Ethnographic Methods to Study Context: An Illustration*

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Abstract. The ability to reflect contextual factors is crucial to the success of computerized support systems. Consequently, identifying how context affects the supported processes is a prerequisite for developing such systems, and ethnographic studies can play an important role in shaping system design. We are developing methods for supporting distributed collaborative troubleshooting by aiding the transmission of useful contextual information between participants, based on a study of contextual influences in the existing troubleshooting process. This extended abstract summarizes methods, motivations and observations from our socio-technical analysis, based on a nine-month naturalistic study of real-world remote diagnosis of electronic devices by ad hoc teams. It illustrates how ethnographic tools can be brought to bear for such analysis, as well as illustrating the richness of the real-world contexts that such an analysis can reveal.

1 Introduction

Troubleshooting assistance must often be conducted remotely, as non-experts call upon "help desks" of geographically-separated experts to assist their diagnosis process. These service calls prompt the formation of ad hoc teams, whose members begin their interaction with little knowledge of each other's situations. However, evidence shows that the task process can be strongly influenced by contextual factors (Albers 1999; Amann & Quirchmayr 2003). Consequently, enabling effective troubleshooting requires making team members' contexts explicit, in order for participants to make appropriate decisions. This in turn requires understanding what constitutes the relevant context for the troubleshooting task. This extended abstract introduces a study analyzing the troubleshooting task and highlights some of the resulting observations.

The context in which a problem is placed can have a significant effect on a human problem-solver's decision process (Albers 1999), making it important to provide decision-makers with contextual information. Ahn, et al. (2000) observe that ad hoc virtual

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collaborative problem-solving presents special impediments to building up the needed knowledge, such as changing sets of participants, resulting in loss of knowledge and skills, limitations on the amount of context it is practical to convey, and the casual loss of information when virtual collaborations are intensive and non-routine. Our project aims to develop support systems to alleviate these difficulties. Our primary domain is the support of collaborative troubleshooting of complex shipboard electronic systems. In the current U.S. Navy troubleshooting process, non-expert shipboard sailors are paired with shore-based experts to assist their troubleshooting. Communication options are limited and often asynchronous, often relying on e-mail, with minimal support for information transmission. We aimed to understand the types of contextual knowledge needed for effective task performance, based on an ethnographic study (Evans 2004).

2 Design of the Study

Ethnographic studies can be conducted with a number of strategies, including controlled and quasi-experiments, surveys, histories, archival analyses, and case studies. According to Yin (Yin 1994, pp. 1–9), the unique advantages of each depends on three conditions: (a) the form of the research questions(s); (b) the control over actual behavioral events; and (c) the focus on contemporary as opposed to historical phenomena. In Yin's assessment, asking 'how' and 'why' questions about a contemporary phenomenon where control is minimal necessitates a case study design. This design requires a commitment to ongoing interpretation of the data from multiple sources, a concern for validation of assertions, an organization of the inquiry around initially etic (meaningful to the researcher) and later emic (meaningful to the participants) issues, the use of narrative to establish context and reveal pertinent details, and an aim toward promoting naturalistic generalization on the part of readers of the study. The commitment to interpretation and validation are integral to the process of the case study research, while organization, narrative style, and naturalistic generalization emphasize the importance of the product.

Data Collection Sources of Evidence. Interviews for this study were semi-structured with the intent of asking key respondents for the facts of a matter as well as for respondents' opinions about events (Yin, 1994, p.84). More specifically, attention was focused on current work and its context. Open-ended, or more conversational, questions were asked of respondents, particularly sailors, technicians, and engineers who were on the job and engaged in actual troubleshooting tasks. Over 50 hours of interviews were recorded digitally and then transcribed. Observations of troubleshooting sessions were conducted at naval installations, labs, and training facilities, focusing on the influence of contextual features on the generation, sharing, and use of knowledge and expertise. Observations were conducted on a weekly basis for six months, from December 2002 to August 2003. Documents related to the case were collected and analyzed to corroborate and augment evidence from the other sources (Yin, 1994, p.81). Sources included maintenance and repair manuals, error reports, meeting minutes, web pages, newspaper reports, training materials, departmental communications, job descriptions, procedural guidelines,

proposals, progress reports, published case studies of similar projects, and reports generated by the design team. Finally, a research journal was kept to capture reflections on the case process, methodological choices, and design choices, and to help to maintain a distinction between the role of the designer and the role of the researcher. Contents included notes from observations, conversations with case informants, reflections about potentially emerging themes and methodological directions.

Case Study and Ethnographic Techniques. The study applied a number of ethnographic techniques to assess observations. One of these, pattern-matching, derives empirically-based patterns from the descriptive case to compare with predicted patterns from theoretical propositions (Yin 1994), adding support for the results' internal validity when empirical and predicted patterns coincide. Patterns from this study include the contextual features that enabled or inhibited knowledge sharing and problem-solving. Another ethnographic technique applied, progressive focusing, guides attention by the unfolding of critical aspects of the case (Hammersley & Atkinson 1983). In our study focus shifted gradually from sailors to a broader unit including technicians and engineers.

3 Contextual Factors Shaping Remote Troubleshooting

In all remote troubleshooting, some explicit problem-solving information must be transmitted between participants. In our domain, this consists of (1) The specification of the device being diagnosed, (2) The symptoms of the fault to diagnose, (3) Offiicial diagnostic resources, and (4) Reports on the actions (such as voltage tests, etc.) carried out by the sailor. However, our analysis identified a rich range of additional contextual factors:

1. **Characteristics of the Participants:** In our data, troubleshooters often infer information from the characteristics of the participants, including inferences based on likely access to knowledge updates (e.g., "these young third class guys would never know there was an advisory out'), and their training/experience.
2. **The Problem Setting:** Characteristics of the problem setting, both historical and current, play an important role in the expert's situation assessment on the current problem, suggestion of possible diagnoses, and selection of diagnostic actions. This context includes factors such as the ship—different ships may configure the same equipment differently, environmental effects, and sailor pre-contact actions.
3. **Institutional, Social, and Cultural Factors:** What information is available to the expert and how to assess that information are shaped by local standards on when to seek help and how to proceed. For example, sailors may be reluctant to reveal that they have deviated from practice or to convey information that they expect to reflect badly on their ship.
4. **Capability Constraints:** The overall course of troubleshooting is also shaped by external limitations in capabilities such as availability of test equipment, schedule constraints, and high-level goals.

Our full taxonomy of contextual factors, based on the study, provides a target set of types of contextual information to be provided by context transmission systems for remote troubleshooting. These are reported in (Leake *et al.* 2005a).

4 Conclusion

When relevant contextual information is difficult for participants to obtain, systems that help provide needed context may have important benefits—if user needs can be identified. We have sketched a case study illustrating how ethnographic methods can be applied to study the types of contextual factors shaping performance in remote collaborative troubleshooting, identifying opportunities for contextual support to aid remote distributed troubleshooting. Based on this study, we are developing a system for knowledge capture, transfer, and sharing as it provides a vehicle for communication between sailors and technicians (Leake *et al.* 2005b). The system captures and conveys information about previous diagnoses, integrating methods inspired by case-based reasoning into the task process to capture and connect contextual information.

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