



University of  
**Salford**  
MANCHESTER

# Accounting for knowledge embedded in physical objects and environments : defining the direction of the research

Rooke, CN, Tzortzopoulos, P, Koskela, LJ and Rooke, JA

<b>Title</b>	Accounting for knowledge embedded in physical objects and environments : defining the direction of the research
<b>Authors</b>	Rooke, CN, Tzortzopoulos, P, Koskela, LJ and Rooke, JA
<b>Type</b>	Conference or Workshop Item
<b>URL</b>	This version is available at: <a href="http://usir.salford.ac.uk/id/eprint/11317/">http://usir.salford.ac.uk/id/eprint/11317/</a>
<b>Published Date</b>	2008

USIR is a digital collection of the research output of the University of Salford. Where copyright permits, full text material held in the repository is made freely available online and can be read, downloaded and copied for non-commercial private study or research purposes. Please check the manuscript for any further copyright restrictions.

For more information, including our policy and submission procedure, please contact the Repository Team at: [usir@salford.ac.uk](mailto:usir@salford.ac.uk).

# **Accounting for knowledge embedded in artefacts within healthcare settings: Defining the direction of the research.**

**Clementinah. N. Rooke, Patricia Tzortzorpoulos Fazenda, Lauri Koskela and John Rooke**  
*Research Institute for Built and Human Environment. The university of Salford*

## **Abstract**

This research takes place within the framework of the Knowledge and Information Management (KIM) is an EPSRC funded Grand Challenge Project which brings together expertise from management and engineering disciplines. The project recognises that, 'in response to customers' changing needs, organisations across all sectors are increasingly being asked not only to provide products in the first instance, but also to support them throughout their service life' (KIM 2006). Thus, the need to consider ways in which knowledge can be preserved in practices, records and artefacts is considered.

The aim of this research, which is in its earliest stages, is to explore multi-disciplinary contributions to this problem from the knowledge management and production management perspectives. The focus is on the role of artefacts in preserving and communicating knowledge. An ethnomethodological approach will be used to produce uniquely adequate (UA) accounts of the situated meaning of artefacts within social processes. The proposed settings for research are healthcare facilities where the researcher will adopt an ethnographic approach to achieve a UA understanding of how patients, staff and visitors in chosen healthcare settings make sense of their built environments.

**Key words:** ethnomethodology; artefacts; unique adequacy; knowledge management; TFV theory of production

## **Introduction**

It is intended that this research, which is in its earliest stages, will be completed within the three years allocated for doctorate studies. The researcher aims to produce a conference paper each year in order to show progress made from beginning to end. This paper is the first of three the researcher intends to publish in the conference proceedings during the course of her study. In this paper, the researcher defines the general path her research is to follow from start to finish. This includes the; background to the study, aim and objectives of the research, the research methodologies and methods, work completed so far, work yet to be completed and targeted contribution to industry and academic knowledge.

## **Background to the study**

Three areas contribute to this research in varying degrees. They are; knowledge management, the TFV theory of production and ethnomethodology. The framework within which the research takes place is provided for by the Knowledge and Information Management Through Life (**KIM**) project. KIM is an EPSRC-funded Grand Challenge project which involves several universities and a number of industrial partners from across the defence, aerospace, construction and healthcare sectors. Its purpose is to 'find robust ways of handling information and knowledge over the lifetime of product-services such as PFI hospitals, schools and military equipment' (KIM 2006) The project, seeks to address knowledge management challenges associated with the move towards through-life product support.

The TFV (transformation, flow, value) theory of production was developed by Lauri Koskela, within the context of developing lean construction theory. It focusses on flows and the elimination of waste (Shingo 1988; Koskela 1992, 2000). According to Koskela et al (2002) lean construction is concerned with the management and improvement of construction processes by considering customer needs, eliminating waste and maximizing value. Thus, lean knowledge management would imply minimising the waste that occurs through loss of knowledge and the most efficient use of knowledge to increase customer value. The aim should be to design artefacts which maximise the flow of knowledge to healthcare professionals, maintenance staff, other staff, visitors and patients, supporting the efficient delivery of services, enhancing the patient's experience, use and maintenance of products. Thus, the transfer of knowledge through objects or environments across successive stages of the life-cycle of a product is of importance.

This research recognises that knowledge embedded in artefacts has not been paid as much attention as that which is written or spoken. In order to fully understand the role played by artefacts in the transfer of knowledge an ethnomethodological approach is suggested. Ethnomethodology is an approach founded by Harold Garfinkel in the 1950s and 1960s. It originated partly as a response to Alfred Schutz's call for the need for sociological analysis to pay attention to the ways in which persons, as members of society experience social life. Garfinkel refined this experiential focus to pose the question of how members of society produce observable social order free from the influences of traditional sociological theories. Here people are seen as rational actors, who employ practical reasoning rather than formal logic to make sense of, and function in, society (Francis and Hester, 2004). Thus, the approach is appropriate for a study which seeks to understand how people who use, maintain or design artefacts and make sense of their physical properties. Garfinkel (1984:vii) goes so far as to observe that "In doing sociology, lay and

professional, every reference to the 'real world,' even where the reference is to physical or biological events, is a reference to the organized activities of everyday life.”

## **Aim and objectives of the research**

This research aims to derive generic principles for embedding knowledge in artefacts (physical objects and environments). It is hoped that this will be achieved, through clarifying the concept of embedded knowledge and exploring the role of artefacts in the management and transfer of knowledge

The objectives are to:

- to clarify the relationship between the concepts of information, social practice and artefact
- gain a uniquely adequate understanding of the mechanisms by which physical properties of artefacts are understood by those that use, maintain or design them
- show how embedded knowledge can be used in the use, management and maintenance of artefacts through life

## **Research methodology and methods/techniques**

The researcher hopes to achieve her objectives through a systematic literature review and fieldwork. An ethnomethodological approach will be used to produce uniquely adequate (UA) accounts of the situated meaning of artefacts within social processes (Rooke & Kagioglou 2007). This approach will primarily adopt auto-ethnographic (Hockey & Collinson 2006) and 'armchair' (Francis & Hester 2004) techniques. Other techniques will including ethnographic interviews, participant observation, direct observation and the analysis of documents and photographs of hospital artefacts. Ethnomethodology and unique adequacy as concepts are discussed in more detail under the section on literature review.

## **Literature review: An initial understanding of key concepts**

### **Knowledge in knowledge management**

Davenport & Prusak (1997) define knowledge as;

*“a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organisations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms.” (p5)*

Rooke et al (2008) discuss at length the current view of knowledge in knowledge management. They argue that two philosophical errors have influenced the way knowledge is currently understood within this context. The 'source and consequences of the first', they observe, is the 'well rehearsed' confusion between information and knowledge. This dichotomous concept of knowledge and information 'lies at the heart of the KIM enterprise', they assert p (1). The second error is 'suggested in an apparent deficiency in the information/community of practice distinction used to formulate the KIM problematic' (Rooke et al p (2). In an effort to clarify this confusion Rooke et al offer a tri-partite approach to knowledge. This approach supplements the two concepts of knowledge (information and community of practice) with a conception of artefacts (objects or environments) as bearers of knowledge. The tri-partite approach highlights the value of physical (including visual and tactile) properties of artefacts in the transfer of knowledge from artefact to user. The value of physical properties of artefacts in transferring knowledge has recently been recognised in a number of fields. The *kanban* system uses physical placement of documents to facilitate improved production flow (Shingo,1988). *Poka yoke* (mistake proofing) involves the physical embodiment of assembly and operation knowledge in components and products. In aerospace, Dekker (2005) observes how the physical conditions and configurations of 'normal work' can contribute to an unnoticed drift towards system failure.

From the above, a number of observations can be made. First, it is clear from Davenport & Prusak's definition that knowledge is perceived as something which is not independent of social practices. Unfortunately this popular view of knowledge, does not seem to acknowledge the role played by artefacts in the transfer of knowledge. However, it is clear that the value of the physical properties of artefacts has started to receive attention from various fields. As this research progresses, more attention will be paid to knowledge embedded in physical objects and environments.

### **TFV theory of production**

Koskela (1992) observes that the conversion model of production has, up until recently, dominated the conventional view of production. According to this model, 'a production process is a conversion of an input to an output' (p.12). The transformation conception of processes treats them as capable of being decomposed into sub-processes, which themselves can be further decomposed. The intention is that tasks can be designed and specified for maximum efficiency. The concept of flow is defined by Koskela (1992) in opposition to the concept of transformation, as an alternative way of looking at the production process. The flow conception, in contrast to the transformation conception, treats the process holistically, as a continuum, time is central to understanding it. Here the processes can be characterised by time, cost and value where value refers to the fulfilment of customer requirements (Koskela, 1992). As has been

highlighted earlier, this research intends to apply the flow conception to the way knowledge can be managed in order to add value to customer experience and service delivery in healthcare settings.

### **Ethnomethodology (EM)**

Ethnomethodology is a sociological approach distinct from traditional sociological approaches in that it concerns itself solely with **observable** features of social life (Francis and Hester, 2004). It focusses on how observable social activities are produced, accomplished and understood by ordinary members of society. Put a different way, it is keen to investigate how members of society (individuals and organisations) make sense of and function in society by creating social facts or understandings of how society works. According to Francis and Hester (2004), ethnomethodology's key assumption is that the production of observable social activities involves the local or situated members' methods for performing such activities. These methods, they further observe, are heavily reliant on the mastery of natural language. For instance, ethnomethodology notes that words are reliant for their meaning on the context in which they are used; they are indexical.

Francis and Hester (2004) sketch some of the ways in which ethnomethodology has developed and diversified. Ethnomethodology has influenced the Sociology of Scientific Knowledge by providing a research strategy that precisely describes the methods of its research subjects without the necessity of evaluating their validity. This has proved to be useful to researchers studying social order in laboratories who wished to understand how scientists conducted their experiments without either endorsing or criticising their activities. Ethnomethodological studies of work have played a significant role in the field of human-computer interaction, informing design by providing engineers with descriptions of the practices of users. Additionally, ethnomethodologically informed management and leadership studies are newly emerging fields. Worthy of mention, is that ethnomethodology has developed what is often considered a sub-field or perhaps an entirely new discipline, that of conversation analysis. It is true that some EM studies, particularly in the field of Conversation Analysis, have achieved generalisability. However, Rooke (1997) points out that, this is due in many ways to specific qualities of the phenomenon under study and the type of generalisation attempted.

### **Unique Adequacy**

The criterion of unique adequacy insists that the methods used to produce a description of a situation, should be those which originate from the situation they describe (Rooke, 1997). Two unique adequacy criteria are suggested; a strong one and a weak one. The weak requirement is that:

*"the analyst must be vulgarly competent in the local production and reflexively natural accountability of the phenomenon" (Garfinkel & Wieder 1992, p182)*

Thus, to analyse a hospital setting adequately, the researcher must know what any member to that setting would ordinarily know about that setting. The researcher is able to perform relevant activities within that setting without censure from other members. Garfinkel & Wieder (1992) state that this might be taken as a criteria for adequate ethnography. By contrast, the strong requirement concerns the reporting of research (Rooke & Kagioglou, 2007). It demands that the methods of analysis used to report on a setting should be derived from that setting, observes Rooke (1997). In effect, he further observes, it stipulates the application of a policy of 'ethnomethodological indifference': a refusal to evaluate, describe or explain the activities that constitute the setting using criteria, concepts or theories that are not a part of that setting. Lynch (1999) asserts that it requires that researchers learn the skilful exercise of this practice. Rooke (1997) observes that work has also been done to develop UA approaches which make a more active contribution to the design process (Button & Sharrock 1995; Button & Dourish 1996; Dourish & Button 1998; Crabtree 2004) or encourage reflection in design and management processes (Seymour, Shammas-Toma & Clark 1997; Rooke & Seymour 2005).

## **Field work**

### **Investigating hospital artefacts (self-reflection and photographs)**

This section looks at some of the work the researcher has started to analyse. The examples chosen are a reflection on her own experience as a nurse, a patient and an ordinary member of the public. All the photographs used in this paper have been taken by the researcher herself. There is no intention to report findings at this time. The research is intended to meet the criteria of the unique adequacy requirement, which have been described above.

### **A visit to the x-ray department**

This is a true account of the researcher's own experience as a patient in finding her way to the x-ray department from home. She will be referred to as Mrs R in this section. The letter offering Mrs R an appointment carried the following as far as directions to the hospital go:

*'...The x-ray department is in the purple zone... Please report to the main x-ray reception on arrival...'*

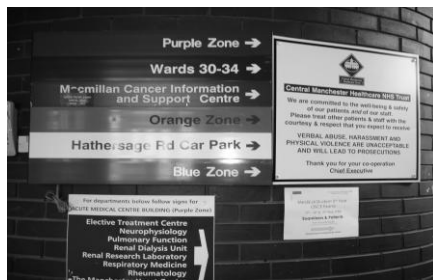
From this instruction she made, certain assumptions. First, that since the letter does not give directions on how to get to the hospital, it must be easy for one to find their way there in the first place. The emphasis

on the location of x-ray department by colour gave Mrs R the impression that the hospital is not an easy place to navigate hence the need for colour coding. However, since the letter omits to mention how to locate the purple zone she further assumed that on arrival at the hospital, it should not be difficult to find this zone. Below is Mrs R's account of how she managed to find her way from the time she got off the bus outside the hospital.

As she got off the bus she saw an opening into the hospital grounds a few yards from the bus stop. This happened to be the only obvious opening so she assumed that it was the entrance she needed. Barely a few yards into the hospital grounds Mrs R was presented with the sign stating:



Unfortunately there was no further information to help Mrs R gain access to the main hospital. On exploring further, she soon finds herself walking along an alley way with no clues as to where the entrance to the main hospital was. At the end of the alley she was suddenly in full view of the entrance to the hospital. It was clearly marked with colour coded signs of which *purple zone* is one (see below).



A few yards into the hospital corridor, she found yet another display of signs directing the user to various hospital departments. The directions for the x-ray department were on it. Further in she was presented with more signs of this nature, some hanging from a height and others stuck on the walls. The confusion occurred at a junction where the sign for the x-ray department pointed upwards. Mrs R automatically assumed that she was to take a lift to the floor above. However, the sign was intended to instruct the user to go forward. Unfortunately, it was not easy to find the way forward at this particular junction of the hospital because of curves, alcoves and corners. Three other people appeared to be struggling to find their way too. A hospital porter spontaneously offered to help, stating; *'Its double Dutch here'*



Mrs R's experience clearly highlights the need to improve the accessibility, usability and legibility of this hospital setting. Wayfinding specialist contend that complex buildings such as hospitals, must facilitate the ability of users to find their way within it (Inside Information Ltd, 2008). They observe that putting up signs without strategy sometimes has the opposite effect. This is certainly true in Mrs R's case. The researcher intends to establish that hospital environments such as these can be embedded with knowledge which should make the task of finding one's way in and around the hospital an easy and pleasant one with minimum need for signs. Further analysis of Mrs R's experience, therefore, will seek to identify features that can be designed into or out of the two specific points where wayfinding became problematic for Mrs R. The first breakdown can be seen right at the beginning where there is no clear access to the main hospital. The second is at the junction where the instruction given by the sign pointing upwards is not supported by the architectural layout of that part of the building.

### **Working in an Alcohol Treatment Unit (ATU)**

Here the researcher reflects on her experience as a nurse in a day centre for people wishing to abstain from alcohol for life. Inside the ATU is a drop-in day area, comprising tea-bar and pool table. Complaints have been made that the area is similar to the bar of a public house. What features provide for the reading of the area as 'similar to a public house' and how might these features be designed out? Analysis of this setting which is in its initial stage is heavily dependent the researcher's experience as a member of this setting. She is reflecting on her patients' opinions about the day room, as communicated to staff both formally and informally and also on her and other staff's opinions about the same.

### **Opening a door**

Think of the simple task of opening a door. How often do we try to open doors the wrong way even where there are clear instructions saying "Push or Pull"? Is it not also true that we feel stupid for having failed to see the written signs? Quite often people have chided themselves (silly me!) for having failed to spot the instruction giving signs. However, according to Norman (2002), well designed objects should be easy to interpret and understand. They should contain visible clues as to how they should be operated without the need for words or symbols and certainly without any need for trial and error (Norman, 2002). In the case of knowing how to operate a door, Norman contends that the correct parts should not only be visible but must convey the correct message. The designer must provide signals that naturally communicate to the user where to push or pull.



A door with a vertical plate on one side and a handle on the other immediately communicates to the user the direction in which the door will open (see photographs below). This is a good example of how knowledge can be embedded in artefacts at design stage. The door is clearly instructing its user on how to perform the task without the need for explicit communication. The user performs the task without the need for trial and error. He or she is able to make sense of how to open the door without having to pay much attention to the task at hand.



Norman assures that

*'The human mind is exquisitely tailored to make sense of the world. Give it the slightest clue and off it goes, providing explanation, rationalization, understanding' (p.2).*

Norman's trust in what the human mind is capable of achieving is reassuring to a researcher who seeks to investigate methods people use to make sense of their social world.

## **The oxygen cylinder**

Healthcare institutions have an obligation to provide an effective resuscitation service and to ensure that their staff receive training and regular updates for maintaining a level of competence appropriate for them to resuscitate a patient in the event of a cardiac failure (Royal College of Anaesthetists *et al* 2004). It is the job of healthcare professionals to ensure that there is adequate oxygen and that it is not out of date. On a regular basis therefore, the cylinder must be checked for fullness and freshness. A replacement is necessary only when the oxygen is out of date or when the cylinder is less than half full. A label carrying the expiry date is attached to the cylinder by the manufacturer (see above). The life cycle of oxygen



cylinders varies by manufacturer from 5-15 years.

In the incident involving the oxygen cylinder, a conscientious student nurse alerted the team to the fact that the cylinder was a year out of date. In their clinical governance meeting the team sought answers to why a period of a year had gone by without noticing this anomaly. Some felt that the team had a poor method of recording results and that a formal check-list would improve things. Others felt that a daily visual check on a life cycle of 15 years was not the ideal way to do it. They argued that it would take more than a check-list to repair this breakdown. As no satisfactory solution could be reached, the team resolved to use a check-list all the same and to exercise more vigilance

Here the researcher is interested in finding practical solutions to this breakdown in the flow of knowledge. Can this device be embedded with knowledge which should make it possible for nurses to know shortly before the long life span comes to an end? If so, what kind of knowledge can be embedded?

## **What is required to complete the study?**

Investigating how staff, patients and visitors make use of knowledge embedded in physical objects and environments to: Find their way to, in and around hospital (Way-finding); Make sense of various hospital rooms (treatment rooms, toilets, etc.); Enhance their hospital experience during a treatment episode (Patient care pathways); Maintain the hospital built environment and technical devices that are part of it. This will be supported by existing good practice from literature on wayfinding as well as an analysis and application of potential solutions to specific problems at the hospital site.

## Conclusion

The researcher hopes to develop generic principles for embedding knowledge in artefacts based on the findings of the research. It is also intended to show that knowledge embedded in physical objects and environments directly impacts on:

- Service delivery (Demarcation of staff and visitors' space on wards);
- Customer experience (those who use hospital facilities).

For academic purposes the opportunity will help contribute towards the achievement of a clearer understanding of:

- How artefacts are used and understood;
- How they support knowledge, communication and organisation.

## References

- Button, G. and Sharrock, W.W. (1995). The Mundane Work of Writing Computer Code. In *Situated Action*. Eds. G. Psathas and P. ten Have. Washington D.C.: University Press of America.
- Button, G. and Dourish, P. (1996). Technomethodology: Paradoxes and Possibilities. *Proceedings of the ACM Conference on Human Factors in Computing Systems CHI'96*. New York: ACM.
- Crabtree, A. (2004b) 'Taking technomethodology seriously,' in *European Journal of Information Systems*, **13**:195-209.
- Davenport, T. H. & Prusak, L. (1997) *Working knowledge; how organizations manage what they know*, Harvard Business School Press, Boston, MA.
- Dekker, S. W. A. (2005) 'Why we need new accident models' *Technical Report 2002-02*, Lund University School of Aviation.
- Dourish, P. and Button, G. (1998). On 'Technomethodology': Foundational Relationships between Ethnomethodology and System Design. *Human-Computer Interaction* 13: 395-432.
- Francis, D. & Hester, S. (2004) *An Invitation to Ethnomethodology; Language, Society and Interaction*, Sage, London.
- Garfinkel, H. (1984) *Studies in Ethnomethodology*, Polity Press, Cambridge.
- Garfinkel, H. & Wieder, D. L. (1992) 'Two Incommensurable, Asymmetrically Alternate Technologies of Social Analysis', in G. Watson & R. M. Seiler (eds.), *Text in Context*, Sage, London, pp. 175-206.
- Hockey, J. & Collinson, J. A. (2006) 'Seeing the way: visual sociology and the distance runner's perspective,' in *Visual Studies* **21**(1).
- Inside Information Ltd, (2008) The A to B of wayfinding [www.info.co.uk](http://www.info.co.uk)
- Lynch, M (1999) 'Silence in context: ethnomethodology and social theory,' in *Human Studies* **22**:211-233.
- KIM (2006) Knowledge and Information Management (KIM) Grand Challenge Project

[www.ukoln.ac.uk/projects/grand-challenge/](http://www.ukoln.ac.uk/projects/grand-challenge/)

Koskela, L. (1992) 'Application of the New Production Philosophy to Construction', *Technical Report No 72*, Centre for Integrated Facility Engineering, Stanford University, California.

Koskela, L. (2000). *An exploration towards a production theory and its application to construction*, VTT Technical Research Centre of Finland, VTT Publication 408

Koskela, L., Huovila, P; Leinonen, J (2002) 'Design management in building construction: from theory to practice' *Journal of Construction Research*. 3:1, 1-16

Norman, D. A. (2002) *The Design of Everyday Things* Basic Books New York

Rooke, J., Seymour, D. & Crook, D., (1997), Preserving Methodological Consistency: a reply to Raftery, McGeorge & Walters, *Construction Management and Economics*, 15 (5) pp.41-494

Rooke, J. & Seymour, D. (2005) 'Studies of Work: Achieving Hybrid Disciplines in IT Design and Management Studies', *Human Studies* **28**(2):205-221.

Rooke, J. A. & Kagioglou, M. (2007) 'Criteria for evaluating research: the unique adequacy requirement of methods', *Construction Management Economics*, 25:9, 979-987

Rooke, J.A., Siriwardena, M., Koskela, L (2008) Methodological, Philosophical and Theoretical developments in conceptualising product-service

The Royal College of Anaesthetists, Royal College of Physicians of London, Intensive Care

Society & Resuscitation Council (UK) (2004). *Cardiopulmonary Resuscitation Standards For Clinical Practice and Training*, Available on line at [www.resus.org.uk](http://www.resus.org.uk)

Shingo, Shigeo. (1988 ) *Non-stock production*. Productivity Press, Cambridge, Ma. 454 p.

Seymour, D., Shammash-Toma, M. & Clark, L. (1997). Limitations of the use of tolerances for communicating design requirements to site. *Engineering, Construction & Architectural Management* 4: 3-23.