Observation of Work Practices in Natural Settings

William J. Clancey

NASA-Ames Research Center

and

Institute for Human and Machine Cognition, UWF

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Address correspondence to:

William J. Clancey
NASA/Ames Research Center
Mail Stop 269-3
Moffett Field, CA 94035-1000

(650) 604-2526
fax (650) 604-3594
William.J.Clancey@nasa.gov

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What are Practices in a Natural Setting?

By watching people at work in everyday settings (Rogoff & Lave 1984), observing activities over time in different circumstances, we can study and document *work practices*. This chapter introduces a theoretical framework and methods for observing work practices in everyday (or natural) settings, in a manner that enables improving how the work is done.

Every setting is "natural" for the people who frequent it. A laboratory is natural for some scientists, while expedition base camps are natural for others. The framework provided here is applicable to any setting, including school playgrounds, churches, interstate highways, and so on. But we focus on workplaces, where people are attempting to get some work done, for which they have been prepared, and have sufficient experience to be acknowledged as experts by other people with whom they interact. This can be contrasted with studies of everyday people being expert at everyday things (e.g., jumping rope, car driving) or events purposely arranged by a researcher in a laboratory.

We view natural settings broadly: We consider a teacher in a school within a community, not just a classroom. We seek to grasp an entire place, with its nested contexts: Rather than focusing on a physician in a patient exam room, we study the clinic, including the waiting room.

Heuristically, we view an expert's performance as a play, identifying the stage, the "acts," roles, and the audience. But we also view the play as having a history, whose nature is changing in today's performance: What are the actors' long-term motives? How is this performance challenging or influenced by the broader *community of practice* (Wenger 1998) (e.g., other clinics and nurses)?

We also inquire more locally about the chronology and flow of a performance: How do people prepare, who assists them (think of actors), how do they get information about today's

work, when and where do they review and plan their work, how are events scheduled? We look for informal places and off-stage roles—backrooms and preparation areas, dispatchers, janitors, and support personnel. All of this is part of the expertise of getting a job done, and all of the parts and contributions need to be identified if the fundamental question about work is to be answered: What affects the quality of this performance? What accounts for its success? As a heuristic, to capture these contextual effects, one might frame a study as being "a day in the life" of the people—and that means 24 hours, not the nominal work day.

Thus, a study of work practices is actually a study of a setting. The context makes the observed behavior understandable. Harper (2000) presents a striking example from the philosopher Gilbert Ryle:

> If we had a film of a clown doing somersaults, and nothing else (i.e., we knew nothing about circuses, about the history of clowns and so on), then the film would not tell us what we need to know to make sense of what the clown was doing…. One would need to know something about how they are part and parcel of circuses, and how their somersaulting is viewed as a kind of sentimental self-mockery. (pp. 244-5)

The view that workers are social actors is important. When we say that work is *socially recognized* as "requiring special skills or knowledge derived from extensive experience" (Hoffman 1998, p.86), we mean that people are visibly demonstrating competency, in how they make interpretations, conduct business, and produce results that are "recognizably accountable" (of agreeable quality) to institutional and public audiences (Heritage 1984; Dourish & Button 1998). This perspective has the dual effect for expertise studies of considering the worker as an

agent who co-constructs what constitutes a problem to be solved and how the product will be evaluated. This theoretical perspective, called *ethnomethodology*, is explained in this chapter.

Observing people in a natural setting is commonly called *fieldwork*. Besides watching and recording and asking questions, fieldwork may include interviewing, studying documents, and meeting with the people being studied to analyze data together and present findings (Forsythe 1999, p. 128). Fieldwork is most often associated with the broader method of study called *ethnography* (Spradley 1979; Fetterman 1998 Harper 2000, p. 239), literally, the written study of a people or culture. Neither fieldwork nor ethnography are specific to any discipline. Originally associated most strongly with anthropology, the methods today are commonly used by linguists, sociologists, computer scientists, and educational psychologists.

The actual methods of observation—spending time in a natural setting and recording what occurs—may at first appear as the defining characteristic of such a study, but the difficult and less obvious part is being able to understand work practice. Some of the analytic concepts are incommensurate with other ways of formalizing work and knowledge. For example, outsiders are often unaware of the inherent conflicts of a work setting (e.g., to physicians dying people are a source of money; to police, crime statistics a source of political trouble), which limit what can be done, making it both necessary and possible to creatively work around and interpret procedures and regulations. This chapter focuses on how to see what is happening, to apply ethnomethodology concepts to analyzing everyday actions. Starting the other way around—with camera at hand and a poor theoretical background—could be like bringing an aquarium fish net to the deep sea, collecting a hodgepodge of anecdotes, narratives, and interesting photographs, with little understanding of people's practices (Button & Harper 1996, p. 267). Furthermore, a planned *analytic program* is important when studying work practice for design, "otherwise

observations can be merely invoked at will for particular purposes such as, for example, to legitimise design decisions already made" (p. 267).

An observational study is itself modulated by the observer's purpose and relation to the organizational setting. Intending to transform the setting (e.g., as a consultant) requires engaging as an observer in a particular way, not merely recording and note taking. A reflective activity is required, called *participatory design* (Greenbaum & Kyng 1991, p. 7; Beyer & Holtzblatt 1998), which includes negotiating and co-discovering with the workers what is to be investigated (e.g., setting up a "task force group"; Engeström 1999, p. 71-73). In settings such as hospitals and business offices, this developmental perspective commonly focuses on software engineering and organizational change.

In summary, expertise is not just about inference applied to facts and heuristics, but about being a social actor. Observation of natural settings begins not with tasks—problems fed to a subject—but how work methods are adapted and evaluated by experts themselves, as situations are experienced as problematic and formulated as defined tasks and plans. Our focus is on socially and physically located behaviors, especially those involving conversations, tools, and informal (ad-hoc) interactions. How an observer engages with people in a work setting itself requires expertise, including concepts, tools, and methods for understanding other people's motives and problems, often coupled with methods for work systems design.

Subsequent sections review the development of the approach of observation in natural settings, key structural concepts (learning to see), methods for observation, and conclusions with prospects and open issues.

Historical and Contemporary Perspectives

This section reviews how observation in natural settings developed and was shaped by photographic tools and how it relates to the psychological study of expertise.

Scientific Observation in Natural Settings

In studies of culture, surveying "informants" on site goes back to the earliest days of 19th century anthropology (Bernard 1998, p. 12). Several articles and books provide excellent summaries of the theoretical background and methods for observation in natural settings, including especially *Direct Systematic Observation of Behavior* (Johnson & Sackett 1998) and *Participant Observation* (Spradley 1980; Dewalt & Dewalt 2002).

As the ethnomethodologist stresses, observation in natural settings is inherent in social life, for it is what people themselves are doing to organize and advance their own concerns. But perhaps the tacit, uncontrollable, and mundane aspect of everyday life led psychologists to set up experiments in laboratories and anthropologists to set up camp in exotic third-world villages. Moving studies of knowledge and expertise to work settings developed over a long period of time, starting with cognitive anthropologists and socio-technical analysts (Emery 1959), and progressing to the "Scandinavian approach" to information system design (Ehn 1988; Greenbaum & Kyng 1991). But today's methods of observation began with the invention of—and motivations for—photography.

Visual Anthropology

Photographs and video are indispensable for recording behavior for later study. The visual record allows studying how people structure their environment, providing clues about how they are relating to each other and structuring their work life. "Using cameras to make records about culture" (El Guindi 1999, p. 459) dates to the late 19th century. Eadweard Muybridge's famous early motion pictures (*Galloping Horse* [1878], *Ascending Stairs* [1884]) demonstrate

the early motivation of using film to study animal and human movements whose speed or structure elude direct observation.

Rather than being only illustrations, the visual records were treated as primary data, irreplaceable for capturing nonverbal behavior: "Margaret Mead and Gregory Bateson pioneered systematic film use over an extended period of research and across cultures [1936-38]…. Bateson took pictures [and film], while Mead took copious field notes of events." (El Guindi 1999, p. 472). Today the use of photographic methods is fundamental in observation of natural settings, and is termed video ethnography or *interaction analysis* (Jordan & Henderson 1995).

An integral part of any observational study in a natural setting considers how physical space, including furniture and designed facilities, is used "as a specialized elaboration of culture" (Hall, 1966), called *proxemics*. This study broadly relates animal studies (Lorenz 1952) to analyses of physical-perceptual experience (e.g., *kinesics*, Birdwhistell 1952), including "body language" (Scheflen 1972), personal and public kinds of space, non-verbal communication (Hall 1959), and culture differences. Whyte (1980; PPS 2004) studied how people used public plazas at lunchtime, a striking everyday application of proxemics for architectural design, using time-lapse video.

Visual analysis considers posture, gestures, distance and orientation of bodies, territoriality, habitual use of space (e.g., movement during the day), relation of recreational and work areas, preferences for privacy or indirect involvement (open doors), and so on. For example, referring to Figure 1, how would you group the people, given their posture and behavior? How is this space used? What are the activities? What do postures and gestures reveal about people's sense of timing or urgency? Even a single image can reveal a great deal, and will

provide evidence for broader hypotheses about relationships, complemented by living with these people for several weeks.

Figure 1. "The area between the tents" at the Haughton-Mars Base Camp 1999.

The Development Of Natural Observation In Expertise Studies

Analysts seeking improved efficiency in procedures and designing automation studied workplaces throughout the 20th century. Developmental psychology primarily focused on schools, while organizational learning chose business settings. Computer scientists brought domain specialists into their labs to develop expert systems in the model-building process called *knowledge acquisition* (Buchanan & Shortliffe 1984). Human factors psychologists took up the same analytic concepts for decomposing work into formal diagrams of goals and methods, called *task analysis*, and characterized decision making as probabilistic analyses of situations and judgmental rules (Chi et al. 1988). At the same time, social scientists were being drawn by

colleagues designing computer systems, motivated largely by labor forces in Europe (Ehn 1988), forming subfields such as business anthropology and workplace studies (Luff et al. 2000).

By the 1990s, industrial engineers and social scientists already in the workplace were joined by computer scientists and psychologists, who had transitioned from laboratory interviews and experiments to "design in the context of use" (Greenbaun & Kyng 1991). The work of studying knowledge and learning moved to everyday settings such as supermarkets (Lave 1988), insurance offices, and military weather bureaus (Hoffman et al. 2000). The discipline of human-computer interaction (HCI or CHI) became a large, specialized subfield, a consortium of graphics artists, social theorists, psychology modelers, and software engineers (Nardi 1996; Blum 1996; Kling & Star 1998).

Broadly speaking, HCI research has progressed from viewing people as computer *users*—i.e., asking questions like, "What happens if people are in the loop?"—to viewing people, computers, documents, facilities, and so on as a *total system*, and understanding the processes holistically. In some respects, this approach began with socio-technical systems analysis in the 1950s-70s (Corbet et al. 1991, p. 9ff).

This chapter presents a particular method of total system analysis and engagement called participatory design, focusing on ways of working with the people system designers are trying to help. This is the dual of participant observation, in which researchers learn about the work by being stepped through representative tasks. Thus, work system design is a learning activity, involving a prolonged, structured interaction with cycles of observation, use of design tools accessible to workers, and prototyping experiments in the work context.

Expertise in Context: Learning to See

Observing and systematically studying a work place is sometimes treated as easy, performed sketchily, or attributed to studies where no analysis of practice actually occurred (Forsythe 1999). The spread of the anthropological and social perspectives to cognitive science was at first limited, at best shifting the analysis to include the social context. For example, only one chapter in *Human and Machine Expertise in Context* (Feltovich et al. 1997) explicitly involved an observational study of a natural setting (Shalin's video analysis in a hospital). Ericsson and Charness used diaries for studying violinists, without investigating their home setting. Other researchers considered experts as socially selected (Agnew et al.) and more broadly serving and part of market, organization, or community networks (Stern); or viewed expertise as part of cultural construction (Collins, Clancey).

The decade earlier *Nature of Expertise* (Chi et al. 1988) focused even more narrowly on mental processing of text: documents were provided to subjects to read, to judge, to type, or learn from. Expertise was viewed not about competence in settings (i.e., situated action), but decision-making, reasoning, memory retrieval, pattern matching—predominantly aspects of the assumed internal, mental activity occurring in the brain. For example, Clancey's study of medical diagnosis (pp. 343-418) presented cases of patients with known diseases to a physician, rather than examining how a clinic comes to view a stranger as a patient by granting an appointment. Even a study of restaurant waiters (p. 27) was reduced to a study of memory, not the "lived-work" of being a waiter. A study of typing concerned timing of finger movements, nothing about office work. Of the twelve studies of experts, only one included "naturalistic observation" to "fashion a relatively naturalistic task" (Lesgold; p. 313), namely, dictating X-ray interpretations.

This said, one of the most influential analyses of the contextual aspects of behavior, Suchman's (1987) *Plans and situated actions*, also did not involve the study of practice. Suchman studied two people working together who had never used a photocopier before (p. 115)—a form of puzzle solving in which a predefined task is presented in "the real world" (p. 114). In this respect, Suchman's study is an example of *ethnomethodological analysis*, because it focuses on mutual, visible construction of understanding and methods, but is not carried out using the *ethnographic method* (Dourish and Button 1998, p. 406), because this was not a study of established practices in a familiar setting.

In summary, a participatory design project uses ethnography to study work practice, which is analyzed from an ethnomethodological perspective (Heritage 1984). More generally, ethnography may involve many other analytic orientations, emphasizing different phenomena, topics, and issues (Dourish & Button 1998, p. 404). Ethnographic observation involves a rigorous commitment to confronting the worlds of people as they experience everyday life, to understand how problematic situations actually arise and are managed. Workplace studies, contrasted with the study of knowledge and experts in the 1970s and 80s (Chi et al. 1988), signify a dramatic change in how expertise is viewed and studied, often with entirely different motivations, methods, and partnerships.

Subsequent sections further explain the ethnomethodological perspective, present contrasting ways of viewing people and workplaces, and present different units of analysis for representing work observations.

Ethnomethodology's Analytic Perspective

The term *ethnomethodology* was coined by Garfinkel in the mid-1950s "to capture a range of phenomena associated with the use of mundane knowledge and reasoning procedures by

ordinary members of society" (Heritage 1984, p. 4). The idea originated in the discovery of jurors' "methodological" issues:

> …such as the distinction between "fact" and "opinion", between "what we're entitled to say", "what the evidence shows", and "what can be demonstrated"…. These distinctions were handled in coherently organized and "agree-able" ways and the jurors assumed and counted on one another's abilities to use them, draw appropriate inferences from them and see the sense of them….common-sense considerations that "anyone could see". (p. 4)

The common-sense perspective and approach refers specifically to members of the juror community, not arbitrary observers.

> Ethnomethodology thus refers to the study of…the body of common-sense knowledge and the range of procedures and considerations by means of which the ordinary members of society make sense of, find their way about in, and act on the circumstances in which they find themselves. (p. 4)

Furthermore, articulating what is occurring (e.g., in a jury) is not just a matter of common sense for anyone, except perhaps an experienced social analyst (Forsythe 1999).

Ethnomethodology has led researchers to reconceive how knowledge and action are framed, "wresting… preoccupation with the phenomenon of error" prevalent in human factors research (Heritage 1984, p. 5). The focus shifts to how people succeed, how they construct the "inherent intelligibility and accountability" of social activity, placing "new weight on the kinds of knowledge … in devising or recognizing conduct" (p. 5). Contrasted with technical

knowledge (Schon 1987), this knowledge of methods is reflective and social, concerning how one's behavior will be viewed, through understood norms and social consequences. Ethnomethodology thus provides a kind of logical, systemic underpinning to how activity is coordinated, which the psychological focus on knowledge and memory takes for granted: "How the actors come to share a common appraisal of their empirical circumstances… neither cooperation nor conflict can be managed by actors who cannot engage in co-ordinated activity" (Heritage 1984, p. 305).

One central idea is that human action is "organized so that it can be rationalized" (Dourish & Button 1998, p. 415). For example, the Mars Exploration Rover's (MER) operations (Squyres et al. 2004) were planned and orchestrated by the science team so the exploration could be recognizable to others in perpetuity as being science, especially through the method of justifying instrument applications in terms of hypothesis testing. In practice, geologists will often just strike a rock to see what is inside. In MER, the application of the rock abrasion tool was often explained within the group and to the public as looking for something specific. As the mission continued on for many months, the need for such rationalization diminished, but as the scientists were bound at the hip, with one rover to command (at each site), they continued to justify to each other why they would hit a particular rock and not another—something that would be inconceivable in their activity of physically walking through such a site with a hammer and hand lens. Thus the practice of geology changed during the MER mission to adapt to the circumstances of a collective, historical, public, time-pressured activity, and production of accounts of what should be demonstrably scientific action were adapted to fit this situation (cf. Dourish & Button 1998, p. 416).

This said, actors are not necessarily reasoning about the methodic bases of their actions, treating norms as explicit rules. But rather, "while such principles may analysably underly the actors' actions, they may manifest themselves from the actors' point of view only as 'practical considerations' in the design of actions" (Heritage 1984, p. 309).

One must avoid a misconception that technical knowledge (existing in the mind in Platonic form) is merely being selectively applied in social ways. Rather what counts as expertise—the knowledge required to identify and solve problems—reflectively develops *within the setting*, which Collins calls "the mutual constitution of the social and conceptual" (Feltovich, et al. 1997, p. 296). Button and Harper (1996) provide a cogent example:

> A reportable crime is not a given feature of activities, rather the *documentability of a crime is achieved in the way in which officers account for activities in the process of 'criming'*. … Decisions about what crimes are reported by police are intimately tied up with questions of what is *practical* for the reporting officer and what is in the *interests* of the police organization as a whole. A balance is struck between accuracy and efficacy in the reporting of crime…. They ask themselves "what can I do about a reported incident given all the other things I have to do?" They also have to bear in mind what kind of "impression" would be given as the result of submitting a report. For example, changes, fluctuations, and increases in the aggregated crime reporting figures could lead to pressures on themselves…Reporting crime is not a simple matter of the literal description of an incident, but is accountable to a swarm of organizational and practical contingencies. (p. 275)

In summary, expertise is more than facts, theories, and procedures (e.g., how to be a geologist or policeman); it includes practical, setting-determined know-how in being a recognizably competent social actor. Ethnomethodology reveals the reflective work of constructing *observable* (non-private) categorizations (e.g., deciding "am I confronted with a crime?"). Thus, an essential task for the outside observer is to learn to see the ordered world of the community of practice: "Human activity exhibits a methodical orderliness…that the co-participants can and do realize, procedurally, at each and every moment… The task for the analyst is to demonstrate just how they do this" (Whalen et al. 2002, p 6). The following section provides some useful frameworks.

What People Do: Contrasting Frameworks

Social-analytic concepts for understanding human behavior in natural settings are contrasted here with information processing concepts that heretofore framed the study of knowledge and expertise (Newell & Simon 1972).

Practice vs. Process

Practice concerns "work as experienced by those who engage in it" (Button & Harper 1996, p. 264), especially, how "recognizable categories of work are assembled in the real-time actions and interactions of workers" (p. 264), memorably described by Wynn (1991):

> The person who works with information deals with an 'object' that is more difficult to define and capture than information flow charts would have us imagine. These show 'information'; in little blocks or triangles moving along arrows to encounter specific transformations and directions along the diagram. In reality, it seems, all along the arrows, as well as at the nodes, that there are people helping this block

> to be what it needs to be —to name it, put it under the heading where it will be seen as a recognizable variant, deciding whether to leave it in or take it out, whom to convey it to (pp. 56-7).

Button and Harper (1996) give the example of people analyzing interviews:

> *In practice* it was not possible to exhaustively and explicitly stipulate the coding rules. However full and detailed the rules in the coders' handbook were made, each time coders had to administer the schedule, there was a need for decision and discretion. The coders would resort of a variety of *practices* to decide what the coding rules actually required of them and whether what they were doing was actually (or virtually) in correspondence with those rules. It was through the implementation of these *ad hoc* practices that coders achieved their work of coding. The formalized account of the work of coding as applying the rules omits the very practices that organize the work (p. 265).

Practice is also called "lived work"—"what work consists of as it is lived as part of organizational life by those who do it" (p. 272). Practice is to be contrasted with formal *process specification* of what work is to be done. In the workplace itself, processes are often idealized and constitute shared values—"crimes should be reported to the bureau as soon as possible" (sp. 277). Narratives that people record or present to authorities cater to these avowed policies or preferences, creating an *inherent conflict* in the work system between what people do and what they say they do. Without the theoretic perspective of ethnomethodology, an observer of natural

settings might be fooled by documents and interviews, mistaking a process description or written record of work for the actual practice.

Two fundamental concepts related to the practice–process distinction are behavior–function and activity–task. Generally speaking, process models (e.g., information processing flowcharts) are idealized functional representations of the tasks that people in certain roles are expected to do. In contrast, practice concerns chronological, located behaviors, in terms of everyday activities, for example, "reading email," "meeting with a client," and "sorting through papers." Activities are how people "chunk" their day, how they would naturally describe "what I am doing now." Tasks are discovered, formulated, and carried out within activities (Clancey 2002).

Putting these ideas together, one must beware identifying a formalized *scenario* (cf. Feltovich et al. 1997, p. 117) with the physical, interactive, social context in which work occurs. The work context is fundamentally conceptual and dynamically interpreted, in which the actor relates constraints of location, timing, responsibility, role, changing organization, and so on. A scenario more often resembles an experimenter's idealized notion of the "inputs" and is thus more like a puzzle assignment, than the flow of events that an actor experiences.

Invisible vs. Overt Work

"Because of the extreme division of labor in postindustrial society, work is, in a sense, always invisible to everyone but its own practitioners (and even they are not always aware of their own special expertise and how it functions)" (Nardi & Engeström 1999, p. 2). Biases, back stage work, and tacit "articulation work" are other challenges to observation.

Preconceptions and biased methods may prevent seeing what workers accomplish. For example, in a study of telephone directory operators the researchers' a priori "notion of the

'canonical call' rendered the variability of actual calls invisible and led to a poor design for a partially automated directory assistance system" (p. 3). A related presumption is that people with authority are the experts (Jordan 1992). For example, the Mycin program (Buchanan & Shortliffe 1984) was designed in the 1970s to capture the expertise of physicians, presumably to help nurses, but no effort was made to understand their role and needs; in the study of medical expertise, nurses were "non-persons" (Goffman 1969; Star & Strauss 1999, p. 15).

Another serious complication is that "many performers – athletes, musicians, actors, and arguably, scientists – keep the arduous process of preparation for public display well behind the scenes" (Star & Strauss 1999, p. 21), which Goffman called "back stage." One must beware of violating autonomy or not getting useful information because of members' strategic filtering or hiding of behavior (p. 22).

"Articulation work" is another fundamental form of invisible work—"work that gets things back 'on track' in the face of the unexpected, and modifies action to accommodate unanticipated contingencies…. Articulation work … is invisible to rationalized models of work" (p. 10).

Participatory design handles the various forms of invisible work by using ethnography to identify stakeholders and then involving them in the work systems design project (Greenbaum & Kyng 1991).

Everyday Accountability vs. Exceptional Performance

The focus of expertise studies on exceptional performance often ignores how people know that a task actually exists. Consider for example this common way of framing the study of expertise: "For these tasks it is possible to have experts and less accomplished individuals perform the exact same task and examine the differences in the mediating processes." In

contrast, a primary question of ethnomethodology is how an experience arises that is categorized as being something to which the expert must attend, and with what priority, delegation, quality, etc. (exemplified by the police work example).

In natural settings, tasks are not delivered as defined problems to be solved. Even explicit forms or orders can be shelved, delayed, sent back, reformulated, etc. Computer systems that force workers to treat events or situations as being problematic (something they must handle) are one of the major causes of disconnect in workflow automation (Button & Harper 1996).

The idea of "the exact same task" ignores the essential aspect of expertise of knowing what constitutes a task and how it should be framed. Deciding what work to do must be "accountably adequate" (Heritage 1984, p. 299). Is this event an actionable "piece of work"? Does this require my attention now? Taking on a task, categorizing an event as requiring engagement is *contingent*. People are not machines processing everything moving down a conveyor belt. Again, the context involves a social conception: How I am conceiving of my job or role today?

Computer-oriented studies viewed medical diagnosis as only an inferential process involving given symptoms, ignoring how the clinic decides that a phone call should be transformed into an appointment (with whom? on what priority?). A significant part of expertise is knowing whether and how seriously to "take" a situation. Pre-packaged "problems" or tasks presented by an experimenter embody the experimenter's theories about what the work entails (Lave 1988), and hence ignore the setting, the worker's world of contextual cues, conflicts, and community encountered in practice.

In summary, the expert as agent (actor, someone in a social setting) is more than a problem solver, but also an expert problem avoider, delegator, prioritizer, reformulater, communicator, and so on. Every acceptance, approach, narrative, and so on, is a socially

accountable action that in some ways reinforces and/or modifies the nature of the work and the actor's identity: What are my responsibilities? What is the timing of my response? How do I handle stress? How do I show respect? How am I trying to change the organization and our practices?

Members' Documentation vs. Literal Accounts

To summarize a key theme, the production of documentation is part of the lived-work of most business, government, and scientific professions. One should beware treating "documents and narratives as a literal description of work" (Button & Harper 1996, p. 271). Rather, one should study the activity of reporting "involved in sustaining an account of the work as a formal sequential operation" (p. 272) as a situated action with social functions. For example, in Mars habitat simulations (Clancey 2002, in press), one can learn from daily reports what the crew did. But one must also inquire how the reporting was accomplished (e.g., contingencies such as chores, fatigue, power failure, etc. that made reporting problematic), what accountability concerned the crew (e.g., the public image of the Mars Society; hence what was emphasized or omitted), and why reporting was given such priority (e.g., to adhere to scientific norms). What people write may not be what they actually did, and interviews may present yet another perspective on why the reports even exist.

Managing Inherent Conflicts vs. Applying Knowledge

The mental view of expertise is that people apply knowledge to accomplish goals (Newell & Simon 1972). Yet, goals are not simply the local statement of a task, but relate to long-term social-organizational objectives, such as later "work load and responsibilities" (Button & Harper 1996, p. 277). For example, the chair of NASA's Mission Management Team during the Columbia mission (which was destroyed on re-entry by wing tiles damaged by broken tank

insulation foam during launch) didn't classify foam damage on the prior mission, STS-112 in December 2002, as an "in-flight anomaly"—the established practice—because it could delay a subsequent mission in February that she would manage (CAIB 2003, p. 138-9). Thus, a recurrent consideration in how work is managed is "what-this-will-mean-for-me-later-on" besides "what-can-I-do-about-it-now." "It is the organizational context of work, not just the nature of an incident, that is the criteria for deciding whether and how to report" a mishap event (Button & Harper 1996, p. 277). "It is only in working circumstances that the complex and practical nature of this decision making becomes clear." Again, social aspects include: What is my responsibility? What are the expectations of my role? What identity am I trying to portray? What values am I promoting? What will happen to me and my team if I take on this task, or handle it in a particular way?

In summary, the view of rationality as "applying knowledge" can be adapted to fit natural settings, but the goal analysis must include broad organizational factors that include role, identity, values, and long-term implications.

Unit of Analysis: The Principle of Multiple Perspectives

A fundamental aspect of ethnography is to triangulate information received from different sources at different times, including reinterpreting one's own notes in light of later events, explicitly related to previous studies and analytic frameworks (Forsythe 1999, pp. 127-8). In conventional terms, to make a study systematic, one gathers data to model the work from several related different perspectives:

- Flows: Information, Communication, Product
- Independent variables: Time, Place, Person, Document
- Process influences: Tool, organization/role, facility, procedure

To provide a suitable social framing and organization of these data categories, this section suggests the following units of analysis: Activity system, temporality, and collectives.

Activity System

Activity theory (Leont'ev 1979) provides essential analytic concepts for understanding what is happening in a natural setting (Lave 1988; Nardi 1996; Engeström 2000). Psychologically, activity theory suggests how conceptual framing of situations and methods (Schön 1979) is influenced by subconscious emotions, desires, and dispositions: "It is the object and motive of activity, not the conscious goals of actions that play the leading role in the creation of the new" (Engeström 1999, p. 78). Just as tasks follow from activities, goals follow from motives, which are "embedded in the object of the activity...a project under construction..." (p. 65). For example, "the object of hospital work is the patient, with his or her health problem or illness. The patient carries the fundamental motive for hospital workers" (p. 65). The patient is not a fixed, given thing, but a conception within an activity system, in which identities, purposes, and methods are dynamically and reflectively changing: "The key is the realization that the objects—the patients with their problems—are constantly changing, and this historical evolution of the patient is partly constructed by the hospital itself. Any transformation of the hospital is also a transformation of the patient" (p. 66).

In summary, a study of work practices in a natural setting is a study of activities: described as actions of individuals with multiple identities (group memberships, perhaps aspiring), occurring in places and times, relating to tools, documents, and other people, carried in a certain manner, visibly demonstrating competence, for at least an implicit audience.

Temporality: Phases, Cycles, Rhythm

How does the work unfold during the course of a day or a week? (Button & Harper 1996, p. 272) Does it vary seasonally? Is a given day typical? This is "the problem of order – discerning patterns characteristic of particular actors and events over time, as opposed to the order apparent at one moment in time or the order that actors believe to characterize their social practices" (Forsythe 1999, p. 134). Learning about the intricate details to find the order members themselves may not name or theorize about is a considerable challenge. One might observe an individual at different times and setting, and look for disparities between interviews and what people say about each other (p. 138). An essential, recurrent organizing conception is the separating of work into categories such as "'someone-now,' 'me-when-I-can,' 'what-is-mine', and 'everyone's-concern' to prioritise…work" (Button & Harper 1996, p. 276). Thus, expertise transcends how individual tasks are accomplished, to involve how time is made accountably productive.

Collectives

The *collective* is the people who are interacting in a setting, as well as the conceptualized audience of clients, managers, and the community of practice. The collective might consist of people who don't directly know each other: "The occupational community [of photocopy machine technicians] shares few cultural values with the corporation; technicians from all over the country are much more alike than a technician and a salesperson from the same district" (Orr 1996, p. 76).

How is the study of a collective related to individual expertise? Lave (1988) contrasts the folk view, that culture is a collection of value-free factual knowledge, with the view that society and culture "shape the particularities of cognition and give it content" (p. 87). Thus, the study of culture is inseparable from a study of what constitutes expertise, how it is identified, developed,

exploited, organized, and so on. Orr's study reveals that "The technicians are both a community and a collection of individuals, and their stories celebrate their individual acts, their work, and their individual and collective identities" (p. 143), such that story-telling has a social-psychological function with many practical and institutional effects.

Methods for Observation in Natural Settings

In considering methods of observation, one should not rush to the recording paraphernalia, but first focus on how the study is framed, the nature of engagement of the observer in the setting, and the work plan. This section surveys useful handbooks, then summarizes key considerations and methods.

Handbooks for Observing Natural Settings

The following handbook-style guides are suggested for learning more about how to observe natural settings. These fall on a spectrum from pure observational science to rigorous engineering design.

*Handbook of methods in cultural anthropology (*Bernard 1998) provides a balanced treatment of the history and methods of anthropology, with tutorial-style chapters on epistemological grounding, participant observation, systematic observation, structured interviewing, discourse and text analysis, and visual analysis.

Design at work: *Cooperative design of computer systems* (Greenbaum & Kyng 1991) is a primer of examples, theory, and methods for participatory design. It represents especially well the Scandinavian perspectives that have defined change-oriented observational studies of workplaces as a morally driven, industrially funded, and theoretically-grounded activity.

Contextual design (Beyer & Holtzblatt 1998) may be used as a guidebook for conducting an "contextual inquiry," especially suitable for novices, including how to observe and work with

customers (with unusually detailed advice about how to conduct interviews); how to model work (organizational flow, task sequences, artifacts such as documents, culture/stakeholders, and physical environment); and how to redesign work (including storyboards, paper prototypes).

Cognitive work analysis (Vicente 1999) provides another program for designing computer-based information systems, based on detailed mapping of information flows, task constraints, and control processes. The perspective is that work models must be detailed for tool design, and hence observation must be systematically organized to understand the *domain* (see also Jordan, 1996). In particular, analysis of *fields*—the physical-conceptual spaces for possible action—is generalized from observations of particular *trajectories* or behaviors in this space (p. 179).

Framing the Study: Purpose, Genre, Timing and Biases

Every study of expertise occurs in its own context, which shapes the observer's interests, targeted product (a publication? a design document?), and the pace of the work. Professionals therefore find it useful to have a variety of different approaches that can be adapted, rather than imposing one rigorous methodology on every setting.

Observation of expertise in natural settings has been undertaken as a scientific endeavor (studying decision making, creativity, etc.), to develop training strategies, or typically, to redesign the workplace by automating or facilitating the work processes (Bloomberg et al. 1993; Nardi & Engeström 1999; Jordan 1993, 1997).

Dourish & Button (1998) summarize the relation of ethnography and ethnomethodology to technological design, emphasizing human-computer interaction (HCI). Luff, Hindmarsh, & Heath (2000) provide an updated collection of detailed workplace studies related to system

design. More generally, workplace studies may be part of a broader interest in organizational development (Engeström 1999; Nardi & Engeström 1999, p. 4).

Before a study begins, one should make explicit one's interests, partly to approach the work systematically, and partly to expose biases so others may better evaluate and use the results (e.g., see Clancey in press). Throughout a study, one should also question conventional metaphors that pre-define what is problematic. For example, the term "homelessness" could lead to focusing on housing, rather than studying how such people view and organize their lives (Schön 1979). The underlying nature of a setting may clarify as change is attempted (Engeström 1999, p. 78).

Observer Involvement

For many researchers, participant observation is the ideal way to study people, informally learning by becoming part of the group and learning by watching and asking questions. But participant observation is not necessary and may not be possible, for instance, in highly technical or risky work such as air traffic control (Harper 2000, p. 258).

Observation should be a *programmatic study* (p. 240-41), with demonstrated sincerity and probity (p. 251). Ethnography is not a haphazard, hanging around or shadowing: "One mistake is to think that anything at all is of interest…" (p. 254). Rather, the observational work must be a systematic investigation, with some sequential order (though often dynamically replanned) that covers a related set of roles, places, situations, and timelines. Specifically, the observer must attempt to understand the details of how the work is done, not merely collect gossip or opinions (p. 255). Interviewing is almost always required to understand how people are categorizing and organizing experiences, time, and materials.

A study is necessarily iterative, requiring deliberate review of what people say and one's notes, to become aware of events and relationships initially taken for granted. For example, during the Haughton-Mars Project (Figure 1), it is easy to watch a biologist preparing equipment without asking what the equipment does, whether it has been used before, etc. In the hubbub of activity, surrounded with many new and stimulating artifacts, and embedded in one's own concerns (e.g., operating a video camera), the observer may easily accept an explanation ("we're going to use it at Lake Stanford") without realizing that there is more to learn. The observer needs to consciously adopt an investigative attitude, like the child who keeps asking, "Why? And how is that?"

Getting at the "mundane details" (Harper 2000, p. 257) also requires care to step beyond initially offered juicy remarks members may make about the organizational culture (viewing the ethnographer as being primarily interested in "social" matters), to probe about what people are doing: The tools they use, what information they use and how they acquire it; what they communicate; where and when they do their work; how documents are created, revised, stored. Understanding the practice requires mapping out how the flows happen, connectivities, timings, artifacts, affects of co-location and distance, the relation of work shifts, and the interaction of technologies, budgets, public relations, motives, and specialized knowledge or skills.

To stimulate inquiry and make learning progressive, the observer should keep a journal and review it periodically for issues to revisit. Another method is to review photographs and ask about every object, "What is that? What is it for? Who owns it? Where is it used and stored?" This can be done effectively via email with colleagues who are not at the study site, encouraging them to ask questions about what they see in the photos.

The people being studied may regard some activity, called a *ritual induction*, as necessary for the ethnographer to undertake in order for "his or her views to be treated as from the 'inside'" the organization (p. 251). For example, in the Haughton-Mars Project, a ritual induction is learning how to use an all-terrain vehicle and going on a "traverse" to explore the Haughton Crater. Getting one's hands dirty may demonstrate that the ethnographer "really wants to know" about the work (p. 252), as well as provide insights that members know can only be appreciated through direct experience. If the purpose of the work involves advising or redesigning the work, then such direct involvement may be necessary to ensure that the workers' views are respected (p. 251).

The ideal in participatory design is to find at least one person in the setting who can be a champion for the inquiry, explaining the study to others, getting access, and making the observational activity legitimate. By this conception, people in the workplace are partners in a cooperative activity, and never referred to as "subjects," "users," or "operators" (Wynn 1991, p. 54). Probably no other philosophical stance is more fundamental to the observer's success. Data is discussed with the workers (in appropriate forums); report outlines are circulated for comment; related local expertise responsible for modeling the workplace is solicited for advice; documents about the work may even be co-authored with organizational champions. This kind of involvement is the antithesis of other design approaches that emphasize "intervention" and "knowledge acquisition."

Program of Work

For an observational study to be systematic, there must be an explicit program or plan for what, where, and how to study the setting (Harper 2000, p. 248). For example:

- Map out the key processes of the organization.

- Understand the diversities of work.
- Understand how different sets of persons depend on one another.
- Determine salient junctures in the information life cycle.

A plan will specify particular kinds of records kept over a certain period, and how they will be created, as described in subsequent sections.

Person, Object, Setting, Activity, Time-oriented Records

To be systematic, the observer must deliberately adopt a perspective, and keep records organized accordingly. Jordan (1996) suggests the perspectives: person, object (e.g., documents), setting, and task or process. More generally, an activity-oriented record includes any recurrent behavior, including both predefined work tasks (e.g., processing an order) and behaviors that may not be part of a job description (e.g., answering a phone call). Time is an orthogonal dimension. For example, one could check to see what people in a work area are doing every 15 minutes or observe a given setting at the same time every day. Time-lapse video can be used to record when people enter and leave a particular place (Clancey 2001).

Anthropologists make a distinction between two kinds of data: Emic categories (after phon*emic*) are used by participants; etic categories (after phon*etic*) are formal distinctions from an analyst's perspective (Jordan 1996). The basic systematic units proposed here are etic: activities, roles, objects, persons, places, durations, etc.,; in Western European and North American business settings these often fit emic distinctions.

Study Duration

Observational studies may last from weeks to years. The duration depends on the logistics and natural rhythm of the setting, technical complexity, and the study's purpose. Generally speaking, long-term involvement is preferable, to follow the development of work

practice. However, a few months of regular observation is often sufficient; a few weeks of daily participation usually enables a proficient analyst to form an understanding that can be a launching point for more focused interviews and design sessions. Indeed, one aspect of a study is to identify periodicities and historical developments, to locate observations within overarching cycles and trends.

Recording Methods and Logistics

Data from natural settings is recorded using tools varying from paper and pen to electronic tracking devices. The standard media are texts (e.g., field notes, documents found in the setting), video and audio recordings, photograph, and computer models (e.g., the Brahms work practice simulation system, Clancey et al. 1998; Sierhuis 2001). Recording has enabled "repeated and detailed examination of the events of an interaction… permits other research to have direct access to the data about which claims are being made… can be reused in a variety of investigations and can be re-examined in the context of new findings" (Heritage 1984, p. 238). Having a body of such data is the sine qua non for being a researcher who studies natural settings.

A fundamental rule is that recordings must be labeled and locked, indicating at least the setting, date, and time. Photographs should be collected in a computer catalog, where they can be sorted by categories into folders. In general, notes should be electronic so they can be easily shared and searched. Files should be organized in computer folders, separating preparatory/logistic information, graphics, documents acquired, photographs, field notes, presentations and reports, press stories, email, and so on. Digital photographs should always be copied to backup media before being deleted from the camera.

When recording outdoors, wireless microphones can be used to avoid wind interference. An audio mixer with several microphones enables combining different sources (e.g., computer speech output, "ambient" remarks (e.g., "outlouds"), radio or telephone conversations). Typically, direct observation reveals settings where interpersonal interaction occurs, from which one chooses "hot spots" (Jordan 1996) for systematic video recording. Use a tripod and wide angle lens, and multiple cameras for different view points if possible. Take systematic photographic records (e.g., the same place each day, such as a whiteboard) or take a rapid sequence to create a "film strip" that captures changing postures and positions as people interact with materials and each other. Interviews can be audio recorded, but video (on a tripod off to the side) provides more information.

Written records include a pocket notebook (for jotting down phrases or noting things to do), a daily journal (often handwritten) that describes one's personal experience, and field notes (using a computer word processor or outline-based note-taker), with different sections to elaborate on observations, raise questions, and interpret what is happening. Surveys given before, during, and after observation are recommended. View a survey as a way to prompt conversations, to encourage people to reflect with you on what is important, including their sense of accountability and how they evaluate their own performance. Finally, if the circumstances of privacy and intellectual property allow, one may learn a great deal from documents found in garbage cans.

Data Analysis

Experienced researchers suggest flexible use of tools for representing work (Engeström 1999, pp. 85-90). Analysis methods are detailed in the handbooks cited above. Key pointers are provided here.

First, video data must inventoried or it probably will never be analyzed. Use a spreadsheet or outline to list the general content for each recording. For material thought to be of special interest, one usually produces a loose transcript. For an extensive video collection of very different settings, it may be useful to create a catalog of illustrative frame snapshots. For shared analysis, long video excerpts can be distributed on digital disks, reformatted with the time and date displayed.

Social scientists often use some form of *conversational analysis* (CA), including gaze and gestures (Heritage 1984, p. 233). This method has revealed that behavior in "naturally occurring interactions" is strongly organized to great levels of detail. In pure form, CA eschews uses of interviews, field notes, and set-up situations even in real world environments (p. 236). CA emphasizes "conversation as social action, rather than as the articulation of internal mental states" (Dourish & Button 1998, p. 402). Whalen et al. (2002) provide a useful case study.

Video-based *interaction analysis* (Greenbaum & Kyng 1991; Jordan 1996; Jordan & Henderson 1995) is another common method for examining data. Typically, scientists from different disciplines will spend hours discussing a carefully chosen, transcribed 5 to 10 minute segment.

Besides narratives and verbal analyses, data may be collected in spreadsheets (e.g., time vs. person/place/activity), flowcharts, concept networks, timelines, and graphs (generated from the spreadsheets) (Clancey 2001; in press). If the data have been gathered systematically, it will be possible to calculate statistics (e.g., how long people did various activities in different places). Such information may prompt further questioning and reveal patterns that were not visible to the ethnographer on site.

Social scientists use a wide variety of metrics. Other studies never measure or count anything, as statistics are viewed as merely an attempt to quantify everything (Forsythe 1999, p. 139) or as being misleading (Nardi & Engeström 1999, p. 1). Designers are more likely to seek a balance. The real issue is whether the measurements are meaningful (Bernard 1998, p. 17); as a stimulus for further inquiry, it may be useful to quantify members' concerns (e.g., "I'm interrupted too much").

Conclusions: Improving Ethnographic Practice

Observation in natural settings is the only way to systematically learn about practical knowledge, that is, to understand how people, places, activities, tools, facilities, procedures, and so on relate. One can learn about technical knowledge from textbooks or lectures, or even get important insights from surveys or by designing experiments in a laboratory. But expertise has a subjective, improvisatory aspect whose form changes with the context, which is always changing. This context includes workers' conception of personal and organizational identity (including motives and avowed goals), economic trends, physical environment, and so on.

Observation in natural settings may be arduous because of the time required, equipment maintenance, the amount of data that is often generated, personal involvement with the people being studied, and political and power concerns of the organizational setting. Some conflicts are inherent, with no easy solution:

- Ethics, privacy, and confidentiality
- Distribution and simultaneity of collective work
- Long-cycle phases and off-hours commitments
- Representativeness and systematicity of the data (vs. details of specific situations)
- Exposing invisible work (e.g., practices may be illegal)

- Point-of-view and authoritative biases

Using ethnography for design is problematic: One often seeks a large-scale system design, but the study focuses on the "small-scale detail of action" (Dourish & Button 1998, p. 411). Observation naturally focuses on what is; how does one move to what might be?

Just like other work, ethnographies in practice do not always measure up to the espoused ideal: "Social scientists have for one reason or another failed to depict the core practices of the occupational worlds which they have studied" (Heritage 1984, p. 300). In particular, technical details of how specialists work (e.g., sitting and watching how they use computer tools, fill out forms, get information from others) is difficult to study and document systematically.

Researchers often have different disciplinary interests, so a group of ethnographers at one site might not collaborate until they write a report for the host organization. At this point, the problem of indexing and sharing data becomes visible: "Few natural observational records of occupational activities are available for social scientific inspection" (p. 301).

The role of simulation for formalizing data is unclear (Sierhuis 2001; Seah et al. in press). As one delves into individual behaviors of specialists, are approaches recurrent or just idiosyncratic? To what extent does a collective have uniform methods? Should a simulation be broad (e.g., several days) or deep (e.g., modeling inputs, user interfaces, and outputs of computer systems)?

Finally, social scientists may be reluctant to generalize about their own methods: There is "no stable lore of tried and trusted procedures" (Heritage 1984, p. 301). Taking interest in practice to the extreme, the notion of "theory" and "generalization" is sometimes viewed as the bad "positivist" world view social science has conquered, so abstracting one's methods and drawing lessons learned are rejected. This may be fine for academic articles, but funded studies

by consultants require conclusions that address the stakeholders' concerns. Effectively, in documenting observational studies, the work practice researcher is caught up in all the familiar issues of lived-work, accountability, and contingent methods.

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