# AN ETHNOGRAPHIC METHODOLOGY
# FOR DESIGN PROCESS ANALYSIS

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## 1    Introduction

Designing as a human activity has been extensively studied from a variety of perspectives. These include designers' cognitive processes, designers' perceptions of their roles and activities, the social interactions in design teams and organisations, and cultural influences on designed artefacts. But another perspective is needed for developing computer tools to support the design process: how information is created, combined, manipulated, transformed and communicated to create a plan for an artefact. This is design as seen from the artefact.

This paper presents a methodology for developing knowledge level models of design processes, that combines ethnographic observational methods from the social sciences with the knowledge analysis techniques of artificial intelligence. This methodology is effective in situations where conventional knowledge acquisition methods are insufficient: when broad understanding of an industry is needed, not just a case study of a single individual or company (which is essential when the goal is to build a design support system); and when the project has no dedicated expert informant.

## 2    An observational approach to process analysis

This methodology is for both scholarly research, to understand design and other complex information manipulation processes; and applied research, to underpin the planning of design support systems and other artificial intelligence applications. It is partly a rational reconstruction of a successful but largely atheoretical study by the second author. This was originally a knowledge acquisition exercise for an intelligent support system for knitwear designers [Eckert 1997; Eckert et al in press; Eckert & Stacey 1995]. It developed into a detailed analysis of the entire commercial knitwear design process [Eckert 1997]. Our aims in developing this methodology include understanding why our knowledge acquisition exercise was successful, how it could have been done better using a more systematic approach, and drawing general lessons about knowledge acquisition from our experience.

Eckert [1997] was unable to use orthodox knowledge acquisition techniques. The designers and technicians who were willing to talk and be observed would not have participated in structured knowledge acquisition tasks, so the study relied on observation. In between visiting 25 knitwear companies lasting up to a week, Eckert took knitwear design courses at Leicester

Polytechnic (now De Montfort University) and knitting machine programming courses at Universal GmbH. She has also designed her own garments. This combination of experiences enabled her to develop much of the expertise of professional designers, while developing an analytical understanding of the process for implementing reasoning modules for a design support system, by asking questions designed to test her hypotheses. She had sufficient understanding of the problem and the culture to be treated like a novice designer akin to a placement student – an insider in the culture of the knitwear industry.

This approach enabled Eckert to overcome some severe shortcomings of more formal knowledge acquisition methods that are especially significant in design. Structured knowledge acquisition techniques from artificial intelligence have been applied successfully to the study of design [see for example Tunnicliffe and Scrivener 1991]. However, they require the undivided attention of a domain expert for many hours, which can be difficult to obtain. As many different people use design support systems, the view of a single expert may be too limited or idiosyncratic; knowledge engineers developing intelligent design support systems to be used across an industry need to understand what is typical and the range of variation. Protocol analysis can give an insight into the thinking processes of a designer doing specific design tasks, but it involves devoting a great deal of effort to studying each individual [see Cross et al 1996]. Protocol studies provide a lot of information about detailed activities but give little indication of the global structure of design processes.

# 3    Knowledge level models

Smithers [1996] argues that analyses of design cognition, instructive though they are, do not provide a useful foundation for building design support systems. We do not have a usable general theory of cognition, and the cognitive approach is unable to give us a usable handle on the huge variation in human design behaviour. What we need for system building are knowledge level theories of design, in terms of what designers *can* do and *must* do. Smithers [1998] outlines such a theory. A knowledge level model describes a process in terms of the knowledge and information required to undertake definable tasks. The model is defined in terms of a network of tasks. The tasks are described in terms of the domain knowledge and the task knowledge required, and the information created through the transformation processes involved in executing a task. The concept of knowledge level models has originally been introduced by Allen Newell [1981] as a contribution to cognitive psychology: models of behaviour in terms of what actors need to know in order to be capable of doing what they do. This competence based view has been extended by the CommonKADS group as a tool for knowledge engineering [see Breuker and Wielinga 1989; Schreiber et al 1994]. Research on techniques for knowledge engineering has developed a rich set of concepts and tools for creating knowledge level models.

# 4    Ethnography

Ethnography is an approach developed in the social sciences for understanding how a culture works by observing it from the inside. Meyer [1992] quotes one definition of participatory observation as a "field method whereby the ethnographer is immersed in the day-to-day activities of the community being studied… The objective of this method is to minimise the presence of the field worker as a factor affecting the responses of the people and to provide a

record of observed behaviour under varying conditions". The special emphasis of ethnography is the dual perspective of the participant observer, to look at everything from the viewpoint of the insider, while remaining conscious of being an outsider with an analytical perspective [see Agar 1980]. Spradley and McCurby [1972] define the perspective of ethnography as "instead of asking 'What do I see these people doing?' [the ethnographer] must ask 'What do these people see themselves doing?'". Many different ethnographic accounts of the same observed phenomena may be valid, and they may couched in terms strange to the people observed, but the test of validity is that an ethnographic account should ring true to the people it describes.

Ethnographic investigations of how organisations use and transmit information are increasingly used as part of the requirements analysis for the development of information systems. Meyer [1992] bridges the gap between traditional knowledge acquisition techniques for expert systems and methods derived from the social scientists by suggesting the use of participatory observation to gain a preliminary insight into a new domain before using structured methods. But ethnographic studies suffer from disadvantages: the ethnographer must invest a large amount of time in the study; the scope of what the ethnographer must study to understand the culture may be very wide; and the ethnographer's observations are necessarily incomplete.

The term ethnography is highly controversial among social scientists, with many different definitions coming from different schools. The authors take a pragmatic view. We see ethnography as a way of developing the perceptual and problem solving skills of domain experts as well as their conscious knowledge, while maintaining the outsider's analytical perspective: questioning, challenging and explaining the community's beliefs, assumptions and actions. Our goals are both to understand the design process, in knowledge level and cognitive terms, and to acquire knowledge for the knowledge based modules of intelligent design support systems. These objectives lead us to a view of how to do ethnography rather different those commonly held by social scientists, many of whom would reject both our theory-driven investigative strategy and our ontological commitment to treating information structures as real entities independent of people thinking them.

# 5    How knowledge level ethnography works

Knowledge level ethnography is an approach that adapts ethnographic observational methods to analysing design processes (and other complex information manipulation activities) at the knowledge level. It combines the flexibility of ethnography with the rigour and structure of artificial intelligence knowledge description techniques. The goal of the methodology is to describe designing in terms of the information that is created, combined, manipulated, transformed and communicated in the creation of designs (design as seen from the artefact), and the knowledge and competencies needed to create them.

## 5.1   Intrinsic structure and external constraints

The most powerful and fundamental influence on the design process is the nature of the product to be designed. A simple initial model of the design process can be developed from the structure of the product and its components, and the interdependencies between these components: logical necessity dictates much of what needs to be done to design the product. Of course, this model is likely to be crude and simplistic, and will certainly be faulty.

The other sources of influences on the design processes, and so on what designers need to know in order to design, are the cognitive capacities of the designers, about which we can make some strong assumptions based on the findings of cognitive psychology; how the design process is organised; and cultural constraints and influences. Again we can make some preliminary guesses about how these factors influence the design process.

## 5.2 The bootstrapping method

Many ethnographers regard ethnography as an open ended observation in which theoretical assumptions are avoided, and everything is documented and analysed later on. We reject the idea of atheoretical observation, as at best inappropriate for our purpose. The core of the knowledge level ethnographic approach is integrating analysis into the observation process to focus the observations on theoretically motivated questions.

In the course of observational work, the observer can use the current theory of the intrinsic structure of the design process, dictated by the product, to refine the theory of how organisation and culture influences design. Similarly the observer can use the current theory of the cultural influences on the design process to refine the theory of its intrinsic structure. At each stage, the observer tests the conjectures by seeking falsifying or confirming evidence in the observations, primarily by asking informants focused questions. Key issues can be discussed with different participants in the design process. As understanding of the process grows, more of what the observer sees makes sense as either conforming to or contradicting the observer's theories of how design works, and as such becomes more salient and memorable. Events and comments can be placed in context.

As many philosophers, psychologists and sociologists have pointed out, human behaviour is often attuned to the demands of situations with remarkable precision. The heuristic principle guiding theory development in knowledge level ethnography is to account for as much as possible of our informants' observed knowledge, strategy choice and other behaviour in terms of rational adaptations to the demands of the task and the environment.

## 5.3 The role of the observer

Many design companies are used to apprentices, trainees or placement students; they are quite happy to let observers join in design activities or supporting tasks, which give an insight into the process and create opportunities for informal chats. For example Eckert once "assisted" with arranging a colour palette for a knitwear presentation and chatted about design research while gaining first hand experience of the inadequate match between linguistic colour terms and the range of yarn colours. The apprentice domain expert role proved extremely fruitful in our own research on knitwear design. However it influences the activities the observer sees, so the role of uninvolved shadow seeing normal behaviour is no longer feasible. But in the spirit of ethnography the observer aims to understand the observed culture from an insider's point of view, not just to develop a theory of the process but so far as possible to develop the domain practitioners' skills and perceptions.

A fundamental problem in ethnography and other fieldwork activities is how to record what is seen. Most observers take so-called *field notes*, which some people treat as data. In our view, field notes are inevitably selective and implicitly theory-laden; and are heavily biased by the observer's ability to take notes and personal interests. They are more properly regarded as part of analysis. (However, field notes taken according to planned coding criteria to investigate

preselected questions may be legitimately regarded as data. But this approach will cause the observer to miss other aspects of the situation that may be vitally important.) A knowledge level approach enables the observer to sort information into confirming and falsifying evidence for the current process model, thus enabling the creation of more objective notes.

# 6    Advantages of the methodology

A knowledge level approach does not require a dedicated expert working as a full participant in the project, as the observer joins into the entire process and can question different participants when it suits them. It is also possible and even beneficial to apply the same procedure to different companies to differentiate between product influences on the process and work culture influences. This breadth is essential for building design support systems, which are used across an industry.

A product centred model of the design process, rather than one based task or organisation, does not imply implicit criticism of the design process as it occurs in a company. By asking product focused questions other explanations can be elicited quite easily. Even otherwise confidential information might be revealed to illustrate factual points.

Traditional knowledge acquisition methods often fail with tacit and perceptual knowledge, as experts find it difficult to verbalise their activities and if they do are likely to give a post hoc rationalisation. Only if the observers begin to develop some of the domain instincts they can begin to identify and discuss decisions that are made based on tacit and perceptual knowledge.

An observer who has developed domain instincts and acquired domain knowledge can be involved in a first pass evaluation of a support system or its interface, and reduce the expert input required in system testing.

# 7    Conclusion

By combining ethnography with a knowledge level approach the rigor of a knowledge level analysis can be combined with the richness of material gathered during an open ended observation. A product model a preliminary model of the design process can be used to focus the observation activities. Through a bootstrapping process, a model of the design process can be iteratively refined by confirming and falsifying hypotheses. The observer acquires domain knowledge and domain instincts at the same time as a process model is created, without requiring access to dedicated domain experts. The observer can guide the later stages of the development of a support tool thus reducing the need for expert time. Eckert [1997] has successfully used this approach to generate a detailed model of the knitwear design process.

# References

[1] Agar, M., "The Professional Stranger, An Informal Introduction to Ethnography", Academic Press, London UK, 1980.

[2] Breuker, J.A. & Wielinga, B.J., "Model driven knowledge acquisition", P. Guida & G. Tasso (eds.), Topics in the Design of Expert Systems, North-Holland, Amsterdam Netherlands, 1989, pp 265-296.

[3] Cross, N.G., Christiaans, H. & Dorst, K. (eds.), "Analysing Design Activity", John Wiley, Chichester, UK, 1996.

[4] Eckert, C.M., "Intelligent Support for Knitwear Design", PhD Thesis, Department of Design and Innovation, The Open University, Milton Keynes, UK, 1997.

[5] Eckert, C.M., Cross, N.G. & Johnson, J.H., "Overcoming the Communication Bottleneck through Automatic Design", Design Studies, in press Vol.21, 2000.

[6] Eckert, C.M. & Stacey, M.K., "An Architecture for the Intelligent Support of Knitwear Design", J.E.E. Sharpe (ed.) AI System Support for Conceptual Design, Springer-Verlag, London UK, 1995.

[7] Meyer, M.A., "How to apply the anthropological observation technique of participatory observation to knowledge acquisition for expert systems", IEEE Transactions on Systems, Man and Cybernetics, Vol.22 No.5, 1992, pp 983-991.

[8] Newell, A., "The Knowledge Level", AI Magazine, Vol.1 No.2, 1981, pp 1-20.

[9] Schreiber, A.Th., Wielinga, B.J. & Breuker, J.A. (eds.), "KADS: A Principled Approach to Knowledge-Based System Development", Academic Press, London UK, 1993.

[10] Smithers, T., "On knowledge level theories of design process", J.S. Gero & F. Sudweeks (eds.), Artificial Intelligence in Design '96, Kluwer Academic Publishers, Dordrecht Netherlands, 1996, pp 561-579.

[11] Smithers, T., "Towards a knowledge level theory of design process", J.S. Gero & F. Sudweeks (eds.), Artificial Intelligence in Design '98, Kluwer Academic Publishers, Dordrecht Netherlands, 1998, pp 3-21.

[12] Spradley, J.P. & McCurdy, D.W, "The cultural experience: Ethnography in complex societies", Science Research Associates, Chicago IL, 1972.

[13] Tunnicliffe, A. & Scrivener, S., "Knowledge Elicitation for Design", Design Studies, Vol.12 No.2, 1991, pp 73-80.

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