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Original Article

Artefacts as designed, artefacts as used: resources for uncovering activity dynamics

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Abstract This paper addresses the use of artefacts as a powerful resource for analysis, focusing on the 'artefact as designed' as a means of eliciting the designers' explicit and implicit knowledge and 'artefacts as used' as a means of uncovering the trail left by currently inactive processes. Artefact analysis is particularly suitable in situations where direct observation is ineffective, especially in activities that occur infrequently. We demonstrate the usefulness of our technique through the analysis of artefacts within both the office and the meeting environment. This is part of a wider study aimed at understanding the nature of decisions in meetings with the view of producing a tool to aid decision management and hence reduce rework. We conclude by drawing out some general lessons from our analysis, which reaffirms the intricate role that artefacts play in maintaining activity dynamics.

Keywords Artefacts - Archaeologically inspired artefact analysis - Transect analysis - Activity dynamics - Decision - Meetings - Field study methodology

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1 Introduction

The ethnographic literature is full of the importance of artefacts as the means with which individuals represent, mediate and negotiate work in collaborative settings (Hughes et al. *1995*; Heath and Luff *1992*). This is also recognised in approaches such as distributed cognition (Hutchins *1990*) and situated action (Suchman *1987*) as well as some more traditional cognitive models (Howes and Payne *1990*). In our previous work, we have studied the way in which artefacts in their

setting act as *triggers* for action and *placeholders* for formal and informal processes (Dix et al. *1998a*, *b*, *2002*) and in related work we emphasised the centrality of artefacts as the focus of work and as the locus of communication *through the artefact* (feedthrough) (Dix *1994*).

Because of this we have proposed various forms of artefact centred analysis to run alongside more direct methods of observation (Dix et al. *2001*). We consider,

- the artefact *as designed*—looking at the ways in which the explicit and implicit knowledge of the designer are exposed in artefacts.
- the artefact *as used*—looking at the way on which people have appropriated, annotated and located artefacts in their work environment.

Artefact centred sources are particularly useful where an activity occurs or is only active infrequently so that direct observation may fail to record any instance or part of the activity at all. The analysis presented here are drawn from our work on the Tracker [1] project where we seek to understand the nature of decisions in teams and organisations; in particular, the way past decisions are acted on, referred to, forgotten about and otherwise function as part of long-term organisational activity.

We have engaged in ethnographic studies, which revealed 'real' decisions being made between meetings or implicitly assumed, but rarely explicitly voiced during official meetings. Furthermore, interactions between decisions take place over periods of month or years. In other words, they have exactly the properties that make artefact-centred approaches attractive.

In Sect. 2, we will examine, in more detail, this role of the artefact as a resource for elicitation and analysis. Section 3 looks at how the use of artefacts relates to various theoretical frameworks. We will then base our discussion on empirical studies in Sects. 4– 6. We first look at cognitive and software tools for meetings (the artefact as designed) in Sect. 4. We then move on to the office environment in Sect. 5, to consider the role of paper and other artefacts in it (the artefact as used). We end in Sect. 6 with an analysis of meeting minutes developed in quite different contexts. Finally, we will present a more abstract discussion of the general lessons learn about artefacts in Sect. 7.

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2 Artefacts as resources

Like the fossil left behind after the soft parts of the body have decomposed, artefacts act as a residual record of work done and work in progress; in and of themselves, they form a resource for analysis.

Furthermore, just like the palaeontologist looking at fossils, there are a variety of circumstances in work domains where the 'soft tissue' of lived work, the ephemeral actions and words, are difficult or impossible to collect and so the matrix of artefacts that remains needs to be interpreted.

This may be because the actions have already taken place and so the physical remains are our only resource. In the Tracker project, we have access to a corpus of meeting minutes. The meetings have long past; we cannot go back and observe what happened; at best we can interview some of the participants; but the formal minutes remain—fossils of the moment.

Perhaps more fundamentally, there are some classes of human activity that direct observation cannot, or cannot easily, capture. Where a class of activity is frequent and short lived we can expect that periods of direct observation, such as ethnographic studies, will completely capture some instances of the activity from end to end. Similarly, where activities are longer lived, direct observation can at best hope to capture aspects of the activity at different points and so piece together the complete story from parts. But where a class of activity happens infrequently or is only active infrequently, direct observation fails to record any instance or part of the activity at all.

However, these activities, even when inactive must in some way still have a representation within the organisational ecology: in people's memories and in physical or electronic artefacts. The 'and' in the previous sentence is not just in the sense that both will be present, but in the more holistic recognition that the interpretation of artefacts is itself invested within the human understanding of the context.

Artefacts tell a story to the extent that they invoke stories. In some cases, as analysts, we may understand the contexts well enough to 'read' artefacts; in others, the artefacts can form the prompts to evoke memories for users during formal and informal interviews.

2.1 The artefact as designed

Long lasting artefacts: tools, procedures, documentation, buildings, organisational structures, have all by explicit action been 'designed'. As we know, these designs can often fail and so are not paradigmatic. However, they are a powerful resource embodying the knowledge, skills and assumptions of the original designer. We call this *archaeologically inspired artefact analysis*. It is based on the techniques that archaeologists employ to infer the patterns of use, work and social activity that surrounds artefacts produced by long-dead civilisations by considering their design.

This process is inherently problematic as it is easy to draw tenuous conclusions from meagre evidence. However, it is in fact more robust when used as a contemporary technique. The archaeologist is far from the culture in which the artefacts were produced; whereas, we are in a better position to understand the target context. The archaeologist is limited to the artefacts themselves, but we may in fact use them as a resource in participative critique.

2.2 The artefact as used

Artefacts are not simply engineered, sculpted, printed and designed; they are also used. The purposefully designed artefact becomes part of a lived environment with its own objectives, conflicts and pressures, and if successful, becomes appropriated and re-purposed. The artefact as designed conveys the designer's intentions and understanding of expected use; whereas, the artefact as used tells us about the pragmatics of actual use.

In previous work, we have focused on the fact that artefacts encode the state and trigger action, not just by their explicit content or significance, but also by their disposition in the environment (Dix et al. *1998a*, *2002*). So, by taking an office at the end or beginning of a day, we can use the artefacts to tell the story of the activities that are, in a temporal sense, passing through the office at that moment. Most significantly this includes activities which are not currently captured in the 'official' systems or whose state is indeterminate or intermediate between 'official' stages. We call this *transect analysis*, given its similarity with the technique biologists use to obtain a transect through an ecosystem such as a shoreline.

Transect analysis is particularly useful when there are many variants of the same activity, each at different stages; for example, in an insurance office where many claims are simultaneously being processed. This is like a biologist visiting a natural oak wood—because different trees are of different ages, it is possible to piece together a view of the complete lifecycle of a tree even though observing this might take hundreds of years.

Transect analysis is not so effective where there are very infrequent kinds of activity, or when all activities are happening in lock step. The latter is like visiting a commercial wood where all the trees are of the same age—one can learn a lot about trees of that age, but nothing about the life cycle. When studying the processes during the management of an academic conference (Dix et al. *1998a*), we encountered a series of lock step activities (e.g. paper submissions, refereeing etc. happened at fixed times). Although artefacts were useful as a prompt, the interviews with the conference administrator were vital, not just to give meaning to the artefacts, but also to fill in the gaps between visits.

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3 Related work

Artefacts are a central part of several conceptual and theoretical frameworks and are a ubiquitous feature in field studies reporting human activity. Ethnographies constantly re-iterate the understanding of artefacts in context as used. Garfinkel (*1967*) describes how clinical records were found to be 'bad' when they were used for statistical purposes with missing details such as the patients age, marital status, race and occupation. Eventually, this was understood as stemming from divergent readings of the record: as an 'actuarial record', which was required for statistical purposes or as a 'record of a therapeutic contract', which was required to make clinical practice work.

The importance of artefacts is also well recognised in distributed cognitive research where artefacts are viewed as physical objects designed by humans to improve and enhance cognition, consequently simplifying or facilitating task performance (Hutchins *1995*). Similarly, in socially complex distributed work activities, technological artefacts form an integral part of the environment and they are vital for facilitating collaboration (Rogers and Ellis *1994*). Artefacts are thus considered to be the crucial element that binds user cognition, information processing, workload management, and task accomplishment (Spillers *2003*). The analytic stance on artefacts in distributed cognition lies on both the minutiae of interaction (e.g. by analysing how interaction takes place through the use of pen and paper or how co-ordination occurs by shuffling a piece of paper around on the desk) and on the computational role that artefacts satisfy. Many examples of distributed cognition focus on individuals and workgroups for relatively short-lived activities. However, some studies do look at a larger scale, for example, Hutchins' (*1995*) study of the navigation on the USS Palau.

Our own interest in artefacts initially stemmed from their role in triggering activity. This led to the formulation of the 'Socio-organisational Church–Turing Hypothesis' (Dix *2002*; Dix et al. *1998b*). Although we share a computational understanding of artefacts with distributed cognition, our theoretical focus is more on the way in which artefacts prompt and drive activity and less on the role of artefacts as intermediate representations.

Another theoretical approach that has a significant role for artefacts is activity theory (Vygotsky et al. *1978*; Bertelsen and Bødker *2003*). Indeed, artefacts and objects form two of the vertices in Vygotsky's original triangle (Fig. 1).

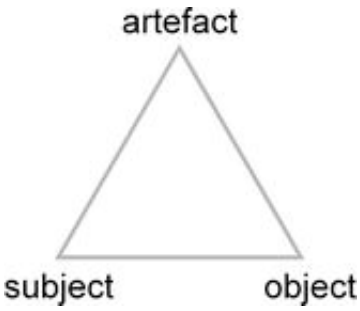

Fig. 1 The original activity theory triangle

The word *object* is actually used in the sense of objective or purpose of work and the artefacts are the tools that mediate the achievement of that objective. As well as extending the activity triangle to include community, division of labour and praxis or rules, Leontiev (*1978*) also looked at the way that this was a dynamic evolving relationship. In particular, the object of one activity may be the formation of rules or setting of objectives for another or the production of tools.

Bannon and Bødker (*1991*) view on artefacts as "crystalised knowledge" echo our own focus on the artefact-as-designed. However, they are principally using this as an explanatory mechanism to reflect on the development of artefacts, whereas we are seeing this more as a forensic opportunity to uncover the embodied experience within artefacts. This crystalising of knowledge is also evident in Bertelsen and Bødker's (*2003*) account of the contribution of activity theory in the design of a tool to aid the production of Coloured Petri Nets. They talk about the concept of artefacts in use through their 'Petri-nets-in-use' study, which looks at the practice and use of paper representations and general purpose graphics editors and how these formed part of a wider work activity.

4 Tools—the artefact as designed

There has been considerable work on techniques, notations and computer systems to support meetings and decision making processes. These different cognitive and computational tools embody within them models and theories of decisions and decisions making, which in some cases are very explicit, while others require 'digging' beneath the surface. Typically, tools with a more explicit model are normative and hence try to impose models and processes upon their users in order to create 'better' decisions. Others however take a more open approach by merely facilitating the human interaction in meetings, but as we shall see later, these too embody their designer's assumptions and models.

The most obvious theoretical models are the different flavours of design rationale, including IBIS (Kunz and Rittel *1970*), DRL (Lee *1990*) and QOC (MacLean et al. *1991*). Many of these have had associated graphical tools developed, such as gIBIS (Conklin and Begeman *1989*) to support IBIS, and SIBYL (Lee *1990*) for DRL. Although design rationales use semiformal, argumentation-based notations, even the simplest model introduces extra cognitive overheads for the designer (Buckingham Shum *1996*).

Moving away from structured representations, tool support for 'ordinary' meetings has long been a part of CSCW research. The earliest roots go back to NLS (Englebart and English *1968*), but the area 'took off' with various technologically enhanced meeting rooms in the mid to late 1980's, such as the Xerox PARC Colab (Stefik et al. *1987*), which drove much of the early work on

understanding groupware. Meeting scheduling has also been a common application domain and also a 'white rat' for CSCW analysis. In Grudin's classic critique (Grudin *1994*), he showed how the mismatch between the cost and benefits explains the failure of online meeting schedulers. The systems require people to invest a lot of time and effort maintaining their local calendars online without seeing much benefit from the system; instead the only beneficiaries are those who are responsible for scheduling the meeting.

The models embodied in the theory-driven systems are relatively clear and those in the classic meeting rooms and meeting schedulers have been heavily analysed. So as part of the Tracker project we focused our analysis on a more recent system, TeamSpace, which is related to the very successful Classroom2000 (eClass) system (Abowd *1999*).

4.1 TeamSpace [2] as an example

TeamSpace supports both synchronous and asynchronous interaction between team activities and facilitates collaboration by maintaining awareness, information sharing, communication and coordination (Richter et al. *2001*). The interface is designed to work with both pen interfaces (e.g. electronic whiteboard) and desktop machines.

Unlike most meeting capture systems which only cater for some work-related activities (e.g. recording notes, audio or video), the meeting data captured by TeamSpace is integrated with other work activities. Furthermore, the captured information can be accessed in different work modes: individually by each team member, during a meeting or other social modes. TeamSpace does not require meeting activities to be structured in a particular manner; however, it does support a fairly structured pre-meeting preparation phase.

The TeamSpace data model supports three main stages of meeting activities.

- Preparation (before the meeting)—where individuals asynchronously prepare for the meeting, create agendas and presentations, invite participants and schedule rooms.
- Capture (during the meeting)—where people greet each other, take notes, give presentations and get involved in brainstorming sessions. The system records events such as joining and leaving a meeting, viewing, editing and creating action items, viewing and annotating presentations.
- Review (after the meeting)—where individuals can access the captured data to create minutes, write reports and search for particular information.

Detailed analysis showed many assumptions, some of which were fairly obvious (e.g. the meeting has an agenda) but others less so. We found three classes of context assumption, which appear likely to occur in any software tool. We shall consider an example of each:

- Assumptions explicitly embedded in the software—the preparation stage is not an optional part of the software; a meeting cannot start if it has not been scheduled beforehand (Fig. 2). One can have an impromptu meeting, but it needs to be scheduled at the time it started—a workaround solution, which suggests that "all meetings are pre-planned events".
- Assumptions explicit in the documentation but not enforced—the documentation suggests that a facilitator is necessary to monitor the flow of discussion, change agenda items and update the item list. However, the software does not require someone to take on this role specifically and it does not even have an explicit 'marker'.

– Assumptions implicit in the software—if a meeting is stopped and restarted after, say, a lunch break, the audio recording for part of the meeting is lost, thus implicitly assuming that meetings do not break and reconvene.

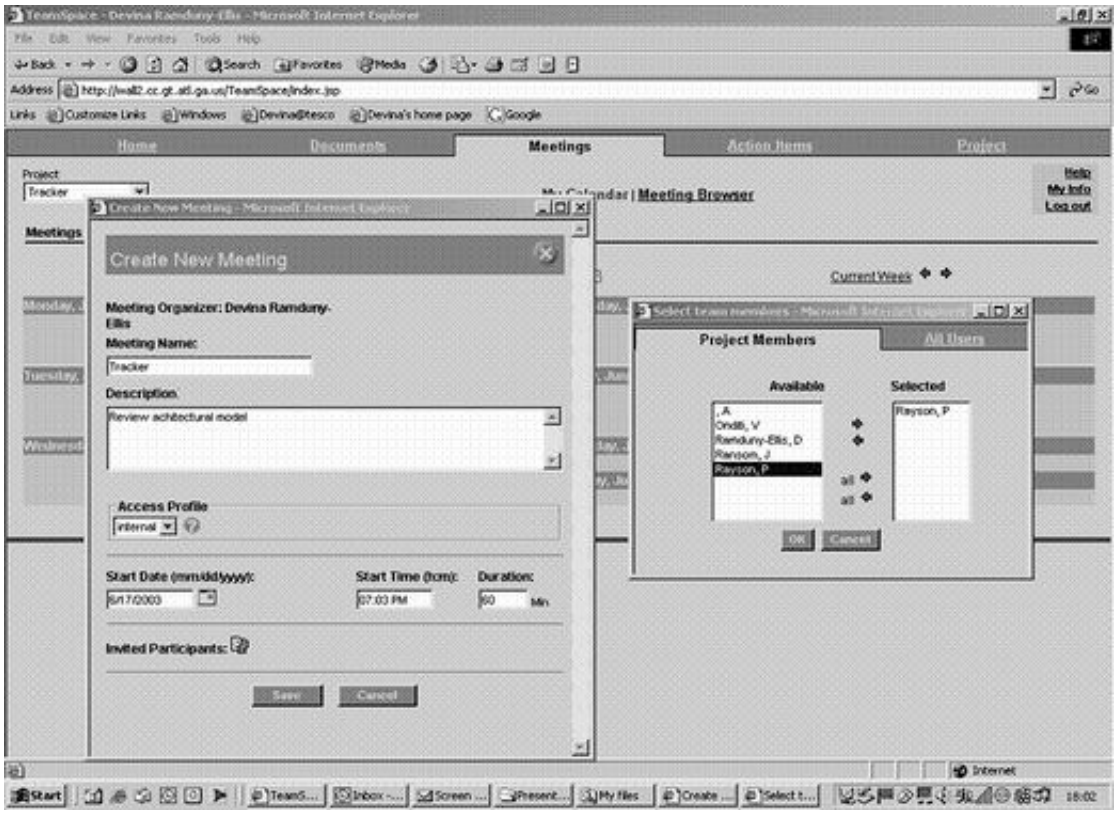

Fig. 2 Snapshot of TeamSpace

The last example is more a sort of 'bug' in the software and does not mean that the developers explicitly thought "people should not break off in meetings". Indeed if they had thought this, they would probably have mentioned it in the documentation! However, the fact that this 'bug' was still in the delivered software suggested that it was either overlooked, hence not tested, or it had been noted but not thought to be important.

After analysing the software, we raised the above point with one of the original developers and she told us that it had indeed been noted as a problem which has been 'fixed' in the latest version of the software. So is this the case of an implicit assumption or simply an oversight? Clearly, it was not a belief they explicitly held as they have changed the software to allow meetings to break and reconvene. However, it was, in some way, part of their underlying expectations of use; otherwise, the anomaly would have been spotted earlier and not been allowed to remain in the original version of the software.

5 The office—the artefact as used

We will now exemplify the role of artefacts as used based on the ethnographic study we carried out at the Business Enterprise Centre (BEC), an independent unit within the university, which is involved in promoting and coordinating the successful implementation of small and medium

enterprises by using the expertise available on site.

Although the study was directed primarily at the processes involved in BEC's internal meetings and the artefacts in use (which will be discussed in Sect. 6), we also observed the work activities within the office environment to capture a slice of the daily activities and follow up on the outcomes of the meetings. We will describe some of the office-related processes here, not so much with an ethnographer's eye on the activities and interactions between people, but rather with the focus on the trail of artefacts that forms the evolving matrix shaping and shaped by that activity.

5.1 Office environment

A typical hourly timeslice of the activities of a member of staff involves a lot of communication (e.g. make and answer phone calls, reply to a colleague's query when she shouts from the office across or walks into the office) and multitasking with various forms of artefacts. These include interactions with paper-based artefacts (e.g. consult files, write to-do items on sticky notes) and computer-based tools (e.g. use spreadsheets, check and reply emails, search on the web).

Another frequent activity was sending documents to the printer, which in itself is very interesting. The data initially lives in the digital medium, but once it has been printed on paper it becomes a physical entity whose very existence signifies some follow-up action, such as the paper may have to be filed away or passed on to someone's attention. So the act of printing does not just transfer information to a new medium or make a document easy to read on the train, it actually creates a new physical artefact that can act as placeholder, *aide memoir* or prompt for action.

Figure 3 shows the desk layout of the scribe and the operations manager. In addition to the computer and the telephone, various artefacts can be seen scattered around, for instance documents, files and sticky notes. Folders were stacked on shelves and filing cabinets and a whiteboard were also in the surrounding space.

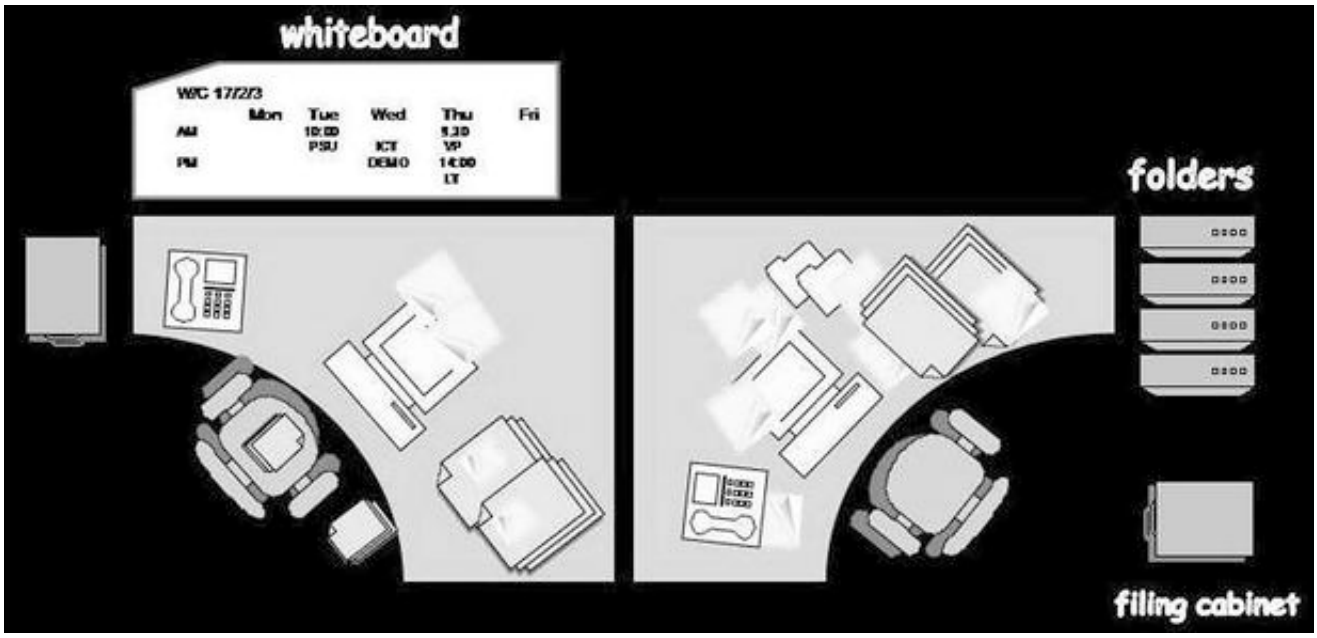

Fig. 3 View of desk layout

Interestingly, the yellow sticky note was a heavily used form of reminder and they were found

practically everywhere: on the desk, folders, paper documents, computer screen and telephone. Only one staff member used the MS Outlook software to manage her to-do tasks; most preferred the easy or less time-consuming method of jotting a to-do item on a sticky note and binning it after the task was complete. Someone even had sticky notes joined together to make up a whole to-do list! When asked why he did not use a notebook instead, he replied "I did start using a notebook but I left it behind in some meeting and it got lost, since then I abandoned the idea". The person therefore did not trust the reliability of the notebook medium and opted to minimise the risk by using sticky notes. Also, by their nature, sticky notes need to be stuck on something someone carries; hence, they are less likely to be left behind.

Finally, the whiteboard was used by the scribe to maintain the booking schedule for the meeting room. Although it mainly acted as a display, the whiteboard was a shared artefact of communication which informed other members, who walked into the office, of the meeting room availability if they required its use to hold project meetings.

5.2 Disposition of artefacts

Artefacts do not have fixed properties due to the diverse locations they may reside in. For example, at one point a piece of paper may be on someone's desk but a short while later, it could be lying on the floor. Usually, some processes must have occurred in between which led to the change in the location.

In BEC's case, the scribe left documents that had not been dealt with on the table and after they had been seen to, any documents that needed photocopying or filing were moved to the floor. The choice of the floor was important to the scribe as he did not like leaving his office untidy. The fact that the documents were still on the floor forced him to complete his tasks before he went home.

Another interesting observation was that staff members left documents that required the scribe's urgent attention on his chair if he was not around. The use of the chair as an in-tray was a form of short-term reminder, which ensured that the documents did not escape the scribe's attention when he got back, as he had to physically handle the documents before he could sit down!

We also once observed the operations manager retrieve a piece of paper stored under his phone. It turned out that the paper was acting as a form of long-term reminder and contained some statistics generated earlier on in the year which was vital for preparing timesheets. Timesheets could in fact be compiled at any time of the year, but it was customary to wait until the financial year drew closer. Since the knowledge of this important piece of paper only lay with the operations manager, it would be impossible for anyone else in the office to complete the task had he not been around.

The study of the office environment has highlighted some interesting and varied use of artefacts for different purposes. Unlike an office setting, a meeting room is usually devoid of artefacts lying around. However, meetings do tend to leave behind some sort of 'official' artefacts in the form of agendas and minutes, the subject under analysis in the following section.

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6 The meeting

The meeting has been described as the "most pervasive knowledge event" in working life (Selvin et al. *2001*). Meetings are not isolated occurrences; they usually exist within a process. The artefacts

and concepts brought into the meeting evolve as a result of the meeting and eventually materialise into work activities (Selvin et al. *2001*).

Unfortunately meetings are an extreme case of 'clean desk policy'. Going into the meeting room at night or morning would only reveal an enigmatic and indecipherable white board and crumpled paper cups in the waste bin. The documents and artefacts used in the meeting leave the room with the participants–the only remnant of the meeting is the explicit records and the changed memories and attitudes of the participants.

The one obvious artefact left behind by a meeting is the formal minutes. These are problematic as they are not a record of *what happened* at the meeting, but rather a *sanitised account* prepared for a purpose, by an individual. However, the minutes are significant—they are the foci by which the participants agree (or are forced to agree) to a fiction that in some way legitimises future actions. In some extreme cases, for example in certain legal situations, minutes of meetings (which never occurred) are created—quite literally legitimising the desired end state by an agreed legal fiction of the process.

We have to read formal minutes carefully, more like an *historical document*, written by someone, for a purpose, but nonetheless exposing aspects of the real process. Both minutes and meeting agendas are written for audiences. In the case of an agenda, this audience is principally those who will be present at the meeting; but this audience may be important for those who would like to put forward their own views beforehand. Minutes instead have a much wider audience and they are often used to communicate outwards to higher authorities, to colleagues or to those who must implement the decisions! The reading of minutes must therefore take this audience into account, both in understanding its language and its political intent.

Because of the limited audience, the language of minutes and agendas is often terse and replete with initials, shorthand and esoteric terms. For example, we came across the following action in one of the minutes "*Get CRM*". This action does not convey much meaning, unless one knows the context in which it was raised within the meeting.

A minuted item is less of a complete statement than an utterance in a 'conversation' that continues from meeting to meeting, and like all conversations, it is hard to 'listen in' in the middle. Sometimes even the participants can lose track. In one of the documents we studied, we found the following remark: "*Neither Dave nor Harry could remember the purpose of this agenda item? !*" Dave and Harry were however in charge of the meeting and they should at least have known who was responsible for proposing the item!

Because minutes form the agreed outcome of a meeting they can be used to give 'spin' to discussions or even by selection, excise problematic parts. The agenda is potentially even more powerful as it pre-selects what can be discussed and often by the assumptions embodied within it, it pre-commits a meeting to particular courses of action. This political nature of the agenda was especially evident in the start-up meeting of a cross-organisational project. A member of one organisation was responsible for drawing up the agenda, which was circulated electronically before the meeting. The manager at the second organisation responded by rejecting the proposed agenda and offering a completely different alternative. This was then counteracted by the manager of the first organisation who backed-up the original agenda. The choice of agenda items at this kick-off stage was crucial as it would drive the discussion at the meeting and hence the course of the entire project.

In ethnography of actual meetings, one of the marked results was the fact that decisions did not '

happen' in the meeting. This is not to say that formal minutes would not record decisions (or their consequences); instead there are no clear points of decision making. Formal minutes do not explicitly record 'decisions'; they either note agreed statements or 'actions', usually relating to formally numbered items in the meeting as the following analysis of minutes show.

6.1 Two sets of minutes

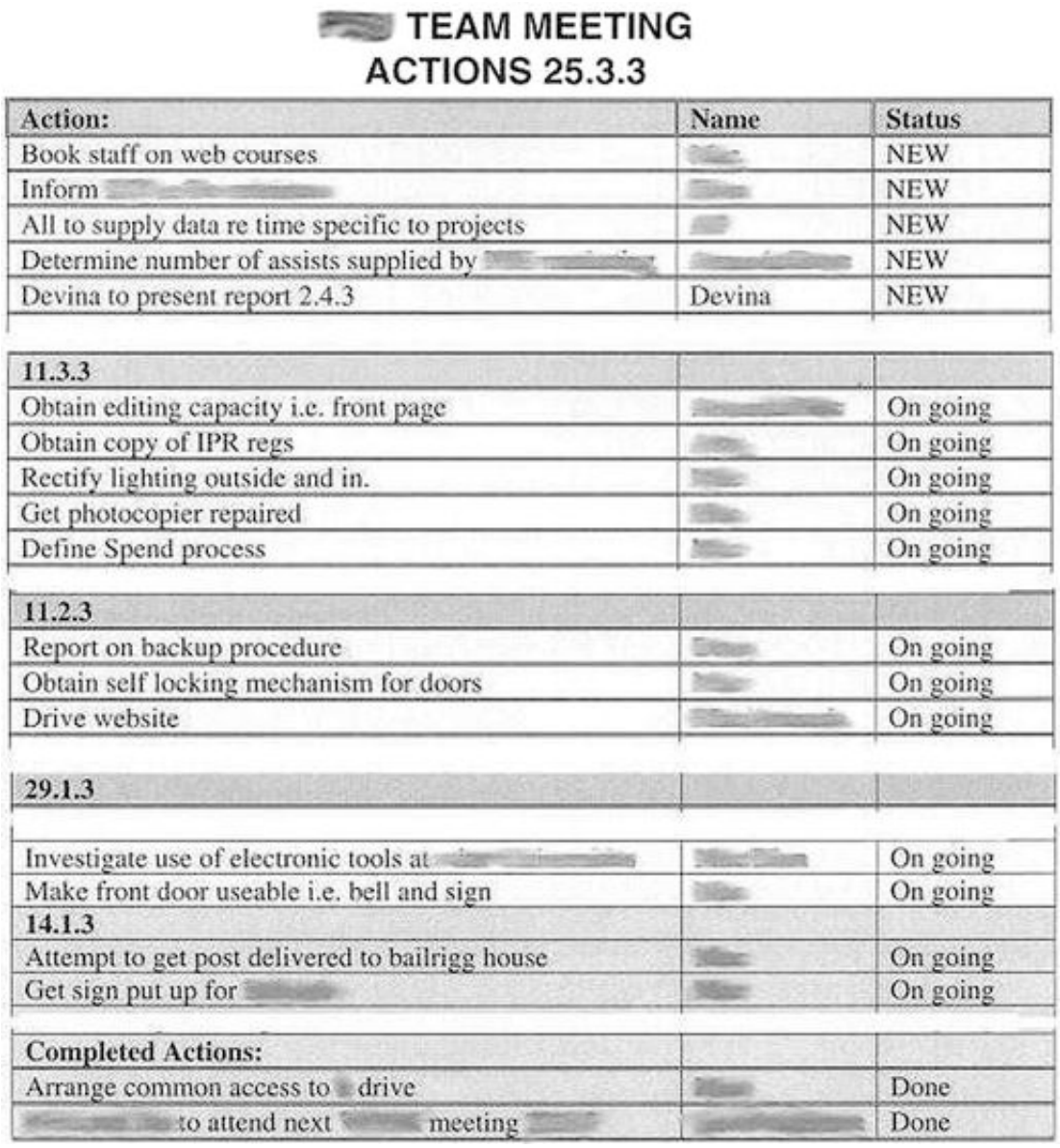
The format adopted for recording meeting data vary between organisations and very often, reflect the nature of the meetings. We will first consider the BEC minutes and then move on to examine the minutes from the DIRC research project meetings.

6.1.1 The BEC minutes

The BEC team meeting was held on a fortnightly basis on site; it was fairly informal and most members of staff were usually present. The purpose of the meeting was to discuss issues, generate actions and act as a platform for knowledge sharing.

The main artefacts present at the BEC meetings include:

- The agenda—which usually remains unchanged and lists issues based on each member's area of responsibility.
- The scribe's notebook—where he records a summary of the main issues discussed and the new actions raised at the meeting.
- The action list (Fig. 4)—which lists the *actions* generated from previous meetings, the *agent(s)* responsible for performing each action and the current action *status* (New, Ongoing or Done).
- Members personal documents (e.g. notebook, sticky note or piece of paper)—which contain a list of issues to raise or report on at the meeting (reminder) and also in some cases, a note of their own to-do actions for the next meeting (placeholder).



[redacted] TEAM MEETING
ACTIONS 25.3.3

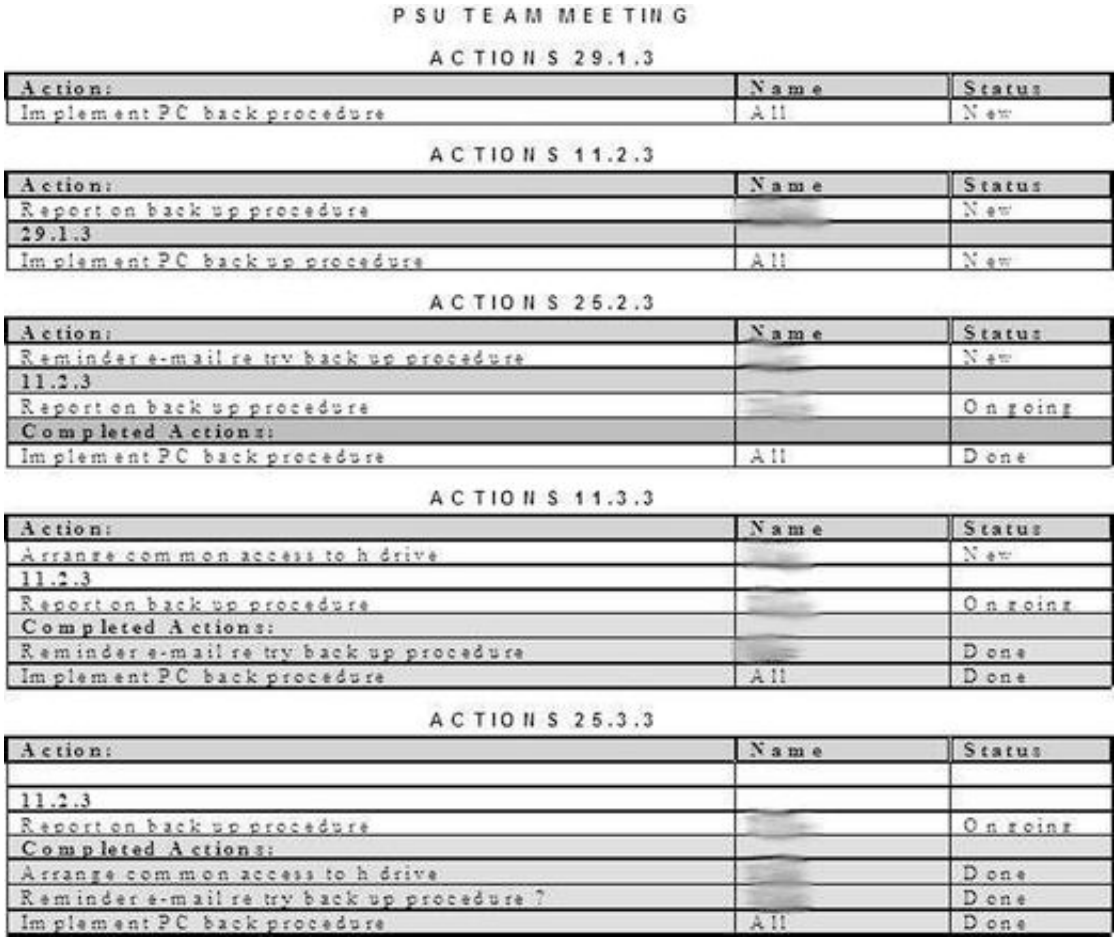
Action:	Name	Status
Book staff on web courses	[redacted]	NEW
Inform [redacted]	[redacted]	NEW
All to supply data re time specific to projects	[redacted]	NEW
Determine number of assists supplied by [redacted]	[redacted]	NEW
Devina to present report 2.4.3	Devina	NEW
11.3.3		
Obtain editing capacity i.e. front page	[redacted]	On going
Obtain copy of IPR regs	[redacted]	On going
Rectify lighting outside and in.	[redacted]	On going
Get photocopier repaired	[redacted]	On going
Define Spend process	[redacted]	On going
11.2.3		
Report on backup procedure	[redacted]	On going
Obtain self locking mechanism for doors	[redacted]	On going
Drive website	[redacted]	On going
29.1.3		
Investigate use of electronic tools at [redacted]	[redacted]	On going
Make front door useable i.e. bell and sign	[redacted]	On going
14.1.3		
Attempt to get post delivered to bailrigg house	[redacted]	On going
Get sign put up for [redacted]	[redacted]	On going
Completed Actions:		
Arrange common access to [redacted] drive	[redacted]	Done
[redacted] to attend next [redacted] meeting [redacted]	[redacted]	Done

Fig. 4 Example BEC action list

The action list acts as the minutes and it is typically the first item on the agenda to be discussed at the meeting. The scribe records any change in the status of 'new' and 'ongoing' actions on his copy of the action list (note that 'new' denotes an action raised in the previous meeting). Each member then takes it in turn to report on recent developments in their work area, which often lead to further discussions and give rise to new actions.

As the meetings are held on a regular basis at the same location with all or most of the team members present, the action list is quick and easy to monitor. Furthermore, the action list looks well structured and the actions are clearly stated, hence the need for further analysis may appear to be unnecessary. However, the ethnographic study of the meetings revealed some threads of activities that were not obvious by simply examining the action list.

One such instance we observed dealt with back up procedures, an issue that came up over several meetings. The extracts from the action list of those meetings have been pieced together in Fig. 5 to show the history of that particular action and how it evolved.



PSU TEAM MEETING

ACTIONS 29.1.3

Action:	Name	Status
Implement PC back procedure	All	New

ACTIONS 11.2.3

Action:	Name	Status
Report on back up procedure		New
29.1.3		
Implement PC back up procedure	All	New

ACTIONS 25.2.3

Action:	Name	Status
Reminder e-mail re try back up procedure		New
11.2.3		
Report on back up procedure		On going
Completed Actions:		
Implement PC back procedure	All	Done

ACTIONS 11.3.3

Action:	Name	Status
Arrange common access to h drive		New
11.2.3		
Report on back up procedure		On going
Completed Actions:		
Reminder e-mail re try back up procedure		Done
Implement PC back procedure	All	Done

ACTIONS 25.3.3

Action:	Name	Status
11.2.3		
Report on back up procedure		On going
Completed Actions:		
Arrange common access to h drive		Done
Reminder e-mail re try back up procedure ?		Done
Implement PC back procedure	All	Done

Fig. 5 Example showing history of actions

'Implement PC back up procedure' first appeared as a 'New' action in meeting dated '29.1.3' and all members were meant to look into the issue. After discussion, someone was appointed to 'Report on back up procedure' for the next meeting. The member concerned put forward several ideas and it was decided, as a start, to remind members via an email to carry out regular back ups, as shown by action 'Reminder email re try back up procedure'. This action was then marked as 'Done' in the following meeting.

Furthermore, 'Implement PC back up procedure' is also marked as 'Done'; however, the issue was still under consideration, as shown by the 'On going' status of 'Report on back up procedure'. In fact, another alternative came up in the meeting as the university was now automatically backing up all systems on h drive. Someone was therefore assigned to 'arrange common access to 'h drive'. This action is clearly related to the back up issue but it is still listed as a separate action. 'Report on back up procedure' maintained its 'Ongoing' status in the next meeting, now that an unforeseen problem had cropped up: not everyone was saving files on the central server!

The above example shows that despite the issues being debated was about back up procedures, they all featured as different actions, thus making it difficult to trace the links between the actions. This lack of visibility was not problematic to the group knowledge in this case, as most members were usually present at the meetings.

However, it could have some implications had there been the need for auditing or reporting to higher levels of management. The action lists do not currently capture the outcomes of the actions

nor do they track the way the actions evolve; hence, the task of linking actions together and uncovering why alternative actions were undertaken would be practically impossible.

Furthermore, the existing model works well with BEC as it is a small unit with eight members (at the time we carried out the observation) everyone could easily bump into each other and catch up on ongoing issues. However, new members may find it harder to get up to speed with past issues discussed by simply reviewing the action lists.

6.1.2 The DIRC minutes

Unlike the BEC action list, the DIRC [3] (Interdisciplinary Research Collaboration in Dependability) minutes have a more formal structure (see Fig. 6). The DIRC group meeting is held once every month and the participants are distributed across various locations. Not all members can attend the meetings regularly; hence the minutes are posted to the group's shared workspace on the web.

Minutes of the Meeting of Board

[redacted]

21 [redacted] 20[redacted] – start 10h00

Present

[redacted]

... ...

Agenda Items

Item 1: Minutes of last meeting

Item 2: Hiring situation (brief reports - not detail - including interview dates)

... ...

Actions

- [redacted] and [redacted] to advise [redacted] by Wed 5 July of suitable studentship candidates.
- [redacted] to write to [redacted] members and inform them of the appointment of the [redacted]

... ...

Minutes

Item 1 – Minutes of the last meeting

Various items from the last meeting were raised as separate agenda items. Other outstanding maters included studentships and advising [redacted] members of progress :

- [redacted] reported that [redacted] had awarded four "quota" studentships and that [redacted] and [redacted] had been allocated one each so far. It was agreed that
- ... ...

Action: [redacted] and [redacted] to advise [redacted] by Wed 5th July of suitable studentship candidates.

Action: [redacted] to write to [redacted] members and inform them of the appointment of the [redacted]

... ...

Fig. 6 Example DIRC minutes

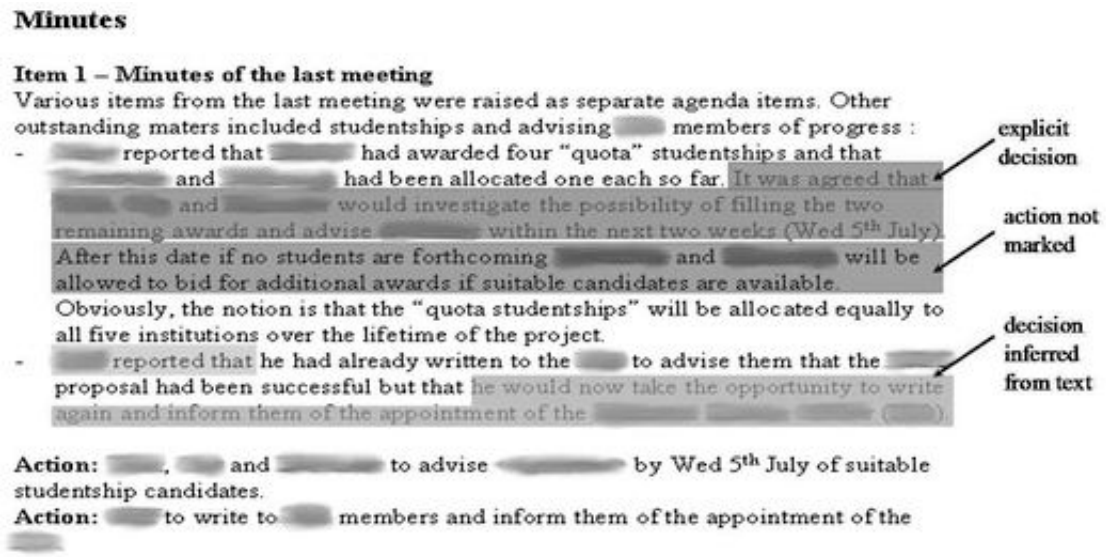


Fig. 7 Manual analysis of DIRC minutes

As an artefact, the minutes hold enough contents for further analysis. A manual analysis of the DIRC minutes (Fig. 7) highlighted the following issues.

- Some decisions were explicit from the text but they were marked as actions (e.g. "It was agreed that ....")
- Some actions although 'explicit' were not marked as such and hence were omitted.
- Some decisions had to be inferred from the text

Both our studies have therefore confirmed that formal minutes rarely capture decisions, instead they record actions or note agreed statements. Furthermore, the analysis of the formal minutes showed the ambiguities in recording decisions.

7 Discussion

In earlier discussion, we have already seen that minutes serve various purposes: they record what happened during meetings, communicate this to others, coordinate future activity and act as a locus for political power and conflict. In this section, we will draw some general lessons from our analysis of artefacts and show how these relate to other theoretical frameworks.

7.1 Attributes of artefacts

Typically, a single artefact can participate in several interacting or independent functions:

- Physical and functional—the artefact may be the outcome of work: a car running off the production line or an order dispatched to a customer. Alternatively, it may be the tool through which outcomes are achieved, such as a spanner or a computer printing an order.
- Information and communication—the artefact may be used to communicate between parties within an organisation/workgroup and record information for later use.

- Control and coordination—the artefact may be used to help people coordinate actions, record the stage an activity has reached within a process or act as the trigger to prompt further activity.
- Social and political—we came across an example in Sect. 6 that demonstrated the political role of the agenda.
- This was important not just in establishing what happened in the project, but also, like deer rutting, the conflict also established initial power relations. Artefacts also display status: the diamond necklace, leather briefcase or clipboard ... even by their absence: the top manager's empty office and desk says "I don't do work I control it".

Artefacts encode these functions in several ways, often representing different functional aspects in different physical attributes:

- Content—for paper documents, computer files, memos, letters, notices, whiteboards, even oil paintings, there is some explicit content in the form of text, diagrams, numbers, images and so on. Our analysis of minutes was centred on this explicit content.
- Appearance—the same letter may be printed or handwritten; it may be on vellum, printer paper or the back of an old envelope; it may be on a pristine sheet of paper or crumpled and oil stained. The appearance is important for its social purpose (at one university, students complained that their diplomas were not printed on heavy enough paper), the messages it gives about provenance (been through many hands or newly printed), communicative status (photocopied for many, or handwritten to an individual) and reliability (formally approved or quick sketch). Note how the headers and formal structuring of the DIRC minutes differ from the BEC minutes, not only in terms of the contents conveyed, but also their formal appearance signal that they have a different purpose. Whereas BEC 'minutes' are an aide memoir, the DIRC minutes are intended for others and for formal audit of the project.
- Disposition—we have already discussed and seen in our studies the crucial importance of the disposition of the artefact within its environment. While appearance and content relate to the intrinsic attributes of the object, i.e. aspects which will remain even if extracted from its physical context, the disposition is more about the extrinsic attributes—where it is: on the desk or on the floor, on the left hand side of the desk or at the front, under the telephone or in the door; how it is placed—in a straight tidy pile or higgledy-piggledy, partially overlapping another document or side-by-side, at an angle or straight. One of the authors recently noted that when putting temporary notes in his door (of the "gone for 5 min" kind), he was placing them deliberately at an angle. He realized that subconsciously he was using this "temporary" look of the angled paper to distinguish it from the aligned permanent notices. The importance of disposition is recognised in other fields: before removing evidence, police will carefully photograph a crime scene and record the location of each article; similarly, an archaeologist will draw diagrams and photographs to record not just the plan view location but also the depth amongst strata of each find so that it can later be related to other artefacts and understood in context.

These different attributes are often used to encode different kinds of function: for example, information and social status in a roughly photocopied letter from management to staff. It may also encode several pieces of 'information' for the same function: for example, the content of an order says what is needed and the fact that it is in the out-tray means the order has been dispatched. However, sometimes a single artefact can use several attributes to encode complimentary or even contradictory elements of the same function; for example, the letter that says "yours respectfully"

yet is clearly hastily written on grubby paper. This is rather like semantic/pragmatic distinctions in linguistics, or the declarative meaning (locutionary) versus illocutionary act in Austin's speech act theory (Austin *1962*): "it's cold in here" meaning "please close the door".

The artefacts we have described in this paper, being focused on meetings and offices, tend to have some form of content. However in, say, a car-repair garage, many of the artefacts will have no explicit content, but their appearance and disposition will be important: for instance, the clean shiny machine that no one uses vs. the oily spanner. Of course, a shiny spanner may mean a tidy workman as opposed to a sloppy one.

As we have already noted, the meaning of an artefact is something that depends on interpretation. We need to know who produced an artefact, who placed it, who it is for. Some of the meaning of an artefact is immediately obvious from its physical properties. Gibson's concept of affordances (Gibson *1977*; Hartson *2003*) relates to this in terms of intrinsic attributes, just as placing a box by a door clearly, by its physicality, is acting as a reminder. Other meanings require an understanding of cultural, organizational, social and individual context. For example, the initials in the DIRC minutes are recognisable by any member of the project, but they do not have much meaning to someone reading them from outside. In contrast, the fact that the document under the operations manager's phone in BEC needed to be dealt with at a particular time in the year was interpretable by him alone.

This interpretation of artefacts is intimately connected to the scale of the role they play. Are they functioning purely in the context of one individual's activity, or wider in the work group, organisation or broader society? Theories and frameworks vary depending on where the main focus lies. For instance, psychology, including the study of affordances, is aimed more towards the individual, work study approaches and distributed cognition instead focus primarily (although not exclusively) on the interaction within the work group, whereas the significance of the twin towers in the US psyche would be the province of media studies.

The title and structuring of this paper has centred on the lifecycle of an artefact, the way it is explicitly (or accidentally) designed or created and then accommodated, augmented and potentially accepted into the process of routine activity. This is clearly related to the longevity of the artefact. Is it like a hastily scribbled note: designed and created in the context of ongoing activity, or like TeamSpace or organisational regulations: carefully designed and crafted to achieve particular purposes over many years? In the former case, design—creation use and designer—craftsman—user are conflated, whereas in the latter these roles are distinct.

TeamSpace and other such tools are interesting as they have their own lifecycle and use but they also create the structures within which individual meetings have agendas, minutes etc. Electronic artefacts are thus created and used within the context of the tool. Electronic artefacts are particularly promiscuous in this intermingling of artefact as tool and artefact as tooled-object. However, this fluidity of design and use is not confined to the electronic artefact: consider the book as written, the book as printed, the book as bookmarked and dog-eared on the shelf, the book open on the desk.

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8 Summary

We have discussed how artefacts can be used as an effective means both to elicit the implicit models and understanding of designers, and to trace the path of tenuous and long-drawn activities in the office. We have looked at the status of minutes in some detail, which although at first appear

to be 'formal' documents, are actually produced in a rich context and must be read and interpreted accordingly. Looking at related techniques, we can see that our own approach is promiscuous—sharing aspects with each. However, this reflects the intricate role of artefacts themselves driving complex activities, requiring rich interpretation and prompting further information from users. Just as artefacts form an integral part of the rich ecology of the work domain, artefacts also need to be used as an integral part of the rich ecology of elicitation and analytic techniques.

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Footnotes

1 http://www.comp.lancs.ac. uk/computing/research/cseg/projects/tracker

2 2001 IBM T.J. Watson Research Center, The Boeing Company http://www.research.ibm.com/teamspace

3 http://www.dirc.org.uk