Imposing Structures: Narrative Analysis and the Design of Information Systems

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Rich Gazan

UCLA Department of Information Studies

GSE&IS Building, Box 951520

Los Angeles, CA 90095

richg@ucla.edu

Abstract

Understanding how designers of information and communication technologies conceptualize and perform their work can contribute to the larger goals of more effective design environments, and more effective information systems. This article discusses the narrative analysis method in the context of a digital library design project related to environmental science, and suggests that useful insights can be gained when both the design product and the design process are framed in narrative terms. When designers embraced the narrative aspects of the system, indicators of communication, information sharing and integrative work increased. Narrative analysis supplemented social network analysis and demonstrated more explanatory power regarding the outcomes of the usability study, and was an effective research method insofar as it mirrored the participants' evolving views of the design environment, suggesting that a reflexive approach to narrative data collection and analysis is warranted.

1 Introduction

What would happen if you took two characters from completely different novels and had them interact in a new story? You would quickly learn the extent to which situation defines character. A strong ship's captain might be meek and unsure on land. The steadfast sidekick in one story might be a treacherous henchman in another. But in fiction or in reality, facing new situations is endemic to human experience.

Bringing diverse individuals together to design information systems creates precisely this sort of challenge. In interdisciplinary collaborations, people bring expertise in one area to bear on problems in another to create more robust solutions. However, the mechanisms by which diverse individuals integrate their expertise in practice is not well understood.

The designers of information and communication technologies (ICTs), broadly defined, are of particular interest here. At first glance, the design of an information system would seem to have little to do with the construction of a narrative. But as ICTs evolve and intertwine, the difference between a database (*information structured for effective access*) and a narrative (*information structured to provide a particular experience*) is becoming less clear (Manovich, 2001). Creators of databases have traditionally adhered to values of neutrality, objectivity and best professional practice, giving primacy to both the contents of the collection and the perceived needs of users in deciding how to structure information. Creators of narratives, on the other hand, do not attempt to make themselves invisible. Much of the value they create is derived from the characteristic ways in which they actively and intentionally structure information to

deliver a particular experience, as any fan of a particular author will attest. However, if an information system is seen *as* a narrative, these two approaches must be reconciled.

Understanding how designers of ICTs conceptualize and perform their work can contribute to the larger goals of more effective design environments, and more effective information systems. This article discusses the narrative analysis method in the context of a digital library design project, focusing on three levels: narratives of the design process, narratives of the design product, and the meta-narrative of the research process.

In the study described here, a team of nineteen librarians, archivists, scientists, managers and programmers confronted the differences between database and narrative in the design of a digital library that merged diverse and unique content related to environmental science. When the narrative aspects of the proposed system were embraced by the designers, indicators of communication, information sharing and integrative work increased. The classification, organization and display of content in a digital library communicates a story about the people and documents represented there, and in an environment where communication and consensus were scarce, all participants agreed that they wanted a voice in shaping that story. In this project, narrative was an important yet underutilized medium across which diverse participants could communicate, negotiate, and integrate their knowledge.

Narrative analysis was an effective research method insofar as it mirrored the participants' evolving views of the design environment, but in the moment that a researcher attempts to distill multiple stories into one in the course of data analysis, the researcher's own role in imposing narrative structure must be acknowledged.

2 Background

This section provides a brief review of a cross-section of literature in philosophy, education, psychology, computer science, library and information science, and media studies, to draw a parallel between mental structures and information structures, to ground assumptions about the different world views and work practices of diverse participants, and how the elements of narrative can be mapped to the interactions of people in collaborative environments. Several previous studies employing narrative analysis are also discussed, to support the choice of narrative analysis as an appropriate research method.

Cognitive scientists suggest that the brain actively imposes structure on the stimuli it encounters, both in storing and recalling information. For example, when events are presented in a random sequence, people tend to reorder them into sequences that make sense when they try to recall them (Lichtenstein & Brewer, 1980). One way this sense-making mechanism has been conceptualized is as a mental model.

Mental models can be informally defined as people's internal representations of reality, the sense-making structure they bring into any situation. Some philosophers have argued that language itself could not function without internally-generated images (Wittgenstein, 1922). The concept of mental models has been explored in fields such as information retrieval system evaluation (Borgman, 1986), system design and learning (Mayer, 1989), human-computer interaction (Staggers & Norcio, 1993), and textual analysis (Carley & Palmquist, 1992). However, in a review of research on conceptual frameworks in information behavior, Pettigrew, Fidel and Bruce (2001) conclude that "the challenge remains to provide concrete guidance for system design" (p. 68).

Narrative can also be conceptualized as a kind of mental model. Labov and Waletzky (1997) define narrative as one method of recapitulating past experience by matching a verbal sequence of clauses to the sequence of events which actually occurred. They argue that the simplest and most fundamental narrative structures are those found in oral versions of personal experience.

Narrative analysis focuses on the ways in which people make and use stories to interpret the world (Lawler, 2002). The narrative analysis method is grounded by a constructionist perspective; the goal is not to discover 'facts' as reported by subjects, but to understand the contexts within which people construct their views, factual or not. Some narrative theorists argue that the narrative form is so deeply embedded in our culture that it is central to how people construct their identities (Ricoeur, 1988). For the social science researcher, the suggestion is that, if left to themselves, people will tend to answer questions and give their accounts of events in a narrative format, linking events within a structure of context, causation and character. In the narrative interviewing method, subjects are actively encouraged to contextualize their responses by telling stories (Bates, 2004).

Structural approaches to narrative analysis (Propp, 1968; Silverman, 2001) include a focus on social context and grammar (Labov, 1973). Most structural analyses of narrative include the following basic elements:

- Setting/orientation;
- Initiating event;
- Complicating action and core conflict;

- Action by protagonist to deal with the situation;
- Consequences of action;
- Climactic moment, and;
- Resolution and implications.

Missing from this list of narrative elements—or at best, included only implicitly—is a core component of practical narrative craft: the crucible. This refers to the overarching situation that compels the characters to remain in the dramatic arena and continue to struggle toward their goal. For example, in the crucible of a committed relationship, a couple will likely endure higher levels of conflict to stay together than would two people who have just met. In a design environment, if there is an unequal level of investment in the details of a finished system among diverse participants, the less-interested party may appear to have 'lost' the struggle, when in fact no struggle ever took place. The narrative form presumes conflict among equally motivated parties, within a crucible not easily escaped. Imposing this structure on a series of reported or observed real-world events and drawing conclusions must be done with caution.

Though structural narrative analysis is the dominant approach, there are alternatives. Bruner (1990) takes a more functional approach, envisioning storytelling as a means to accomplishing tasks such as using subtext to convey meaning beyond the words chosen, and resolving dilemmas by implicit or explicit reference to familiar characters and situations. Chaotic, unstructured experiences in the real world are thereby recast into stories with cultural reference points and causal relationships. Using a metaphorical shorthand to understand people and events might be an effective strategy to

deal with information overload, but in so doing, details of the lived situation can be obscured.

In library and information science research, use of the narrative analysis method has largely been related to the deconstruction of social messages in texts, such as young adult novels (Crew, 1996), as they relate to the provision of library services. More recently, narrative analysis has been used to examine the experience of professionals such as school library media specialists (Watson, 2001), as a way to allow them to tell their own stories about their work practice.

Narrative analysis has also been employed in studies of systems implementation, such as an enterprise resource planning system (Alvarez & Urla, 2002). While acknowledging the drawbacks of "messy or uncodeable data" (p. 38) inherent in a narrative-analytic approach, the authors found it an effective method to reveal work practices, worker perspectives, and the larger organizational and political structures that influence system design, adoption and use.

Narrative practice is as important as narrative theory. Professionally-created narratives dominate the society in which we live, and it is instructive to read from the guidebooks of those who craft them. The essence of narrative is characters in conflict, but the role of the author who creates and structures the narrative is even more central. In creating a narrative work, the author imposes a structure within which the actions and motivations of the characters make sense. When we say that someone has acted 'out of character,' their actions don't fit our expectations, given what we know about their personality and the situation. In a well-crafted narrative, actions and interactions flow plausibly, yet not predictably, all in service of the premise (Egri, 1946)—the larger

message created by the author. For example, the premise of *Romeo and Juliet* is that great love defies even death, a premise that has been used in countless other stories. It is in the crafting of the narrative around the premise where art is created. The author of a children's book about how to deal with the death of a grandparent would approach this premise far differently than would a writer in the horror genre.

The premise of a story is closely related to what is commonly known as its 'moral.' According to Pentland (1999, p. 1041), "the most challenging and important issue in narrative analysis is how to retain aspects of moral context that give it meaning for the participants." This echoes the "situations—gaps/bridges—outcomes" model in the sense-making research of Dervin (1980); one cannot understand an outcome without understanding how the actor perceived both the situation and the consequences of alternate possible actions.

Databases, and ICTs more generally, are rarely considered to be 'authored' in the same way books are, but the difference is certainly open to question. Even in a profession with stated values of equitable information access and representation, imposing any sort of classificatory structure on information brings consequences in the form of tacit messages about the items classified (Bowker & Star, 1999; Olson, 2000), thereby revealing or reinforcing underlying assumptions, biases and realities (Winner, 1986).

Manovich (2001) draws an interesting contrast between databases and narrative, suggesting that the goal of the former is information access, and that the goal of the latter is psychological immersion in the story, but that both of these are better conceptualized as two ends of the same continuum. Manovich imagines a higher-order entity he terms a

'new media object,' (p. 14) which includes databases and other ICTs as well as the full spectrum of narrative forms. Creating an information system such as a digital library is rarely if ever equated with creating an immersive environment—save for those rare individuals who can derive as much joy from a well-crafted database as a well-crafted novel—but under the common umbrella of 'new media objects,' the facade of objectivity is lifted, with intriguing implications.

Researchers are not immune from imposing structures. Talja, Keso and Pietilainen (1999) analyze multiple approaches to context in information seeking research, and suggest that contextual entities do not exist to be observed, but rather are produced by researchers' social interaction with the research object. At bottom, in databases, narratives and social scientific research, humans impose structure on information to serve particular purposes.

In the context of design research and data collection, an embedded and reflexive approach is warranted. Suchman (1987) presents a theory of situated action that has a process approach at its core. She suggests that to understand human actions, one must understand the interactions between individuals and the environment as they happen, not just what is described in a plan such as a grant proposal. Rogers and Bozeman (2001) support this wider view. They coin the term "knowledge value framework" to describe a more appropriate level of analysis for collaborations; they argue that to study the dynamics of collaborative research and development projects, one must account for external influences such as the background of the participants. People bring all kinds of baggage with them when they sign on to a project. Their disciplinary upbringing of course, but also their previous project experience, the values and expectations of their

home institution, and the technologies and practices with which they are familiar. Also underlying this approach is an iterative design philosophy, which has been explored in digital library development by Borgman et al. (2001). Here, ongoing evaluation and feedback are built in to the design process from the beginning, allowing for on-the-fly adjustment of both system requirements and research methods when the dynamics of the project warrant.

Bowker (2003) writes that biodiversity data, like that of environmental science more generally, relies on data sets from a large number of disciplines in order to build up a coherent picture of the extent and trajectory of life on earth. As sets of heterogeneous databases are made to converge, Bowker identifies a layering of values in the emergent infrastructure, operating simultaneously at a very concrete level (fields in a database) and at a very abstract one (the coding of the relationship between the disciplines). For reasons of data preservation, integrability and scientific reproducibility, system designers must "engage the complexity and historicity of data within the sciences so that social, political and organizational context is interwoven with statistics, classification systems and observational results in a generative fashion." So the goal is far more challenging than creating integrated collections and metadata. Multiple stories must be merged as well.

Of at least equal concern are the *untold* stories. Forsythe (1999) conducted an ethnographic study of the designers and builders of a medical informatics system, using observations, interviews and document analysis. A quote from her study illustrates that what people leave unsaid about their work practices can reveal as much as what they do say:

> "designers consistently discounted those aspects of their own work that involved social interaction or maintenance activities, such as teaching, planning, discussion at meetings, reading and sending email, or backing up their computers. While the people I studied regularly carried out such tasks and often spent a good deal of time on them, they resented having to do so. They dismissed these tasks as 'pseudowork.' Such activities were not included when I asked people to describe their work to me." (Forsythe, 1999, 142-143)

This has been referred to as "deletion," an often unconscious process by which certain kinds of social phenomena are systematically rendered invisible to those involved (Star & Strauss, 1999, p. 10). Encouraging people to tell stories can help reveal some of these hidden aspects of practice.

This section has discussed how structural aspects of narrative, and information behavior more generally, can be related and used as a framework to analyze the practices of people involved in the design of information systems.

3 Research environment and method

This section describes the research environment and how the narrative-analytic approach evolved. Names and certain details have been altered to preserve participant anonymity.

A university library was awarded a grant to digitize and integrate some of its collections related to environmental science, and make them accessible via the Web. What differentiated this grant proposal from other digitization projects was its focus on integrating diverse content (datasets, expedition reports, oral histories and archival photographs, among others) owned by diverse organizations (the university, a university archive, and a historical society), and including people from diverse disciplinary backgrounds in the design process. It was imagined from the beginning not just as a collection of disparate items, but as an integrated resource that would present a more holistic and realistic view of environmental science to both researchers and the public.

To design the system, a team of nineteen environmental scientists, librarians, archivists, educators, managers and system builders from a variety of institutions were brought together to define and create collections, catalog and structure the data, then decide how to present the merged collection to both researchers and the public, all in the space of one year. Though each of these nineteen individuals was named in the grant proposal, some participated only in an advisory capacity or on an as-needed basis. Two of the nineteen people were unaffiliated with any of the participating institutions and worked on a contract basis: the Web Designer and the Usability Consultant. The latter was my first role in the project; upon completion of the usability work, my role shifted to that of a participant observer.

Core participants were identified as whose who regularly attended meetings, were included in e-mail discussions, and who were named by other participants as someone with whom they worked closely (Table 1).

Table 1: Project Participants and Closest Collaborators

Participant	**Worked most closely with:**
Principal Investigator	Project Manager Associate University Librarian
Environmental Scientists (as a group)	Library Director Archivist
Associate University Librarian	Project Manager
Project Manager	Principal Investigator Associate University Librarian Web Designer Usability Consultant
Library Director	Environmental Scientists Digital Archivist Archivist
Archivist	Project Manager Environmental Scientists Library Director
Digital Archivist	Archivist Project Manager Library Director
Web Designer	Project Manager Digital Archivist
Usability Consultant	Project Manager

Combining the disparate collections and having researchers and professionals come together to help design the system was supposed to create new knowledge, in the sort of "integrative synthesis" that typifies true interdisciplinarity (Klein, 1990, p. 118). This was one of the most captivating rationales for the project*:* the potential to create hybrid knowledge—the emergent, innovative outcome resulting from the synthesis of diverse types of knowledge—by the juxtaposition and integration of diverse resources. For example, much environmental research relies on existing data sets, which researchers often download directly into an application with sparse or nonexistent contextual information. Mission logs of research expeditions and other unpublished archival materials often have precisely this sort of missing detail, about the equipment that was used to take readings, when and by whom the instruments were calibrated, and the conditions under which data were collected. Linking these related yet disparate forms would allow researchers to take a more critical view of the numerical data their models ingest. Similarly, combining oral histories and digitized copies of researchers' personal letters with the data they collected could give users a better sense of how environmental science is actually done.

The evaluation component had been written into the grant proposal and scheduled such that the findings from the usability study could be fed back into ongoing system design in an iterative manner. To develop the evaluation instrument, project participants were first asked about the goals of the finished system, and they gave many different answers. Project members alternately referred to the evolving site as a digitization project, a digital library, a Web portal, a marketing tool, and a "showcase" to support larger grant proposals in the future. People from different communities of practice

brought different visions of what environmental science is, and how a merged collection of environmental resources should be created, structured and presented.

These tensions and negotiations revealed themselves in the design and functionality of the site. In the usability assessment, potential users expressed the same diversity of opinion as the designers had regarding the system's content and goals. Some saw it as a repository of datasets for environmental research, others as a digital archive of unpublished expedition reports and historical photographs, still others as a simple Web portal containing links to a variety of environmental information.

The site that was delivered at the end of the one-year grant period could be accurately described with all of these statements. The centerpiece of the integration effort within the project had been to merge the metadata of the constituent collections (Gazan, 2003), which scarcely happened at all. Though it was a unique and useful resource, the system had not met its integrative goals. There was a story here. Or more accurately, many stories.

Data gathered during the usability phase served as a baseline for a more formal study. This phase of the study began with the assumption that the integrative aspirations described in the initial grant proposal had not been realized due to a lack of clarity about how diverse people communicate and collaborate; in short, how hybrid knowledge is created. It is not enough to bring diverse people and collections together; there must also be some mechanism for communication across boundaries and effective synthesis of diverse ideas. This mechanism was termed 'connection work': activity directed toward creating opportunities for the exchange of diverse types of knowledge. This could include facilitating meetings, linking unconnected individuals, translating documents or

similar work. When connection work happens in collaborations, it is generally in a passive, unintentional or invisible manner, due primarily to its low perceived value. One of the primary goals of this study was to identify and analyze instances of connection work in this project.

The post-usability phase of data collection began by eliciting the participants' accounts of when the integrative process had succeeded or failed. The data collection was focused by using observations, interviews, document analysis and social network analysis to identify instances of connection work. Initial indicators of connection work included the identification of associative relationships between individuals in the project, but the choice of indicators was continuously refined throughout data collection and analysis. This resulted in a multifaceted indicator of connection work that can be characterized as instances of multiple inputs and a single output. This included metaphors of reception, connection and integration in documents and interview responses (e.g., "she's the linchpin"), people who self-reported as coordinators or intermediaries, and centrality in social network diagrams based on self-reported information sharing patterns. Contraindicators of connection work included times when there were multiple inputs and multiple outputs; the failed attempt at integrating metadata schemes for the diverse collections was one prominent example. Other contraindicators included metaphors of disconnection (e.g., "out of the loop"), lack of participation in meetings when invited, and relative isolation in the social network diagrams, that is, people with few information sharing ties.

One might think of a social network as a planetary system, with each body having an influence on the position and motion of the rest. But when dealing with human

beings, motion and position is by no means linear or predictable. These networks continuously evolve, break apart and re-form in new ways. Though a given design project may be a convenient unit of analysis, none is severable from the simultaneous influence of larger scale networks (see, for example, Carley, 1999).

To refine the social network diagrams, the critical incident method (Flanagan, 1954) was employed. Project participants were asked to "describe a time" when they shared information with someone, and what the circumstances were, instead of asking about information sharing in the abstract. This exposed conflicts in people's views of the nature and amount of information they shared with one another, and led to a more finely grained sense of the various forms of connection work that were done in this project. Interviews centered around project practice, but also included some history, such as the rationale behind the grant proposal, how and why people joined the project, and people's past experiences with other participants, technologies and participating institutions.

A perennial weakness of social network diagrams is their static nature. To overcome this, diagrams were constructed at four critical points in the project as defined by the participants: the vision, inception, practice and aftermath phases. However, it must be noted that even a series of snapshots can represent the interpersonal dynamics of a year-long project about as well as four sequential still photographs can represent a movie.

Though people's level of participation varied at different points in the project, after several iterations seven core individuals were identified as the most central across the project as a whole in terms of being an information sender or receiver, or in linking otherwise disconnected individuals. In-depth, open-ended interviews were conducted

with these seven people, focusing on connection work as they envisioned it. Most were audiotaped—though a technical breakdown and one subject's discomfort necessitated the abandonment of audiotape as a primary option—supplemented by detailed handwritten notes. In the interviews, participants told stories about instances of translation, negotiation, bottlenecks, and interactions, and how each of these changed over time. Specifically, participants were asked to "describe a time when you…":

- Explained the project as a whole;
- Explained your role in the project;
- Participated in project planning or coordination;
- Needed to learn new terminology to communicate with other project members;
- Negotiated work roles or processes;
- Served as an intermediary (prompt: passed along information, or introduced people who otherwise might never have met);
- Felt that you were 'out of the loop' (prompt: missing needed contacts or information);
- Solved a problem;
- Had to invent or use a 'work-around';
- Had to use unfamiliar tools;
- Learned something new;
- Taught somebody something;
- Brought new information or knowledge into the project;

- Felt that you were working in a creative environment; and,
- Did something outside your formal job description that you feel contributed to the success of the project.

The open-ended nature of the interviews allowed subjects to diverge from these scripted questions and tell their own stories. This was encouraged. Re-reading early field notes and interview transcripts in light of later observations yielded the realization that people had been trying to express themselves by telling stories all along. An overly rigid data collection method can compartmentalize natural responses into variables and indicators, stripping them of the context within which activities are understood by the participants:

> "…the first-rate social scientist does not regard a research design as a blueprint for a mechanical process of data-gathering and evaluation. To the contrary, the scholar must have the flexibility of mind to overturn old ways of looking at the world, to ask new questions, to revise research designs appropriately, and then to collect more data of a different type than originally intended." (King, Keohane & Verba, 1994, p. 12)

The data collection method was then changed to be more reflective of the stories the participants were telling, and it was at this point that the narrative analysis commenced.

4 Narrative analysis

This section describes the results of the narrative analysis at three levels: narratives of the design process, narratives of the design product, and the meta-narrative of the research process.

A successful grant proposal will link the stated or perceived goals of the funding agency with those of the project as explicitly as possible, even when the connection might be rather tenuous. But merely reciting bullet points from a call for proposals is generally not enough. Something surprising or innovative must come out of these goals—a 'hook'—to get a funding agency interested;

> "Part of the art of grant writing is interpreting vague language in a way that lets you do what you want to do." (Principal Investigator)

In other words, grant writing might be considered the art of aligning your story with that of the granting institution. But the nineteen different people who worked on the project were not of one mind on the goals of the imagined system. For example, more and more science is driven by information systems, and the environmental scientists had a real stake in helping to select the rare holdings that would be digitized and integrated, and the new datasets that would come out of those efforts. The archivists saw a lot of disconnected, underused resources that taken together could create new environmental knowledge for audiences beyond just environmental scientists. The scientists and archivists had to work together and confront problems in one another's domain in order to create a successful, integrated system.

In early meetings, scientists and archivists debated the importance of their areas of specialization in deciding what should be digitized. Generally, scientists sought to support their narrow areas of research, while archivists appealed to best professional practice, seeking to digitize items often requested by non-scientists as well. This was mostly one-way communication, with very little information sharing or negotiation taking place. At that early point in the design process, no one knew what the finished system would look like, until a *narrative of exploration* was adopted as a unifying theme for the system:

> "I'm not saying 'exploration' was a brilliant idea. It just seemed like that's what were all talking about." (Project Manager)

Participants identified this as a critical moment in the project, when goals became clearer, participation increased, and the project became more fun for them. Exploration carries with it a sense of history, and this gave archivists and environmental scientists some common ground. By imposing this narrative framework, a relationship between historical photographs, fish catch data, and reports from research expeditions could be expressed. The scientists were particularly satisfied with this approach, because it gave their research an air of historical importance; one scientist said he planned to show the site to his grandkids.

With this apparently small act, the Project Manager did connection work by simply listening to a wide range of participants, then articulating a common theme. This provided the opportunity for archivists and other information specialists on the project to

merge disparate collections and structure information in a purposeful, creative manner akin to authorship:

> "We were trying to tell a story with this system...like lots of people visited the South Pacific islands, but what's most commonly recorded are the impressions of missionaries and doctors. Sailors also visited and wrote diaries, but their point of view is much less represented. So I made sure to include letters from sailors [in the collection]…" (Archivist)

The design of the project Web site was also controlled by the narrative of exploration. Each page contained several sample photographs to give users a hint of the collections inside, including rusty oceangoing research vessels, compasses and antique maps, as well as the obligatory scientist in a white lab coat. These sample photographs were evaluated and debated by librarians, archivists and scientists not just as design choices, but as the opening chapters of the story the site would tell. The librarians and archivists were more central here; they understood both the collections and the users, and could articulate a wider range of possibilities for portraying both on the site. The realization that creating a database and creating a narrative could be one and the same was crystallized by a comment from the Web Designer:

> "It was a major categorizing project to visually organize the site. I come from the museum world, this is my first library project. I wanted to know the context of the images, and telling a story of exploration really helped

me figure it out. Museums do this, impose narratives across their collections, but libraries usually don't." (Web Designer)

When the diverse collections were related within this narrative framework, scientists who initially thought they would only find data sets useful could see that maybe the archival photographs contained some useful information as well. The librarians and archivists saw the narrative as a way to articulate connections between the disparate collections that they always knew were there. The narrative of exploration served as a boundary object (Star & Griesemer, 1989), across which scientists, archivists and managers could communicate, negotiate and collaborate.

Like the Project Manager, the Web Designer was more of a generalist than a specialist. It is worth noting that the Web Designer was an outsider in two ways, by being an contract employee, and by not being a member of the library community. Though the Web Designer's work was praised by the project members and the usability study participants alike, the Web Designer reported a surprisingly low level of interaction with other project members, even those whose work was directly related:

"I was never sure how important it was to distinguish to the user where [in which collection] the search was taking place. I was never given set directions on how to break up the collections...I didn't get feedback as to whether that was a problem. Maybe nobody noticed." (Web Designer)

Though social network analysis was useful to identify the Web Designer's few information sharing ties with others in the project, some of the possible reasons for his relative isolation only emerged in the narrative analysis. The Web Designer was hired by the Project Manager, and continued to communicate primarily with her, more out of habit than for any necessary collaborative purpose. The Digital Archivist, who interacted with the digitization contractors, found herself the default liaison with contractors of all sorts, including the Web Designer. Despite the Web Designer's experience and skill, the lack of prestige inherent in being a 'temp,' in the opinion of the Web Designer, interfered with his ability to interact directly with higher-level employees such as the Library Director, who knew the collections and the Environmental Scientists best. The Web Designer's job was to transform the shared narrative of exploration into a workable design; in other words, to do connection work and integrate the visions of diverse participants—precisely what was stated in the grant proposal. But even in a project where collaborative work was explicitly valued, social and structural realities made the Web Designer a supporting character, when he might well have warranted a starring role.

The digital library was released with little fanfare, and with participants already writing new grant proposals to finance improvements. When asked why the finished system hadn't met its goals, many of the participants pointed to a lack of communication on the part of the systems staff:

> "The systems people were to blame...they couldn't deliver what they promised in terms of time or functionality or engagement with the project.

> That was the main reason we weren't as successful at merging [the collections]." (Associate University Librarian)

Though three members of the systems staff had been named collaborators in the grant proposal, they attended fewer meetings, and were peripheral or absent in most information-sharing social network diagrams. They did not respond to repeated requests for interviews, and it is a weakness of this study that their point of view is not included here. But what is not in dispute is that the technical solutions outlined in the grant proposal were not delivered, and the social network analysis confirmed the relative isolation of the systems staff.

Following a narrative analytic approach, the focus of the analysis shifted to discovering the reasons for their lack of participation. Some library staff members who co-wrote the grant proposal admitted that they had assumed that there were technical solutions to the challenges of integrating diverse collections, and that the systems staff would "just figure it out." Taking a structural approach to the narrative analysis and attempting to break down these responses into initiating events, conflicts and divergent goals did not yield any insights into why the systems staff had not participated as expected. It was not until a follow-up interview with the Principal Investigator that evidence was found that the root of the difficulties with the systems staff may have been largely unrelated to the project:

> "At that time, the systems staff had lots of turnover. The whole damn place fell apart, and [the project] got caught betwixt and between...In the

> defense of the IT department, we did underestimate how much work would be required to get this done, and since it was our first stab at this I guess that was to be expected. I built in 20% contingency and I probably should have built in 50%." (Principal Investigator)

Connelly and Clandinin (1990) note that "Research is a collaborative document, a mutually constructed story out of the lives of both researcher and participant." Despite being aware of narrative as a focusing and filtering mechanism on the part of the research subjects, its influence on the research process itself was greatly underestimated. By assuming that that some sort of rift existed between the library and systems staff, a narrative structure of conflict had been imposed. Stated as an author's premise, it might have read "mutual disrespect leads to shared failure." Not surprisingly, trying to make the data fit into this imposed structure proved fruitless; based on the Principal Investigator's comments, respect was not the issue. It was more likely that the systems staff simply had too many other, higher-priority demands on their time. In narrative terms, there was no crucible.

One of the likely reasons for this researcher-imposed structure was my initial role as Usability Consultant. To design a focused evaluation instrument, one strips away the 'extraneous' elements of the project members' stories to reveal the core functionality that the system should provide and the evaluation instrument should test. However, even after the usability phase, this instrumental mindset persisted and hindered understanding of the rationale and interactions in the research phase. The data collected during the evaluation phase then had to be revisited and re-analyzed in a different light. It should be

noted that in-depth interviews with iterative participant validation were essentially equivalent to subject-aided data analysis. The informal nature of the interviews seemed to put people sufficiently at ease to clarify points of confusion and expand on possible reasons why the initial findings had come out as they had.

As a participant observer conducting research, active and passive abandonment of a project are difficult to distinguish, but this experience helped illustrate the ubiquity of human-imposed structures, and served as an effective cautionary tale for subsequent data analysis.

5 Conclusion

The critical insight from this study is that connection work, that which creates opportunities for the exchange of diverse ideas, is a necessary yet undervalued component of collaborations. It happens almost invisibly, and is characterized by individuals who receive, synthesize, and articulate the ideas of others, even in the simplest ways. Connection work is the practice of aligning diverse perspectives, and creating an emergent, shared story. Connection work can be inhibited by its lack of visibility and prestige, by a lack of common vocabulary between diverse actors, and by social and institutional norms regarding, among other things, valid knowledge and who is entitled to participate in its creation. Understanding communities of practice as social entities that create and perpetuate these norms and foster shared images in the minds of their members is a necessary first step toward meaningful integration of documents in merged information systems, and people in collaborative environments.

This article has focused on the primary means by which connection work took place in this project: across the boundary object of narrative. In an environment where people with diverse skills, backgrounds and goals had to interact and collaborate, the results of this study suggest that conceptualizing an information system as a narrative was key. When designers embraced the narrative aspects of the system, indicators of communication, information sharing and integrative work increased, and participants identified the narrative discussions—defining the story the system would tell about environmental science—as the most successful and enjoyable aspects of the project. Framing future information systems in light of the stories they tell about the people and content represented within can inform design, and better match how designers and users approach the systems in practice.

The means by which narrative analysis might be applied to the design of future systems already exists within most project plans: the evaluation component. However, the evaluation process should be elevated from simply testing system functions one by one to a more integrated, iterative feedback mechanism fueled by more qualitative, impressionistic data. Though it is more difficult to gather and code, narrative data more accurately reflect the world as it is understood and communicated by people, for example in the form of local best practices and cautionary tales. While the objectivity and generalizability of narrative data are always questionable, narrative has a higher level of explanatory power, and can be triangulated through the stories of multiple subjects to help reveal not just what happened, but why. However, it is important to remember that compiling and analyzing multiple stories does not automatically result in the equivalent of a synthetic work with shared authorship; it is more akin to an edited volume, where the

editor is the person conducting the evaluation, and imposing his or her own structure on the data.

Librarians, archivists, taxonomists and information professionals more generally have a unique role to play here. Understanding the conceptual structures of information seekers and the classificatory structures of collections is an advantageous starting point from which to anticipate the stories an information system might communicate to particular user communities, and in helping to structure those narratives in a more conscious and active manner. Though it is not usually perceived as such by the people doing it, structuring information is a creative act. Understanding the nature and consequences of the structures people impose on information is a valuable contribution that few other fields can claim.

Social network analysis was an effective means of documenting the interactions of people throughout the course of the project, given the limitations of a static representation of a dynamic process. In a collaborative environment, contact between individuals from diverse backgrounds who can share information is often necessary, without regard to their relative position in the organizational hierarchy. Social network analysis revealed unexpected points of connection between people in terms of information sharing, as well as unexpected isolates. Narrative analysis was then employed and helped reveal instances of connection work, and helped explain a lack of interaction between individuals who might have benefited from working more closely together.

As future environmental information systems draw from and attempt to integrate a wider range of data, they will involve a wider range of designers and builders. These

systems will be expected to serve a constituency beyond the researchers that collected the data, and the owners and stewards of the constituent collections. When the goal is to create new knowledge by integrating diverse people and resources, the processes of negotiation and translation that occur in the practice of designing and building these systems need to be better understood as the means by which integration either happens or does not. In this project, the negotiation of a shared narrative helped serve that purpose, and narrative analysis as a research method helped reveal it. In the design of future information systems, the interactions of different communities of practice and diverse knowledge forms might be usefully acknowledged and articulated through the lens of narrative, to achieve something closer to synthesis.

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