature of work production in sociology, social networks as a sample subspecialty and the material use practices in this discipline. The major findings of this chapter are that sociologists must attain and sustain mastery ability in multiple subspecialties. Sociology is a multiparadigmatic discipline. As such some sociologists followed a humanistic approach and others worked with a scientific approach. In addition, sociology often tackles topics of popular interest and topics of interest to a wide range of subspecialties in sociology and other academic disciplines. The sociologists tended not to use comprehensive searching in their own subspecialty, but often used it to develop some level of mastery ability in other subspecialties. Comprehensive searching helped sociologists develop mastery ability because they could use results to get a snapshot of how other subspecialties studied or discussed a common research problem. Browsing supported the application of mastery ability in a sociologist's own subspecialty to a related area in popular or out of specialty materials. Retrieving tended to be centered around borrowing or purchasing books and photocopying articles. Sociologists tended to rely on retrieving to focus the selection of materials for work.

5.2 Work Production in Sociology

Work in sociology was organized around the study of social behavior. The output of work production included both research articles and books based on findings about social behavior. Sociological research concerned topics which had broad interest outside the specialty area, though the approach and conceptualization may not always be easily understandable by a lay person. The following excerpt describes the way this issue influences the character of the discipline:

> It is evident that sociology has not achieved triumphs comparable to those of the several older and more heavily supported sciences....The true situation appears to be that in some parts of the discipline...there has in fact taken place a slow but accelerating accumulation of organized and tested knowledge. In some other [parts of the discipline] the expansion of the volume of literature has not appeared to have had this property....Bias, in more than one direction, is sometimes presumed to be a chronic affliction of sociology. This may arise in part from the fact that **the subject matter of sociology is familiar and important in the daily life of everyone**, so that there exist many opportunities for the abundant variations in philosophical outlook and individual preferences to appear as irrational bias (Britannica Online, 1996b)

This excerpt indicates that the broad interest in sociological inquiry undercuts its potential legitimacy. In sharp contrast to computer science where external interests provided support for research, sociological inquiry has been to a large extent absorbed into other research disciplines where funding is less focused on social behavior and more focused on social behavior in a particular context. Sociologists also repeatedly pointed out that the discipline as a whole lacked a common core of knowledge.

As a multiparadigmatic discipline, sociology encompassed several approaches for inquiry. This study included informants who used experimental paradigms, simulations, modeling, statistical analysis, historical and qualitative analysis. These informants' work tended to be project-oriented, focusing on theoretical development or analysis of different kinds of data.

Sociologists spoke of "getting papers out of" projects. In this example, a sociologist described a shift in his work from secondary to primary data analysis.

> I think part of [the shift in his work from analyzing secondary data to collecting his own data] is that if you have the opportunity to interview these people, it gives you more information. But the problem with that is that you have to have some funding to do that. [FSUSOC1]

Grants helped sociologists purchase data sets, collect data, analyze data, collect supplementary materials or collaborate with distant colleagues. Sociologists in this study varied in terms of grant funding. The majority of the 24 informants were not currently funded by grants. Several had grants brought in about $25,000-60,000/year. Several other sociologists had grants over $100,000/year for large or multiple projects.

Many of the sociologists collected their own data, but some acquired data sets from public or private sources. Some sociologists created computer programs for analyzing data, or creating simulations. Others worked with computers much as they would have 20 years ago, using statistical programs to computationally analyze large data sets, though in recent years the resources they needed had become faster and more affordable. Some sociologists explored interaction in networked computing environments. Others used their computing resources primarily to prepare papers, communicate with colleagues and search for library materials. Some sociologists drew very heavily on materials they used in their doctoral training which provided them an initial set of materials to draw upon.

Sociologists who worked with data sets were starting to use the World Wide Web for retrieving data or papers from certain study centers.

> But in terms of research, it's primarily going into home pages of say, population centers, say Wisconsin, Michigan. They have available, say their working papers, their working paper series that they have so I can see those... [HUSOC2]

However, most of the sociologists in this study were using computer networks more for electronic mail and accessing library-oriented resources than creating their own Web pages. There was a dearth of discussion lists, Usenet bulletin boards, electronic journals and World Wide Web pages on sociology at the time of this study.

Sociologists disseminated research contributions via two publication models: refereed articles and books/monographs. Whereas in some humanistic fields, a scholar might publish a much-revised version of her dissertation as a first book, a post-dissertation project was necessary to establish a legitimate contribution in the sociology book publication model. However, criteria for credit varied in different university departments.

Sociologists also attended conferences but did not cite conference papers frequently in their publications. In fact, submission of conference papers at some meetings was optional and although there were formal and informal arrangements to obtain copies of papers presented, proceedings were not always available as such. Here is an example of how one informant described his use of conference papers.

> [About receiving paper preprints] Not really, not unless I request it... It gears up a little bit around conference time too because you miss all these paper sessions and like the titles, so after the conference, you [request them]. Of course they never actually have finished the papers they're presenting... You ask them for a paper at the conference, they say, can you write me for that and I'll send it to you later, you know [laughs]....Yeah, they're presenting some draft of the paper at the conference because often times all you need is an abstract. The abstract sells enough to get on the program . There are some conferences like ASA that actually require a paper be submitted [HUSOC3].

The output of work production in sociology was spread across multiple specialized publications. For high visibility and prestige, sociologists submitted findings to several widely read outlets: American Sociological Review (ASR) published by the American

Sociological Association (ASA), Social Forces published by the Southern Sociological Society, and the American Journal of Sociology (AJS) published by the University of Chicago. In addition, sociologists also published in specialty journals, gave papers at the ASA annual meeting and specialty conferences, wrote books and contributed book chapters.

> Before I got tenure, that would be ... a seven year output, I had about 12 refereed articles, something like that, 6 book chapters, and there were two Social Forces and one ASR. So that probably gives you a fairly good sense... But then in the last year, two books have gotten done. Between about October and February I got an edited book out with my colleague... and then also a solo book out that had been kind of laying around and hadn't gotten finished, you know, but I finally got it done. And then in addition to that, there's a couple other journal articles have been accepted. And now I'm backed up and I haven't been able... one of them is accepted pending revision...So I'll probably be able to get a couple of journal articles out.... I'm getting asked to do more chapter text, I've been invited to and stuff. [FSUSOC1]

Instructions to contributors for journals commonly mentioned by the informants showed no explicit page length limit or number of reference limit. However, the length of abstracts were limited, probably because of abstracting and indexing services. Many sociology journals also require a $15 submission fee. Compared to the cross-cutting journals (ASR, AJS, Social Forces), social network journals printed shorter articles (in terms of number of pages and references) and there was no submission fee. Contemporary Sociology (CS) was a popular journal among sociologists since it reviewed a broad range of relevant books. For instance, in a special issue on the 10 most influential books, CS reviews included Foucault's *Discipline and Punish*, a book of great interest in philosophy, literary theory and sociology, and the Boston Women's Health Collective's, *Our Bodies, Ourselves*, which is more a popular reference manual about women's health than a formal research contribution.

Table 5.2.1: Profile of Sociology Journal Sample

Journal	Type of Submissions	Rough Average Length	Rough Average Number of References
Social Networks	Research, Reviews, Commentary, etc.	Papers: 15-25 pages	36
Mathematical Sociology	Research articles	20-30 pages	40
American Sociological Review (ASR)	Research Articles (by topic)	Papers: 20-30 pages Others: 8 pages	51
American Journal of Sociology (AJS)	Research Articles Book Reviews	60 pages	71
Social Forces	Research, Reviews, Commentary, etc.	20-30 pages	60
Contemporary Sociology (CS)	Book Reviews only	2-5 pages	n/a

Sociologists described their specialties in terms of methods they use or topics they study. The multiple diverse subspecialties are shown in the following list of "sections" which organize and meet around the annual ASA meeting:

Table 5.2.2: List of ASA Sections (Subspecialties)

Alcohol and Drugs
Asia and Asian America
Collective Behavior and Social Movements
Community and Urban Sociology
Comparative and Historical Sociology
Crime, Law, and Deviance
Environment and Technology
Family
International Migration
Latino/a Sociology
Marxist Sociology
Medical Sociology
Methodology
Organizations, Occupations, and Work
Peace and War
Political Sociology
Political Economy of the World Systems
Racial and Ethnic Minorities
Rational Choice
Science, Knowledge, and Technology
Sex and Gender
Social Psychology
Sociological Practice
Sociology and Computers
Sociology of Aging
Sociology of Children
Sociology of Culture
Sociology of Education
Sociology of Emotions
Sociology of Law
Sociology of Mental Health
Sociology of Population
Sociology of Religion
Theory
Undergraduate Education

Because sociological research cut across multiple subspecialties, it demanded that sociologists keep current in multiple, diverse fields to address not only related topics from general discussion, but also to address findings from other areas. The tension between specialization and generalizing from different specialties was particularly evident in interdisciplinary projects.

This sociologist was exemplary of social scientists working on interdisciplinary projects. Her project emerged from two established areas: sociology of education and sociology of the family. She had attained a minimal level of mastery ability in both areas. However, because her project entailed examining links between a variety of institutions, she needed to develop mastery ability in these related specialties to be able to address her central inquiry.

> So although it's allegedly on [social group], it's really on the linkages between [social groups] and institutions. When I was at [Alma Mater] I was well-trained in both education and family. So I was pretty sure that I knew the literature in both education and family... [However] I have to study a lot of fields that essentially, I'm not interested in: say dentist's office: Is there a class difference in how often kids go to the dentist? how parents interact with dentists?, and I have no idea what I am doing. I mean I send an [research assistant] in the library saying well look at dental journals. I didn't even know the name of the databases. [DSUSOC3]

She observed that one of the challenges in this project was the specialization inherent in research. Whereas she was trying to address a very important question that cuts across a variety of specialties, she had to develop a minimal level of mastery ability in each of those specialties in order to produce legitimate work in her field. She concluded that interdisciplinary projects tended to be overwhelming and time consuming. She considered the problem to be a "database" (body of knowledge) problem.

> But it's partly I think there is an intellectual issue here because you can see the pressure to specialization. And I'm trying to do a project that's resisting specialization.... And there are formidable barriers because you end up looking like an incompetent. But on the other hand, you spend the time to become competent, which is sort of a database issue in some ways, it's just too overwhelming.[DSUSOC3]

Despite the lack of a common mode of inquiry, work production patterns in sociology as a whole have common patterns. Work tends to be project focused, overlapping, not usually well-funded and published in both field-wide and specialty journals. Another characteristic of work production is the plethora of subspecialties, the need to connect to relevant areas outside of the focal subspecialty and the need to manage multiple types of materials.

5.3 Social Networks Subspecialty

Social networks constituted one subspecialty in sociology and had subspecialty conference and publications. In this section, I describe the subspecialty and their inputs to research. I then highlight specific features of work production in this subspecialty and describe how they differed from other sociology subspecialists.

The following description of the social networks subspecialty was posted on a Web page associated with one of the major journal for the subspecialty:

> Social network analysis is focused on uncovering the patterning of people's interaction...From the outset, the network approach to the study of behavior has involved two commitments: (1) it is guided by formal theory organized in mathematical terms, and (2) it is grounded in the systematic analysis of empirical data. It was not until the 1970s, therefore--when modern discrete combinatorics (particularly graph theory) experienced rapid development and relatively powerful computers became readily available--that the study of social networks really began to take off as an interdisciplinary specialty. (Freeman, 1996)

Among research subspecialties, sociologists categorized social networks as mathematical sociology. Beside social networks, mathematical sociology included econometrics research. Social networks researchers made use of computational resources to carry out simulations, modeling work and analyze data sets. Some methods they used were structural analysis, discrete mathematics and network visualization. Programs implementing these methods were amenable to sharing and social network researchers made their network analysis programs available on ftp sites and World Wide Web home pages.

This example illustrates the interdisciplinary nature of social networks research. Here, a social network researcher described a project which overlapped other specialties and approaches. Although this project favored mathematical methods for analysis, it also included using other methods to investigate subtasks as part of the phenomenon under inquiry.

> The project is this multi-year thing.... And it involves several things. It involves simulation of [work groups], using alternate models of human cognition, so it gets you into what extent the model matters. It involved collecting experimental data on [work groups] and relating that back to the simulations, collecting real-world archival data on [work groups] relating that back to the simulations. And we're looking across multiple organizational tasks, from one involving [manufacturing], doing [sales]-type things to this [accounting] task which is really a categorization task. [TUSOC2]

Social networks researchers were likely to belong to the International Network for Social Analysis (in addition to the American Sociological Association) which published the journal Social Networks (mentioned above). Social networks research was also relevant to business and industry who are interested in the relationship between "who talks to whom" and measures of productivity.

> The principal functions of INSNA are as follows. First, it publishes Connections, a bulletin containing news, scholarly articles, technical columns, and abstracts and book reviews. Second, it sponsors the annual International Social Networks Conference (also known as Sunbelt). Third, it maintains three electronic services: (a) a web page accessible as http://thecore.socy.sc.edu/INSNA, (b) INSNALIB, an anonymous ftp site for sharing network papers, computer programs and data files, and (c) SOCNET, a ListServ electronic discussion forum. Fourth, INSNA maintains a database of information on members, selling a mailing list to selected publishers and educator. Fifth, it provides a way to subscribe to the journal of Social Networks, published by Elsevier and edited by Lin Freeman. (International Network for Social Analysis, 1996)

It also sponsored an ftp site and the SOCNET listserv mailing list as well as other member services. Social network researchers also tended to read the Journal of Mathematical Sociology. The social networks researchers sometimes attended the Sunbelt conference in addition to attendance at more general conferences such as the ASA or the Southern Sociological Society Conference.

Unlike sociologist informants in other specialties, the social networks researchers were extremely knowledgeable about software and computer systems, though some mentioned not keeping up with the latest technology. Similar to sociologists in other specialties, social networks researchers varied in their knowledge of and degree of use of bibliographic databases and other library-oriented electronic resources on their campuses. Social network researchers tended to use computational resources more intensely than sociologists using qualitative approaches or even those using more conventional quantitative data analysis. However, social networks researchers did not publish or read electronic publishing more than sociologists in other subspecialties. Some electronic journals were in the works during the time of this study, but there was not yet significant publishing or reading activities in this media.

Social networks researchers used the same abstract and indexing services as other sociologists: Sociological Abstracts and Sociofile. In addition, some of them used

Magazine Indices, News Indices, ABI/Inform and other specialty services. The Social Networks researchers accessed more mathematical-oriented services than the other sociologists.

Although the social networks subspecialty was not particularly characteristic of other subspecialties in sociology, it provided an interesting example of work production. Even in a more computationally intensive subspecialty, research in social networks resembled other subspecialties in the use of paper materials and electronic means to access them.

5.4 The Principle of Mastery in Sociology

In sociology the mastery ideal included finding and keeping up to date in multiple subspecialties. In this section, I will discuss how the principle of mastery in sociology reflects the elements of work group norms, the working environment and the materials access in work production.

In sociology, researchers worked either alone or in small research groups (as compared to molecular biology or computer science). Researchers developed and sustained mastery ability working alone (with peer or supervisory review for feedback) or in these small groups. However, working with doctoral students differed greatly from working with research staff. For instance, a sociologist described her dilemma in working with research assistants. Although research assistants could help her use comprehensive searching and retrieving in a field outside her specialty, she could not depend upon working with the research assistant to help her update that work. This example illustrates why she also needs to know how to update the literature.

> Right now I have an [research assistant], [but] I might not have an [research assistant] in 3 or 4 years. So I need not only an article but I need to know how to go back and get the article. And there's no one really that you can sort of pay to think [about how] to do this....
> And so I have this problem... - I don't need 55 articles on this - I just need one or two. And truthfully, it's probably going to be 3-4 or 5 years before I'm really done, so I need a way to update it too. [DSUSOC3]

Sociologists tended to use their home offices as primary workspaces. Many of them owned more powerful personal computing equipment at home (rather than what was provided in departmental offices). Working at home, however, isolated them from some of the work production infrastructure available on campus. Compared to researchers in other disciplines, sociologists had fewer high-speed network connections in their departmental offices and older computer equipment.

Because specialties touched on topics "familiar and important" to other specialties within sociology as well as other disciplines, the body of knowledge was distributed among multiple subspecialties. Therefore, to develop and sustain mastery ability in multiple subspecialties researchers needed to gain access to diverse sets of materials. Sociologists did not usually have access to departmental libraries focused solely on sociology and thus tended rely on university (and other departmental) libraries to gain access to archival materials. Browsing materials in geographically dispersed libraries was time intensive so sociologists often browsed materials in library systems (online public access catalogs, bib databases) from office or home before visiting these facilities.

This social networks researcher found that he had to browse materials in at least five libraries on his campus. He characterizes using browsing as "hunting" with a specific need.

> [About searching the Psychological Literature] I hunted through recent issues of specific journals... [I find the journals] in this room, [Main Library], [Medical Institute nearby], [Biology Branch Library]. I've also gone to the Math Library [indistinct] has books of graph theory, some of which has [topic] stuff in it. I've also gone to the Business School Library... It's irritating to have it so dispersed, particularly when I have to return books....[RSUSOC3]

The mastery ideal in sociology included comprehensive access to materials in multiple subspecialties. However, sociologists working alone in specialized areas or in small work groups with few paid staff have less of an opportunity to develop mastery ability in social settings. The lack of availability of infrastructure further increased the barriers to using electronic materials or even databases to access paper materials.

5.5 Material Use Practices in Sociology

Since sociological research topics were often generated in other fields, sociologists had a need to address known discourse in those fields. Sociologists used comprehensive searching to develop mastery ability over a bodies of knowledge outside their specialties. They used browsing to maintain a level of mastery ability in multiple specialties. Sociologists used retrieving to collect materials into a working collection. As the focus and nature of phenomena they study changed over time, sociologists added to and extended their working collections through material use practices.

The following quote by a social network researcher illustrates the genesis of a project in social networks. It provides a good overview of how sociologists developed a minimal level of mastery ability in related fields.

> [about the occasion for starting a particular project] I guess I was reading [Name]'s dissertation.... There was a book that was never published that was even more famous, because he published his data set that was incredibly rich...[Then] I just went back through the literatures I had on [topic].... I've obviously encountered structural models before so I simply began going back into what I knew in terms of books and articles. I began hunting in mainly psychological journal literature and at a much later point, began looking in the mathematical literature.... I would say that by now, [I own] 80% or 90% [of the topic literature]. At the outset, let's say 75%. And when I found articles that I really thought were relevant, I would Xerox them....So I began hunting in journals that I knew or tracing citations I already found.[RSUSOC3]

This researcher started working from an insight through using retrieving on books and articles in his personal collection, then retrieving articles found through references from those works and branching out using browsing journals in his and other fields to find (and collect) materials for the work.

5.5.1 Comprehensive Searching

Sociologists used comprehensive searching to identify materials outside of their subspecialties. They mentioned using bibliographic databases, particularly those that included abstracts for later browsing. Sociologists' comprehensive searching resembled other disciplines, often resulting in search failures. However, they also differed from other disciplines because they had more opportunities to use comprehensive searching in different areas. Because of the diversity and fragmentation in their own discipline, they had less of an expectation for materials to be similar and relevant outside of their specialties.

The following example illustrates how comprehensive searching may result in unusable results for sociologists when the search space is too large.

> In the Math Library ...[I used a CD-ROM by the] American Mathematical Association. [It has] a very large number of articles and books on there, frighteningly large number. And so I hunted through there and using the keywords: graph, signed, sign graph. I actually tried balance, but it didn't help me very much....[It has] abstracts - abstracts and descriptors all. [RSUSOC3]

Even if sociologists were used to searching for materials outside their subspecialties, they had the same problems with comprehensive searching as researchers in other disciplines. Terminology had different meanings in different specialties rendering keyword searching difficult or useless in databases with broad coverage. Also, when searching outside a specialty, sociologists were less familiar with the nature of the body of knowledge they were searching as well as the relationships among the materials.

However, the sociologist informants used comprehensive searching more frequently that researchers in other disciplines (except those who routinely conducted interdisciplinary work). On the other hand, comprehensive searching was not always used as a first resort to identify materials. The following account illustrates a common experiences of the sociologist informants. They used comprehensive searching when they were examining a new or unfamiliar area:

> If I'm branching out into some area I know nothing about - if it's an area that I know something about, then I know the area, I know the people. I know about everything that they've done. There are no mysteries. If I looked at Soc Abstracts then, I'd just find an incomplete listing of what I know exists. I use it when I'm completely utterly unfamiliar and don't know much about what's been going on. If I knew something about the area 15 years ago, and I wonder what's been happening since, that's when I use it. [BSUSOC1]

Researchers in other disciplines also complained about the incompleteness of comprehensive searching. This finding is in congruence with results from Line's INFROSS study of information requirements in the social sciences (Line, 1974). He

claimed that three types of filters were necessary before information was used: to screen out irrelevant material, inadequate material and too much material. Although individual sociologists had differing criteria for these filters, mastery ideals influenced these judgments.

Some sociologists mentioned using Social Science Citation index, but that was not common, especially for identifying materials in other specialties. Often comprehensive searching provided an initial identification of materials that sociologists would examine and then identify other materials via other methods. The following account illustrates how a sociologist used comprehensive searching in contrast with a method she called snowball searching (a term related to a method of data sampling in social science).

> What I did pretty much was snowballing which is the way that I've always worked. Start with a few pieces that I "happen on to" - a couple of articles and then I use the references that are in the back....On reflection, I realized that I do use on-line searches more than I recognized, but typically I use them when I'm really unfamiliar with a topic. The more familiar I am with an area, the more likely I am to conduct a "snowball search" from articles I have. [MUSOC3]

Her "snowball" approach resembled a common pattern of material use in all disciplines. Researchers in all disciplines routinely would start with materials they use regularly or have in their own personal collections.

In sociology, the principle of mastery shaped comprehensive searching in several ways. Because sociologists frequently conduct searches in areas outside their subspecialty, they were more likely to use comprehensive searching frequently. However, sociologists had similar problems as researchers in other disciplines despite their increased need for developing mastery ability. Comprehensive searching both within and outside sociological specialties required sociologists to develop mastery ability by learning the contents of the body of knowledge they search and learning about the relationships between materials in

that body of knowledge. Finally, comprehensive searching was often used as a first attempt to identify materials outside of sociologists' specialties. Sociologists preferred to search materials in their own collections when possible.

5.5.2 Browsing

Sociologists used browsing chiefly as a way to digest a large number of materials in searching for worthwhile materials. Although sociologists needed to develop mastery abilities in multiple subspecialties, they drew upon mastery ability in their own specialties to evaluate materials in other subspecialties. This created challenges for sociologists to work with a large number of new materials since a minimal level of mastery ability in a particular subspecialty enabled browsing in that subspecialty.

This example from the sociologist working with materials outside her specialty illustrates why browsing required a minimal level of mastery ability in an area. She described how her research assistant retrieves abstracts for her, but she was unable to move through the materials quickly enough to find the one or two relevant articles she needed. She contrasted her problem with using a more general source to develop mastery ability like an encyclopedia, but that resources was an inappropriate material for her work.

> I need one or two high quality research articles in the field [outside her specialty].... And that is really hard to do.... I have an [research assistant] and she ... brings back all these abstracts and I don't have time to [sift through all the abstracts]. I mean maybe I'll have time eventually.... There are annual review pieces, but they tend to be much more global and they'll give you 100 articles. And I think encyclopedias are helpful, but those aren't really giving you sort of research articles. [DSUSOC3]

Aside from working through research materials, sociologist informants tend to enjoy less structured browsing in their free time. Sociologists browsed more recreationally in

libraries, bookstores and electronic bulletin boards. These three examples illustrate sociologists' affinity for browsing and the eclectic occasions and places associated with it.

> I like [browsing] ... if I've got some things that I need to get, you know but it's not pressing....I'll track this particular book down and I'll take the time to look at the books next to it. ... I may pull a couple of magazines and find a couple of journals, maybe look around for personal interest books.... [HUSOC1]

> [When I'm in the library I do] things I can't do on [online public access catalog]. Like browse. I also like bookstores too because you can browse. I like browsing at [Avant Guard Bookstore]. I also browse at BSU's bookstore...[BSUSOC1]

> I [read electronic bulletin boards] all the time. There are some on law and law school, I do a lot of prelaw advising so I look at sort of the law school and law professor discussion about law school students and advisors. There's a white collar crime board I look at occasionally.... I actually, just treat it like a shopping mall. If I have some time to spend. It's not particularly focused. [RUSOC1]

Sociologists also used browsing in conjunction with retrieving to collect new and relevant materials. In this example, a sociologist found greater value in using browsing to find references lists than comprehensive searching.

> Sure, on multiple occasions, [I used] primarily sociofile, sociological abstracts. But I actually find you know, that once you get into it, you start reading the new issues of the best journals as they come up...- they have articles relevant to what I'm doing. And they're citing people and it's everyone else's bibliographies that get me where I'm going more than anything. [HUSOC1]

Sociologists browsed materials when they were selecting materials in their own or other subspecialties. Mastery ability enabled browsing and sociologists struggled when they were trying to work with materials in areas where they have not developed mastery ability. However, sociologists also browsed books more casually and tended to work with books more routinely than molecular biologists or computer scientists.

5.5.3 Retrieving

Sociologists used retrieving to collect materials in multiple subspecialties. In order to use retrieving however, sociologists needed to find locations of materials. Sociologists obtained materials in a wide variety of specialties, but cited mainly research articles and books. Before choosing materials in work production, sociologists did not only require access mechanisms and unique location identifiers, but they also needed to communicate the relevance of the material to their work. The latter task was further complicated by the fragmentation of the discipline despite the importance of the top-tier publication outlets that cross multiple subspecialties.

Sociologists typically first used retrieving on their own collections. However, the shifting public dialog about social life and continual publication of new findings made it necessary for sociologists to increase their collections continually. They found materials for retrieving through browsing current journal articles, reference lists from books and articles, materials from student work, referrals from colleagues and suggestions from referees.

However, sociologists often lacked the mastery abilities necessary for retrieving materials outside their own subspecialty. In this example a researcher who did not have mastery ability in a new area he is investigating, could not use retrieving based on expert referral because his colleagues cannot provide references for him. However, he previously reported using reference lists from other key papers and browsing to develop mastery ability and therefore acquire the materials he needs. This shows how a minimal level of mastery ability was always necessary for retrieving and thus work production.

> I've tried [talking with colleagues]. They either suggested stuff that I knew already or stuff that turned out to be not much use. I think colleagues have a different role and that's to comment on the ideas in it. [RSUSOC3]

Sometimes sociologists collected review articles or seminal papers to develop mastery ability, but in order to use retrieving, they first needed to have a minimal level of mastery ability in the new area in order to identify which review articles or papers to obtain.

Sociologists also used retrieving to obtain brief citations to work that they couldn't remember or to obtain a location identifier to obtain the full work. In the following example, a sociologist describes how she used an online public access catalog as a memory aid and to retrieve the location of a book during a discussion with a student.

> And I'll have a graduate student in my office and I'll tell them the name of a book and won't remember the author or the title, and I'll just get to the library and ... I'll get the call number and I'll tell them. That's one thing I do use a lot. [DSUSOC3]

Sociologists liked using retrieving to create their own body of knowledge especially when working in an area with a vast amount of possible materials. Obtaining materials when they needed them whether via library paper collections or from the Internet via ftp (file transfer program) or World Wide Web allowed sociologists to digest the materials as they needed them rather than having to process all the materials that were sent or presented to them. Sociologists also preferred retrieving from their own collections because of increased accessibility. This example illustrates a sociologist's preference for the convenience of obtaining the material at the moment when he needs it.

> My wife hates me but I subscribe to 5 journals and then, at various old sales that they had up in my department, I bought old ASRs so whenever I run into an older article or newer ones, a lot of times I get off the shelves.... I hate going to the library.... You need an article, you need it now and in the middle of your research, you don't even have the time to go out there and go to the fifth floor and track it down....[HUSOC1]

Here's another example of the preference for retrieving on demand. This sociologist explains how mastery ability in combination with e-mail contact with the author facilitated retrieving.

> Right now I'm writing this kind of review article in the computational org theory area and so I'm writing it and I notice that I need references on a couple things. I had known they'd been presented. So I just e-mail the participants at the conference and say he, can any of you guys send me references, then they e-mail back their references [paper or electronic versions]. That's one of the things I've been starting to do lately. It's very helpful.

In sociology a minimal level of mastery ability was necessary for retrieving. However because sociologists worked in multiple subspecialties, they drew upon multiple sources to develop mastery ability in order to use retrieving. Sociologists collaborated with colleagues in other specialties, obtained papers from conference participants, and subscribed to multiple journals that published articles in different subspecialties. Sociologists used online public access catalogs and bibliographic databases to identify locations for retrieving more frequently than for comprehensive searching. Retrieving allowed sociologists to collect a body of knowledge necessary to produce work in their specialty. Because sociologists worked in multiple subspecialties with vast bodies of knowledge they could potentially use, they had a greater need to develop their own working bodies of knowledge especially when materials are less locally shared.

5.6 Summary of Material Use Practices and the Principle of Mastery

Sociologists worked in a discipline with many subspecialties and no common core. They conducted research based on multiple paradigms for inquiry and multiple methods for investigating social behavior. Sociologists developed mastery ability through doctoral study, participation in research subspecialties and working with materials in similar

specialties outside their own. Table 5.6.1 characterizes attributes of mastery ideals in sociology as a whole.

Table 5.6.1: Mastery Ideal in Sociology

Discipline	Attribute of Disciplinary Mastery Ideal
Sociology	Sociologists attain and sustain mastery of bodies of knowledge in multiple subspecialties

The principle of mastery in material use practices reflected the nature of work production in sociology. Sociologists varied in their use of Sociological Abstracts, ABI/Inform and other bibliographic databases in comprehensive searching. However, they tended to use comprehensive searching when they were entering an unfamiliar subspecialty. The informants' accounts illustrated challenges in developing mastery ability in new subspecialties with comprehensive searching and how comprehensive searching was used in conjunction with other methods of material use. Within a subspecialty, sociologists browsed both books and articles to keep current. The sociologists also mentioned more casual browsing for recreation and less focused reading. However, in sociology browsing was an especially difficult way to work with materials outside a subspecialty. Without a minimal level of mastery ability over of a body of knowledge, it was difficult for sociologists to identify relevant materials for their work through browsing. Mastery ability enabled browsing within the subspecialty but became more necessary for browsing outside the subspecialty. Retrieving was the most popular material use practice in sociology. The fragmentation of the discipline and selection of diverse specialists within local departments made it difficult for colleagues to share materials or libraries to collect a core set to satisfy all sociologists. Therefore, sociologists purchased books and collected reprints extensively, effectively building a working body of knowledge for individual work production in their subspecialty.

Table 5.6.2: Material Use Practices In Sociology

Discipline	Comprehensive Searching	Browsing	Retrieving
Sociology	Researchers found it hard to limit search space by topic, but used searching in outside subspecialties	Researchers found identification of materials outside of a subspecialty difficult using browsing	Researchers tended to collect the vast majority of materials they needed
The Principle of Mastery in Sociology	Searching was difficult because the body of knowledge includes a wide range of both popular and scholarly materials	A minimal level of mastery ability was necessary for browsing outside of a subspecialty	Retrieving helped researchers develop more focused bodies of knowledge from larger or more diverse collections

Chapter 6
Material Mastery in Computer Science

6.1 Introduction

This chapter describes how the principle of mastery shapes material use practices in computer science research. I first describe work production in computer science, and then provide examples from a sample subspecialty: computer networks research. The attributes of the mastery ideal in computer science are followed by the findings about material use practices in computer science. The chapter concludes with a summary of the principle of mastery in relation to the findings. This chapter will explain the following findings. Computer scientists used more electronic materials than either the sociologists or the literary theorists. However, they used comprehensive searching the least. Some computer scientists shared personal bibliographies and review articles to look over a body of work. Because computer scientists' work focused on creation of artifacts (such as databases, models and programs) and the infrastructure to support them, they could more easily exchange electronic materials than those who didn't already have access to networked electronic resources. Norms for work production in computer science often induced the use and provision of the body of knowledge in electronic form, even if most work was published in print form. Computers scientists used retrieving by exchanging electronic reprints and preprints and used browsing when looking for information about conferences, grants, and projects (via ftp sites and World Wide Web home pages).

6.2 Work Production in Computer Science

In this section, I describe the features of work production in computer science highlighting those features that describe attributes of the mastery ideal in this discipline. First, I describe what constitutes work production in computer science. Then, I turn to the organization of work, work inputs, demands for infrastructural resources, and work outputs. Finally, I examine an interesting case of one work output: electronic journals in computer science. I highlight this case because it was unique in this study that specialists read and several submitted work to this type of forum.

Work production in computer science was organized around the study of computers as well as artifacts and applications to problems external to the field. This short description provides a general thumbnail sketch of the field for a lay person:

> Computer science is the study of computers--namely, their design (architecture) and their uses for computations, data processing, and systems control. Computer science includes engineering activities such as the design of computers and of the hardware and software that make up computer systems....The major subdisciplines of computer science have traditionally been (1) architecture (including all levels of hardware design, as well as the integration of hardware and software components to form computer systems), (2) software (the programs, or sets of instructions, that tell a computer how to carry out tasks), here subdivided into software engineering, programming languages, operating systems, information systems and databases, artificial intelligence, and computer graphics, and (3) theory, which includes computational methods and numerical analysis on the one hand and data structures and algorithms on the other. (Britanica Online, 1996c).

As a discipline, computer science has had some identity problems (see Chapter 2): computer scientists have not had a consensus on the balance between responsiveness to external needs for information technology and preservation of the integrity of the discipline as a science. This controversy reflected the dual origins of computer science from engineering

(as an applied discipline) and mathematics (a pure science). This study focuses primarily on the more engineering-like research subspecialties.

Specialization in computer science is primarily organized around professional organization umbrellas, such as the Institute of Electrical and Electronics Engineers (IEEE) or the Association for Computing Machinery (ACM) which have numerous special interest groups and conferences. There are other organizations that sponsor publications and conference in computer science but they often correspond to specialized groups in the ACM and IEEE.

Computer scientist informants produced artifacts and theoretical findings and published them in scientific journals, conference proceedings, and a variety of reports. Their work built on existing findings and technology, yet production of research requires a new or creative contribution via theory, proof of concept, or application of computational methods. Computer scientist informants tended to work within major subdisciplines, such as those mentioned above but sometimes worked in several subspecialties such as drawing on information systems theory to design artificial intelligent agents. Most computer scientists in this study belonged to several special interest groups that supported conferences and journals in their subspecialties.

Their work was also organized in ways that reflected doctoral training, external funding, and the division of labor among research groups headed by faculty investigators. In general, computer science doctoral students were supported by research grants administered by their advisors. They also often pursued internship opportunities in industry at different points of their doctoral training. The computer science faculty usually had close ties to funding agents in industry and government. They worked on multi-year grants funded typically by the Advanced Projects Research Agency (ARPA), National

Science Foundation, and corporate sponsors. Funding levels varied (some researchers had little or no funding), but typically, researchers had annual grants of several hundred thousand dollars per year and several had grants totally over one million dollars. Computer science faculty worked as managers of the funded work, supporting groups of doctoral students who designed and implemented the systems and published on specific aspects of the project for their dissertations. This assistant professor contrasted the shift in his work to writing using the LaTex text formatting program from programming in the C language:

> I spend a lot more of my time writing English than writing C code - programming. I run LaTex a lot more than I run the C compiler.[TUCS3]

The inputs to work production in computer science in terms of personnel and equipment were not always shared between research groups. Computer science departments usually provided a small group of computer support professionals to install and maintain computer systems and networks for all projects in the department. Although many researchers no longer used shared computational resources such as mainframes and central file servers, almost all researchers had desktop workstations connected to local high-speed computer networks in their offices which required coordination and support. In addition, some computer science departments provided direct dial-up access to the local resources to alleviate difficulties in access departmental resources through the regular campus network. Some computer science researchers used shared facilities such as supercomputers, but predominantly the department provided electronic mail access and storage backup rather than the bulk of computational resources.

Computer scientists had a normative work pattern that influenced their demand for infrastructural resources. They favored a work day beginning late in the morning and extending into the wee hours of the night. Although some researchers worked more of a business day schedule due to class schedules, outside consulting or personal family

demands, computer scientists demanded a high level of access to and reliability in their computational resources around the clock. For instance, an unexpected outage of electronic mail was perceived as disastrous. Often computer scientists organized their work to maximize their level of control, access and reliability to needed resources. Some computer scientists kept their primary work machine at home maintaining acceptable connectivity to the campus network. In general, computer scientists worked in the location that provided the best access to computational resources.

Outputs of work production were primarily short articles which appeared in diverse forums, usually in IEEE or ACM-sponsored scientific conferences and journals. Conferences in computer science were considered a serious form of publication and were counted in performance evaluation. The importance of producing viable contributions for external funders was one explanation. Computer scientists judged the quality of the conference based on its rejection rate: the higher percentage of papers rejected, the better the conference.

In addition, computer scientists often published project reports, professional articles and technical reports distributed by their computer science department which were typically not refereed nor counted heavily toward promotion and raises. However, these non-refereed publications did play a role in securing and soliciting external funding. Computer science publications were predominantly multi-authored with the convention that the first named author received the most credit for the work.

Computer scientists also produced software systems as another type of work production output. Systems were often used by research groups for several years. Sometimes computer scientists shared systems with other researchers in a similar subspecialty, but these systems were typically used for research problems rather than industrial-oriented

applications. Sometimes a group of researchers in a subspecialty shared test suites or common approaches to test the robustness of the systems they produced. These outputs were also cumulatively compiled and used in multiple projects over time. Computer scientists were expected to develop new systems every few years in order to be considered productive, but also because of the rapid pace of technological innovation.

The enthusiasm for creating new artifacts did not parallel the technological innovation for creating new types of research outputs. The case of electronic journal publishing is a useful contrast that supports the notion that material use practices will change more slowly than the availability of new artifacts. Few informants in any discipline used electronic journals to identify source material. One computer science informant had contributed an article to the Electronic Journal of Virtual Culture "as an experiment" but did not believe his colleagues would consider it recognized as a legitimate publishing outlet.

> I actually published in one [electronic journal]... To tell you the truth I haven't looked at it since then. In fact, I don't know whether it is still around or not.... Since I haven't come up for tenure, I think that [whether his article will count for tenure] will be fully answered only at that point. I only did it because I was curious about the whole electronic publishing area. This was... sort of a chapter from my dissertation which was my opinion about an issue.... I deliberately went to an outlet which I found was not controlled by the hierarchy so I could get my ideas published and get them out of my head and move on to something else. [DSUCS3]

In general, computer scientists felt that journals distributed in paper format were more legitimate, since most prestigious journals in the research subspecialties were distributed in paper (Kling and Covi, 1995). However, there was one exception that illustrated the pervasiveness of these normative values. Artificial Intelligence researchers published in and regularly read the Journal of Artificial Intelligence Research (JAIR). However, JAIR differed from other forays into electronic journal publishing because a publisher sold each volume in (paper) bound form at the end of each year. Although it was published and distributed electronically free of charge, the papers published via JAIR were not visually

identifiable as electronic journal articles. Instead of distribution in plain text, JAIR distributed articles in postscript format which closely resembled a photocopy from the bound volume. One informant explained his understanding of JAIR's value:

> The major journal of AI is the AI Journal [AIJ - paper] and it has a 2-year backlog and it takes a year to get papers reviewed... by the time they come out they're not relevant any longer. So [JAIR-electronic] was an attempt to do something [about this problem]... It's not uncommon to try to get the reviews back in 6 weeks. You can get a paper published within two-three months of writing it.... The idea [behind using an electronic format that prints like a print journal] is ... if your deans are going to say, "Is this an electronic journal?" ... you can show him that it's a real journal, that the people using it can read it [in a print journal format].... I guess I'm not quite sure [if it's "better" to get into AIJ-paper]. My feeling is that actually the [JAIR-electronic] is better. [AIJ] unfortunately has had the same editor for 20 years and he's been focusing it towards a certain class of research which is becoming less and less relevant to my own work.... [FSUCS1]

In this account, the informant first depicted the value of JAIR as a faster way of publishing research before it gets out of date. This account supports arguments about the impending demise of paper journals due to their inflexibility, the availability of the article around the clock, and the advantages of online searching (Odlyzko, 1995). However, as the informant continued to explain his use, he placed JAIR in relation to the norms of work production. JAIR met a need in the subspecialty to have an additional publication outlet with a faster time to publish. In addition, he has marginalized the value of the older paper journal due to the content rather than the distribution mechanism.

Even computer scientists who were associate editors of electronic journals expressed some doubts about the benefits of electronic publication. This senior professor contrasts benefits with the central issue of quality in research publication.

> I can't answer [how e-journals figure into merit and promotion decisions] very definitely because I do not know what quality these electronic journals will be. The conviction which we have for the [e-journal for which he is an associate editor] is that it will be fiercely written and so I would have no objections [to having e-journal articles count for tenure] if the evidence is strong that these are not just a sloppy way of getting papers published, you know - half-baked ideas.... [MUCS2]

Work production in computer science, as in the other disciplines, thus hinged on evaluating work based on the social processes that determine quality. In order to create quality contributions, researchers drew upon norms of work production.

6.3 Computer Networks Subspecialty

Computer Networks research examines the architecture of computer communications. Here is a brief description of the major aspects of the research area:

> Another important architectural area is the computer communications network, in which computers are linked together via cables over short distances to form local-area networks (LANs) or via telephone lines or satellite links to form wide-area networks (WANs). By the 1990s, worldwide communication became possible by internetworking, the interconnection of multiple networks by means of so-called gateways. Linking computers physically is easy; the challenge for computer scientists has been the development of protocols (i.e., standardized rules for the format and exchange of messages) to allow processes running on host computers to interpret the signals they receive and to engage in meaningful "conversations" in order to accomplish tasks on behalf of users. (Britannica Online, 1996d)

Much of the impetus for this work came from government and industry stakeholders in developing these protocols. Like other highly visible subspecialties in computer science, researchers were eligible for funding under large projects. This informant described a well-funded joint project to implement and test technologies such as the Asynchronous Transfer Mode (ATM):

> The key product of our research is developed into protocols - network protocols and these protocols, we usually simulate, software simulation. We evaluate the analytic tools for simulation. And in some cases, we also implement. Now we have a couple of ARPA grants for which we are required to actually implement these protocols to see if they work....We are now part of a testbed called [project]. It is an ATM testbed... we're in the process of buying a switch right now and we will evaluate different congestion control schemes for ATM. For that we will have to be complying to standards. [BSUCS1]

In relation to other subspecialties in computer science, computer networks was one of the best funded and had the largest audience due to increased public interest in computer networking. The time frame for producing work in computer networks research was typically quite short in comparison with other disciplines. Here is an account of the genesis of a project from one researcher:

> The workshop paper was presented in December, was written within the few months before that, I probably first started thinking seriously about it around a year ago or maybe a little more than a year ago.[TUCS3]

Although there was some competition in the computer networks subspecialty, there was less risk of loss for priority of discovery (as compared to molecular biology research). Like other computer science subspecialties, there were few penalties for not citing other relevant work. Researchers instead valued producing something important to address current problems in an appropriate time frame.

> I guess I saw that this paper was coming out and from the title of the paper I knew it was related to what I was doing and I was sort of anxious - did somebody else just think of the same idea? But no, I wasn't scooped. What this other paper was, was sort of a pretty good improvement on the same basic way that the ten-year-old stuff had done. Interestingly unaware of the ten-year-old stuff as it turned out. [TUCS3]

Computer networks researchers typically organized themselves in project groups of doctoral students directed by a faculty researcher. They had regular meetings for their

project group. The doctoral students shared group offices with separate desks and workstations whereas the faculty member usually worked in an office elsewhere in the department. Research groups usually shared meeting facilities, computer equipment and journals and conference proceedings (usually owned by the faculty director). In addition, doctoral students used departmental reading rooms and campus branch libraries to obtain paper materials.

The inputs for work production in computer networking often followed from needs in the telecommunications industry. Doctoral students in computer networks, like those in other computer science specialties often found ideas for dissertation projects in work related to projects their advisors were conducting. Computer science doctoral students would often work for industry for short periods of time, especially when their project was related to a current problem faced by industry.

Although several researchers in computer networks mentioned accessing bibliographies mounted on the World Wide Web, they found the most relevant materials in conference proceedings. They attended and collected proceedings for the IEEE INFOCOMM, IEEE ICCC, ACM SIGCOMM, and the jointly sponsored IC3N conferences. Computer networks researchers belonged to the IEEE Communication Society as well as ACM's special interest group SIGCOMM. They typically read IEEE Networks, IEEE Transactions on Communications (TOC), Communications Magazine, IEEE/ACM Transactions on Networking (TON) as well as other subspecialty journals.

Students tended to use bibliographic databases, Usenet newsgroups and World Wide Web more intensely than faculty researchers. They often served as human intelligent agents and filters (as opposed to computerized intelligent agents and filters) to help faculty researchers identify lesser known literature or discussions. However, the primary role of the students

was to produce the systems and analysis for the project. The faculty were generally pleased when the students found relevant references for the project, but faculty researchers tended to rely on current publications in conferences, journals and magazines, many of which they examined before publication through peer review.

The outputs of computer networks research conference papers, journal articles and nonrefereed publications.

Table 6.3.1: Profile of Computer Networks Publication Sample

Journal/Conference	Type of forum	Rough Average Length	Rough Average Number of References
INFOCOM	Conference	7 pages	13
ICCC	Conference	4 pages	9
ACM SIGCOMM	Conference	10 pages	24
IEEE GLOBECOM	Conference	4 pages	9
IEEE Networks	Magazine	8 pages	16
IEEE TOC	Scientific Journal	6 pages	12
IEEE Communications	Magazine	6 pages	12
ACM/IEEE TON	Scientific Journal	10 pages	22

The average length of computer networks publications were shorter than papers in most areas of sociology and literary theory but longer than the molecular biology papers. However, the production nonrefereed work distinguished computer science work production from the other disciplines.

6.4 The Principle of Mastery in Computer Science

In computer science, the mastery ideal for working with a body of knowledge included comprehensive knowledge of both conference and journal literature in their subspecialties.

Because most computer scientists worked on current fundable problems which often had high relevance to the computer industry, they favored more immediate forms of publication. They were also somewhat less incremental than work in molecular biology because work was less interdependent upon the results of previous work.

The principle of mastery in computer science encompassed normative values about how to utilize the body of knowledge. For instance, computer scientists favored electronic means to exchange documents, even though they continued to rely upon print publication mechanisms to coordinate their contributions. Aside from JAIR, there was little mention of reading or contributing to electronic-only journals. Another normative aspect of use was the preference for electronic formats. Even though no computer scientist had an office without paper, many collected and stored electronic copies of articles and bibliographies on their machines.

Besides what kinds of materials to access, computer science had normative values about who would use certain types of materials. In their role of directing and coordinating the resources of the group, faculty researchers relied on interpersonal contact at conferences and meetings to keep up with current work. Faculty researchers sustained mastery ability through conference and journal activities. On the other hand, to develop mastery ability, doctoral students used resources in different ways. Because they need to find research projects to pursue or identify areas in their advisor's research project in which to specialize, they tended to use online bibliographic databases, World Wide Web, technical reports and Usenet news more than their faculty supervisors. This account illustrates this key difference:

> I'd say that in the initial stage when the topic is not very well turned out yet, I notice that my students go out and search and once they lock on a topic, then they can just proceed on their own with as little interference, with not very much input from the ongoing literature. Although I push them... but you understand there is also a reason for that.... Once upon a topic, they prefer not to know that there is research going on in some area... But I notice that it varies very much, some students are doing very extensive search and often in areas that are not particularly relevant. [BSUCS1]

In summary, the mastery ideal in computer science included keeping up with conference and journal literature. Because production in computer science required attention to contemporary problems, the pace of work production is quite rapid. This resulted in normative practices that facilitated easy access to research materials. Also, the technologically intensive environment for production and norms for utilizing computations resources also prescribed the use of electronic documents and technologies that facilitate their exchange. However, computer scientists continued to rely upon print channels of processing to legitimate the production of work.

6.5 Material Use Practices in Computer Science

Computer scientists privileged efficient access to materials using the infrastructure available to them. Because their research involved creating artifacts, they had high expectations and often expressed dismay at the shortcomings of artifacts available to them for obtaining materials. The following quote illustrates frustration these shortcomings.

> Did you ever read the first book in Winnie-the-Pooh? On the very first page... here's Edward bear coming down the stairs, bump, bump, bump on his head? He thinks there may be a better way to come downstairs but he's too busy thumping to think of it. Well, that's the way I feel about reading. There's just got to be a better way and I don't know how. [TUCS2]

This frustration stemmed from the overwhelming task of keeping up with new developments in computer science subspecialties. Computer science material use practices also relied on keeping up with hot topics within the discipline. Unlike the molecular biologists, keeping current was not so much about competition for priority of discovery, but instead addressing external needs for systems and solutions for changing technologies. Time pressure in computer science research played a role in not only what they cited, but how they found citations. For example, this researcher characterized work written 10 years ago as old.

> Well, there was one old piece of work that was ten years old or something...The people I've talked to suggested that they weren't sure copies still existed...The problem [with thinking about libraries] is that a lot of work, by the time it hits your library is pretty old, now. Most stuff I look for isn't ten to fifteen years old [laughs]. [TUCS3]

In order to get work out more quickly, some computer scientists created their own Web pages or students created Web pages for their projects. Computer scientists were more likely to utilize these types of Internet resources to access information about grant programs, collect and analyze experimental data or share resources with collaborators than researchers in other disciplines. However, Web page publication was not used as a substitute for submitting work to refereed forums.

The low use of library resources and print materials matched computer scientists norms for the mastery ideal. Because they were oriented to using high-powered machines for computational purposes, well-designed interfaces or high-speed direct communications, the traditional paper-mediated means to identify colleagues' research was not as pervasive as other disciplines. Computers facilitated high-speed conversations and highly interactive electronic mail exchange prioritizing the exchange of information which was later legitimated via preprints and citations provided by people. Because computer scientists

tended to work in grant-rich fields that depend upon access to current technology, they had access to good resources which facilitated intensive use of electronic documents.

Computer science material use patterns also offered a glimpse of how electronic document exchange was facilitating access to new types of materials. These materials, though oriented towards teaching work, could eventually provide new avenues to develop mastery ability for researchers entering certain new research subspecialties.

> People don't publish too much about homeworks and assignments and how they teach their courses. It just is not published, but you can find it on the Web and you can find what people have done in their courses. That is the praxis of teaching. It's really coming much more this way than I know than in any other way and by looking at assignments, I also have a very good idea of what really people do and expect of the students. I'd be even more happy if they also showed me what the students have answered because I can make a very difficult exam, just my students cannot do it. So it would be nice to know both things. [DSUCS1]

6.5.1 Comprehensive Searching

In general, computer scientists rarely used comprehensive searching. The interactive nature of sharing research results at meetings and conferences, in many cases superseded the need to exhaustively scan materials even outside their subspecialties. For instance, this computer scientists explained how she kept up with current research related to her area:

> I follow stuff coming out of [western state university], ... I follow everything coming out of the [subspecialty] group in [midwest state university]... and the [inter-university ARPA- funded project] work. [The project] work has a mechanism for [following other people's work], -- we have a workshop every nine months. Every single person talks and you know what they're doing. And then of course, you have to correspond [via e-mail] with them to get the real details because the talks are only 10 minutes long. [TUCS1]

On the other hand, students just entering the field, conducted searches for class work and choosing a dissertation topic. This illustrates how junior researchers use comprehensive searching to develop mastery ability:

> I ask my students to work on term projects. Actually they can choose their topics. And often what they do, they search on [local database front-end] and they choose a topic so that they get a good list of references. They come up with a very good set of references, way beyond what I told them. And in fact, five years ago my preoccupation was that I would have to do all the work. To present them with topics and a list of references. They want some references. Now they say, well, give me the topic - we're going to find the references themselves so they go out and search. [BSUCS1]

Because of the hierarchical division of labor in many computer science research groups, faculty researchers were pleased that the students have the skill to identify materials on their own. However, faculty researchers frequently expressed displeasure with the library systems:

> Interviewer: Do you use the library system that's available?
> TUCS2: Rarely. I find it too hard.... The issue is that I don't want to have to learn to use it. I want to be able to walk up and use it. .. But I would like something that would teach me rather than these things that - switch databases. How the hell do I know what database I want to be in?... The other problem I have is that it is set up to work from an X windows system and I am a Mac person. So I only have a dumb terminal emulator to get to the library system so the interface is text-oriented and I am not computationally set up to take advantage of the stuff they have there.

Computer scientists could not reconcile their frustration with systems they could not adapt or improve. The three issues that this researcher expressed: avoiding time needed to learn the system, requiring searchers to know what database they want and resolving technical incompatibilities were in conflict with the norms for the mastery ideal. In a sense, incentives to conform to the mastery ideal in computer science inhibited use of shared library-oriented systems because computer scientists preferred systems they or their students could control and adapt for their needs.

Another inhibiting factor for comprehensive searching was the priority for creating solutions that addressed current concerns. Because computer scientists wanted to match solutions to mastery ability over a current set of approaches, mastery ability replaced the need to find approaches through comprehensive searching.

> I am knowledgeable of the literature in that domain, in the sense that I teach the course and I have been interested in the subject essentially for a long time. I was reading the literature already. The truth is that I did very little of it. I had many discussions. I was very much convinced of what it is I came to do.... I must confess that I had a really strong sense of what is right. [DSUCS1]

6.5.2 Browsing

Like researchers in other disciplines, computer scientists used browsing to keep up with and initially identify materials to sustain mastery ability. However, they differed in the extent to which they relied upon meetings and conferences to familiarize themselves with related work in their subspecialty. Typically computer scientists sought materials via journal runs or area scans of material in their own collections.

> My feeling is that within computer vision there are basically three conferences and two journals where most work that's interesting appears. And so ...[to direct students at material] I say, "Go read the last few proceedings of this conference, the last couple years of this journal." Often times I just know, I mean particularly being on the [journal] editorial board I see [the interesting papers]. So I try to keep up on things, attend these conferences.... [MUCS3]

This researcher actually indicated during the interview, the compact area on the shelf where he stored all of what he considered to be the relevant materials in his area. Although he later indicated that he also used the library on some occasions, the efficiency of searching within a well-bounded domain appeals to the norms for the mastery ideal in computer science.

This next example illustrates how computer scientists limited their browsing space to work through a set of materials most relevant to the task at hand. This researcher contrasted his use of the term systematic to mean browsing with another use of the term to mean comprehensive searching.

> [It] depends on your definition of systematic [searching]. I went to places that I knew were likely to have pertinent articles and so I did sort of a systematic search of a selected set of places....So there's a couple of journals, some conference proceedings that would tend to have papers on this subject if there were any. And I looked at the past few years of those and searched through those.[TUCS3]

The majority of computer scientist informants relied more on interactions with other researchers and funders at conferences than on reading to sustain their mastery ability in their subspecialty. Although they certainly contributed and subscribed to journals in their subspecialty, conference proceedings and the activities surrounding peer review helped them sustain mastery ability. They also had ready access the means to directly contact researchers by electronic mail for retrieving. This researcher provided a good example of how most computer scientist conducts a routine search via browsing:

> I use the [subspecialty] conferences first because almost everything is published there in some form and then you can follow it either by author and go forward because if you got an author giving a paper at a [subspecialty] conference, you know a couple of years down the line, there should be a journal article about it. So if I find something in a 1990 [subspecialty] proceedings, then I go searching for the author in other journals. [TUCS2]

Computer scientists also used browsing to identify sessions or materials of interest in electronically distributed conference announcements posted on Web pages or sent via mailing lists. In this case, a computer scientist used browsing in conjunction with retrieving to obtain a copy of a conference paper.

> Sometimes people say, hey I've written a new paper, and if you want a copy, you can get it by anonymous ftp, this kind of thing. Sometimes, there will be advance programs for conferences where they'll say, here's the papers that are going to be at this conference and if you are interested in a copy of those papers, and you're working in the area, it's usually pretty easy to get a hold of the authors. There are various Web sites that have lots of interesting stuff like this filed away.[TUCS3]

Despite the affinity of computer scientists for conference and meeting attendance, faculty researchers did not find public bulletin boards useful to substitute for or sustain interpersonal interaction. They participated on conference organizers mailing lists and journal editorial lists, but did not typically post regularly on public Usenet newsgroups (bulletin boards). However, the doctoral student informants relied upon bulletin boards extensively to develop mastery ability in their area.

> Netnews, I don't use at all. If anything interesting shows up there, I'm sure one of my students will tell me about it, since they waste much too much time on that. [MUCS3]

Computer scientists relied on browsing, first of conference announcements and proceedings, then journal articles and bulletin boards (primarily doctoral students) to develop and sustain mastery ability in their subspecialty. The preference for current materials that are relevant to important problems explained why browsing activities were more predominant than comprehensive searching.

6.5.3 Retrieving

Computer scientists preferred retrieving electronic artifacts to retrieving library materials. The efficiency of electronic document exchange was not the only reason for this preference. Because of the normative work schedule of computer scientists, availability of library collections were another barrier to using the library.

> You know I can't walk into the library at midnight and get them. And that's almost always the time I want them..[TUCS2]

Electronic retrieving therefore offered the advantages of accessibility around the clock and whenever the researcher needed them.

The perceived ease of organizing and searching electronic documents as compared to paper also offered an advantage to the computer scientists. Here a researcher compared running search tools on his computer system with locating papers on his desk.

> I keep almost everything electronically. Many, many megabytes of stuff that maybe I could find again if I needed but it's at least there. Paper stuff is likely to get lost. If I print it out on the laserprinter, I'll read that copy and not really probably take a lot of great effort to save that printed copy. I'll recycle that printed copy. But I will save that electronic copy if I found it useful....And the interesting useful feature of having it electronically is that if I can't find it, there's various tools like Unix find command or grep. I can't run that on my desk [laughs]. So the electronic copy is more reliable, I can't lose it, it can't get damaged or whatever, I can always find it, I can reproduce copies off of it if I need to. It's much better for archival for me than filling filing cabinets with lots of printed paper. [TUCS3]

The researchers preferred to keep an electronic copy of a document on their hard disk rather than depend on access to networks for retrieving. Most had ample-sized hard disks and were hesitant to risk that the document would not be available when they wanted to use it. This account also illustrated how this information scientist believed that retrieving an electronic document is more reliable than retrieving paper (a view not shared by literary theorists). He also enjoyed the benefit of easy reproducibility of electronic materials.

In contrast, the following researcher preferred to send paper on some occasions. However, efficiency prevailed since this researcher had an assistant that helped with these tasks.

> Sometimes I meet researchers at conferences - we talk about research topics. Then sometimes they ask me to send them some of my papers and I ask them to send their papers on the topic they're working on.... Sometimes I send postscript, sometimes a hard copy.... [It depends on what they ask for] plus how many papers do they want. If it's a hundred papers, it's easier for me to just grab a hard copy. If it's one paper, then I send it postscript - it seems to be easier. [FSUCS2]

Computer scientists were the only discipline in this study who routinely exchanged preprints electronically. Computer scientists developed standard document formatting conventions (e.g., postscript, LaTex) and had been using established programs to exchange documents (e.g.,. ftp, World Wide Web and e-mail) for many years previous to this study. However, computer scientists still relied upon the conventions of print publication to determine the quality of disseminated material and exchange of preprints or reprints often followed discussions or meetings with other researchers at conferences and project meetings. The following account illustrates how conferences provided the occasion for document exchange:

> Now with its project with TUCSG, that is also modeling work, but it's modeling in a different domain....There was a couple of things I did. One I sent TUCSG off to go find things. The other thing was I was on a panel at the [New Domain Conference] in December of 199[X]. Somebody was twisting my arm to be on this panel. And I said, YES because TUCSG wanted me to go into this area. So I said, fine, we'll go to this conference, we'll meet these people, we'll know what's going on. And so then, I got the proceedings from that conference, and then that gives you lots of pointers in the reference sections of the papers that what you're seeing, you get to meet all the people getting papers and all that. It's a really small conference - you actually get to meet people. [TUCS2]

Computer science departments continued to support mechanisms for disseminating current findings by supporting technical reports. In fact, technical reports databases were one area of early digital library work (Fox et al., 1995; French et al., 1995; Lagoze and Davis, 1995). Technical reports were nonrefereed manuscripts distributed by computer science departments to facilitate access to current computer science findings. However for research

purposes, technical reports were sought more for identifying a strategy for problem-solving rather than as serious publication outlets.

Digitization of research documents was not usually retrospective in computer science. When obtaining work that predated the advent of electronic collections, computer scientists had to revert to retrieving practices similar to other disciplines.

> I have been working in [subspecialty] for ... almost 3 years. And so I knew some people who were sort of related, knew one recent piece of work in the area, knew of one large piece but fairly old piece of work [10 years] in the area and dug up all the old material on that by looking at references in papers and going back and finding those and sort of chaining through the references. [TUCS3]

These examples illustrated the important role of conference publication, preference for using electronic artifacts to share documents and the need to maintain accessibility to research inputs in retrieving. A minimal level of mastery ability was necessary for retrieving because computer scientists might not know that something exists unless it is available online or through conference channels.

6.6 Summary of Material use practices and the Principle of Mastery

Computer scientists worked in a discipline that incorporated conference publication as a serious form of contribution. The mastery ideal in computer science included a working knowledge of both conference and journal literature (Table 6.6.1). In addition, computer science privileged efficient access to the most recent published work and thus it was not surprising that the only electronic journal in this study that was used intensively was a computer science journal.

Table 6.6.1: Mastery Ideal in Computer Science

Discipline	Attribute of Disciplinary Mastery Ideal
Computer Science	Computer Scientists have a working knowledge of both conference and journal literature in their subspecialties

Compared to the other research disciplines in this study, computer science research had a different mission. Even though there was not yet a consensus about the balance in computer science between responsiveness to demands for the discipline to address external needs and the integrity of the discipline as a science, computer science was still organized around computational artifacts. Whereas molecular biology, sociology and literary theory interpreted the world by examining biological systems, human system or the construction of meaning through written artifacts, computer science research focuses on the design, construction and use of computational artifacts which presumably change the ways the world functions.

The orientation to research in this discipline thus influenced material use practices. Because of the external interest in computational artifacts, computer scientists had incentives to produce publishable findings in computer science in a variety of refereed and nonrefereed forums. Computer scientists developed conventions for distributing nonrefereed publication (technical reports and magazines) and distinct conventions for evaluating conference publication (i.e., judging quality by rejection rate). However, there was little comprehensive searching by faculty researchers because they worked within specialized forums where they could more efficiently find the materials they needed. This precluded comprehensive searching to identify an exhaustive set of materials in a wider variety of forums. Browsing activity was much heavier and computer scientists used browsing to select materials from their more specialized forums. They also used browsing to examine electronic announcements of conferences, and table of contents of journals distributed on

electronic mailing lists. Retrieving was also very popular. Computer scientists made intense use of electronic mail, ftp sites and World Wide Web to request papers and share other research inputs such as data sets or tool kits. Retrieving also provided an effective mechanism to connect with other researchers and projects after meetings. Work in computer science is less focused on the craft of writing than sociology and literary theory, and less focused on announcing a discovery than molecular biology. Instead, computer scientists contribute work by proposing a problem-solving approach, applying a new solution to an existing problem or constructing an artifact that provides features that illustrate the former contributions. Publications largely function as a way of documenting their systems. In computer science, the system is the text much as in physics, the particle detectors are the text and in molecular biology, the genetic sequence is the text.

Table 6.6.2: Material Use Practices in Computer Science

Discipline	Comprehensive Searching	Browsing	Retrieving
Computer Science	Graduate students predominantly used bibliographic databases	Researchers browsed conference proceedings, announcements and tables of contents	Researchers retrieved materials in electronic format or using e-mail to obtain paper
The Principle of Mastery in Computer Science	Access to current or relevant materials were more important than comprehensiveness	The preference for online materials and tools facilitated browsing activities	Direct distribution of materials matched preferences for efficient, fast access to current work.

Chapter 7
Material Mastery in Literary Theory

7.1 Introduction

In this chapter, I describe the fourth case: how the principle of mastery shapes material use practices in literary theory. I will discuss the nature of work production in literary theory, comparative literature as a sample subspecialty and the material use practices in this discipline. A major finding of this chapter is that the mastery ideal in literary theory includes comprehensive knowledge of a particular subgenre of literature and the intellectual discourse about it. Literary theorists made little routine use of comprehensive searching and instead favored browsing online public access catalogs, topic-oriented bibliographies and World Wide Web collections to identify materials which they obtained through retrieving. The mastery ideal in literary theory differs from the other three disciplines which used predominantly scientific modes of inquiry. Instead, literary theorists constructed meaning through a more solitary mode of work. They analyzed specialized individual collections of materials. Browsing library catalogs or special collections was more prevalent than comprehensive searching because they preferred to limit the amount and nature of materials they examined. Literary theorists were usually bibliophiles and used retrieving to collect books as well as articles.

Next I discuss several features of work production in literary theory: what comprised the discipline, the construction of meaning in literary theory, the work production environment with associated resources, the flow of production, and the role of discourse.

7.2 Work Production in Literary Theory

Literary theory, as a research discipline in this study, refers to **the analysis of literature by drawing on theories of philosophy, linguistics, cultural studies and other fields in humanities and social sciences.** A literary theory, as a particular analytic approach refers to one of a set of theories employed in textual analysis. The use of these terms can be confusing, even to people who work in the discipline. One definition equated literary theory with one particular theory: poststructuralism (Komar, 1994). On the other hand, an informant in this study described his theoretical work as "literary theory of romanticism" which was, in fact, opposed to poststructuralism. Literary theorists often provided their own definitions when writing about "literary theory" and other related terms. In an introspective paper about literary criticism and theory, one scholar writes:

> By 'literary discourse' I mean writing about literature; by 'theory' I mean general principles applied in literary discourse; and by 'criticism' I men commentary on specific literary texts. (Harris, 1996)

The confusion over the use of the term literary theory was characteristic of work production in the discipline. Establishing meaning was a central activity of work production in literary theory. With respect to the ways the informants presented their work production, this study refers to them as scholars rather than researchers. This term sets them off from informants in the other three disciplines who predominantly characterized themselves as scientists: computer scientists, social scientists or biological scientists. Instead, literary theorists are humanists, part of the family of inquiry that includes philosophy, languages, classics and history. The term research was also problematic. For example, one informant

took research to mean scouring the library (or even the libraries of the world) for critical materials:

> It would probably be a misnomer to say I do research. I mean I do arguments and so I'd be more interested in, informed by what other critics have had to say about this argument. So I read a lot in philosophy, I read a lot in social theory, but I don't do anything resembling research and there's never a point where I would need the standard week in the library to find arcane text.... I deal primarily with fairly well known primary texts. [DSULT3]

However, the term scholar and scholarship was problematic for other informants. For this informant "scholarship" connoted a historical tradition of an ascetic lifestyle of library work separated from worldly concerns.

> I'm not really a scholar.... I guess I do have a feeling, especially the semester I spent in the Bibliotheque Nationale, it was sort of playing at being a scholar. Going to the library everyday and reading all these old 19th century books, and that was - I knew that was not really me... I was playing that role for a moment....Critic versus scholar is usually is the way we used to speak of it. But I'm not really, not particularly nostalgic for that. [MULT1]

Noting these conflicts, this study refers to literary theorists as scholars rather than researchers.

Similar to sociology, the pluralistic nature of the discipline produced central disagreements about a common paradigm for inquiry. In several key debates in the study of literature, literary theory as a research discipline plays a central role. Jay Parini, a literary theorist, wrote in an opinion column in the *Chronicle of Higher Education* about one key debate:

> Traditional scholars -- those who edit texts, write biographies, and provide close readings of poems and novels -- are upset by literary theory and its supposed downgrading of literature into "textuality." (Parini, 1995)

Although some informants relied on more "traditional approaches" in their work, they were all aware of the literary theory approach and provided contrasts between their techniques and those of "literary theory." Another conflict in the study of literature was between literary theory, creative writing, and criticism outside the university. For example, Mark Edmundson, a literary theorist, characterized this conflict as reminiscent of the classical debate between poets and philosophers about the nature and purpose of literature (Edmundson, 1995).

These debates provide clues to the boundaries of what literary theorists consider their discipline. These definitions of work also circumscribe the generalizability of this studies findings to the "literary theory" approach to analyzing literature. There were several informants who worked in both literary theory and other approaches or disciplines. I will note differences in those informants' material use practices.

In the acrimony of some debates, some academics and administrators question the legitimacy of the study of literature. The tradition of literary studies dates back to ancient times but had declined in status over the years in the face of increasing emphasis on big science at most research universities. Sociology suffered similar problems with legitimacy as noted in Chapter 5. Reginald Gibbons, a poetry critic, remarks in his examination of criticism in the university:

> If there is a crisis in literary criticism as it is practiced in the academy, it is not the struggle between opposing theoretical camps, but the question of whether any kind of literary criticism is of great value now (Gibbons, 1985)

The declining legitimacy of literary studies was accompanied by decreased infrastructural arrangements for work production. There were few sources of funding for their scholarship. Small grants from within universities and fellowships outside the university often paid for conference attendance, travel to remote libraries for study and sometimes

even infrastructure for material use. However, most literary theorists depended upon allocations from the department, school or university. They often used old computer equipment, slow computer network connections and scarce computer support assistance from their department offices. Although this section reports on the use and perceptions of literary theorists who used some electronic materials, in several departments, informants did not even have access to high speed networks. When they did have access, it was usually because of some additional responsibility that spurred an installation:

> Well, I think it started with this [university committee about technology] that I was on....Then the chair says well of course we'll send memos to each other via e-mail and I was the only person in the humanities and I was the only person that was not connected to e-mail. And so... the chair ... had to get special permission for me to plug into the [campus network] because this building was not even wired ... other people [in the building] had to use modems... so that I could use e-mail. So then I was probably a year or two ahead of colleagues in using e-mail.... A work study student gave me a ten-minute orientation. With that ten-minute orientation I was the department's instant expert. [MULT3]

This informant emphatically denied that she was knowledgeable about computers. In fact, although she was publishing a paper concerning theoretical issues in computer mediated communication, she confessed that the occasion for her increased interest and use of electronic networks and services was because of a family issue at home:

> That actually came about because of a news report a couple of years ago with the earthquake. The LA earthquake. There were earthquakes in Los Angeles and there was major blizzards up east. And there was a news report that Compuserve's use jumped those couple of days - 70% and most of the place where it jumped was on kids who were home from school and were sending messages to each other across the country saying what about the earthquake. And we thought, our children are missing out. [MULT3]

In general, literary theorists had low access to computer skill and depended upon the scarce help of shared computer support specialists. At several universities there was only one specialist assigned to all departments in the humanities. Therefore, literary theorists primarily had to rely upon themselves to learn how to use digital libraries effectively in their

work. Many of their institutions offered Internet courses, but there was a common problem with these opportunities:

> Unless it is directly relevant to what I'm doing at the moment, if I go to a 2-hour seminar on the World Wide Web, it sounds interesting....I did that at the very beginning of the term, back in January and now I've basically forgotten everything he's said. I've probably got a piece of paper that he handed out somewhere and I might be able to reconstruct it, but....[MULT1]

This corroborates findings from other knowledge work settings about the importance of introducing new skills and technologies during a "window of opportunity" (Tyre and Orlikowski, 1994). The digital library infrastructural arrangements for work production in literary theory were often minimal and sometimes substandard with respect to other disciplines. Next, I explain the predominant characteristics of work practices of the scholars.

Work production in literary theory included a set of very individualized work practices that resulted in the production of essays, arguments, presented papers, articles, book chapters or books about literature. Work production depended upon discourse, contemplation, writing, and a theoretical orientation with which to interpret the work. Literary theory did not build directly upon previous results in the way that scientists depended upon each other's findings. Instead, they organized themselves according to their common interests based on theoretical approaches, arguments, or materials. Most literary theorists did not work on a shared set of literary works that served as inputs to work production, even during graduate training. Unless they shared works that were housed in special library collections, literary theorists tended to collect what they need, work individually and share ideas through written or oral discourse.

Literary theorists described their work flow in terms of projects. The occasions for initiating a project were diverse: invited papers, tangents from ongoing projects, or the discovery of a new material. Often, the first book literary theorists wrote was a revised and extended version of the dissertation. Typically, one work leads to another helping them produce several articles, papers and book chapters related areas:

> I was invited to contribute a book chapter... on the strength of [my] book. So the project's been through a number of phases. I've written two papers based on it: one that I gave at the Shakespeare association on [topic] in the 18th century, and one that I gave at the Society for the [related topic] on publishing at the Library of Congress which focused on a little more on [narrower topic] per se. Then I actually gave another lecture where it's much closer to the final form on - at a conference on [topic] at [Neighboring State University]. And using all that material, I submitted one draft of the article. In November I did another draft, a revised draft right around the 8th of December...[DSULT1]

In another case, the occasion for an initial work was the organization of a group of literary theorists to comment on a particular work. These occasions sometimes triggered extended discourse with other scholars on the same project.

> [Author] had this essay which the editorial board found very interesting - provocative and invited a number of people to respond to it. And the idea was to make a special issue then in which they would have this essay and have this essay responses from these people.[MULT3]

Book projects differed in many ways from the projects producing articles. One common approach to publishing a book was for a literary theorist to select several previously published essays written on different occasions united by one or more common themes between them. Typically books included original work in addition to previously published articles or extensions to previous papers. Other occasions for pursuing new themes came from invited lectures and discussions in graduate seminars. This example illustrates how a literary theorist drew upon his teaching experience to revitalize a 10 year old book project:

> While I was reading for that, I discovered in fact, ... that I wasn't doing that at all. I was off on, in fact, another book which grew out of that which is the one I've now finished....I just got back my original proposal and I've been teaching a course for the second time that goes back to the original proposal. And I thought, how did I ever get around to this?... That's not how I'm teaching it anymore. [RULT3]

In other cases, scholars initiated work upon discovery of new material: a critical obscure book that provided rich material for exploration, access to a newly cataloged collection in a scholar's own university library, or a deeper exploration of a previously known book. Here is an example (from field notes) of the way a novel sparked a book project:

> The piece on [Author] was started 2 years ago when she encountered a novel she hadn't read before... This was [Author]'s last novel which was a miserable failure, but experimental and more daring than novels nowadays. She said that this novel "took over my life." It was so compelling that she taught a graduate seminar around value of fiction, especially as expressed in this book. They used this book " as a prism to read everything else." [HULT1]

Typically, the source texts about which literary theorists write tended to be older than the material used in the other disciplines. They also used browsing to examine journals in the library and journals they owned. Literary theorists were not in competition with each other for credit but nevertheless took pride in discovering little-known unique or rare texts. Reading as an activity was more central to disciplinary practice than in the other disciplines. In addition, some literary theorists were beginning to explore themes having to do with theoretical views of discourse via and about internetworked technologies (e.g., electronic mail, electronic journals). There was a burgeoning number of gopher and Web sites publicizing and archiving discussion lists and journals for literary theory.

Literary theorists typically worked on projects (especially books) over a number of years. Two years was a short time frame for a book as compared to ten years or more for some projects. Although most literary theorists tended to work intensely on one paper or chapter

at a time, many projects were ongoing. The balance between reading and writing was more critical in this discipline than typically in the other three of this study:

> In practice, since you usually have deadlines of one sort or another for a lecture or a conference paper that you agreed to give so you are sort of reading and writing at the same time. You're writing some part which may not be designated as a particular part of the project that is part of it nonetheless. A talk for a conference or an essay. So you are doing both. And certainly that's one reason one accepts those obligations, is to keep yourself, keep writing. Right, because it would be easy to just go on reading forever, without writing. [MULT1]

The career of literary theorist tended to be quite closely tied to classroom responsibilities. Doctoral students supported themselves largely on teaching assistantships and it was not uncommon for literary theory graduate students to teach every term (especially in compulsory writing programs for undergraduates). Some doctoral students even found positions in other areas of the university based on other skills. Finding academic positions had become highly competitive in literary theory and most students could not recruit for tenure-track positions until they had completed their doctorates. Faculty advisors carried a larger number of graduate students than the other disciplines but work with them less frequently for joint projects.

Although most work was single-authored, literary theorists connected their work to other scholars in several ways. Several informants had created their own groups of colleagues with whom they shared their work, sometimes at workshops, journal editorial board meetings or private electronic mail discussion lists. Some informants found new technologies helpful to save precious money and time in gathering resources and communicating with colleagues. For example, this literary theorist used electronic mail to supplement her interaction with a valued colleague.

> I think I sent a draft off to a friend of mine [at Canadian University], ... and he made some suggestions. We exchanged work because he is doing something for the same collection. So we had a conversation about, [common topic of interest] So we exchanged sources that way.... He read my dissertation actually and we did similar kinds of works and we wrote and we e-mailed and we're seeing each other times at conferences. [DSULT1]

The main professional organization to which the literary theorists belonged was the Modern Language Association (MLA). They met yearly in late December at a large scholarly conference that hosted paper sessions and professional services (workshops and employment resources) for their members. Several informants preferred smaller conferences and workshops to the MLA conference:

> I actually tend to avoid MLA - I like the smaller conferences: The Shakespeare Association or more specialized conferences rather than MLA if I can manage it .... I average about 2 a year. [DSULT1]

Work practices varied by individual, but typically literary theorists studied and wrote at home, while visiting other institutions, during summers and while on sabbatical. This literary theorist provided a typical example of how isolation from library materials and colleagues often spurred interest in trying new types of materials and technologies to connect with other scholars.

> Next year, I'm going to be... living in a village in [Europe] and the electronic world is likely to be much more important to me.... I know very little about the resources that the local university library and the [university] so my plan is not to worry about it too much. I'll be there with [the author he is writing about] and such notes as I have on my laptop and huge hard disk - just working. But I am ...trying to rely on e-mail for contact with people... I could imagine in certain sense in which I want to talk. [MULT1]

In summary, literary theory, as a discipline, drew on different theories to analyze literature and had construction of meaning as a central activity of work production. The production

of papers involved personal contemplation and individual writing. However, scholars connected their work with other through written and oral discourse.

7.3 Comparative Literature Subspecialty

> The comparative study of literature is concerned with the relationships between literature and other arts and fields of knowledge. Its traditional emphasis has been on the systematic comparison of literary works from more than one country. This comparison may be made in the framework of a literary genre, of a period in literary history, or of dominant themes and motifs; or it can be undertaken in the context of the mutual impact of two national cultures or entire civilizations.(Stevens, 1996)

Comparative literature informants further identified their specialties by the kind of texts they used (often read in other languages) or by their incorporation of cultural theory into literary interpretation and criticism. They regularly worked abroad, sometimes for part of the year. Some of them published in foreign language journals.

Comparative literature informants were much more likely to use foreign language libraries or collections than the literary theorists who primarily worked with English. Work production otherwise resembled the other specialties in terms of flow, individual orientation and outputs.

> I had an [] fellowship for a different, I mean it was a [Author] project, but it had a different title and a slightly different focus back in 1987-88, I guess....But it's now different, it's now rather different - it's focus than what it was then. But still.... that was still a year that I spent, I spent that year at [Prestige University]. I had been doing a lot of reading in the library....And the Bibliotheque Nationale, in 1990, I spent a lot of time reading earlier criticism of [author], the 19th century criticism and the early 20th century that I've never tackled. [MULT1]

Comparative literature informants relished unique opportunities to work with colleagues in different countries. Even when they didn't work abroad as frequently as they would have liked, they maintained contact with colleagues via correspondence and increasingly electronic mail. Sometimes projects arose from this correspondence. In this example, a comparative literature scholar described how her experience using e-mail during a political event provided material for an article about themes of location:

> This is an article which began as a response to a theoretical discussion on [subspecialty] literature and the postcolonial situation. And so there was an original article and ... a full length article .... that was a response to it. And when I wrote the article it was about a year ago exactly when the [political event happened]. And so it became kind of a meditation on topics of location, and the location that it specifically used was the location of e-mail. That is, what does it mean when the location is the net rather than specific geographical space. And so I wrote this article using [political event] as the example, incorporating a lot of stuff that was coming over the e-mail network. [MULT2]

Opportunities for writing figured as key factors in work production. Access to people and materials was also important but the amount and quality of time shaped that access.

> [Mountaintop]'s holdings are actually quite good. It's just somehow when I'm here, I don't spend enough time in the library.... So even [FSU], if I may say so... I was more productive there with a less good collection than here, but with more time to get at it. [MULT1]

Comparative literature scholars were also more likely to span multiple subspecialties than literary theorists in other specialties who worked with one theory, genre or time period. As was the case in other disciplines in this study, when people worked in various subspecialties, they often sought different kinds of materials. This example illustrates an occasion for finding source materials on the Web:

> As an idea, of course it floats around in European philosophical circles rather than American circles.... So the French have established on the [World Wide] Web culture and history [home pages] where there is considerable bibliographical resources as well as some useful information on current work in architecture or architectural history, current exhibitions in Europe. [RSULT3]

Since the subspecialty of comparative literature was predicated upon comparing materials from at least two countries, scholars needed to be able to identify and select materials from a variety of sources in different languages.

The outputs of comparative literature scholars were not homogeneous. The choice to study Judaic texts, classics, Hispanic literature or German culture influenced the outlets where informants preferred to publish. However, there were some common journals that most comparative literature scholars subscribed to or browsed occasionally. Table 7.3.1 provides a thumbnail sketch of publications in comparative literature. In terms of length, number of references these journals most resemble those in sociology. Both these journals and those listed in Chapter 5 (Sociology) usually come out quarterly or bimonthly rather than every month (Computer Science) or every week (Molecular Biology).

Table 7.3.1: Profile of Comparative Literature Journal Sample

Journal	Type of Submissions	Rough Average Length	Average Number of References
Critical Inquiry	Research Papers	23 pages	37
Poetics today	Research Papers	22 pages	38
Diacritics	Extended review essays	19 pages	18 (some 1, 20-60)
Representations	Research papers	24 pages	56
Publications of the MLA (PMLA)	Research, Reviews, Commentary, etc.	14 pages	45

At the time of this study, several new journals had been started which were distributed in electronic format (e.g., E-Journal and the Journal of Postmodern Culture). However, informants were still reading and publishing in predominantly traditional print forums. Book publishing played a greater role in comparative literature and literary theory as a means of establishing one's contribution.

7.4 The Principle of Mastery in Literary Theory

Literary Theorists sustained mastery ability based on a particular subgenre of literature and intellectual discourse about it. In this section, I describe the principle of mastery in literary theory: attributes of the mastery ideal in terms of a subgenre of literature and intellectual discourse.

The mastery ideal in literary theory included comprehensive knowledge of materials from a particular subgenre and sustaining knowledge of the intellectual discourse surrounding those materials. A genre is a category of literary works which may be based on a particular author, time period or topic. This study uses the term "subgenre" instead of genre to emphasize that literary theorists work with a particularly small subset of materials out of a much larger body of literature. The term subgenre refers to the literary works which are at the heart of the study of literature. Sustaining knowledge of the intellectual discourse surrounding a subgenre refers to published criticism and analysis of the subgenre as well as themes from conference papers and informal discussions about that subgenre.

Graff attributes patterns of specialization in scholarship to the "field-coverage principle" where university departments hire instructors in different specialized areas (Graff, 1987). In literary theory, he argues that this principle assumes to some extent that literature (and by

extension literary scholarship) is self-evident. Specialization externalizes the framework in which readers interpret literature to a predefined period, theoretical approach or method of discourse. Disciplinary patterns of specialization therefore provided incentives for scholars to find unique texts and/or new interpretations in order to participate in work production.

This case illustrates how for people who are looking for new materials and interpretations, electronic mail and the Web offered new ways to find source materials. This scholar particularly avoided using materials that might be found in the MLA bibliography

> Electronically for the most part, it's easier to compile both bibliographic resources necessary for such a project and track down using things like the World Wide Web in some cases to access material directly online.... There are ways of gaining access to what some people, especially in economics ...Just tracking down materials outside what would normally be thought to be good materials - the regular competence of somebody whose been in the humanities. Say by contrast for example, I've never worked with the Modern Language Association Bibliography. [RSULT3]

This was rather a unique situation among informants in the study, but characteristic of people who worked between disciplines. However, part of the reason for seeking a different type of mastery ability, was because of the need to find new audiences for a new type of contribution (work production output). Scholars such as RSULT3 were trying to create a new type of subspecialty and therefore are beginning to define a new mastery ideal themselves.

This chapter previously reviewed common debates with the discipline of literary theory. These debates over the nature of literary theory and what defines a contribution to the discipline were one example of intellectual discourse that literary theorists must follow to sustain mastery ability. With regards to discourse (criticism and arguments) surrounding a subgenre, this literary theorist illustrated the influence of specialization:

> In the field of literary theory ... where you're trying to keep up, it's not a problem to find out what to read because, in a sense, the field is ... so elastic that anything that is read by people outside the field in which it originated, becomes its own literary theory....So in a sense in the field of literary theory, you're trying to keep up your reading - what other people are talking about so there you are to some extent following journals or other books. Though you can occasionally make a discovery, push forward some source of your own that you think is important and interesting that others haven't noticed. [MULT1]

This informant explains how literary theorists sustain mastery ability by keeping up with what people are talking about in journals and books. "Keeping up" with intellectual discourse is necessary for making a contribution because it entails adding to the discourse something that "others haven't noticed." This next informant describes how he uses a World Wide Web page to make connections to other scholars and researchers.

> [The World Wide Web page for the journal he edits is] important because it's the most hypertextual facile way to pursue interests that other people, other connections that people may have noticed, some theories over here that I haven't myself noticed or found easy ways to pursue instead of jumping around inside the Web sometimes.[RSULT3]

The journal he edited served as a forum to connect a diverse group of scholars interested in a relatively new subspecialty. He extended these connections by using electronic materials (World Wide Web page) to sustain his need to connect to and sustain intellectual discourse.

The next informant worked in more traditional ways to sustain mastery ability of intellectual discourse. He described how he developed mastery ability to do work in a new area. He not only had to identify useful texts, but also the discourses or traditions surrounding the work of these key figures.

> Those are new fields for me. They demanded a certain amount of working from scratch. So I had to use a number of very general say histories of anthropology, histories of sociology. I had to work backwards in many ways. I knew that a lot of the work that I was dealing with made references to, let's use a very obvious example, made references to the work of Marcel Mauss. I then realized that I had to understand to some extent the tradition out of which Mauss came, which led me to Durkheim. So then I had to read some books on Durkheim to figure out what I wanted to do there. So there's really a process of working backwards. [BSULT1]

Keeping up with colleagues also figured prominently in literary theorists account of work production. Many literary theorists relied heavily upon electronic mail to supplement published materials by communicating with distant colleagues who informed their work.

> I'm actually just a better correspondent on e-mail than I am on paper. I just find it easier to keep communication going on e-mail.... Some of it is very quick. These people are in [Canada] and New Zealand, that's a long way.... A piece of paper took three weeks to get to [Canadian University]... Typically what will happen is a kind a little flurry of correspondence and then not much and then another flurry. And I just find that a lot easier to keep up with than paper correspondence. [DSULT1]

Several literary theorists used discussion lists such as list servers, but in general, most researchers avoided them because of the burden of keeping up with discussion that does not interest them:

> I subscribe to several listservs: Shakespeare has one, there's one called FICINO, which is a Renaissance list.... Also, SHARP-L which is the Society for the History of Authorship. Those are the main ones... depending on what I feel like and what my interests, I might subscribe to ones outside my field. I subscribe to Medieval list for a while and the Victorian list. Both of those, they each [send mail] way more than the Renaissance ones for some reason. Both are very chatty, so I tend to unsubscribe after a while.[DSULT1]

7.5 Material Use Practices in Literary Theory

Compared to researchers in other disciplines, the literary theorists depended on the

traditional library the most, but chiefly to supplement their own collections of provide old or rare materials they couldn't own. Literary theorists produced work based on particular texts, not only including current and ancient literature, sometimes in foreign languages, but some also drew on social critique to inform their analytical interpretations. Some literary theorists traveled to specialized collections at Harvard, Yale, the Huntington Library (Los Angeles), and Le Bibliotheque Nationale (Paris) to view and study texts as artifacts or to work with facsimiles. In this section, I describe some common material use practices and highlight how the principle of mastery shapes them.

A typical style of working in literary theory was to start with some known texts or articles (usually which the scholar already possessed) that addressed a theme or argument and expand the set of working materials from there. Literary theorists often referred to a particular piece by the author's name in the context of a project:

> So I had [Author] and I had a couple of other things that I was interested in talking about as a kind of theoretical take-off. [MULT3]

Even when literary theorists collected most of the chief works they used, especially when they drew on contemporary theory and popular texts, they still depended on library collections to obtain articles from journals to which they did not subscribe or to refer to work they did not collect.

Despite some individual forays into writing about or searching electronic materials, literary theorists primarily used technological resources to prepare manuscripts and look up paper materials. This example shows one scholar's concern over the way use of online card catalogs prioritize speed and searchability over completeness and accuracy of book records.

> I'm perfectly happy with the old catalogs.... I think they may have made a mistake of throwing them away. There's information in those cards that doesn't get [converted to digital form].... Partly, of course, if the transcriber made a single error, the book may be lost forever, whereas the card catalog, typos and things get a little easier to be manipulating the cards and come across things. Also there's more.... I don't continually look at the long forms but often the cards in the card catalog, especially the older ones have, especially collections of essays will give you the entire list of essay contents of something. Whereas in the modern one, we don't get that.....[MULT1]

On the other hand, literary theorists were increasingly using electronic mail use for substantive discourse, academic business and communication with publishers. As with informants in other disciplines, the need to bridge geographical isolation from people and resources, participate in conferences and workshops and in some cases, master new areas of discourse spurred them to utilize Internet resources as reference tools, supplements for telephone and search engines for research materials. However, literary theorists were also wary of the legitimacy and quality of these resources. The following example (from field notes) describes one informant's concerns about discussion lists and electronic bulletin boards:

> She describes the bulletin boards she uses as "tempests in teapots" or "local weather systems" where "there are no consequences beyond the small." She is uneasy about them because they are undisciplined and writing is about discipline and censorship. People on these bulletin boards talk about things she thinks and reads about and there is some air of seriousness. However there is also some total frivolity and no self-censorship. She finds this irresponsible because people make statements semi-anonymously. She knows people who use bulletin boards, but she feels that she is in the majority in lurking rather than participating. [HULT1]

7.5.1 Comprehensive Searching

Literary theorists rarely used comprehensive searching of online databases in the course of writing most papers. Instead, they tended to start with their own collection or use limited

comprehensive searching on a subset of material. Two exceptions to this were scholars who worked in multiple subspecialties and therefore had need to access different kinds of material in multiple subspecialties, and bibliographers who compiled collections of work by book, author or period. However, this study excluded exclusively bibliographic work.

Comprehensive searching helped develop mastery ability for literary theorists because it provided an orientation to the contents of the body of work, relationships between materials in that body and provided a set from which to begin to identify material of interest to the task at hand. Literary theorists used comprehensive searching when they were starting work in an area new to them, but when possible, they preferred to go directly to known sources rather than initiate work with comprehensive searching.

In this example, a literary theorist was starting a project using a set of materials (18th century books) and found limited comprehensive searching useful to develop mastery ability over the topic in a new domain. She used comprehensive searching by gathering all the books in a particular facility around a particular period so she could start to formulate her approach to a new topic.

> This summer I was at Harvard [rare book room] for a week or so and decided that I didn't quite know what I was doing and the best thing to do might be to poke around and get as many, get 18th century books, kind of get a sense of [topic] 18th century, how it changed. [DSULT1]

This style of work was typical of literary theorists who used rare and unique materials. Many scholars were bibliophiles, expressed an affinity for working with the book as an artifact and enjoyed working with books in tangible forms.

Another means for comprehensive searching was to use different campuses' online catalogs to identify books of interest. In this case, the scholar chose which library to access based on comprehensiveness in collection.

> I do online searches of catalogs, I get on to gopher, or whatever - telnet and check out. Sometimes I just will check out a library that I know has a distinguished collection not because I can go to that library, but because their catalog system is pretty good, like the Berkeley one seems pretty good and know that they can have almost everything. [DSULT1]

Several scholars used ARTFL (an online database of French texts) and online concordances which are specialty-specific. However, the informants used MLA bibliography, a general purpose database for the entire discipline, rarely if at all. Not only did they have few occasions for doing comprehensive searching, but also, due to infrastructural accessibility issues, these resources were often located in library buildings and could not be accessed by campus offices or from home. Therefore, accessing the MLA bibliography usually turned out to be inconvenient.

> The library has a [Computer-database and user area] - that becomes prohibitively crowded.... They have a lot of resources - MLA Bibliography - that you can only get there - you can't [dial] in. But this time of year, it becomes impossible to check it because students are all writing papers on the machines..... There's a couple of workstations that are set aside that you can only do MLA searches on, but only a couple.... But, it's really a student center and it's really not about research mostly, it's much more about word processing.[DSULT1]

Even when literary theorists overcame accessibility barriers (in this case, through use of a research assistant), MLA bibliography searches proved to have a similar problem as other online databases: too many references.

> I've had research assistants in the summer who I've asked to do a search in the MLA bibliography and they always came back with such huge piles of print outs that almost never seemed useful.... I suppose it's true that I tend not to search for articles unless I have reference already. [MULT1]

For the most part, literary theorists relied upon keeping up with work concerning their subspecialty through reading journals and participating in intellectual discourse. For most work in their subspecialties, literary theorists relied upon their mastery ability over the body of knowledge in their subspecialty to provide starting points in particular projects.

> Most of what I'm doing doesn't involve any actual research because I sort of keep up with the field and I know, I need to read new books or know of them so if I'm going to be making X claim about [author], I'll know somewhere in the back of my mind that such and such a book came out three years ago and I better go and look at it. [DSULT3]

7.5.2 Browsing

Literary theorists sometimes used browsing to follow-up on citations from comprehensive searching to determine what materials were of interest to them. A minimal level of mastery ability enabled browsing by literary theorists because knowledge of a particular subgenre helped narrow the browsing domain. Because literary theorists tended to spend a lot of time reading, it was particularly important for them to focus their reading rather than to browse as much as researchers in other disciplines.

Most scholars browsed print materials more than electronic materials. Aside from the scholars who worked in multiple subspecialties, there was little use of the World Wide Web to identify materials at the time of this study. For instance, one informant explained:

> I guess not a lot [of people have World Wide Web].... I don't hear a lot of talk about the Web from colleagues anyway. [MULT1]

Besides comprehensive searching, literary theorists often began examination of materials by browsing materials suggested by colleagues. In the following example, a literary

theorist started work in a new subspecialty by browsing books suggested by colleagues. As previously noted, she traveled to another collection to do the initial part of her research.

> I went and asked a couple people in 18th century here what they recommended in Shakespeare and 18th century [DSULT1]

This example describes in detail how one informant actually browsed. Although he characterized browsing as "hit or miss," he used area searching to develop a sense of what materials are available in a particular library.

> Well with books, of course, you poke around and then see - does this look interesting? What are the chapters on? Get into it. You hear from other people or other people refer to something. Whether or not you think that this is likely to be an important part or not.... So it is to some extent hit or miss. I mean in catalogs, I do use subject headings to see what there is there and open stacks, of course, are great that's one of the nice things about libraries like Mountaintop and [Prestige University]. You can go and browse on the shelf and see what there is there. [MULT1]

Because area scanning relied upon the library organization to group like materials together, literary theorists used the library classification system as one method for browsing books more than researchers in other disciplines.

Some literary theorists used library services where books from the campus collection could be sent directly to the scholar. Although this method was more strictly a type of retrieving, this account shows how using an online public access catalog in the course of retrieving provided another occasion for browsing when nearby books also appeared in the search result:

> I'm using the general book catalog for the BSU library. Generally speaking, you know what you want and then order it. However, there is a lot that comes up on your screen that you didn't know about when you're browsing and certain books - I asked for books that way. [BSULT1]

7.5.3 Retrieving

Literary theorists used retrieving to collect materials they most used for their work. As bibliophiles and productive researchers, they preferred to collect the materials they used, when possible. Their offices and homes were packed with books and papers. Despite this preference, many researchers expressed anxiety about being overwhelmed with material.

> There seems to be plenty to read. And there are days when I have a feeling that life would be much easier if all my [notes from the materials he reads] were to be destroyed tomorrow and I just had to sit on a dessert island with [the book he is studying] and write my book. There are moments that I feel burdened. [MULT1]

This literary theorist exaggerated his desire to work with one book, but echoed sentiments sociologists also expressed. Digesting a vast quantity of material was particularly problematic for prominent (particularly highly cited) researchers who received unsolicited materials regularly.

A minimal level of mastery ability was necessary to use retrieving in literary theory because it was necessary for scholars to know what they wanted before they could select it. Therefore, literary theorists, more than researchers in other disciplines mentioned working with librarians who provided expert knowledge about the availability of collections. The following example shows how literary theorists who used special collections often work in conjunctions with librarians as infrastructure providers who knew that collection.

> The next primary source I found was a reprint of a [] in the 18th century so I went to that. I even went to the librarian to ask if he knew of more. He actually e-mailed somebody else to see if this person knew more citations and the person wrote me back. [DSULT1]

One informant characterized his use of library collection based on his basic desire to own what interests him.

> I use the library more for books I don't like - I don't want to own. Most of the books I respond to, I buy [DSULT3]

Some literary theorists who worked with contemporary materials were able to collect all the works of a particular author as well as journal articles and other works on related themes. Although all the literary theorists received PMLA (as part of their membership in the Modern Language Association), most literary theorists did not subscribe to all the specialty journals they used in their work and also relied upon libraries to archive materials that might interest them in future projects.

Reference chaining to identify related resources was also quite pervasive in literary theory. In fact the whole approach of starting with items already in a working collection often provided the starting point for retrieving.

7.6 Summary of Material use practices and the Principle of Mastery

Literary theorists worked on multiple year book and article projects requiring access to specific texts. They preferred finding unique materials and developing an individualistic set of working materials to sharing common bibliographies and texts. They influenced each other's work through correspondence, seminars, peer review and workshops. They preferred interpersonal electronic mail to public discussion lists and forums which abounded on specialized topics. The mastery ideal in literary theory included comprehensive knowledge of a particular subgenre of literature and the intellectual discourse about it. Literary theorists drew on particular theories to interpret literature, but

they also engaged in ongoing discourse about the nature and validity of different means of interpretation.

Table 7.6.1: Mastery Ideal in Literary Theory

Discipline	Attribute of Disciplinary Mastery Ideal
Literary Theory	Literary Theorists master a particular subgenre of literature and intellectual discourse about it.

The principle of mastery in literary theory reflected the individual nature of work production as well as the need to connect with other individuals who inform work. Comprehensive searching was uncommon except among scholars who were entering a new subspecialty or working in multiple subspecialties. Some literary theorists occasionally used MLA bibliography and cultural repositories such as ARTFL. Mastery ability replaced comprehensive searching because once a literary theorist had developed an understanding of his topic and working set of materials, he or she no longer needed to compile complete sets of materials that they already possessed or with which they were familiar. Literary theorists frequently browsed materials by conducting area scans of books in libraries, examining materials suggested by colleagues or browsing through the material itself. A minimal level of mastery enabled browsing in literary theory particularly because interpretation of literature is such an individual activity, literary theorists could select materials only if they had a clear idea of what they were looking for or what they could do with the material. For instance, literary theory requires an extensive amount of reading and some literary theorists use a practice called "close" reading to thoroughly review a text for criticism and interpretation. Effectiveness in browsing was therefore necessary to identify a small subset of materials (or even one text) that the scholar has time to read closely. Literary theorists specifically mentioned the importance of maintaining focus in browsing and selecting materials. Literary theorists used retrieving to collect their set of working

materials into an individualized collection. A minimal level of mastery was necessary for retrieving because the literary theorists have to know about materials they want to collect and the relationships between them. Because of the fragmented and individualized nature of specialization in literary theory, retrieving a productive working collection is critical.

Table 7.6.2: Material Use Practices In Literary Theory

Discipline	Comprehensive Searching	Browsing	Retrieving
Literary Theory	Scholars limited search space by author's work but did not use comprehensive searching frequently	Scholars browsed catalogs and topic-oriented corpora to select source materials	Scholars worked with books and articles obtained from personal collection or libraries
The Principle of Mastery in Literary Theory	Searching was infrequent because body of knowledge used by literary theory was more individually-defined	Browsing indices of textual works helped scholars identify materials for retrieving	Retrieving helped scholars create their own body of knowledge

Chapter 8
Summary and Conclusion

In the past several years, researchers in information science, computer science and information systems have claimed that knowledge workers will work in new ways due to new access to internetworked digital libraries. However, new ways of work still resemble old ways in essential attributes of work production that change slowly, if at all, over time. In my study of university researchers in four disciplines, **I found that knowledge workers' material use practices are shaped by the requirement to master bodies of knowledge for production of work** (Figure 8.1.1). This finding indicates that the principle of mastery will continue to shape the ways knowledge workers will use new materials in a body of knowledge and how new material use practices develop.

8.1 Mastery as an Essential Attribute of Knowledge Work Production

Knowledge workers drew upon a body of knowledge relevant to their community of practice to sustain their work production.. However, in order to utilize this body of knowledge in their community of practice, knowledge workers needed a minimal level of mastery ability determined through socialization and norms for participation in their profession. A minimal level of mastery entailed being able to discern the scope of the body of knowledge, the qualities of specific materials in that corpus, and relationships between materials. Knowledge became part of work production through material use practices:

selection of relevant materials from a body of knowledge. Materials included a wide variety of artifacts such as books, articles, indices and networked databases.

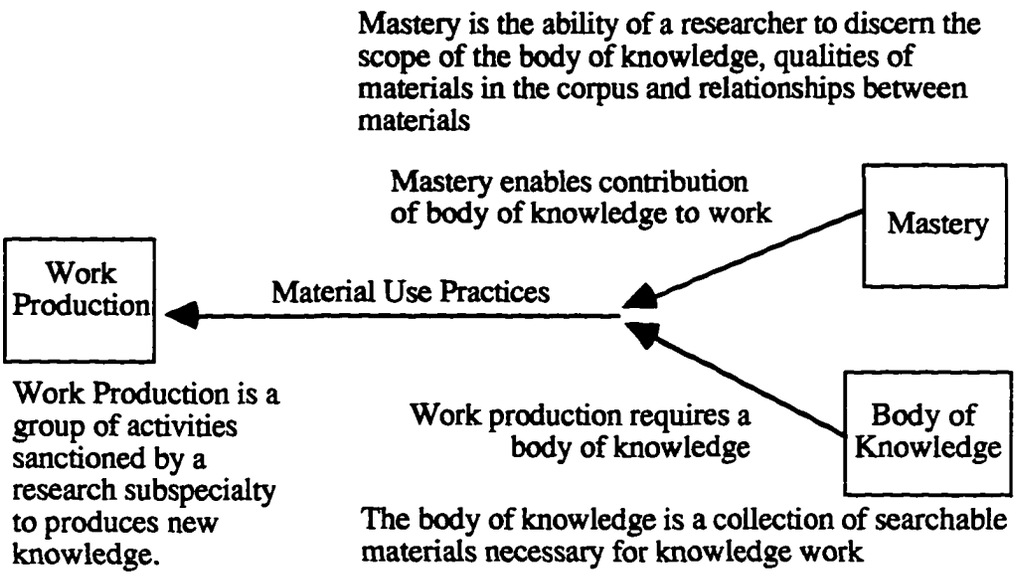

Figure 8.1.1: Essential Attributes of Knowledge Work Production

8.2 The Principle of Mastery in Materials Use Practice

In examining a broad range of resources and services connected with paper and electronic materials, I analyzed three material use practices: comprehensive searching, browsing, and retrieving (Table 8.2.1). Comprehensive searching has been well-studied by end-user searching researchers, particularly in relation to online public access catalogs and bibliographic databases. Browsing behavior has been examined in information use studies and has gained increasing interest from researchers studying use of the world wide web. Retrieving is the third material use practice. Although retrieving was the predominant mode of material use in this study, it has been previously understudied. Retrieving consists of obtaining a desired material in either paper or digital form based on reference information in

the knowledge worker's memory or some other identifier (e.g., a citation). These practices were also used in conjunction with each other.

Table 8.2.1: The Principle of Mastery in Material Use Practices

Material Use Practice	Definition (in terms of this study)	Findings about the Principle of Mastery in Materials Use Practice
Comprehensive searching	Looking into or over the body of knowledge thoroughly in an effort to find or discover something	Mastery ability replaced comprehensive searching. Researchers used comprehensive searching to develop mastery of a body of knowledge
Browsing	Looking into or over the body of knowledge reading random passages that catch the eye in search of something of interest	Mastery ability enabled browsing. Researchers used browsing as a time effective way to examine materials when they know them to be in a legitimate and bounded body of knowledge.
Retrieving	Getting and bringing back from storage something chosen for a reason	Mastery ability was necessary for retrieving. Researchers used retrieving to collect materials they already know they want.

Researchers used comprehensive searching on occasions when they entered a new research subspecialty or went back to one where they were no longer current. Occasions of work production activities which required comprehensive search were looking at a problem in another research subspecialty or writing a review paper. Researchers used comprehensive searching to develop their mastery ability over a body of knowledge. Comprehensive searching would help them learn about the scope of the body of knowledge, how authors investigated particular topics, recent work in a particular area and terminology researchers utilized to describe certain issues. Although comprehensive searching was a relatively quick way to begin to learn these things, researchers also used review articles, reference lists of key papers and author's vitae to discover these patterns. Comprehensive searching would often lead to browsing or retrieving some materials in the search result. However, search results were frequently insufficient for a researcher's immediate need. Mastery ability replaced comprehensive searching because once a researcher became familiar enough

with a body of knowledge, there was no need to take the time to examine long comprehensive search results to find relevant materials. Researchers found comprehensive searching most useful when they had acquired some skill to perform the search, they were familiar with the organization and keywords in the database and searching produced desired results. However, in most cases, researchers didn't use comprehensive searching. They did not have the time or attention to develop the skill necessary to make comprehensive searching useful.

Researchers frequently use browsing for paper materials but computer scientists primarily used browsing for electronic materials. Researchers occasionally used browsing in libraries and bookstores for interesting materials but they perceived this kind of materials use practice (area searching) to be a luxury or recreational. On the other hand, researchers often used browsing to examine tables of contents of periodicals in their own collections or in libraries for new materials of interest. Since reading an entire scholarly work could be time-consuming, researchers would frequently first use browsing to identify materials of interest to the task at hand. The occasions for browsing were varied from routinely glancing at journals when they arrived in a lab to making a point to examine a particular collection during the course of a project. Some researchers used browsing on the world wide web with their family or in pursuit of recreational interests, but they did not consider that activity part of work production. Browsing sometimes resulted in researchers retrieving particular material that they wanted to read at length or more intensely. Mastery ability enabled browsing because it allowed researchers to move quickly through related materials. However in order to use browsing effectively, they required a bounded search space in which they had confidence they could find legitimate and relevant materials. Browsing also sometimes resulted in the identification of key words common in a certain class or materials that could later be used for comprehensive searching or retrieving. Researchers didn't use browsing when they didn't have knowledge of the scope of the

collection they were browsing, they didn't trust source material, or they required a closer consideration of materials than browsing activities provided.

Researchers used retrieving most frequently of the three practices for both paper and electronic materials. Even graduate students who had fewer resources than the faculty researchers to conduct their work preferred to use retrieving (i.e., purchase, copy or otherwise obtain materials) to create their own personal libraries rather than depend upon access to centralized organizations or resources (such as libraries and collections available over computer networks). All the researchers in this study had files of reprints, journal collections, books and conference proceedings on shelves in their workspaces. Even the researchers who favored electronic materials, created electronic copies on their own disk space and frequently printed electronic copies on paper when they wanted to read or discuss the material with colleagues. The most common mode of material use was for researchers to obtain the material they wanted to work with and use it in a paper form. Retrieving requires that a researcher have a unique identifier and a means to obtain an accessible material. Unique identifiers included call numbers, volume and issue numbers, page numbers, ftp sites and file names, URL's on the world wide web, or the filing system of personal libraries. Mastery ability was necessary for retrieving because retrieving requires that a research know exactly what material they want and the reason they want it. They didn't use retrieving when identifiers were unreliable, an identifier did not exist, or they couldn't distinguish between very similar materials.

The study found that these three material use practices were used sequentially and nonsequentially. When used sequentially, comprehensive searching helped a researcher construct a search space, browsing allowed the researcher to sift through the materials and retrieving brings the material into the researchers own personal collection. Because to some extent all researchers are constructing their own unique bodies of knowledge for

work production, all three practices are useful regardless of whether the researchers uses a central library, an digital library or resources or personal libraries.

8.3 Mastery in Information Science Research

Previous information science research examined several aspects of knowledge work production (Figure 8.3.1). End-user searching research has tackled problems concerning how material use practices make a body of knowledge available for work. For instance, the implementation of cognitive models for online information retrieval described the interaction between an individual user and an online information system (Hawkins, 1981). Studies of online catalog use found that comprehensive searching of online information systems based on subject was popular but had problems such as producing results which were too broad or retrieving nothing at all (Mischo and Lee, 1987). My study explained why these problems persist, in the world of both paper and electronic materials practice by identifying the principle of mastery to access a body of knowledge. For instance, my study provided evidence that highly skilled knowledge workers frequently preferred retrieving to comprehensive searching and browsing when they already have mastered the body of knowledge. My study took a user-centered approach by shifting the paradigm of inquiry from examining interactions between users and systems to a paradigm to examining social aspects of how people produce knowledge work in a research subspecialty.

Another area of information science research, information needs, has explored aspects of how the principle of mastery influences material use practices for work production. It focused on communities of practice and conceptualizes material use practices in terms of the values of the communities (Sugar, 1995). For instance, Dervin's sense-making approach (Dervin 1992) viewed knowledge-workers as active creators of their own information. This was particularly relevant to my study's population of faculty researchers at research

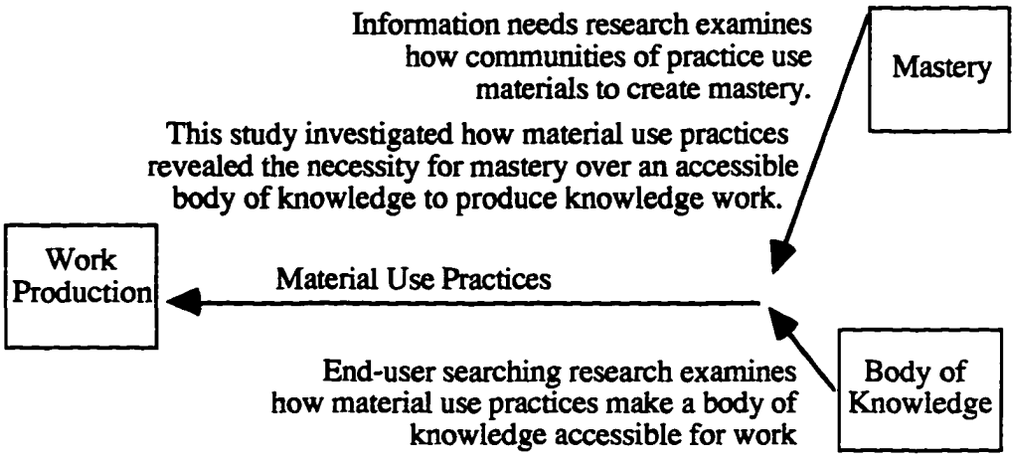

Figure 8.3.1: Framework for Information Science Research

universities since they play a primary role in authoring and reviewing each others' work. Kuhlthau's study on intellectual access also supported the principle of mastery in knowledge work (Kuhlthau, 1993). Kuhlthau described the occasions for information seeking as "uncertainty due to a lack of understanding, a gap in meaning or a limited construct."

My study combined these two streams of work by investigating how material use practices are shaped by the principle of mastery. Although digitization of collections make new material use practices possible, it does not change the need for knowledge workers to select materials according to social norms of professional practice. Though the norms may change (this is not studied here), the role of the norms do not.

8.4 Materials Use Practices in Four Disciplines

This dissertation examined the principle of mastery in four research disciplines: sociology, molecular biology, literary theory and computer science. Each discipline consisted of

researchers in different research subspecialties. Each discipline approached different questions, had different access to different kinds of materials and conducted their work on different time scales. The work production in these cases is scholarly communication, which consists of production of published research articles as a criteria for participation in work production in a research subspecialty.

The principle of mastery was very apparent in molecular biology. The nature of biological discovery was so interdependent on sharing previous results that the body of knowledge upon which molecular biologists based their work was highly organized and standardized. All the molecular biologists used the MEDLINE bibliographic database which indexed the vast majority of relevant journals. Publishers and funding agents also mandated contribution of genetic sequences to GENBANK or similar other sequence databases which they widely used. The stakes were high for a molecular biologist to keep abreast of the latest developments in a subspecialty: researchers compete for multi-year grants providing support of at least $100,000 a year. Winning a grant meant the chance to be the first to discover a gene sequence, functions or structures of a particular model organism. Browsing the latest journal issue table of contents was widespread (as was continuous communication with colleagues by telephone and electronic mail). Molecular biologists also used retrieving by photocopying articles or exchanging preprints by postal mail. Because articles frequently used graphics to report results and biologists did not share common formats for exchanging electronic documents, molecular biologist relied primarily upon print materials.

Table 8.4.1: The Principle of Mastery in Four Disciplines

Discipline	Comprehensive Searching	Browsing	Retrieving
Molecular Biology	Researchers searched MEDLINE for grants and in new areas	Researchers browsed tables of contents of subscribed journals to keep up with field	Researchers copied articles and shared postal mail preprints with trusted peers
The Principle of Mastery in Molecular Biology	Comprehensive searching helped researchers gain knowledge of areas outside their specialty	Browsing helped researchers keep current with newly published results	Retrieving helped researchers create a more field-specific corpus to use
Sociology	Researchers found it hard to limit search space by topic, but used searching in outside subspecialties	Researchers found identification of materials outside of a subspecialty difficult using browsing	Researchers tended to collect the vast majority of materials they needed
The Principle of Mastery in Sociology	Searching was difficult because the body of knowledge includes a wide range of both popular and scholarly materials	A minimal level of mastery ability was necessary for browsing outside of a subspecialty	Retrieving helped researchers develop more focused bodies of knowledge from larger or more diverse collections
Computer Science	Graduate students predominantly used bibliographic databases	Researchers browsed conference proceedings, announcements and tables of contents	Researchers retrieved materials in electronic format or using e-mail to obtain paper
The Principle of Mastery in Computer Science	Access to current or relevant materials were more important than comprehensiveness	The preference for online materials and tools facilitated browsing activities	Direct distribution of materials matched preferences for efficient, fast access to current work.
Literary Theory	Scholars limited search space by author's work but did not use comprehensive searching frequently	Scholars browsed catalogs and topic-oriented corpora to select source materials	Scholars worked with books and articles obtained from personal collection or libraries
The Principle of Mastery in Literary Theory	Searching was infrequent because body of knowledge used by literary theory was more individually-defined	Browsing indices of textual works helped scholars identify materials for retrieving	Retrieving helped scholars create their own body of knowledge

Sociology is a multiparadigmatic discipline. As such some sociologists followed a humanistic approach and others worked with a scientific approach. In addition, sociology often tackled topics of popular interest and topics of interest to a wide range of subspecialties in sociology and other academic disciplines. Therefore sociologists have to develop mastery ability in multiple subspecialties. The sociologists tended not to use comprehensive searching in their own subspecialty, but often used it in other subspecialties. Comprehensive searching helped sociologists develop mastery ability because they could use results to develop mastery ability in other subspecialties. Browsing supported the application of mastery ability in a sociologist's own subspecialty to a related area in other subspecialties. Retrieving tended to be centered around borrowing or purchasing books and photocopying articles. Sociologists tended to rely on retrieving to focus the selection of materials for work.

Computer scientists used more electronic materials than either the sociologists or the literary theorists. The importance of producing results quickly and responding to external stakeholders in their work made conference publication an important outlet in computer science. Computer Scientists therefore needed a working knowledge of both conference and journal literature in their subspecialties. However, they used comprehensive searching the least. Some computer scientists used other researchers online bibliographies or worked from review articles to look over a body of work. Computer scientists' work focused on creation of artifacts (such as databases, models and programs) and the infrastructure to support them. Thus they were more able to exchange electronic documents than those without space or equipment to utilize networked electronic resources. The norms for work production in computer science often induced use and provision of the body of knowledge in electronic form, even if most work was published in print form. Computers scientists used retrieving by exchanging electronic preprints (via ftp sites and electronic mail to the

author) and used browsing when looking for information about conferences, grants, and projects (via mailing lists and world wide web home pages).

In literary theory, I found that literary theorists made little use of comprehensive search and instead favored browsing online public access catalogs, topic-oriented bibliographies or even world wide web collections to identify materials which they obtained through retrieving mechanisms. The mastery ideal in literary theory differed from the other three disciplines which used predominantly scientific modes of inquiry. Instead, literary theorists constructed meaning through a more solitary mode of work. They analyzed specialized individual collections of materials. Literary theorist sustained mastery ability based on a particular subgenre of literature and the intellectual discourse about it. They wrote long articles and books over several years about a particular text or set of texts from a certain author, time period or school of thought. Browsing library catalogs or special collections was more prevalent than comprehensive searching because they preferred to limit the amount and nature of materials they examined. Literary theorists were usually bibliophiles and use retrieving to collect books as well as articles.

Table 8.4.2 Attributes of Mastery Ideals in Four Disciplines

Discipline	Attributes of Disciplinary Mastery Ideals
Molecular Biology	Molecular Biologists have knowledge of both previous and concurrent research projects to make a unique contribution
Sociology	Sociologists attain and sustain mastery of bodies of knowledge in multiple subspecialties
Computer Science	Computer Scientists have a working knowledge of both conference and journal literature in their subspecialties
Literary Theory	Literary Theorists master a particular subgenre of literature and intellectual discourse about it.

8.5 Conclusions and Future Work

This dissertation contributes several advances to the understanding of the principle of mastery and digital libraries as resources for knowledge work.

This study defined material mastery as the ability for the researcher to discern the scope, qualities and relationships between materials in the body of knowledge. Although the term "materials" referred to data and documents used in knowledge work production, by examining the principle of mastery, another meaning of material emerged. Materiality is the quality or state of being material, a.k.a. relevant. Material mastery therefore alludes to the understanding of what constitutes materiality: determining what data and documents in the body of knowledge are relevant for knowledge work production. Recognition of this two-pronged definition of material contributes a deeper understanding of the process of how "materials" become material. For example, the resource decision-makers for library "materials" budgets and computer service acquisitions need to consider not only how to purchase the materials that university researchers need to use, but also how to purchase the most relevant materials for their work. Thus the utility of digital libraries depends not only upon having electronic materials available, but also upon making relevant collections available in ways that support the development and maintenance of mastery ability in research subspecialties.

This study also found that the principle of mastery governs the production and use of the body of knowledge. Norms for mastery ideals socially guide what constitutes legitimate and relevant materials. The attributes of mastery ideals in these four disciplines indicate to researchers what materials are acceptable for work production in that discipline. Participation in work production (i.e., peer review) is the mechanism for socializing new entrants to material use practices which will sustain what constitutes a body of knowledge,

how to access it and how to produce it. Enumerating these attributes of mastery ideals will help guide digital library infrastructure providers in how to construct artifacts, collections and mechanisms to support mastery abilities. By designing for the principle of mastery, we can enhance materials use at different levels of mastery ability.

This study also provides a new orientation for design. By paying attention to the establishment and maintenance of mastery ability, and changing the focus of design from increasing use to supporting work, designers can capitalize on the interests and opportunities researchers already have to use resources that will enhance their productivity. Designing systems that provide indices to criteria that researchers use to select materials will ensure not only a well-organized collection, but one that will be used. Building systems that support specialized collections will better meet the needs of subspecialties, research groups and individuals who have a stake in being able to define their own search space.

This study provides a basis for future work. These findings about the principle of mastery in university research indicate that other forms of knowledge work may also involve mastery ideals and ability. Although mastery ability over a body of knowledge may have different manifestations and degree of influence in industrial research and development, professional services industries or manufacturer marketing, the study suggests that mastery ideals will play an important role in communication and information flow in those settings. Another direction for this work is to generalize the principle of mastery to develop infrastructure and design tools for collaborative knowledge work. Collaborative knowledge work often results in archives and organizational systems that could provide a means for learning and knowledge transfer. The ways in which the discovery of the principle of mastery in knowledge work can influence design provides a rich area for investigation.

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Appendix I
Project Organization and Methods

I.1 Introduction

This appendix describes the project organization and the methodological decisions and procedures for this study. First, I will give an overview of the project organization. In this appendix I make a false, but analytically useful distinction between methodological considerations and the practical aspects of project organization. In fact, they are inextricably entwined. I will describe the project organization first to provide a framework in which to discuss the study. I will refer constantly to the practical considerations which influenced the methodological choices in the research design. This appendix also examines the analytical approach and its constraints. Interpretive analysis is very sensitive to the experiences of the investigators who act as data collection instruments. However, I will attempt to describe the organization of the study in such a way that other investigators will be able to adopt or adapt this method.

I.2 Project Organization Overview

At its inception, I perceived this project as an opportunity to study social behavior via networked electronic resources by studying the domain of digital libraries. In 1993, the National Science Foundation, the National Air and Space Administration and the Advanced Research Projects Agency (from the United States Department of Defense) put out a joint

call for proposals to research digital libraries. Although, this event mobilized increased interest in study in this field, the Digital Library Initiative was actually the product of extensive preparation as chronicled in the Digital Library Source Book (Fox, 1993). At that time, my advisor and co-investigator, Rob Kling had become increasingly interested in the use of library-oriented electronic materials as a domain for investigating telework. Together with my orientation to Internet-oriented electronic materials, we developed some ideas for proposals to study use of both paper and electronic materials. It was a fortunate choice to include both types of materials, not only for me to be able to pursue my long-standing interests, but also because of the rapid emergence of the World Wide Web which has raised the visibility and enthusiasm for Internet-oriented materials.

We briefly considered applying to the Digital Library Initiative program, but the requirements of the proposal entailed more external and internal research resources than were immediately at hand. Instead, we prepared a proposal for the United States Department of Education's Office of Educational Research and Improvement for a Research and Demonstration Grant under the College Library Technology and Cooperation Grants Program. I developed a small pilot study with a simplified design to examine conceptions of digital library use focusing on faculty and digital library infrastructure providers on two campuses. This study provided a means to test out the protocol of the proposed research project and some preliminary results to explore (Covi and Kling, 1996).

After the pilot study was completed, we decided to refocus the data collection on an increased number of faculty researchers and decrease the number of digital library infrastructure informants. We primarily interviewed digital library infrastructure providers responsible for the key resource allocation decisions and supplement our understanding of what digital library infrastructure resources were available at each campus through collecting documentation at campus computer centers and libraries. In many cases, we also

spent several hours at each campus utilizing their library and computer resources ourselves. Based on previous work and consultation with expert colleagues, we focused data collection around variables perceived to effect researchers' accessibility to paper and electronic materials on their campuses (Kling, 1987; Kling and Jewett, 1994). For this reason we added graduate students, who had different degrees of access to resources than their faculty advisors. Another reason to include graduate students was that the structure of work in different disciplines meant that graduate students had more contact with paper and electronic materials and often conducted the bulk of labor-intensive tasks (e.g. programming, wet lab work) for research published by our faculty informants.

The dissertation project examines several of the questions from the Department of Education proposal (described below). We have named the Department of Education project as Scholarly Communication with Information Technology.

The field visits were conducted shortly following the dissertation proposal. Most field visits consisted of a week's stay in the university locale. I describe site selection criteria below. Most of the sites were located in urban settings, primarily in the Eastern and Western sections of the country (due to cost considerations). On the whole, digital library infrastructure providers were happy that we chose their institution for our study and we agreed to share our results with them. We chose to use pseudonyms and mask the identities of the universities to preserve anonymity of the informants. Rob was on sabbatical for the first few weeks of the field visits. Thereafter, we staggered the site visits in order to accommodate both our schedules, the availability of our informants and the universities' schedules.

Table I.2.1: Field Visit Schedule (completion dates)

Week 1	Diamond State University (DSU)
Week 2	Mountaintop University (MU)
Week 5	Tech University (TU)
Week 6	River State University (RSU)
Week 9	Revere University (RU)
Week 11	Harbor University (HU)
Week 18	Branch State University (BSU)
Week 19	Forest State Univeristy (FSU)

Our project generated more interest than we had anticipated among colleagues and practitioners. We frequently consulted colleagues and potential participants for input on site selection during the project planning phase and there was growing interest in electronic materials and studying their use. Many faculty informants also showed great interest in our project before, during and after meetings with them. During field visits, we learned about projects at the individual campuses, in informants' departments, in scholarly societies and personal projects. We also had the opportunity to discuss our study with colleagues during the course of the study. We presented informally at a research seminar at one of the campuses we visited (not a department we were studying) and I presented to one of the campus' library noontime seminar. We also presented work-in-progress at several conference including the Association for Information Science, the Allerton Workshop at the University of Illinois (Covi, 1995), the Hawaii International Conference in Computer Systems (1996), ASIS Mid-Year Meeting (Covi, 1996a), Computers in Social Science (1995) and the Center for Research Libraries Annual Meeting (Covi, 1996b).

We collected an enormous amount of field data considering we spent a little over eight weeks in the field. After we had settled upon the sites, I obtained the consent of the human subjects committees at the individual campuses (see Appendix II). Although we had the necessary human subjects approval at our own campus, we contacted the site campuses as

a courtesy which had been important to some of the informants in the pilot study. Most campuses welcomed us warmly even though in one case, I had to obtain a letter of permission from the University Librarian before the Human Subjects Office acknowledged my request.

I contacted each department at each of the eight campuses to obtain their graduate student brochures which listed (even if a year or two out of date) the current faculty and their research areas. We discussed briefly writing letters of introduction (or sending similar messages via electronic mail) to the informants with whom we wanted to meet, but most of the interviews were arranged by telephone (thanks to the social convention of faculty office hours). We first arranged to meet with the key digital library infrastructure providers since University Librarians and Vice Presidents often had less flexible schedules than faculty and graduate students. Then we proceeded to fill up the week first by arranging interviews with the literary theorists and sociologists (who frequently arranged their schedule according to the days when they were teaching or had meetings) and then the molecular biologists and computer scientists who were easier to contact by phone and electronic mail. Most faculty generously offered a half-hour or forty-five minutes of their time, and a few ended up meeting with us for several hours. Access to digital library infrastructure providers was also fairly easy to arrange. However, it was more difficult engaging them in the topics we were exploring as I will detail below. The hardest meetings to arrange and hardest informants to select turned out to be the graduate students. We sought advanced doctoral students who had been involved with at least one serious research project (perhaps their dissertation). In some departments, these students were invisible to us, having no offices, infrequently visiting campus or employed elsewhere. Referral from their faculty advisor was our chief means to contact these informants. Because the faculty informants frequently did not understand our study until after we met with them, they could not provide us referrals until we were on-site. We scheduled the student interviews hastily

during our field visits and often missed contacting valuable informants due to time and contact difficulties.

We attempted to tape-record every faculty and graduate informant meeting. Initially we attempted to also tape the meetings with the digital library infrastructure providers. However, after several informants seemed uncomfortable with the recorder, we dispensed with the effort and instead relied upon written notes. Rob also decided to abandon consent forms with digital library infrastructure providers since what they reported generally was of a public nature. We did not write down issues that they asked us to hold in confidence.

During our meetings, we always initiated a "grand tour" question (Spradley, 1979) to elicit material use patterns by asking them to select a manuscript they were working on in an advanced stage or had published and described the sources of materials they used in the project (see informant interview schedule in Appendix VIII). We collected some of the papers that the informants gave to us to use as a supplement to our interview notes. Several of our informants demonstrated certain paper and electronic resources they regularly used if they were at hand. At the end of many research informant interviews, we photographed the informant's office and possibly the informant as a memory aid to analysis and to compare the amount of paper and technology available across the study.

We also collected a fair number of materials from public information sources (brochures, newspapers, etc.), Academic Computer Centers and Libraries. Most universities' libraries and computer centers published resource guides. At all sites, we were granted access to library databases and facilities and Internet access to our accounts at our home campus. By trying out the digital library infrastructure available to our informants, we were better able to make sense of their accounts of difficulties or dilemmas with campus resources. We also raised common issues with the key digital library infrastructure providers for referral if

there were continuing vagaries. We collected documentation, directories, organizational charts, departmental and campus-wide studies, vision statements and statistical reports. We also collected some local publications that provided a sense of the cultural and intellectual character of the community.

The project was completed in September of 1996. Besides the dissertation and the conference papers, we are preparing a report for the Department of Education and we expect to prepare several journal papers from this work. This project also served as a basis for future work in studying use of networked electronic resources and several aspects of electronic publishing activities is described in Chapter 8.

Table I.2.2: Project Chronology

Date		Activity
August-December	1993	Department of Education Proposal
May-September	1994	Field Visits, Pilot
August	1994	Notification of Proposal Acceptance
October 94-January	1995	Data Analysis, Pilot
September 94-February	1995	Project Planning
February	1995	Dissertation Topic Defense
February-June	1995	Field Visits, Study
June	1995	CSS Conference
August	1995	AIS Conference
September	1995	Pilot Paper Completed
October	1995	Allerton Workshop
December	1995	HICCS Conference
August - December	1995	Data Analysis, Study
September	1996	Dissertation Defense
November	1996	Department of Education Report

I.3 Project Design Rationale

We designed this project as week-long field studies at eight diverse universities to collect important data about how faculty were actually using paper and electronic resources in the offices, laboratories and homes in which they worked. We considered other methods such as surveys and telephone interviews, but face to face interviews were the only option to collect this kind of data for several reasons. First, our informants were elites in the university research community. Their time was important to them so it was necessary to engage their interest as well as cooperation. Second, the phenomena we were studying was extremely complex. It would have been impossible to devise a questionnaire about the mix of materials they use without interviewing them to understand what to ask them about. Third critical details would have been hard to see from afar. For instance, several times, at the end of the interview, we would learn something about the researcher, something about his or her work and professional life that altered our interpretation of their account. Fourth, the informants themselves did not usually understand the phenomenon that we were studying. Many informants were not familiar with the term "digital libraries" and some did not believe that they had any relevant behavior to this study. Therefore face-to-face interviews helped to establish rapport, explain what we were interested in and engage the informants by discussing their work, a topic with which they were very familiar. Although faculty researchers were usually more aware of their research endeavors then the nuances of their material use practices, they could still report useful data in the context of projects or problems which consumed their worklife. Finally, this approach was necessary because we were not previously familiar with critical aspects of working in the chosen subspecialties. In the course of conducting interviews, I could, for instance, ask questions about the terminology researchers were using to describe their work and verify initial

patterns by actually asking other researchers about disciplinary practice in subsequent interviews.

I.4 Discipline and Site Selection

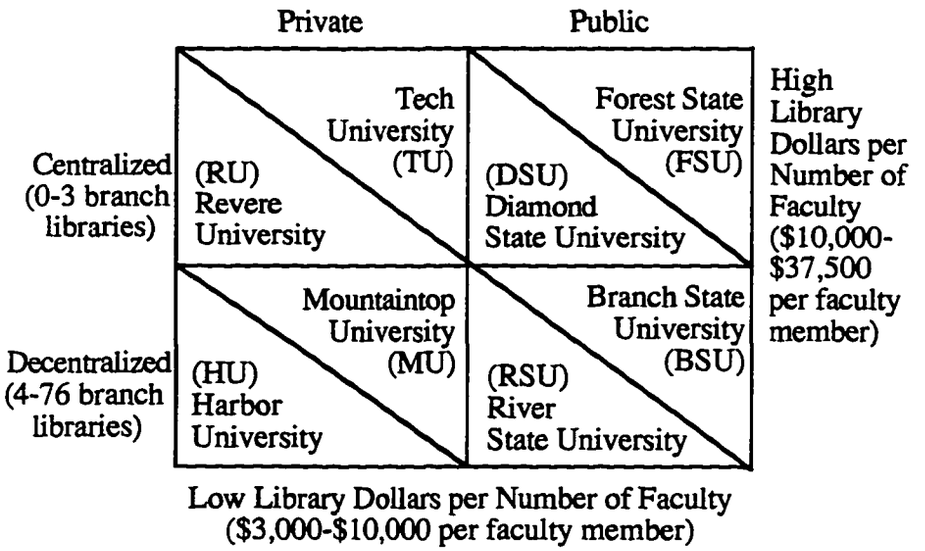
In this section I describe the choice of disciplines and sites for the study. We chose four disciplines which would provide contrasts in material use practices. We chose them because they vary by mode of inquiry, resource level research materials and the visibility of their presence in online-discussion groups and networked bibliographic databases. Molecular Biology is well-funded, is based upon laboratory work and work is interdependent on shared materials and data. Molecular biology is also the focus of several studies in Computer Supported Cooperative Work about the Worm Community (Schatz, 1993, Star and Ruhleder, 1994) and was also one of the exemplars for a recent study of national collaboratories (Computer Science Telecommunications Board, 1993). Within the molecular biology community, however, we chose the drosophila subspecialty because more drosophila researchers were available and we were aware of their use of FLYBASE electronic database, a system that was similar in some ways to the worm community system. In social sciences, we chose sociology because it encompassed multiple paradigms of inquiry and some specialties traditionally made use of large data sets. Within sociology, we focused on the social networks subspecialty since we figured that they might be more likely to have some familiarity and use of digital library infrastructure as compared to the vast majority of sociologists who seemed slow to adopt electronic materials. Computer science was the third discipline chosen. Not only were we more familiar with research in computer science, but it was also a locus of technology activities for development of digital library infrastructure. Within computer science, we focused on computer networks researchers since that subspecialty was the first group of researchers to

adopt computer networks in work production. In the humanities, we chose literary theory as a text-based discipline that had a large stake in print materials and collections. We chose to focus on the subspecialty of comparative literature since we knew of some electronic collections available in that area and there were some avant guard uses of electronic materials. We purposefully neglected research in professional-oriented fields such as medicine, law and business. We chose to defer study of these disciplines because of practical considerations (off-campus facilities, the predominance of professional experience in training). To a lesser extent we chose our four disciplines based on some basic familiarity with these fields so we could more quickly grasp the worlds in which these researchers do their work.

To make site selection, I gathered data on 76 United State higher education research universities including the winners of grants for the digital library initiative, institutions that expressed interest in participating in our study, institutions who had high-profiles in the development of electronic collections and institutions that might offer useful comparisons. In order to have a large enough sample of active researchers in all four disciplines, we subsequently narrowed our sample to the 67 of the 126 universities that fell into Carnegie Research I and II classification which are institutions awarding more than 50 doctorates annually and with federal funding over 15.5 million (Carnegie Foundation for the Advancement of Teaching, 1994).

Our data sources were primarily the United States Department of Education's Integrated Postsecondary Education Data System, and self-reported figures for data missing from those studies. We chose three dimensions for site selection criteria. The first was based on the governance of the institution: public or private. This criteria would help us determine if there are broad patterns that characterize large variations between accounting practices, resource bases and perhaps even perceptions of cultural difference between these two

categories of research universities. The second dimension was centralized or decentralized library facilities (based on the number of branch libraries). We hypothesized that library usage patterns would be based on proximity and organization of physical library materials, availability of support personnel and perhaps even equipment that departmental or division libraries provide. The third dimension was library dollars per capita which we chose to indicate the existing resources for local library collections of all formats. We did take into account the differences between faculty, graduate students and all student per capita measures and considered the role of academic computing infrastructure in supporting alternative digital library infrastructure resources and services. We felt that by choosing one university in each of eight areas, we could capture a broad sample of active researchers in all four departments. The final choices were made based on budgetary and practical considerations, even though we tried to get as broad geographic representation as we could.



Note: The figures are based on self-reported institutional-level data from the U.S. Department of Education's Integrated Postsecondary Education Data System 90-91 College and University Library Data. These data are available via URL=gopher://gopher.ed.gov:10000/11/data/postsec/ipeds

Figure I.4.1: Categories for Site Selection

We checked the diversity of our sample via subsequent reports from different sources. Without revealing the names of the institutions, I will briefly profile of our sample as a whole. Seven out of the eight universities we studied, were members of the Association for Research Libraries and thus appeared on the rankings of the 1993-94 survey of 108 research libraries (Association of Research Libraries, 1995). Five of the eight are in the top 50 campuses with the largest enrollments (Fall 1993), U.S. Department of Education (Chronicle of Higher Education, 1995). Most of the departments we studied appeared in the National Research Council's study of Research-Doctoral Programs in the U.S.(National Research Council, 1995). Out of the departments ranked, all were in the top 75 except several departments of Molecular Biology (4 were in the top 75).

Table I.4.1: Departmental Ranking from Spring 1993 (National Research Council, 1995)

English Language and Literature	All 8 departments (79 ranked)
Biochemistry and Molecular Biology	All 8 departments (194 ranked)
Computer Science	All 8 departments (108 ranked)
Sociology	6 of the 8 departments (95 ranked)

I.5 Informant Selection

We interviewed three faculty members in each of four departments. We initially tried to focus on arranging interviews with informants in particular research subspecialties to develop some commonalties within each discipline. When possible, we selected informants at different institutions who worked in similar research subspecialties to follow invisible college ties through referral, journal editorial boards, and conference program committees.

The faculty informants assisted us in contacting graduate students. We chose to include doctoral student informants in our study for several reasons. First they often are instrumental in producing research (their own or in conjunction with their advisor) and could provide us some perspective on the outlook for research as they consider embarking on careers in academia or industry. Also, some of our colleagues suggested to us that doctoral students would be more comfortable with the technology and therefore more likely to use it. Besides getting a generational difference perspective in graduate preparation (which later showed up in our interviews of faculty informants), the doctoral student informants had differing access to materials, technology and other resources than the faculty.

The following table characterizes the informants by rank. We were able to interview more graduate students in molecular biology and computer science because they were more likely to work on campus in labs and offices in their departments. We had a fairly good mix of informants by rank in the other disciplines. To overall mix of our informants was somewhat representative of faculty in their departments in terms of the growth of their research subspecialty and promotion practices describe in Chapter 4-7 in the different disciplines.

Table I.5.1: Profile of Faculty Informants by Rank and Discipline

By Rank	Grad	Asst	Assoc	Full	Totals
Molecular Biology	10	6	11	7	34
Literary Theory	6	4	6	14	30
Sociology	4	3	9	12	28
Computer Science	8	8	6	10	32
Total	28	21	32	43	124

The following charts list the molecular biologist's specialty by the model organism which was for research. Even if a molecular biologist worked with more than one model organism, they identified one particular group as being their main subspecialty.

Table I.5.2: Profile of Molecular Biologists by Rank and Model Organism

By Rank:	Grad	Asst	Assoc	Full	Totals
Drosophila	6	3	6	2	17
Aspergillis			1		1
Bacillus Subtilis		1			1
Escherichia Coli	2			3	5
Caenorhabditis elegans		1			1
Rabbit	1		1		2
X-ray Crystalography			1	1	2
unspecified	1	1	2	1	5
Total	10	6	11	7	34

We were fairly successful at finding some common specialties among the sociologists. we interviewed. These categories also refer to the areas which the informants identified as their focal interest as distinctions from their membership in sections of the American Sociologists Association (ASA) which was another common identifiable cohort.

Table I.5.3: Profile of Sociologists by Rank and Research Subspecialty

By Rank:	Grad	Asst	Assoc	Full	Totals
Social Networks	1		3	3	7
Sociology of Medicine	2		1	1	4
Global or World Systems	1		1		2
Organizations			1	2	3
Urban Sociology			1		1
Sociology of Culture		1			1
Sociology of Education			1		1
Sociology of Protest Movements				1	1
Social History				1	1
Sociology of Technology				1	1
Sociology of the Family		1			1
Sociology of Law			1		1
Theory and Methodology				1	1
Institutional Theory				1	1
Economic Sociology and Development		1			1
Sociology of Family				1	1
Totals	4	3	9	12	28

In computer science, our informants sometimes identified several research subspecialties. However, this chart describes the informants by the subspecialty that they discussed most extensively in their interview.

Table I.5.4: Profile of Computer Scientists by Rank and Research Subspecialty

By Rank:	Grad	Asst	Assoc	Full	Totals
Information Systems	1	1			2
Complexity Theory	1			3	4
Computational Geometry		1	2		3
Multimedia Systems	1	1			2
Computer Networks	2	1		2	5
Educational Software	1		1	1	3
Human-Computer Interaction	1	1		1	3
Computer Graphics		2			2
Decision-making Systems			1	1	2
Software Engineering	1			1	2
Databases		1		1	2
Parallel Simulations			1		1
Machine Learning			1		1
Total	8	8	6	10	32

The following table lists the specialties of the literary theorists as reported in our interviews. These labels mix periods, authors, theory, approach and languages. This list shows the mix of how our informants identified their subspecialties and the predominance of full professors in the sample..

Table I.5.5: Profile of Literary Theorists by Rank and Scholarly Subspecialty

By Rank:	Grad	Asst	Assoc	Full	Totals
Renaissance			1	1	2
19th Century	1	1	1		3
19-20th Century	1		1	2	4
Comparative Literature			1	4	5
Dickens				1	1
Judaic/Spanish Texts				1	1
Middle/Early Modern English				1	1
Victorian Literature				1	1
British and Romantic			1		1
Romantic Literature		1			1
British & American Culture	2				2
Cultural Studies (unspecified)			1		1
NeoDarwinism				1	1
Modern Hispanic Literature				1	1
American Literature		1		1	2
African American Literature		1			1
Gender Studies	1				1
American Studies	1				1
Total	6	4	6	14	30

Lastly, I provide a profile by institution of the graduate students in the study. Our ability to identify graduate students at both RSU and TU in both disciplines was a reflection of the access we had to the site and the time of year when the visit occurred. As is apparent in this table, identifying literary theory and sociology graduate students posed a challenge. Frequently advanced students in those disciplines no longer worked regularly on campus.

Table I.5.6: Profile of Graduate Students by Discipline and Institution

	DSU	MU	TU	RSU	RU	HU	BSU	FGU	Totals
Molecular Biology	3	1	1	1	1	1	1	1	10
Literary Theory		2	1	2			1		6
Sociology			1	1		1	1		4
Computer Science	2		1	1	1	1	1	1	8
Totals	5	3	4	5	2	3	4	2	28

In retrospect, the research informant selection was adequate and diverse enough to provide a variety in the experience and accounts we collected. Although most interviews were highly interesting and relevant, some faculty informants' accounts reflected a decline in research activity due to illness, career issues (recent administration service) or retirement.

We had a good access to the key digital library infrastructure providers at each site. In two cases, there was no comparable position for Academic Computing Director and we were able to meet with the Vice-President, Provost or Senior-level administrator who oversaw the academic computing domain. After the first two site visits, we added an interview with the faculty member at each campus who chaired the faculty library committee. Meeting with this informant enabled us to supplement the accounts of the digital library infrastructure providers with the controversies from a faculty perspective. These interviews also gave us insights into whether the needs our faculty informants expressed were included in the discourse of this forum.

Table I.5.7: Profile of Digital Library Infrastructure Provider Interviews

	DSU	MU	TU	RSU	RU	HU	BSU	FGU
University Librarian	√	√	√	√	√	√	√	√
Academic Computing Director	√	n/a	√	√	√	√	√	n/a
Faculty Library Chair				√	√	√	√	√
VP/Provost	√	√	√					√

I.6 Data Collection

Appendix VIII contains the most updated version of interview schedule which was developed and enhanced from the time of the pilot study through the early site visits of the main study. However for the interviews with the key digital library infrastructure

providers, we used the following or a very similar variant of the following protocol for a semi-structured interview:

Background
Professional/Educational Background
At what other institutions/universities has s/he worked?
Years at this university
Scope of Responsibility

Decision-making
Is there a preference for electronic formats in allocation for scholarly resources?
What are the current budgetary patterns?
What is ther relationship to neighboring universities'/communities' libraries or computing facilities?
What consortiums are important to the facility?
What are surprises about coming to this institution or with new administrators/presidents?
What are the key trade-offs?

Status of Services
What are the strengths and weaknesses of of this Library/Computing Facility?
What is the faculty demand for computing/library services?
What are the constituencies for this demand?
Are there specific constituencies who prefer electronic or paper materials?
Is there pressure for expanding library or computing services?
What joint projects (if any) are there between the library and the computing center?

Requests for Materials
Organizational Charts, Vision Statements, Recent Reports or Assessments, IPEDS data, ARL report, Annual Reports, Budget Statements

Figure I.6.1 Semistructured Interview Protocol for Key Digital Library Infrastructure Providers

We also collected site materials (see Appendix X) and took field notes on direct observation of work setting (offices and homes) and libraries.

I.6 Data Analysis

The main form of data analysis was theory evolution through grounded analysis of this data (Strauss, 1987). Coding proceeded from the richest faculty research interviews which I identified and fully transcribed. After the first eight (out of 96) were coded, I conducted selective transcription and wrote analytic memos (about 50 on different topics) starting in the late stages of the field work into the early stages of the dissertation writing.

Initially, data analysis focused on how researchers' material use practices were influenced by disciplinary, campus and departmental resource arrangements. However, the informants' accounts instead revealed that disciplinary norms for material use practices were more salient to them than resource provision arrangements. A pervasive theme throughout the data was the importance of attaining or maintaining mastery over a body of knowledge in their subspecialty in order to contribute to work production. Disciplinary norms defined what constituted mastery in their subspecialty. The informants drew upon this mastery in the course of finding relevant materials, selecting which materials they wanted, and managing the materials they collected.

This research approach is limited in several ways. First, theory evolution is very data-driven so choices of field sites, informants and interview questions limited the ability to focus on issues that did not show up on this data. Field studies are very time-intensive which constrained the number of sites and interviews that were considered. Also, studying material use practices involved complex and interdependent aspects of worklife so it was impossible to chronicle all the factors involved with this approach. These limitations make theory evolution based on field studies hard, but it remains the best strategy to begin to understand what factors shape practice in situ.

Appendix II
Courtesy Letter to Human Subjects Committee

Center for Research in Information Technology in Organizations
University of California
Irvine, CA 92717
714-824-5955
kling@ics.uci.edu

Mr. XX
Office of Sponsored Research
Tech University
234 Main Street
Anytown, USA XXXXX

Sometime 30, 1995

Dear Mr. XX,

As requested, you will find enclosed our Human Subject Review Committee approval form for our study on Institutional and Organizational Dimensions of the Effective Use of Digital Libraries.

We will be very pleased to conduct our study at Tech University and look forward to providing preliminary results to our interview participants.

Please feel free to contact me or my research assistant, Lisa Covi at 714-824-5086 (covi@ics.uci.edu) for further information.

Yours truly,

Rob Kling
Professor

Appendix III
Electronic Mail Request to Meet Informant

Received: from ics.uci.edu by q2.ics.uci.edu id aa17833; <Received Date and time>
To: <Informant's Email Address>
cc: covi@ics.uci.edu
Subject: Seeking a meeting with you
Date: <From Date and Time>
From: Lisa Covi <covi@ics.uci.edu>
Message-ID: <9503291452.aa17833@q2.ics.uci.edu>

<Dear Informant>,

I am working with Rob Kling at the Information and Computer Science Department at UCI. We are currently conducting a study funded by the U.S. Department of Education about how active researchers use electronic resources in their work. We'd like to meet with you for about 45 minutes to discuss your research and your work practices during the week of <Requested Date>. Please let me know when you would be available. The week is pretty open right now, though Wednesday is not available. I'm including a description of our project and a short bio of Rob below. Thanks for your consideration.

Lisa Covi

Appendix IV
Confirmation Electronic Mail to Informants

Received: from ics.uci.edu by q2.ics.uci.edu id aa26876; <Date and time>
To: <informant's email>
cc: covi@ics.uci.edu
Subject: confirming meeting
Date: <Date and time>
From: Lisa Covi <covi@ics.uci.edu>
Message-ID: <9504051439.aa26876@q2.ics.uci.edu>

<Dear Informant>,

Thanks for agreeing to meet with us <Meeting Date and Time> in the <place>. Below is a description of our project and a brief biography of Rob Kling the principal investigator who will be meeting with us. Please let me know if you have any questions.

Lisa Covi
covi@ics.uci.edu
714-824-6290

Appendix V
Confirmation Letter to Informants

Department of Information and Computer Science
University of California
Irvine, CA 92717
714-824-6290
Fax: 714-824-4056

<Date>

Dr. <Name>
Department of English
Mountaintop University
<City>, <State> <Zip>

Dear Dr. <Name>,

Thank you for agreeing to meet with us on Monday <Date> at <Place>. Enclosed is some information about our project and a short biography of Rob Kling, the Principal Investigator. We will be staying at the <Hotel> in <City> beginning on <Arrival Date> If you need to contact us, you may leave a message for me at <Local Phone Number>, I will also be checking messages at 714-824-6290. Please do not hesitate to contact me for more information.

Sincerely,

Lisa Covi

Appendix VI
Human Subjects Approval

HS # _____
(Leave Blank)

UNIVERSITY OF CALIFORNIA IRVINE
APPLICATION TO HUMAN SUBJECTS REVIEW COMMITTEE

Check one: _x_ EXPEDITED REVIEW (CATEGORY # 5) OR ___ FULL COMMITTEE REVIEW

This form must be typed and filled in completely. Insert N/A if not applicable. *Note: A member of the UCI faculty must either be principal or co-investigator or faculty sponsor, and a UCIMC staff physician may be required to be associated with the study.

1. PRINCIPAL INVESTIGATOR Rob Kling
Check one: _x_Faculty ___"House" Staff ___Grad. Student ___Undergrad. Student ___Staff ___Other_____

Department Information and Computer Science Telephone x5955
Mailing Address ICS 458D
(If UCIMC, include building & route #)

2. PERSON TO CALL FOR QUESTIONS (Name & Telephone #) Rob Kling, x5955

3. *FACULTY SPONSOR (IF APPLICABLE)
OR CO-INVESTIGATOR _____
Check one:___Faculty ___"House" Staff ___Grad. Student ___Undergrad. Student ___Staff ___Other_____

Department _____ Telephone _____
Mailing Address _____
(If UCIMC, include building & route #)

4. CO-INVESTIGATOR Mark Ackerman
Check one: _x_Faculty ___"House" Staff ___Grad. Student ___Undergrad. Student ___Staff ___Other_____

Department Information and Computer Science Telephone x7355
Mailing Address ICS 458B
(If UCIMC, include building & route #)

(If there are additional co-investigators, use attachment sheet.)

5. TITLE OF STUDY Institutional and Organizational Dimensions of the Effective Use of Digital Libraries

6. GOG/ECOG/SWOG/ETC. # (if applicable)_____ 7. PROJECT PERIOD: 10/94 to 10/96 (if f
(month/year to month/year)

8. PERFORMANCE SITES: see attached
(See Appendix A for UCI Policy regarding Off-Site Research)

9. SUBJECT POPULATIONS (Enter all that apply):

#____ *PATIENTS*	#____ *NORMALS*
#_x_ ADULTS COMPETENT TO CONSENT	#____ MINORS
#____ ADULTS NOT COMPETENT TO CONSENT	#____ PREGNANT WOMEN
#_x_ UCI STAFF/STUDENTS	#____ NURSING MOTHERS
#____ DEVELOPMENTALLY DISABLED	____ CHART REVIEW ONLY
#____ NON-ENGLISH SPEAKING	____ DISCARDED TISSUE ONLY

#1450 *TOTAL NUMBER OF SUBJECTS*

10. Will subjects be compensated for participating? ____ Yes _x_ No. If yes, discuss compensation and ter within protocol under "Costs/ Compensation."

Page 1 of 2

HUMAN SUBJECTS REVIEW COMMITTEE

INVESTIGATOR'S ASSURANCE

TITLE OF PROJECT Institutional and Organizational Dimensions of the Effective Use of Digital Libraries

MY SIGNATURE BELOW CONFIRMS THAT:

I HAVE READ THE PROTOCOL AND CONFIRM BY MY SIGNATURE BELOW THAT I WILL BE AN ACTIVE PARTICIPANT IN IT. I UNDERSTAND THAT EITHER AS PRINCIPAL INVESTIGATOR, I HAVE ULTIMATE RESPONSIBILITY FOR THE PERFORMANCE OF THE STUDY, OR AS CO-INVESTIGATOR/FACULTY SPONSOR/ATTENDING PHYSICIAN, I SHARE THE RESPONSIBILITY FOR THE ETHICAL PERFORMANCE OF THE PROJECT. THE PROTECTION OF THE RIGHTS AND WELFARE OF HUMAN SUBJECTS, AND STRICT ADHERENCE TO ANY STIPULATIONS IMPOSED BY THE HUMAN SUBJECTS REVIEW COMMITTEE. I AGREE TO COMPLY WITH ALL APPLICABLE REGULATIONS, LAWS AND POLICIES REGARDING THE PROTECTION OF HUMAN SUBJECTS IN RESEARCH, INCLUDING, BUT NOT LIMITED TO, THE FOLLOWING:

Obtaining the legally effective informed consent from human subjects or their legally responsible representative, and using only the currently approved, stamped consent form with human subjects.

Making no changes to the approved protocol or consent form without first having submitted those changes for review and approval of the UCI Human Subjects Review Committee.

Filing a final report with the HSRC at the conclusion of this project.

Promptly reporting significant or untoward adverse effects to the HSRC verbally within 48 hours and in writing within 5 working days of occurrence.

Promptly and completely complying with an HSRC decision to suspend or withdraw its approval for the project.

Promptly providing the HSRC any information requested relative to the project.

Submitting an application form for continuing review prior to the date approval for this study is scheduled to expire. I understand if this form is not submitted, approval for the study will expire and its performance must cease until HSRC reapproval is obtained.

ALL PARTICIPANTS IN THIS PROJECT MUST PERSONALLY SIGN THIS ASSURANCE

Signature: PRINCIPAL Investigator	Date	Signature: Faculty Sponsor*	Date
Signature: UCIMC Physician**	Date	Signature: Co-investigator	Date
Mark Ackerman	12/10/93		
Signature: Co-investigator	Date	Signature: Co-investigator	Date

IF ADDITIONAL SIGNATURE LINES ARE REQUIRED, CONTINUE ON REVERSE SIDE.

** A member of the UCI faculty must be principal investigator, co-investigator or faculty sponsor for projects utilizing human subjects in research at the University of California Irvine. The faculty member is considered the responsible party for legal and ethical performance of the project.*

*** A UCIMC staff physician is required to accept responsibility for medical care of human subjects on projects where there is even a remote possibility of physical injury to human subjects.*

11. Does the study involve investigational drugs? ____ Yes __x__ No. If yes, list below:

Name of Drug	Phase	IND #	Date of IND Filing*	Manufacturer

(Continue on attachment sheet if necessary)

* Provide date IND was filed for the drug's use in this study.

12. Does the study involve investigational devices? ____ Yes __x__ No. If yes, list below:

Name of Device	IDE # (if applicable	IDE Filing Date	Manufacturer

(Continue on attachment sheet if necessary)

13. Will radiation (including radioisotopes) be used? ____ Yes __x__ No. If yes, identify within protocol, incluc dosages, and radiation exposure information. *(Note: Requirements of the UCI/UCIMC Radiation Safety Committe must be met independent of HSRC review and approval.)*

14. HOW IS THIS STUDY BEING FUNDED? (Provide name of sponsor or source of funds) _____
US Department of Education: proposal in process

Discuss research costs and how they will be covered within the protocol, under "Costs." However, if some or c costs relating to the research are intended to be billed to the subject or a third party carrier, adequate justificatic must be provided. See also Appendix A in the Handbook: UCI Policy on the Costs of Research.

SIGNATURE: PRINCIPAL INVESTIGATOR — DATE 12/2/93

SIGNATURE: CO-INVESTIGATOR — DATE 12/10/93

SIGNATURE: FACULTY SPONSOR (if applicable) — DATE

SIGNATURE: UCIMC PHYSICIAN (if applicable) — DATE

DEPARTMENTAL CERTIFICATION AND APPROVAL:

I have read the protocol and find that the research is appropriate in design and the investigator (and/or fac. sponsor) is competent to perform (or supervise) this study. My signature below denotes departmental approval this study as submitted. Thomas A. Stanbish 12/10/93

SIGNATURE: DEPARTMENT CHAIR — DATE

Instructions regarding number of copies and required materials appear in Handbook, under "Requirements for Submission"

Rev. 7/93

Appendix VII
Individual Consent Form

[redacted]
[redacted]
[redacted]
[redacted]

Purpose of Study:

[redacted]

Procedures:

If I agree to participate, the following will occur:

(1) [redacted]
(2) [redacted]

Risks:

[redacted]

Benefits:

[redacted]

Costs/Compensations: [redacted]

I understand that:

1. [redacted]

2. [redacted]

3. If at any time I have questions regarding the research or my participation, I should contact the investigator who must answer all questions. A telephone number is provided at the top of this consent form.

4. If at any time I have comments or complaints relating to the conduct of this research or questions about my rights as a research subject, I should contact Human Research Administration at 714-824-6048

Signature of Subject — Date

Signature of Witness — Date

Signature of Investigator — Date

Rev 4/95

Appendix VIII
Research Informant Interview Schedule

Faculty Interview Guide -- SCIT
4/2/95 v 6

Note: thanks, introduce self, SCIT, anonymity, consent forms, interview overview

Faculty Name _____ Dept _____

Office Address: _____ Phone _____

Email ____

Interviewer _____ Date _____

Intrvw Code ___

BACKGROUND

PhD Field _____ University _____ Yr ___

Yrs @ This Campus _____ Rank _____

LINES of WORK

TEACHING: # of classes per yr _____ #BS/BA ___ #MA/MS #PhD _____

PhD active dissertation advises _____ #MA/MS ths ___

Use computers in teaching

RESEARCH: Specialties _____

basic scholarly approach (experimental, secondary data anal, simulation, system building, documentary, theoretical ....)
_____

Grants:$/yr _____ (key sources) _____ duration __

Common meetings/workshops:_____

Invited lectures at other universities/institutes/ etc._____

Typical formats of publication & frequency _____

PROF ROLES: EDITORIAL _____
CONF. PROGRAMS _____
OTHER _____

PROF/CAMPUS ACTIVITIES RE. ELECTRONIC DOCUMENTS, LIBRARIES, E-JRNLS.

USE OF DOCUMENTARY RESEARCH MATERIALS --

Central Narrative

Select a current project that represents your scholarly work and is in ms form or has been published.

We'd like to understand your central questions and the research process with special attention to your use of articles, books, reports -- both paper and electronic -- at various stages of your research -- conception, development, funding, research publication.... Feel free to discuss your relationships with collaborators & RAs re. use of documentary materials on this project. (Examine the bibliography of paper/book and discuss citations, if possible/sensible)

VALUE OF DOCUMENTARY SOURCES (SHARED DATA) & DEPENDENCE

PAPER - MOST RELEVANT COLLECTIONS & JOURNALS & CONF. + where found & basis of relevance (content, visibility, status, ...) ....

ACCESS TO PAPER MATERIALS:

books in office _____ # bookcases @ home _____ (#books_____)

#jrnl subscriptions ____ # lib books _____

#ILL _____ Freq (ILL) _____

Other Libraries Visited _____

Which jrnls:

ACCESS TO ELECTRONIC MATERIALS

- MOST RELEVANT (& TRIED): & How accessed, perceived value & legitimacy.

PROBES FOR:
Email, LISTSERV, Netnews,
gopher, WWW
OPAC, Bib Databases,
Outside databases
E-journals, Other .....(local, commercial)
Note other formats: CD, Video, Microforms, slides.

How typical is your style of use re. your colleagues in your dept or field?

How sophisticated is your electronics materials usage relative to your colleagues & PhD students?

DISCIPLINARY INTEGRATION

Discuss the size and character of the academic community whith the person sees as their primary audiences? Whom do they want to see their research? Who seems to see it (via personal contacts, citations) ... and how (talks, papers, electronic media).

Has R reviewed papers/proposals with inappropriate/poor/inadequate citations? (Actions?)

WORK PRACTICES

Common work locations & why: (Probe for electronic access from locations)

When do you do most of your scholarly work

How do you work w/collaborators?

How do you use the campus/departmental libraries?

How do you learn about new electronic document sources (Campus or Internet)?

Who do you ask for help w/docs & computing?

What kinds of help do you have re. work, incl. secretarial?

How many share secy?_____ + tasks ??? _____

Who do you ask for help w/docs & computing?

Ever get help from computing consultants? (scope, value)

Ever get help from librarians? (scope, value)

How typical is your style of work re. your colleagues in your dept or field?

RESOURCES

Probe for hardware, software, communications, OS, WP choices,

Which HW/SW used most often?
Which printing ...?
Internet access?
Managing long electronic documents?

computer/laptop -- printer -- modem -- network -- other (scanner)

COMPUTING/PRINT FACIL. IN OFFICE _____

COMPUTING FACIL. NR. OFFICE _____

COMPUTING FACIL. @ HOME _____

COMPUTING FACIL. USED @ CAMPUS CENTER _____

Who paid for key eqpt & upgrades?

Bottlenecks?

CLOSING

Inquire about possible PhD students to interview ...

Take a photo of office/work area ...

What could (YOUR UNIVERSITY/UNIT) do better in providing computing support or library support for your research?

Appendix IX
Project Description

Scholarly Communication with Information Technology (SCIT) Project:

Institutional and Organizational Dimensions of the Effective Use of Digital Libraries

Professor Rob Kling
Principal Investigator
Department of Information and Computer Science
University of California
Irvine, CA 92717

Brief Project Description (2/9/95)

There has been recent rapid growth of diverse digital library (DL) services such as: on-line bibliographic databases and catalogs, distributed document databases (including Gopher, World wide web), scholarly and professional discussion lists, electronic journals, and other on-line databases.

However, there has been little systematic investigation into the conditions that foster their effective use. This project examines how university faculty and students use relevant DL resources, and the institutional and organizational practices that effectively support the use of DLs for university teaching and research. Institutions and organizations vary in their ability to provide materials to students and faculty in the libraries and their work places. These services are now provided by librarians, academic computing support and booksellers. By identifying the institutional practices that can boost DL access and effective use, we are developing guidelines for planning and supporting network resource sharing.

We are conducting a multi-tiered study including: (1) a pilot study of molecular biologists and scholars of literary criticism in two research universities, and (2) a comparative institutional analysis of faculty and resource providers in 4 disciplines at 8 universities.

Some key research questions:

1. How accurately do faculty and students perceive the availability of resources, services, contents, and formats of electronic materials?

2. How much do faculty and students actually utilize these resources, and how do they fit their informational preferences and work practices?

3. Under what conditions do faculty and students prefer electronic information to be available in specific forms? For example, when do faculty and students prefer ASCII text, bitmapped text, annotated text, multimedia, or print formats? Under what conditions do faculty and

students want networked versus CD-ROM or downloadable resources? Under what conditions can librarians, departments and academic computing support provide these formats?

4. To what extent do faculty and student use services where they have assistance from skilled help such as reference librarians, colleagues or computing support assistants.

5. How do these patterns of preferences and usage vary with different disciplinary traditions, institutional pressures and values and working conditions?

6. How can we succinctly characterize the differences between higher quality and less quality delivery/support of digital library services at a campus level?

This study is funded by the U.S. Department of Education and is administered by the Center for Research in Information Technology in Organizations at the University of California, Irvine. For more information, contact:

Ms. Lisa Covi
Research Associate
(covi@ics.uci.edu)
714-824-6290

Professor Rob Kling
(kling@ics.uci.edu)
714-824-5160

Department of Information and Computer Science
University of California
Irvine, CA 92717-3425
Fax: 714-824-4056

Appendix X
List of Site Materials

Author	site	Dept.	No.	Material Description
Lisa	all			Field Journal
Lisa	all			Electronic Field Journal
Lisa	all			Study Field Note Database
Lisa	all			Email archive of Interview setup
Lisa	all			Email archive of design crrspnds
Lisa	DSU	all	9	Tapes of Interviews
Lisa	DSU	CS	5	Interview Schedules
DSU	DSU	CS	1	Grad Brochure
cni	DSU	CS	1	Paper Draft
Lisa	DSU	LT	3	Interview Schedules
Lisa	DSU	LT	1	Conf Letter to DSULT3
DSU	DSU	LT	2	Grad Brochure
Rob	DSU	LT	3	Photos of DSULT1, Suite,
Rob	DSU	LT	1	Photo of DSULT2's Office
Lisa	DSU	MB	4	Interview Schedules
Lisa	DSU	MB	1	Conf Letter to DSUMB3
DSU	DSU	MB	1	Grad Brochure
DSU	DUS	MB	1	Photo of DSUBM1's Office
Lisa	DSU	SOC	3	Interview Schedules
Rob	DSU	SOC	1	Photo of DSUSOC3's office
DSU	DSU	SOC	1	Grad Brochure
Lisa	DSU	DLP	4	Interview notes
Lisa	DSU	DLP	1	Survey of Materials
DSU	DSU	ACC	1	Growth on Academic Mainframe
DSU	DSU	Lib	1	Library Organizational Chart
DSUVP	DSU	VP	1	Academic Plan for University
DSUVP	DSU	VP	1	DSU self-study
DSUVP	DSU	VP	2	Memos on Peer Institutions
DSUVP	DSU	VP	1	DSU Organizational Chart
DSUVP	DSU	VP	1	Press Release on Tuition
DSUUL	DSU	Lib	2	Automation Plan
DSUUL	DSU	Lib	1	Library Automation Report
DSUUL	DSU	Lib	1	ni department Virtual Library
DSUUL	DSU	Lib	1	Library Automation Report
DSUUL	DSU	Lib	1	Letter to ni department
DSUUL	DSU	Lib	1	State of the Library Report

DSUUL	DSU	Lib	1	Application Usage from Lib
DSUVP	DSU	VP	1	Networking Plan
DSU	DSU	VP	2	IPEDS Report 94-95 (IC & Fin)
DSUVP	DSU	Lib	3	ARL Reports
NI	DSU	Lib	1	Nearby Lib Resource Guide
NI	DSU	Lib	8	2 copies each of NI Docs
Locale	DSU		1	City Cultural Information
Rob	DSU		7	Site Arrangement Notes
DSU	DSU	ACC	2	Computer Account Requests
DSU	DSU	Lib	1	Pass to Libraries
Locale	DSU		1	Hotel Information
DSUUL	DSU	Lib	1	Letter of Invitation to Site
Lisa	DSU	HS	1	Human Subjects Courtesy Pk
Lisa	DSU		1	Setup Notes
DSUUL	DSU	Lib	3	Library Newsletters
DSUAC	DSU	ACC	1	ACC Newsletter
DSUAC	DSU	ACC	1	ACC Resource Guide
DSUAC	DSU	ACC	11	ACC Misc. Documentation
DSUUL	DSU	Lib	16	Lib Misc. Documentation
DSU	DSU		5	Map
DSU	DSU		2	Housing Brochure
DSU	DSU		1	News from PR office
DSU	DSU		1	Campus Information Bulletin
DSU	DSU		1	Student Newspaper (wkly)
DSU	DSU		4	Faculty Newpaper dups (wkly)
DSU	DSU		3	Student Alt. Nwppr dups (wkly)
DSU	DSU		1	Alumni Magazine
DSU	DSU		1	Graduate Bulletin
DSU	DSU		2	Founders Documents
Lisa	DSU		21	Consent forms for all informants
Lisa	MU	all	6	Tapes of Interviews
Lisa	MU	CS	3	Interview Schedules
MU	MU	CS	1	Grad Brochure
Rob	MU	CS	2	Photo of MUCS1
Rob	MU	CS	1	Photo of MUCS2
Rob	MU	CS	1	Photo of MUCS3, Hallway cblng
Lisa	MU	LT	3	Interview Schedules
Lisa	MU	LT	1	Interview Notes with MULT2
MULT3	MU	LT	2	Draft and exhibit of material
MU	MU	LT	1	Grad Brochure
Rob	MU	LT	2	Photo of MULT1
Rob	MU	LT	1	Photo of MULT2
Rob	MU	LT	2	Photo of MULT3

MLA	MU	LT	1	MLA Statement
Lisa	MU	MB	4	Interview Schedules
MU	MU	MB	1	Grad Brochure
Rob	MU	MB	2	Photos of MUMB1 's office
Rob	MU	MB	1	Photo of MUMBG's Bench
Rob	MU	MB	2	Photo of MUMB2
Rob	MU	MB	2	Photo of MUMB3, office
Lisa	MU	SOC	3	Interview Schedules
MU	MU	SOC	1	Grad Brochure
MUSOC3	MU	SOC	2	Draft of MUSOC3's paper
Rob	MU	SOC	1	Photo of MUSOC1
Rob	MU	SOC	2	Photo of MUSOC3
MUSOC3	MU	SOC	1	Email from MUSOC3
Lisa	MU	DLP	4	Interview notes
MU	MU	ACC	1	Application Usage from Lib
MUUL	MU	Lib	1	DL Resource Documentation
MUUL	MU	Lib	1	DL Projects
MUUL	MU	Lib	1	Report on Electronic Journals
MU	MU	VP	2	IPEDS Report 94-95 (IC)
MU	MU	VP	2	IPEDS Report 94-95 (Fin)
MU	MU	Lib	2	ARL Reports
MUACC	MU	ACC	3	Surveys of Accss & Ownshp
MUUL	MU	Lib	3	Preservation Project
MU	MU		1	Technology Plan
MU	MU	Lib	1	Reprint on Library
Locale	MU		1	Hotel Information
Locale	MU		2	Local Free Papers
DSU	MU		2	Map
Lisa	MU		1	Setup Notes
MU	MU	ACC	1	Pass to ACC facilities
MUUL	MU	Lib	1	Supplemental Letter to Rob
MU	MU		2	Campus Flyers
MUUL	MU	Lib	1	Library Newsletters
MUUL	MU	Lib	26	Lib Misc. Documentation
MUACC	MU	ACC	1	ACC Resource Guide (Grad)
MUACC	MU	ACC	2	Directory
MUACC	MU	ACC	2	Collaboration Brochure
MUACC	MU	ACC	1	Memo
MUACC	MU	ACC	1	Course Catalog
MUACC	MU	ACC	11	ACC Misc. Documentation
Lisa	MU		18	Consent forms for fac,grad,lib
MU	MU	Lib	1	Library Guide
MU	MU		1	Campus Facts

MU	MU		5	Different Students Newspapers
MU	MU		2	Staff Papers
MU	MU		2	Faculty Papers
Rob	MU		5	Photos of Campus
Rob	MU		4	Photos of Reading Rooms
Rob	MU		2	Photos of Student Computings
MU	MU		1	Postcard
Lisa	TU	all	11	Tapes of Interviews
Lisa	TU	CS	4	Interview Schedules
TU	TU	CS	1	Grad Brochure
TUCSG	TU	CS	1	Report on own materials usage
Rob	TU	CS	2	Photo of MUCS2, office
Rob	TU	CS	2	Photo of MUCS3
Lisa	TU	LT	4	Interview Schedules
TU	TU	LT	1	Grad Brochure
Rob	TU	LT	2	Photo of TULT1's office
Rob	TU	LT	3	Photo of TULT2, office
Rob	TU	LT	1	Photo of TULT3
Lisa	TU	MB	4	Interview Schedules
TU	TU	MB	1	Grad Brochure
Rob	TU	MB	2	Photos of TUMB1
Rob	TU	MB	1	Photo of TUMB2, Office
Rob	TU	MB	1	Photo of TUMBG
Rob	TU	MB	2	Photo of MUMB3
Lisa	TU	SOC	4	Interview Schedules
TU	TU	SOC	1	Grad Folder
TU	TU	SOC	1	Grad Brochure
TUSOC1	TU	SOC	2	Draft of TUSOC1's paper
TU	TU	SOC	1	Newpaper Article on TUSOC1
Rob	TU	SOC	2	Photo of TUSOC1, Office
Rob	TU	SOC	3	Photo of TUSOC2, Office
Rob	TU	SOC	3	Photo of TUSOC3, View
Rob	TU	SOC	2	Photo of TUSOCG's office
Lisa	TU	DLP	3	Interview notes
TUUL	TU	Lib	17	Lib Misc. Documentation
nL	TU	Lib	4	Neighboring Library Docs
TU	TU	VP	2	IPEDS Report 93, 94 (ALS)
TUACC	TU	ACC	1	ACC Resource Guide
TUACC	TU	ACC	1	ACC Newsletter
TUACC	TU	ACC	11	ACC Misc. Documentation
TUVP	TU	ACC	1	Talk Slides from TUVP
TU	TU	ACC	1	Memo
TU	TU		6	Student Newspapers

TU	TU		1	Presidential Message
TU	TU		1	Student Organizations
Locale	TU		1	Museum Information
Rob	TU		2	Photos of Campus
Rob	TU		5	Photos of Libraries
Rob	TU		3	Photos of ACC
Rob	TU		3	Photos of Locale
TU	TU		2	Postcard
Locale	TU		1	Hotel Information
Locale	TU		2	Local Free Papers
TU	TU		1	Campus Facts
TU	TU		3	Map
Lisa	TU		2	Setup Notes
Rob	TU		1	Contact Information
Lisa	TU		1	Contact Information
Lisa	TU		16	Consent forms for faculty & grad
Lisa	RSU	all	7	Tapes of Interviews
Lisa	RSU	CS	4	Interview Schedules
RSU	RSU	CS	1	Grad Brochure
RSU	RSU	CS	1	Faculty Bios
Rob	RSU	CS	3	Photo of RSUCS1, office
Rob	RSU	CS	3	Photo of RSUCS2, office
Rob	RSU	CS	2	Photo of RSUCS3, office
Lisa	RSU	LT	4	Interview Schedules
RSU	RSU	LT	1	Grad Brochure
Rob	RSU	LT	2	Photo of TULT1
Rob	RSU	LT	3	Photo of TULT2
Rob	RSU	LT	2	Photo of TULT3
Lisa	RSU	MB	4	Interview Schedules
RSU	RSU	MB	1	Grad Brochure
Rob	RSU	MB	3	Photos of RSUMB1's Office
Rob	RSU	MB	2	Photo of RSUMB2
Lisa	RSU	SOC	4	Interview Schedules
RSU	RSU	SOC	1	Grad Brochure
Rob	RSU	SOC	2	Photo of RSUSOC1
Rob	RSU	SOC	3	Photo of RSUSOC3
Lisa	RSU	DLP	3	Interview notes
RSUUL	RSU	Lib	8	Lib Misc. Documentation
RSUUL	RSU	Lib	1	Lib Resource Guide
RSUUL	RSU	Lib	1	Library Newsletter
RSUUL	RSU	Lib	1	Library Map
RSUUL	RSU	Lib	1	Library Technology Plan
RSU	RSU		1	University Future Plan

RSU	RSU			IPEDS Report 93, 94 (ALS)
RSUACC	RSU	ACC	1	ACC Resource Guide
RSUACC	RSU	ACC	1	ACC Newsletter
RSUACC	RSU	ACC	5	ACC Misc. Documentation
RSU	RSU		1	Campus Facts
RSU	RSU		6	Student Newspapers
RSU	RSU		2	Faculty Newspaper
Locale	RSU		1	Local Newspaper
Rob	RSU		1	Photos of Campus
Locale	RSU		1	Hotel Information
RSU	RSU		3	Map
Lisa	RSU		2	Setup Notes
Lisa	RSU		1	Contact Information
	RSU		1	Newspaper Article on RSU Pres.
RSU	RSU		1	Student Organizations
Lisa	RSU		16	Consent forms for Faculty, grads
Lisa	RU	all	7	Tapes of Interviews
Lisa	RU	CS	4	Interview Schedules
RSU	RU	CS	1	Grad Brochure
RSUCSG	RU	CS	1	Draft Paper
Lisa	RU	LT	3	Interview Schedules
RU	RU	LT	1	List of Faculty
Lisa	RU	MB	4	Interview Schedules
RU	RU	MB	1	Grad Brochure
Rob	RU	MB	3	Photos of RSUMB1's Office
Rob	RU	MB	2	Photo of RSUMB2
Lisa	RU	SOC	3	Interview Schedules
RU	RU	SOC	1	Grad Poster
RU	RU	SOC	1	Faculty Research Interests
	RU	SOC	3	RUSOC2's students' drafts
Lisa	RU	DLP	4	Interview notes
RUACC	RU	ACC	2	ACC Misc. Documentation
RUUL	RU	Lib	6	Lib Misc. Documentation
RSU	RU		5	Student Newspapers
RSU	RU		2	Faculty Newspaper
Locale	RU		1	Local Newspaper
RU	RU		1	Postcard
RU	RU		1	Science at RU
RU	RU		1	Grad School Catalog
RSU	RU		2	Map
Lisa	RU		2	Setup Notes
LIsa	RU	LT	1	RULT1 Confirmation
Lisa	RU		1	Contact Information

Locale	RU		1	Locale Information
RU	RU		1	Seminar Outline
Lisa	RU		1	Confirmation Letter for RULT2
Lisa	RU			Update Letter on HS Approval
Lisa	RU		5	Consent Forms
Lisa	HU	all	9	Tapes of Interviews
Lisa	HU	CS	4	Interview Schedules
HU	HU	CS	1	Grad Brochure
HUCS1	HU	CS	1	Draft Paper
HUCS3	HU	CS	2	Draft Paper
Rob	HU	CS	5	Photos of HUCS1, Office, Grad
Lisa	HU	MB	5	Interview Schedules
BSU	HU	MB	1	Grad Brochure
HUMB1	HU	MB	1	Draft of Paper
Rob	HU	MB	2	Photos of HUMB1
Rob	HU	MB	3	Photos of HUMB2's Office, room
Lisa	HU	SOC	4	Interview Schedules
HU	HU	SOC	1	Grad Brochure
Rob	HU	SOC	2	Photo of Soc Lab
Rob	HU	SOC	2	Photo of HUSOC3
Rob	HU	SOC	2	Photo of HUSOC1's office
Lisa	HU	LT	3	Interview Schedules
HU	HU	LT	1	Grad Brochure
Rob	HU	LT	1	Photo of HULT2, Office
Lisa	HU	DLP	3	Interview notes
HUUL	HU	Lib	1	Electronic Collection Policy
HUUl	HU	Lib	1	Librarian Address, 1993
HUUL	HU	Lib	1	Future of Library
HUUL	HU	Lib	11	Lib Misc. Documentation
HU	HU	Lib	1	Email to Bibliographer
HUUL	HU	Lib	1	Library Resource Guide
HUUL	HU	Lib	1	Library Newsletter
HU	HU		5	Student Newspapers
HU	HU		2	Faculty Newspaper
HU	HU	Soc	1	HUSOC2 Confirmation
Lisa	HU	MB	1	HUMB1 Confirmation
Lisa	HU		1	Human Subjects Requet
Lisa	HU		1	Setup Notes
HUACC	HU	ACC	1	Unix Primer
HUACC	HU	ACC	1	ACC Newsletter
HUACC	HU	ACC	2	ACC Resource Guide
HUACC	HU	ACC	6	ACC Misc. Documenation
HU	HU		3	Maps

HU	HU		1	Student Guidebook
Lisa	HU		15	Consent forms for faculty, grads
Lisa	BSU	all	11	Tapes of Interviews
Lisa	BSU	CS	4	Interview Schedules
BSU	BSU	CS	1	Grad Brochure
BSUCS2	BSU	CS	1	Draft Paper
Lisa	BSU	LT	4	Interview Schedules
BSU	BSU	LT	1	List of Faculty
BSULT1	BSU	LT	1	Draft of paper
BSULT3	BSU	LT	1	Draft of paper
Lisa	BSU	MB	5	Interview Schedules
BSU	BSU	MB	1	Grad Brochure
BSUMB2	BSU	MB	1	Draft of Paper
Lisa	BSU	SOC	4	Interview Schedules
BSU	BSU	SOC	1	Grad Brochure
BSUSOC2	BSU	SOC	4	Draft of Papers
Lisa	BSU	DLP	3	Interview notes
BSUFLC	BSU		1	Report on Library Task Force
BSUACC	BSU	ACC	1	Campus Network Report
BSUACC	BSU	ACC	1	ACC Newsletter
BSUUL	BSU	Lib	1	Library Resource Guide
BSUUL	BSU	Lib	1	Library Newsletter
BSUUL	BSU	Lib	20	Lib Misc. Documentation
BSU	BSU		4	Student Newspapers
BSU	BSU		1	Faculty Newspaper
Lisa	BSU		1	Setup Notes
Lisa	BSU		1	Campus Brochure
BSUUL	BSU	Lib	1	Pass and Setup Notes
BSU	BSU		1	Confirmation for BSUMBF
Lisa	BSU		1	Information on BSUMBF
Lisa	BSU		6	Consent Forms
Lisa	FSU	all	8	Tapes of Interviews
Lisa	FSU	CS	4	Interview Schedules
FSU	FSU	CS	2	Grad Brochure
FSUCSG	FSU	CS	1	Draft Paper
Rob	FSU	CS	2	Photo of ni home setup
Lisa	FSU	MB	4	Interview Schedules
FSU	FSU	MB	1	Grad Brochure
Lisa	FSU	SOC	3	Interview Schedules
FSU	FSU	SOC	1	Faculty List
Lisa	FSU	LT	3	Interview Schedules
FSU	FSU	LT	1	Grad Brochure
FSULT1	FSU	LT	1	Vita for FSULT1

Lib	FSU		1	Search on FSULT1
Lisa	FSU	DLP	4	Interview notes
FSU	FSU		1	Memo for IT equipment
FSU	FSU	VP	1	Memo from Faculty Committee
FSUUL	FSU	Lib	1	Annual Report 93-94
FSUUL	FSU	Lib	2	Library Newsletter
FSUUL	FSU	Lib	4	Lib Misc. Documentation
FSU	FSU	ACC	2	ACC Misc. Documentation
FSU	FSU		1	State-wide Univ. Newspaper
FSU	FSU		1	Student Newspaper
FSU	FSU		1	Faculty Newspaper
Lisa	FSU		2	Setup Notes
Lisa	FSU	SOC	1	Confirmation for FSUSOC3
Lisa	FSU	FLC	1	Confirmation for FSUFLC
Lisa	FSU		12	Consent forms for faculty, grads