Dissertation Proposal by Eric T. Meyer

Socio-Technical Perspectives on Digital Photography: Scientific digital photography use by marine mammal researchers

Project Summary: This project studies the consequences of the computerization of photography for scientists, specifically marine mammal researchers. The research applies Kling's Socio-Technical Interaction Network (STIN) framework, which analyzes socio-technical systems by integrating the social and technical to develop a more nuanced understanding of technology in society than is possible with alternative frameworks; the STIN framework extends Actor-Network Theory.

Digital photography is a recent, novel information technology that has been widely and rapidly adopted across a variety of domains. Digital photography has widely replaced traditional film photography in recent years. By 2006, the major camera and film manufacturers had essentially abandoned film as they discontinued the manufacture of most types of film and film cameras. Even though digital photography has become ubiquitous in the last five years amid claims that it is a 'revolutionary' technology, there has been relatively little research into digital photography as a socio-technical phenomenon.

To understand the role of digital photography as a technology used in scientific work, this study will examine marine mammal researchers who use photo-identification as a tool for gathering, organizing and analyzing data. Many marine mammal researchers have recently switched from film to digital photography and report anecdotally that this has fundamentally altered the ways in which they do their scientific work.

Scientists studying marine mammals employ photo-identification methods to record natural markings, and use the collected data to estimate population parameters, including population size, survival rates, reproductive rate, and age at first reproduction (Hammond, Mizroch, & Donovan, 1990). Besides photo-identification, other major techniques for studying marine mammals include acoustics, genetics, telemetry, anatomy, and toxicology. A combination of these techniques may be used by any given research project. Marine mammal researchers first began using photo-identification methods in the early 1970s to study population dynamics of marine mammals (Würsig & Jefferson, 1990). One of the

reasons that researchers were interested in developing these techniques was because they were non-lethal, and non-invasive compared to other techniques such as radio tagging, biopsy sampling, or capture-release study methods (Hammond et al., 1990).

Photo-identification in practice involves taking photographs of animals in the field; the preferred angle and part of the body is dependent upon the species. Humpback whales, for instance, are identified using fluke (tail) photographs which capture the outline of the fluke's shape, any notches or bite marks in the fluke, and the coloration pattern on the fluke. Dolphin identification relies on the shape and pattern of nicks and notches in the dorsal fin, while seal identification relies on scars and general pelage pattern on the body. The images are then added to a catalog either manually by a knowledgeable researcher familiar with the population's members, or with the assist of automated identification software such as FinScan or DARWIN (for dolphins), or DIGITS (for whales). The image data is also associated with other data collected on the animal, including GPS readings for sightings, genetic information gathered through biopsies, and other research information. There do not appear to be any standardized databases currently for this work, so many of the systems in use are custom, locally-made applications.

Most marine mammal scientists contacted by the PI report that they only began to switch to digital photography in the last 2-3 years. This shift corresponds with a major workshop on digital photography techniques convened at the 2003 biennial meeting of the Society for Marine Mammalogy (Mizroch, personal communication, Dec. 2005). There have been controversies within the field over the technology, such as an exchange between Markowitz et al. (2003a; 2003b) and Mizroch (2003) debating whether digital photography was of sufficiently high quality for photo-identification work compared with the standard of fine-grained black-and-white film. There are also indications that current controversies include differences over various photographic file standards, such as lossy JPEG versus RAW or TIFF formats as a storage format.

Theoretical Perspective: Kling's STIN approach (2003) is "an emerging conceptual framework for identifying, organizing, and comparatively analyzing patterns of social interaction, system development, and the configuration of components that constitute an information system" (Scacchi,

2005:2). The STIN approach draws on both Social Construction of Technology (SCOT) and Actor-Network Theory (ANT), and emphasizes that "ICTs [information and communication technologies] do not exist in social or technological isolation" (Lamb, Sawyer, & Kling, 2000). According to Kling:

> Several fundamental assumptions underlie the application of the STIN methodology, and drive the methods used to construct STINs. These assumptions include:
>
> [1] the social and the technological are not meaningfully separable…,
>
> [2] theories of social behavior…should influence technical design choices…,
>
> [3] system participants are embedded in multiple, overlapping, and non-technologically mediated social relationships, and therefore may have multiple, often conflicting, commitments…, and
>
> [4] sustainability and routine operations are critical. (Kling et al., 2003:56-57)

The first assumption, that the social and technological are not meaningfully separable, should be familiar to those acquainted with the theoretical approaches of SCOT (Bijker, 1995; Pinch & Bijker, 1987) and ANT (Latour, 1987; Latour & Woolgar, 1979; Law, 1999), particularly ANT's concept of actors that can be human or non-human participants in a socio-technical system. The STIN approach extends SCOT and ANT, however, by problematizing information technologies and making the "association between STS [Socio-technical systems] concepts and IS [information systems] research [which] is often not explicitly articulated as such in contemporary literature" (Lamb et al., 2000:1). One of the major differences between Latour's and Kling's approaches is that "Latour theorizes about how new technologies come to be; Kling and Scacchi theorize about how new technologies come to be used" (Orlikowski & Iacono, 2001:126). The STIN approach is also less committed to ANT's concept of "radical indeterminacy" (Hanseth, Aanestad, & Berg, 2004; Latour, 1988) and is "much more conservative in attributing action to nonhuman agents" (Kling et al., 2003:66). Kling argues that this integrated concept of socio-technical systems is more useful than the more common use of the term socio-technical to argue merely that technologies have consequences for social and organizational behavior. This highly intertwined nature of the social and the technical is central to the STIN approach.

The second and fourth assumptions reflect a normative element of the STIN approach. Arguing that theories of social behavior should influence technical design choices and that it is critical to consider the sustainability of socio-technical systems both reflect Kling's background in computer science and concern for social issues. This differs from SCOT, which does not generally concern itself with such prescriptive concerns, and from ANT, which is much more theoretically oriented, to the extent that even ANT's methodological prescriptions are primarily methods of analysis and not methods of collection (Bowden, 1995).

Kling's third assumption regarding the multiplicity of social relationships and commitments for system participants is the key to understanding the contribution that STIN makes to research into change in socio-technical systems. This element of the STIN approach looks beyond the socio-technical system under study and also examines how other portions of an actor's social world are connected to their use and understanding of technology.

Sawyer & Tapia (2005) argue that while theory building is desirable in the extension of a new field like social informatics, a "more modest approach is to focus on developing, demonstrating and exporting analytic approaches…to bring theory and evidence together" (p. 13) and cite the STIN model as an example. The STIN framework allows for a nuanced examination of socio-technical systems by integrating the social and the technical, and provides a useful addition to SCOT's focus on case studies of mutual shaping and ANT's methods of following the actors, opening black boxes, and examining inscriptions. STIN's inclusion of the social roles of actors beyond their roles specific to the socio-technical system under analysis, the ability to track social actors whose roles are not primarily technical, an attention to excluded actors and undesirable interactions, and a focus on the importance of social change in socio-technical networks all make STIN a worthwhile addition to the social studies of technology and social informatics literature.

Research Questions: A major goal of this research is to contribute to theory by testing Kling's Socio-Technical Interaction Networks (STIN) strategy, which is an extension of Actor-Network Theory (ANT). However, in terms of the specific topic, this research also combines theory with novel empirical

data because both the research topic of digital photography and the research domain of marine mammal researchers have been little studied to date among social scientists. As such, rather than list hypotheses *per se*, it is more reflective of the actual processes we will follow to lay out a set of research objectives phrased as questions which will guide the research. These interrelated research questions are based on Kling et al.'s (2003) prescriptive tools for modeling STINs.

1. Who are the relevant actors within the systems supporting photo-identification research, and what are the core groups both related and unrelated to photography to which these actors belong?
2. What are the pressures/incentives or impediments to adopting digital techniques?
3. How is knowledge about how to use digital photography technology obtained (e.g., is it formal or informal, what role do other researchers play, who in the scientist's networks participate in the learning)?
4. What are the resource flows (e.g., to pay for equipment, staff, field work, new specialists in digital technology, etc…) that the scientists have mobilized to pay for their photo-identification work?
5. Who becomes involved in the photo-id process for the first time when scientists adopt digital photography, which formerly involved actors and technologies are excluded, and how are peripheral actors affected?
6. What conflicts arise over the digital photography computing package in routine use, and what are the biggest benefits of digital photography in routine use?
7. How are the data shared with other scientists?
8. What are the architectural choice points for the system (e.g., what choices are made over time that influence the current configuration of the computing package), and what are the rejected alternatives? What are the other elements of the total computing package (e.g., databases, GPS, etc…) used to support photo-identification and have these changed?

9. What technological alternatives would be desirable to improve the existing system (e.g., if one were not limited to existing technology, what sort of system could they imagine that would make their research more effective)?

Preliminary work: The PI has also engaged in preliminary work with marine mammal researchers to determine the feasibility of this study, gauge the interest among the scientists in participating, identify key players, and identify likely research sites. In December 2005, he attended the biennial meeting of the Society for Marine Mammalogy (SMM) in San Diego, California. The SMM is the main professional organization for scientists studying marine mammals. At the meeting, he attended every paper, panel and poster session whose abstract indicated any involvement with photo-identification and spoke with the author(s). In these approximately 40 conversations, he described this research project, asked researchers some general details about their project's involvement with photo-identification, digital photography, the size of their group, and the location of their work and field sites. He also asked the researchers who else he should be meeting, and gained a number of valuable personal introductions this way.

While these contacts were preliminary and did not involve formal interviews, he was able to gain valuable initial insights into this field. He also identified many of the key players in the field and was able to obtain agreement from a number of research sites who agreed to participate in this research; these sites are discussed in the section of this proposal on field sites. Overall, he found the scientists with whom he spoke to be very interested in this work, open to participating in it, and very interested in the results as a way to continue to improve their own research and technology choices in the future. Attending this meeting will likely prove to have been a vital first step in ensuring the success of this project.

General approach: Studying digital photography use by scientists could be approached in a number of possible ways, but an appropriate strategy for answering the research questions laid out above is case study research. Marine mammal researchers operate within a bounded system, which makes them amenable to the case study approach (Stake, 1998). Furthermore, the reason for studying this multi-site

case (Creswell, 1998; Nadai & Maeder, 2005) is to develop an instrumental case study that helps to pursue an external interest of refining theory, as opposed to developing an intrinsic case study designed to understand the phenomenology of a particular case (Stake, 1998). It will do this by contributing to STIN research and to the development of communication regimes (Meyer, 2005) as useful conceptual tools for empirical research. Multiple sites, which can also be thought of as specific sub-cases of the main case, are selected not in an attempt to make statistical generalizations about a population, but to develop analytic generalizations about theory because "if two or more cases are shown to support the same theory, replication may be claimed" (Yin, 2003:38). Case study research, which may use either positivist or interpretive approaches, is also a commonly accepted tool in information systems research (Myers, 1997), particularly for research that "investigates a contemporary phenomenon in a real-life context when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used" (Yin, 2003:23).

This research will involve qualitative research, including approximately 40 semi-structured interviews, 6-8 site visits, and 3-4 short periods of observation of marine mammal scientists in the field. The main reason why not all site visits will include observation of the scientists in the field is that some of this research is done on small boats in remote and sometimes sensitive locations, and accommodating an observer would not be physically possible. Other research is done on larger craft in more accessible spots; these are the studies that will be observed, with the scientists' permission.

Field sites: While there is still some flexibility with the selection of additional field sites, the following sites, grouped into three major research trips of approximately 1-2 weeks each, all represent major sites of photo-identification research in North America and have all agreed to allow access for this research. (Note: Human subjects committee limitations prevent us from identifying specific researchers by name, but we can identify research locations where a number of scientists will be interviewed. IRB approval was granted April 27, 2006.)

Costs associated with these research trips represent the majority of funds to be spent in this study. Being able to undertake these trips to a variety of major research centers will be invaluable in ensuring the

success of this project. While a non-representative case study could be produced by visiting just one site, by comparing and contrasting what occurs at the different research centers, this study will be able to make conclusions about the field of marine mammal research. This is preferable to only being able to discuss what happens at a single, possibly idiosyncratic, location. The multi-site method will allow the PI to have a higher degree of certainty that this research is accurate and truly representative of this field.

Trip 1 to Florida: Two major research centers in Florida have agreed to participate in this research. One site studies dolphins and manatees using photo-identification methods, and has been involved in photo-identification research for 36 years. The other site also studies dolphins and includes researchers who were among the pioneers in using digital cameras for photo-identification work.

Trip 2 to the Northern Pacific: One of the leading innovators in using photo-identification works with a group doing photo-identification of humpback and blue whales in the Pacific Northwest and is strongly supportive of this research. This site has agreed to allow access to their approximately seven staff. Also, another major research unit with 20 staff located in the Pacific Northwest is a central collaborator in a Pacific-wide collaborative project studying blue, humpback and gray whales.

Trip 3 to the Northern Atlantic: Two projects located in New England have both expressed a willingness to allow access for this research. One first started doing photo-identification work in 1972, and has developed a catalog of 5500 whales in all known North Atlantic feeding grounds. These two projects have approximately 20 staff combined.

Additional telephone interviews: Some researchers work on small studies in locations which make interviewing them in person not feasible. At least 6-8 of these scientists will also be interviewed by telephone. Contacts have already been made with scientists working with Hawaiian monk seals, arctic Bowhead whales, and California harbor seals who have agreed to be interviewed for this research. Others will be identified using purposive methods based on publications and personal references.

Intellectual Merits: The field of social informatics is a new interdisciplinary approach to the study of technology in society (Kling, 1999). The PI on this project worked closely with Rob Kling, the founder of social informatics in the United States, until his death in 2003. He has published in the area of

social informatics and on the topic of digital photography. This particular research project is original because it examines how a new technology (digital photography) is being used in an understudied scientific field (marine mammal research), as well as tests and develops one of the central propositions of social informatics: that information and communication technologies (ICT) have important and sometimes unforeseen consequences in social settings, but that these outcomes are not determined by the technology and are a part of complex socio-technical networks.

Broader Impacts: The proposed research broadens the understanding of the relationship between new technologies and changes in social organization and behavior. Even though digital photography has become ubiquitous, very little systematic research has been done to understand the measurable consequences of this new technology. This study contributes to a broader research agenda aimed at understanding how other new technologies can be understood and theorized as they enter into routine use, which is a major research concern of social informatics. Also, by engaging the STIN framework, this research will help develop this relatively new model for understanding the role of technology in society. Alternatively, should the research discover that the STIN framework is inadequate to deal with the data in this study, it will suggest that the STIN framework should be either modified or abandoned in favor of other approaches for future work on this topic. This research will also contribute to the literature on technological changes in scientific communication practices, which continues earlier research completed by the PI.

The results of this research will be disseminated as a completed dissertation which will be available on the internet, through publication of at least one journal article in a quality journal, and presentation of at least one conference paper to an information science audience and one conference paper to a marine mammal science audience. By disseminating this research to a marine mammal science audience, the hope is that the scientists can use the theory and data from this research to improve their practice of digital photography. In addition, the PI plans use this research as a base for a research agenda that will examine additional domains of digital photography beyond marine mammal scientists over the next several years.

B. Schedule of Completion

July, 2006:	Start date
July-Nov:	Visit research sites and collect data, write research notes, and begin to analyze data
Dec-Mar, 2007:	Write up data from interviews and field observations
Apr-June:	Finish writing dissertation based on data collected
After project ends:	Publish results and present data at conferences in information science, social studies of science and technology, and marine mammal research

C. Budget and Budget Justification

	Yr 1	Per Diem/ Lodging	Days	Airfare	Local trans	To Airport / Parking
Travel	**7/1/06-6/30/07**					
Trip #1: Pacific Northwest	$2,450	$ 127.00	14	325	200	146.77
Trip #2: Florida	$2,110	$ 117.00	14	175	150	146.77
Trip #3: New England	$2,394	$ 185.00	10	275	150	118.97
ASIS&T Annual Meeting	$500					
Other Direct Costs						
Materials and Supplies	$200	$200	telephone/long distance			
Other	$560	$250	digital audio recorder			
		$160	NVivo license			
		$150	Storage Sticks			
Total Budget	$8,214					
ISI Diss Prop Scholarship	$1,500					
Attendance at ASIS&T Meeting	$500					
Amount requested	**$2,000**					

Budget Justification:
This application for the ISI Dissertation Proposal Scholarship is to fund a portion of the research travel for this proposal, as well as to request $500 to attend the ASIS&T annual meeting in Austin, Texas, as outlined in the announcement.

Travel: $7454

The majority of funds for this research are to pay a portion of the travel expenses required to visit laboratory and field sites in Florida, Washington, Oregon, Maine, and Massachusetts. This budget is based on three trips taking a total of 5-6 weeks combined. Trip 1 to the Pacific Northwest is budgeted at $2450, trip 2 to Florida is budgeted at $2110, and trip 3 to New England is budgeted at $2394. These rates will pay for coach-class advance purchase roundtrip airline fare, local transportation, and per diem/lodging rates.

The $500 flat rate to attend the ASIS&T annual meeting is that outlined in the announcement for this award, and will be used to defray the costs of airfare, registration, and lodging at the conference.

Other Direct Costs: Materials and Supplies: $200

Materials and supplies for this proposal include telephone calls and expenses for office materials ($200).

Other Direct Costs: Other: $560

Project-related expendable equipment expenses include a digital audio recorder ($250), storage cards ($150), and a software license for NVivo ($160).

D. Other Support for 2006-2007

Employment: Employed as a data manager at the Institute of Psychiatric Research, Indiana University School of Medicine, Indianapolis, Indiana

E. Dissertation Advisor

Howard Rosenbaum, Associate Professor of Library and Information Science, School of Library and Information Science, Indiana University, Bloomington, Indiana

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