

Mobile technologies in mobile spaces: Findings from the context of train travel

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Abstract

Whilst mobile work is increasingly prevalent, there is little detailed study of this phenomenon in the specific context of a train. Thus, the current study focuses on how mobile work is conducted onboard trains, as a way of exploring general issues relating to mobility. Through survey and interview data, several constraints to mobile work on the train were revealed. These include the lack of reliable communications network, access to co-workers and lack of privacy which together restrict the types of communicative tasks people carry out. We found that the majority of tasks conducted were socially independent in nature (without the need for communication with others). However, people made some technological task and contextual adaptations which allowed them to work around these limitations to conduct some socially interdependent work (with the need for communication with others). We explain why and how specific technologies/media are used (and adapted) in this setting and explore the implications this has for technology design and our thinking about mobile work.

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1. Introduction

Mobile work is increasingly prevalent (Hardill and Green, 2003; Hislop and Axtell, 2007; Felstead et al., 2005) with workplace studies showing that office professionals now work away from their desks 50–90% of their time (Bellotti and Bly, 1996; Wiberg and Whittaker, 2005) and even work on business related journeys (e.g., Axtell and Hislop, 2007). Mobile teleworkers can be characterised as people who spend time travelling and/or working at different locations, who use ICTs in their work, whose work involves some level of knowledge intensity and communication with others either internal and/or external to their organisation (Daniels et al., 2001). Such work has partly been facilitated by recent developments in mobile

computing and communications technologies, e.g., mobile phones, laptop computers, PDA's, Blackberry email devices. Wider wireless connectivity in airports, trains and even planes (Perry et al., 2001; Brown and O'Hara, 2003) has also increased the potential range of tasks that can be done on the move. For example, mobile phones have evolved from simple telephony devices to now incorporate a wide range of functionality including calendar and diary, email, photo and video capabilities, as well as (somewhat limited) document storage, retrieval and utilisation functions. These changes have a number of potentially significant impacts on the nature of mobile work, and communication. This paper attempts to explore the impacts of one specific mobile setting, that of the train, on work and technology usage.

First we need to explain what we mean by mobility. As Perry et al. (2001) assert, a core part of mobile work is travelling. We draw on Kristoffersen and Ljungberg's (2000) conceptualisation of mobile modalities. They distinguish between 'travelling' (the process of going from

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one place to another in a vehicle); ‘visiting’ (such as when visiting a client site, where the worker spends a prolonged period stationary); and ‘wandering’ (which involves extensive local mobility/walking around within a building or small area). Train travel, which is our focus here, can mainly be seen as occupying the ‘travelling’ mode of mobility within this framework. This can perhaps be seen as an intermediate form of mobility as mobile workers on a train may well be stationary relative to the immediate physical context (e.g., sitting in a seat—if they are lucky) whilst at the same time moving relative to space outside the carriage.

The technological requirements of work tasks conducted on a train reflect this modality of being at the same time stationary and yet mobile. Tasks can be characterised by the level of social interdependence (or interaction between people) required (Mintzberg, 1979). This is particularly relevant when considering the use of communication technologies. For tasks that are socially independent (without the need for interaction with other people), there is the requirement that the work media/technology are portable, fits and can be manipulated in the space allowed, and have enough power to work in that local context. However, for socially interdependent tasks (which do require interaction with others), there is also the requirement for network connectivity if the other person is not co-present. Connectivity cannot be guaranteed on a moving train which goes through signal blackspots, although in the dynamic and unpredictable context of the train carriage, the portability/manipulability requirements may also prove difficult to satisfy.

So, whilst ‘remote mobility’ is important (having access to, and being able to share information with, distant colleagues when on the move) another form of mobility that is of importance on a train is that of the ‘micro-mobility’ (cf. Luff and Heath, 1998) of the mobile technology and artefacts themselves. Micro-mobility refers to the ability to manipulate technology and other artefacts in order to complete the work. Whilst Luff and Heath’s original use of this term refers to passing or sharing artefacts between individuals, we might also be able to extend this notion to include the ease of manipulation of artefacts for use by lone individuals within the mobile work context they inhabit. This becomes particularly important in the tight spaces available onboard a train (particularly when crowded) or when limited time is available. In such circumstances, setting up and using some technologies (like laptops) might be difficult or inefficient. Moreover, the local context of the train carriage is not static and is not as predictable as a normal office environment and so mobile workers may have to move and reconfigure what they are doing as circumstances change. For instance, workers may have to move to allow another passenger to sit down, or change from standing to sitting down when a seat becomes available, or conduct a different sort of task if the carriage becomes too noisy or crowded. Therefore, the mobile worker has to dynamically re-configure the space around

them, or the technology/artefacts they are using in order to conduct their work (Brown and O’Hara, 2003).

When considering ‘context’, we refer to the local context as both the *physical* and *social* space that the mobile worker is currently inhabiting (in this case the train). The physical space includes the layout, noise, etc., on the train, whereas the social context refers to the norms of conduct in that space (e.g., the desire for privacy and not disturbing others). However, other *more distant contexts* may also influence mobile worker activity. For instance, the social aspects (norms and expectations) of the mobile worker’s distant organisational context may still have an effect. Kakiyama and Sørensen’s (2002) perspective on mobility emphasises the notion of contextual mobility. They propose that although there might be some local contextual constraints on human action, mobile technology releases people from the usual contextual constraints on human interaction and allows people to interact across multiple contexts. We, however, argue that the constraints that do exist in some contexts are likely to inhibit the use of ICTs and human interaction. At the same time, there may be a strong motivation to manipulate the local context to reduce these local constraints on human interaction (as well as to manipulate the technology to overcome technological constraints). Such manipulations and adaptations may be more likely if the norms and expectations of the distant organisational context demand it.

The local constraints onboard a train are clear when considered relative to the traditional office with its typically resource-rich and stable environment. Office work is highly communication-intensive with workers spending between 30% and 90% of their time engaged in communication with others (Whittaker et al., 1994; Wiberg and Whittaker, 2005), and much of this communication is facilitated by straightforward access to co-workers for face-to-face communication. Office workers have ready physical access to other important resources too; they generally have their own desks, allowing them to organise their papers for processing (Kidd, 1994). They also have access to key data sources such as filing cabinets or computers (Sellen and Harper, 2003). They also have resources such as meeting rooms to use for discussions, allowing them to hold confidential conversations in ways that do not disturb their co-workers. A final important characteristic of the office is that there are certain organisational norms and expectations in operation, such that people are expected to be available for work-related communication and to be engaged in work activities (e.g., Rousseau, 1995).

The resources available on trains are impoverished compared with the office. Electronic access to co-workers is restricted to communication using mobile phones and email, both of which may suffer from lack of network coverage. Moreover, when conversations take place, they may be overheard or (in the case of emails) overseen by others. Information too is limited to what is brought on a laptop, PDA or printed out. Physical space is restricted and workers are vulnerable to interruptions from others

holding conversations. It is difficult, too, to find private places for conversations of a confidential nature. However, as trains are a public space, norms of conduct also operate here, such as the desire to maintain privacy and not disturb others, and this may limit what work can be done. Together these technological and local contextual factors may combine to reduce the likelihood of certain tasks being conducted on the train. Thus, the rhetoric of ‘anytime, anywhere’ access may not easily be realised in this context (cf. Perry et al., 2001; Wiberg and Ljungberg, 2001).

There is already existing literature that explores the relationship between mobility and work (e.g., Perry et al., 2001; Brown and O’Hara, 2003; Felstead et al., 2005; Perry and Brodie, 2006). Some of this work mentions the impact of contextual constraints. For instance, Perry et al. (2001) argued that the context that mobile workers find themselves in, and the uncertainty of resources that will be available to them, will determine their work activities. They also found that travel time was considered ‘dead time’ where access to certain artefacts and technologies was restricted. Nevertheless, it was still considered a key element of mobile work, and people planned what they would do in this period around what resources they would have available. Brown and O’Hara (2003) also talk about ‘place’ being a concern for mobile workers. They note several examples of local contextual constraints in various situations and the ‘uncertainty’ this offers. They argue that mobile workers cannot anticipate exactly what situations they will encounter or what resources will be available whilst mobile and so they plan for this by taking different technologies and documents that might be useful. Oulasvirta and Sumari (2007) also observed mobile workers using and switching between multiple devices when mobile. There were several reasons for this: set up time of some devices, the need for a fallback device (if one is not working or not suitable in a particular situation), to enable multi-tasking, to avoid social obtrusiveness or to preserve security/confidentiality.

However, this previous work has not generally focused (as we do here) on how the affordances of the *specific mobile context of the train* influences work. In transportation research, there has been research into the activities conducted on the train (Lyons et al., 2007) but this did not focus specifically on work or use of technology. Within the technology literature, much prior research has tended to focus on general aspects of mobility across multiple travel modes and multiple sites. Whilst some research has examined mobile work in specific contexts such as travelling by car (Laurier and Philo, 1998; Perry et al., 2001; Laurier, 2004; Middleton and Cukier, 2006), or in road haulage (Andersson and Lindgren, 2005; Lindgren et al., 2008) or while driving underground trains (Heath et al., 1999), little in detail is known about how business travellers use the (overland) train for work and how they use various technologies or artefacts to do this. The neglect of this specific context by mobility researchers is surprising, not only because trains have been promoted as

the ‘mobile office’ (Felstead et al., 2005), but also because available statistics suggest that mobile workers making work related journeys on trains frequently spend part of their journey time working. For example, Lyons et al.’s (2007) analysis of a large scale survey of UK rail passengers found that over 25% of those who were using the train to *commute* to and from their usual workplace worked for some of the time on both legs of their journey and approximately 50% of passengers making *other business related trips* were found to work for some of the time on both legs of their journey.

To understand how technology is used within this context, we draw on theories of technological determinism and adaptation. Whilst it may be tempting to assume that the ‘mobile’ environment of a train is not malleable and that tasks have to be adapted to fit this context, an alternative approach would suggest that people may be more adaptive in the face of contextual (and technological) limitations (e.g., Brown and O’Hara, 2003). For instance, some recent work suggests that people attempt to change their local environment on a train by seeking out a suitable space to construct an office and marking and protecting this area from invasion by others (Letherby and Reynolds, 2003). Moreover, whilst technological determinism suggests that technology is non-malleable and that the context has to change to fit the nature of the technology, instead adaptation approaches view technology as both shaping and being shaped by the work environment or context (e.g., Orlikowski, 1992, 2000; DeSanctis and Poole, 1994). Thus, technologies may be adapted for purposes beyond their intended use—depending on the resources available or constraints in the local context. For instance, the mobile phone can be used as a phone, text messenger, a web browser, camera and video recorder, but the functionality that is used is determined by people within their existing social context (Wajcman, 2006). Moreover, Perry et al. (2001) although not explicitly referring to adaptation, mention the notion of using the mobile phone by proxy (to access documents via distant others). Although not in a mobile context specifically, Murphy et al. (2005) talk about convergence in use—where the joint potential of different technologies might be harnessed together (e.g., a home entertainment system where multiple remote controls are physically bound together), and divergence in use—where multiple separate technologies might be deployed to support a single activity perhaps due to weaknesses in a converged technology (e.g., not using the phone capability on a Blackberry, but using a separate mobile phone instead). This type of adaptation may be evident onboard a train.

One shortcoming of the adaptation theories mentioned above is that they tend to assume that people are acting *within one particular work context*. With mobile working, the picture is more complex, as we argue there are (at least) *two work contexts* operating at the same time. These are (a) the local mobile context of the train and (b) the individual’s employing organisation and associated work norms. These two contexts are both likely to interact with

the technology to influence mobile practices and tasks done whilst on a train. For instance, if a person is required by their employing organisation to be available on the phone whilst travelling, they are likely to try to adapt the local situation and their use of technology to fulfil that obligation. Such behaviours are particularly interesting as they involve technological or contextual adaptations, which have implications for technology design. We discuss these implications in the conclusions.

This paper therefore has two main objectives:

1. To characterise the key differences between the train-based mobile work environment and that holding in office situations. In particular, we look at the local (train) resources and constraints (e.g., lack of space and privacy), as well as characteristics of the organisational context (e.g., expectations about availability while mobile).
2. To explore the main impacts of this important type of mobility, particularly in relation to tasks conducted and adaptations made in order to do the work.

To explore the train context and use of technology, we use a mixture of surveys and interviews. This approach allows us to gain a wider overview across a range of train users regarding the tasks conducted and technologies used onboard a train, which we follow up with qualitative interviews to gather rich descriptions of novel working practices that are difficult to find through surveys alone.

2. Method

A short survey was administered to all business passengers who were working (or said they did work during train travel) whilst travelling on a busy intercity line within the UK during 3 days in the summer of 2006. The majority of trains between early morning and early evening were boarded by a researcher who handed out and collected surveys (some were returned by reply paid envelope if people did not complete them on the train). Of the 514 surveys administered, 350 were returned (a response rate of 68%) and so a reasonable level of representativeness of the business traveller population on that route was sampled. The age of the respondents varied between 19 and 67 years, with an average age of 42.5. The gender split was almost equal with 56.5% of the respondents being male, and respondents covered a range of (predominantly white collar professional) occupations including solicitors, management consultants, teaching and research professionals, health professionals, sales and customer service.

The survey asked a range of questions about working onboard trains such as the balance between socially independent and socially interdependent tasks (i.e., how much the task required interaction with others) that the respondents conducted whilst travelling by train. It also probed the extent to which different work media and

Table 1
Background details of interviewees

Interviewee ID	Age	Gender	Occupation
01	43	Female	Communications consultant
02	48	Male	Judge
03	30	Female	Business consultant
04	38	Female	Sales manager
05	30	Female	Solicitor
06	49	Female	Arts consultant
07	38	Male	Civil servant
08	47	Female	Senior IT manager
09	51	Male	Civil engineer
10	51	Female	Civil servant
11	41	Male	Academic
12	27	Female	Health and safety/environment officer
13	43	Male	Education consultant
14	53	Female	Healthcare consultant
15	40	Male	Administrator
16	34	Female	Water board manager
17	43	Female	Finance manager
18	38	Male	Management consultant
19	46	Male	Regional manager

technologies were used. Questions were answered on a five-point scale from 'not at all' to 'a great deal'. The survey provided the background about generalised practices and constraints for business travellers onboard a train which could then be explored in more detail via interview. One hundred and thirty respondents indicated on the survey that they would be willing to take part in a follow-up interview. Of these, 26 were approached and 19 finally agreed to be interviewed (see Table 1 for summary). These 19 people had an age range of 27 to 53 (average age of 42), 42% were male and they occupied a range of occupations and technology usages, so that they were representative of the survey. The interviews went into more depth on some of the issues raised in the survey and explored the reasons behind the choice of task and technology, as well as workers' perceptions of the constraints of train-based working and what actions they took to circumvent these constraints. Interviews were either conducted in person or by telephone, and lasted approximately 1 h each. All were recorded and transcribed. Analysis was conducted through template analysis (King, 2004). This is a technique whereby some themes in the data are identified prior to analysis but can be modified and added to from the interview data. Themes are identified and organised hierarchically from broader to narrower sub-themes. Analysis was aided through the use of NVivo (a computerised tool to help with the organisation of themes and data).

3. Findings

In the following sections, we first explore the main differences between the office and train. We next describe the adaptations and use of technologies within the context of the train (or changes to the context to accommodate the

Table 2
Summary of main survey findings

	Never	A little	Moderately	Quite a lot	A great deal
Constraints on mobile work					
Space	3	16.5	25.5	37	18
Noise	7	41	29	18	5
Movement	14.5	40	28.5	13	4
Task type conducted					
Socially independent	1	7	12	37	43
Socially interdependent	23	50	16	9	2
Technology used					
Pen and paper	1	18	24	29	28
Laptop	29	18	15	20	18
Mobile phone	12	35	29	15.5	8.5
Blackberry	87	1	2	4	6
PDA/Palmtop	85	6	5	3	1

Figures in table represent percentage (%) of sample.

use of technology). We illustrate these findings with representative quotes and analysis from the interviews and survey. A summary of survey findings can be found in Table 2.

3.1. What are the main differences between office and mobile (train) contexts?

3.1.1. Local contextual resources and constraints

Local contextual resources and constraints can be thought of as the main facilitators and inhibitors within the immediate local environment which affect the worker's ability to conduct their work. For instance, the immediate physical situation differs quite radically between offices and trains. In the office, there are a range of resources available as people typically have their own desk, with straightforward access to others for formal and impromptu face-to-face conversations, as well as access to reliable email and phone connectivity. On the train, however, such resources are harder to come by. There may be competition for physical space, and facilities such as electrical power and Internet connectivity may not be available (although WiFi and power are now provided on some train services). Access to distant others is limited to that conducted via mobile communications technologies. The sorts of work media and technologies that business travellers have at their disposal are what they are able to carry with them and can use within the space available in the carriage, including paperwork, mobile phones, PDA's and Blackberries, and laptops.

In terms of constraints, 55% of survey respondents said that *space* affected their ability to work on the train either 'a lot'/'a great deal'. Expanding on this, interviewees complained about there not being enough table space, particularly with 'airline' seats and their fold-down tables. Even at larger tables, it is cramped if four people are using laptops. One interviewee described this competition for space as 'laptop bumper cars!'

Noise was also a factor that could inhibit work (with 23% on the survey saying noise affected their ability to work 'a lot'/'a great deal') although most said noise did not effect their work much (48% saying 'never/a little'). Indeed, when discussed with interviewees in more detail, some spoke of the relative quiet of the train compared with their offices, especially in first class carriages. Another limitation of the train interviewees described was the *lack of mobile phone/internet signal* through certain network black-spots and tunnels. Moreover, where WiFi facilities were available on the train, the *cost* was mentioned as being prohibitive by some interviewees. Somewhat surprisingly, however, the lack of connectivity had some positive impacts; as it meant that there were fewer interruptions from phone calls (thus, contributing to the relative quiet described). However, connectivity problems also removed the control that people had over whether to use network-dependent technologies:

... the fact that people can't ring me on the train, can actually give me quality time to sit and work away quietly ... But then again, I would rather have the communication potential, and I can choose to answer or not to answer. (09)

Train *movement* could also be a problem, particularly for writing with a pen (although only 17% of survey respondents said that movement affected their ability to work 'a lot'/'a great deal'). Thus, movement was not considered a major constraint. Although not asked about in the survey, the *length of journey* was also mentioned by interviewees as a factor that affected the type of tasks that can be done, as there can be insufficient time to make progress on 'longer' tasks on a short journey and it may not be worth using or setting up particular technologies, such as laptops, for short periods.

Other salient features of the local train context are the *norms of conduct* within a public space which could be a constraint on work. For instance, most interviewees had a

desire to maintain privacy and not disturb others, but in this relatively cramped public space, there is *lack of privacy* which meant confidential tasks were less likely to be done. As one interviewee said:

I would like the opportunity to review commercially sensitive documents on the train, on the screen ... but I feel I can't do that, because I never know who's behind me or who's next to me. (08)

Moreover, some tasks may require one to *disturb others*, such as making phone calls, and people may overhear things that you do not want them to overhear.

3.1.2. The worker's organisational context

Even distant organisational contexts exert some influence on mobile work which can inhibit or facilitate mobile work. In the office, there are various *norms and expectations* (i.e., authoritative standards regarding what workers should be doing) such as making themselves available to co-workers or customers for conversations, and to be engaged in work activities during work hours (or sometimes even beyond). This may not be true on the train; if people are travelling, they may not be expected to work or to be constantly available for others. Indeed, most of our interviewees were not directly told that they had to work on the train, and so had less motivation for mobile working when local conditions were prohibitive (e.g., noisy, lacking privacy, space, etc.). However, others *were* explicitly expected to work on the train. One such interviewee said:

Yes [my company would expect me to work on the train] because otherwise they would require me to travel in my own time ... I have hourly targets and financial targets but if I didn't work whilst I was on the train then I wouldn't ever achieve them unless I worked in the middle of the night. (05)

Even without this being made explicit, there was often an implicit expectation to be contactable by mobile phone:

Yeah I mean there is an expectation if I am on a train, you know I'll have my mobile switched on and I'll be contactable on that and I think there is an expectation that we do some work on trains but not, it's not measured. (07)

Such expectations were likely to be stronger during busy periods when the requirement for contact was more urgent. Thus, it can be seen that the organisational context and expectations can vary but in some cases can be quite demanding. Therefore, we might expect that the norms and expectations of the organisational context will affect whether mobile workers try to overcome the limitations of the local (train) context and technological limitations to conduct their work. This will be expanded in the next section.

3.2. What adaptations do people make in order to conduct their work?

Having characterised the main differences between the office and mobile context, we now explore how these differences affected the tasks carried out while mobile, the technologies that people used, how people adapted to local context and finally how organisational factors affected mobile work.

3.2.1. Task adaptations

One major implication of the limited resources available when mobile is that people modified their tasks. They tended to carry out *socially independent* tasks with reduced need for communication with others. Technical and local contextual constraints (such as privacy concerns, lack of mobile signal, expense of WiFi) lead to difficulties communicating with others via ICTs, and so people mostly conducted socially independent tasks that did not require real-time interaction or connectivity with others (such as reading, typing up notes, deleting previously downloaded emails). Indeed, the survey found that 43% of respondents said they conduct socially independent tasks 'a great deal' when on the train, whereas only 2% conduct socially interdependent tasks (which require interaction with others) 'a great deal'. Thus, the task is adapted to, or is limited by, the local context of the train and technological characteristics. Several interviewees directly acknowledged that they adapted to these local and technical limitations and only conducted work that they could do easily on a train (unless there were strong external pressures from their organisation to communicate with others). One task adaptation mentioned by some was to do socially independent work (like completing expenses forms) in places where they know there is a signal black-spot and conduct socially interdependent tasks (like phone calls) where they know the signal is better. As one interviewee said:

The signal [on the first part of the journey] is non-existent. So, that's probably when I do most of my email catch up [off-line], responding to things, pick up on expenses—all the mundane duties. Then [on the second part of the journey] I'll pick up on mobile calls, catch ups. (08)

Other interviewees mentioned that they deferred socially interdependent tasks until they were off the train. Yet others circumvented connectivity issues by changing how communication was conducted, so for instance emails were written but not sent. Some interviewees also mentioned taking socially independent work with them that could be done if the network signal is bad, such as reading. Thus, the mobile context offers clear trade-offs; although one type of work (socially interdependent) is limited or deferred until later, another type of work (socially independent) can be enhanced.

The noise, crowdedness and space constraints of the local context can also limit the level of concentration that

people feel able to give to tasks, which in turn affects the types of tasks they conduct whilst on the train, leading some to select fairly undemanding tasks. As one interviewee stated:

I try to take what I realistically can do on the train. I wouldn't try to do any real brain-work apart from stuff I am formulating for the meeting ... because you can never tell until you get on the train whether it is going to be worth doing any real thinking. Sometimes you get a nice quiet carriage and there is no-one being noisy so you could then actually get that sort of stuff done but you can't guarantee it. I wouldn't like to wait until I get on the train to see. If it is busy you can't get your laptop out or you're crammed in and noisy people, so I don't risk it. (03)

Instead, many therefore choose to do administrative tasks that require low levels of concentration such as planning reports, drawing diagrams, creating presentations, planning ahead, moving emails to different folders. Thus, here again, the task is limited by the constraints of the local, train context. Similarly, due to concerns about privacy, several interviewees said they do not conduct (or they try to limit) private/confidential work that others might overhear or oversee. Due to privacy concerns, 'silent' socially interactive tasks (like emailing) might be preferred when communication is required, as illustrated below:

I would be unlikely to ring someone if it wasn't a required action for that day on the train, because it's not the best place to have a conversation ... whereas emails I might pick up ... and just bat it back just because I can pick it up now and I've got nothing else to do so I may as well just respond to it there and then. (16)

Thus, socially interdependent, communicative tasks may still be conducted if the task does not require privacy or consistent network coverage (e.g., sending a text message, email or a short call to say one has arrived).

However, the interviews also revealed a positive side of the lack of consistent connectivity with others. Some people exploit their freedom from co-workers interruption to work on substantive socially independent tasks like writing reports (assuming the carriage is not too noisy or cramped). Others exploited the fact that they were not in their usual organisational context. They used their relative freedom from office interruptions for conducting tasks that they would not normally get the chance to do, such as catching up on reading documents. There is clear adaptation at work here. The limitations of the local context and technologies within that context (i.e., lack of signal for social interactivity) can facilitate the conduct of some socially independent tasks, giving people the freedom and time to do things that would otherwise be neglected.

3.2.2. Technology/work media adaptations

We found that the limited resources of the mobile situation led people to use technology/media in various

ways. The choice (and use) of technology again seems to be constrained and enabled by the local context as well as technological limitations. Some choose to either not use certain technologies, or use these technologies in a limited way.

First, in the survey, pen and paper was shown to be the *primary* work medium on the train, with nearly 57% using pen and paper 'a lot'/'a great deal'. The second most popular work medium was the laptop, with 38% saying they use these 'a lot'/'a great deal'. Analysis of the survey data showed that these two work media were strongly related to socially independent tasks (although laptops were also related to socially interdependent working, probably due to the facility to email). Paper may have been used more than laptops due to the restricted space available on the train (and the greater micro-mobility of paper to be usable even in a small space) and relatively longer set-up times for laptops. As two interviewees noted:

I do find it much easier to write rather than use a laptop because of the design of the trains. (02)

This commute is almost too short by the time you have set it all up. I think if my commute was longer I would definitely be doing more work on my laptop. (01)

However, carrying and using paperwork and laptops was not without its problems. For instance, interviewees felt both can be heavy, which can limit their use due to the need to carry them around when mobile.

Nevertheless, somewhat surprisingly, despite being relatively lightweight and mobile, the mobile phone was only the third most used device according to the survey, with 24% of respondents using this technology 'a lot'/'a great deal'. The survey also suggests that other small mobile devices were used infrequently on the train (with only 10% using a Blackberry 'a lot'/'a great deal'; and PDA/Palmtops being used by just 4% 'a lot'/'a great deal'). This may be because these technologies were not that widespread in the UK at the time of the research, rather than due to contextual or technological limitations. Indeed, those interviewees we spoke to who did use such technologies reported on their usefulness for emailing whilst mobile on the train. Thus, the limited general use of Blackberries on the survey does not necessarily reflect their real potential for mobile work at this stage.

Mobile phones, however, are widely available but were not used as much as other work media on the train. There were contextual and technical reasons for this; phone calls violate the privacy norms of a public space and they also require sustained network coverage. Thus, some people switched their phones off whilst on the train, or put them on silent so as not to disturb others. This behaviour was more likely for interviewees where the organisational norm for 'being available' was less strong. Some people tried to make sure that others would not try to contact them during train travel, by providing access to their diary, alerting potential callers that they would be on the train and so not

available. For example, for the following interviewee, the organisational norm did not appear to have a strong pressure or requirement for availability, in part due to the recognised limitations of conversation in that context:

We don't tend to get a lot [of calls] because the people I manage have access to my calendar and they know where I am and they know when I am on a train and generally they'll tend to hold off until they know I am somewhere where they can speak in an uninterrupted way. (19)

Others did use the phone but tried to make short, infrequent calls, or used 'silent' text based communication instead such as email:

I hate noise pollution so I try and avoid too long phone calls because I hate people talking around me and I don't want to be the person annoying everyone around me. So Blackberries are great. (04)

Similarly as a consequence of privacy concerns, mobile phones were sometimes used for silent work (e.g., text messaging, linking to laptop for downloading email) rather than for phone calls. Text messaging (or email) was also often possible in areas where network coverage was only patchy, where long phone calls could not be made. For example:

I tend to send them a text saying 'I'm on a train. I will call you at such and such' and then wave my hand around until the message goes. (19)

I use my phone to download my email, which plugs into my laptop so the advantages are that I can keep up to date with, I mean it is a three and a half hour trip so you can get a lot of emails in that time and it is useful to send emails and that is what I mostly use my mobile for rather than making phone calls ... (07)

So whilst limiting conversation on a mobile phone, these privacy/noise and network connection constraints increase the use of asynchronous functions like text messaging or email.

However, as mentioned previously, even with the 'silent' socially interdependent task of email, many people worked on these in a socially independent manner (off-line), unless they were urgent or the organisational requirement for being contactable was high. A delay of a few hours (until the end of the journey) before sending an email was not generally seen as a problem, as emails are not generally considered urgent. Somewhat surprisingly, however, email *was* sometimes used for urgent communication (especially via Blackberry devices) when there was no other choice, i.e., if network coverage was poor, when trying to get hold of other mobile workers, or where there were privacy concerns:

... we use email to get round that if it's something urgent. You tend to stick it on the email and then reinforce it [later] with a phone call ... (04)

In such cases, the technological and local contextual limitations are worked around if the need to communicate is high. This results in a technological (divergence in use) transformation, as under normal circumstances the mobile phone would be used for something urgent rather than email.

Another aspect of mobile phone functionality that is *emphasised* due to local constraints is call filtering. For instance, if interviewees know a call is likely to be confidential or turn into a long conversation, they may decide not to answer. However, if a call is urgent and/or there is a high organisational expectation to answer, then they will take the call. Other people put their phone through to their voicemail and call back later. Call filtering can reduce disturbance, help people control work demands and enable them to match calls to particular settings (Felstead et al., 2005). As one interviewee said:

I mean sometimes, the honest truth is occasionally somebody will ring and I'll have an idea what they are ringing about and I might think, 'oh, can't be bothered to do that now', or more often I will know what it's about and its like a ten/fifteen minute call and I know I am going to go through tunnels and stuff and I'll tend to just hit the button and take the message really and then ring them back in my own time. But most of the time if the phone rings I'll answer it. (19)

Indeed, voicemail was considered to be a very useful aspect of mobile phone functionality, especially for call filtering or if the network coverage is bad.

What tends to happen is they leave a message on voicemail because a lot of people don't get through first time. I suppose that ... could be an advantage actually as you can listen to the message before speaking to the caller. (13)

The limitations of the local context (e.g., lack of privacy, and lack of consistent network coverage) can result in communication technology being used in somewhat unexpected ways when the requirement to communicate is high (such as when the pressures and expectations of the organisational context are high). For instance, new communication protocols were developed for confidential mobile phone conversations. Some interviewees mentioned having stilted, 'one-way' conversations, in which the person on the train is asked a range of specific questions by the caller and just answers 'yes' or 'no'. Alternatively, people who are the subject of the conversation may be referenced anonymously or given code names. For example:

I generally say to the caller I am on the train so I can't have as full a conversation with you as I might like and I would say if you ask me questions then I can give you the answers ... (05)

The only issue I find on a train is if you're having to discuss a commercial issue relating to a particular supplier—and there are ways around that. If I reference

them anonymously, and as long as the other person knows that's the reference you're using, there are certain conversations that you can take. (08)

Although there were fewer privacy concerns when using a laptop, when confidential email communication was necessary, then similar abbreviations or codes would be used so that anyone looking over the typists' shoulder would not know who was being written about.

... it isn't blatantly obvious who I am writing about because particularly with emails it tends to be Doctor S or Doctor T so you are never one hundred per cent certain as to who it is unless you are actually involved in it. (05)

Such new communication protocols were developed by our interviewees when the local context was prohibitive (in terms of lacking privacy), but the organisational expectations and requirement to communicate was strong. Where the expectation to communicate was weaker, there was less evidence of such communication protocols. Such workers were more likely to avoid the phone call or email instead if there were privacy concerns.

3.2.3. *Local contextual adaptations: train*

When the need to conduct certain tasks is high, people may attempt to change the local train context to use mobile technologies and conduct these tasks. For instance, due to restricted table space, many interviewees said they opt for putting laptops on laps! People may try to counteract the lack of space and privacy by trying to create and guard a personal workspace. They put bags in the next seat, or sit in seats where they hope nobody will sit next to them, such as in a two-seat/airline-seat arrangement rather than a table seat. People compete for space in this context, and a hierarchy seems to have emerged on the train, based on the space required for certain work and technologies. As one interviewee put it:

I will never bother getting a table seat because I am always fighting laptop users who some how regard themselves as having a moral right which outweighs my pencil and paper ... so I am not having to compete with the laptop users [in the airline seats]. (02)

Other transformations of the local environment occur to block out the noise and lack of privacy. For instance, earphones were often used to block out carriage noise and create extra-perceived privacy. Moreover, sitting in certain seats also enabled a greater sense of privacy. As one interviewee said:

... I tend to go ... for the little sort of two-seat, and generally beside a window if I can. I don't like the bays with the tables (I feel too, I suppose too involved with the other people really ... I feel slightly more cocooned in the other seats. (06)

Furthermore, to counteract privacy problems with mobile phone conversations, people may leave the carriage

to make a call in the corridor. To deal with space and noise constraints, others opted to either travel in the first class carriage which is generally quieter and has more space, or travel outside normal working hours where possible. Interviewees who did this felt they were more productive as a result as they had fewer disturbances (which runs somewhat counter to Perry et al.'s (2001) finding that 'dead-time' is rarely used efficiently):

I've done quite a lot of writing of papers and grants on trains, because if you have two or three hours on your own you can actually focus on something and be quite productive. (11)

... working outside normal office hours ... by having that more relaxed atmosphere, I find I can get through significant—it's [the one and a half hour journey] probably worth about three hours in the office, because of phones ringing, team members seeking advice—so you can purely concentrate ... (08)

Thus, people try to adapt the local context (or even remove themselves from part of the context to a more conducive one) to facilitate the use of certain work media and to conduct tasks that require more space, privacy or concentration.

3.2.4. *Contextual adaptations: remote organisational context*

The remote organisational context (with its norms and expectations) also exerted an influence on tasks and was the driving force behind many adaptations made. For those interviewees who were not expected to work on the train, there was little motivation to conduct tasks or use technology that was difficult within the local (train) context. These people were more likely to just turn their mobile phones off or not attempt getting a laptop out. However, despite only a few interviewees having explicit requirements to work on the train, several felt their organisation required their availability by phone whilst travelling. Nevertheless, some interviewees would subvert this expectation and take advantage of the notoriously bad network coverage to switch their phones through to voicemail even when a network was available, relying on the fact that people would most likely assume that they were in a meeting or out of network reach. For example:

... occasionally you will get days when you are trying to concentrate on something and you turn the phone off and you don't ever get people saying why didn't you answer? ... If people get a message they just assume you are doing something else. (09)

Others marshalled technological or contextual excuses for not having done certain types of work. For instance, the following quote is from someone who was normally

expected to work on the train, but who valued the technological ‘excuse’ to not do certain types of work:

I’ve never managed to get wireless to work. I don’t know if the signal is very good. I think it’s probably my technology that isn’t right, or I don’t have the correct piece to do it. I quite like the fact that I can’t really ... It would be handy to send emails but it is also good to say that I can’t if I haven’t got access. (03)

Thus, the limitations of the technology and local conditions can result in temporary avoidance of the organisational expectations and norms for working or being contactable whilst travelling. This in effect becomes a transformation of the organisational context, as its impact becomes reduced.

4. Discussion

We have explored the main differences between office and mobile train-based work, showing how differences in data and communication resources combine with local and organisational contexts, leading to very different work tasks and uses of technology. A combination of unreliable connectivity, respect for fellow passengers and the need for confidentiality, led participants to reduce the amount of time they spent communicating with others. Instead, they worked on socially independent tasks, often using pen and paper rather than digital ‘technologies’, because of their greater flexibility/micro-mobility (cf. Luff and Heath, 1998). When workers were under organisational pressure to communicate, however, they adapted to local situational constraints by modifying how they used various technologies, as well as by working around connectivity problems. Others exploited their freedom from the organisational context with its frequent interruptions, to work on tasks that required high levels of concentration which they had problems completing in their normal working environments. People were highly flexible in their responses to various technical and contextual constraints. Neither technology nor context directly determined people’s behaviours. Instead, people adapted to them both, sometimes making adjustments to their activities within a journey—distributing socially independent and socially interdependent tasks around wireless black-spots. The technological adaptations sometimes involved what Murphy et al. (2005) describe as divergence-in-use. For instance, when email on a Blackberry was used for urgent messages (later followed up by a phone call on a mobile phone), this might be considered divergence in use as multiple technologies are being used for the same activity (i.e., communicating an urgent message). And consistent with Oulasvirta and Sumari (2007), there is evidence of mobile workers switching between devices and using some devices (or certain functionalities) as ‘fall back’ options such as using text messaging instead of phone calls.

Thus, as Perry et al (2001) assert (along with others, e.g., Wiberg and Ljungberg, 2001), the rhetoric of working with

mobile technologies ‘anytime, anywhere’ is far more complex than technology providers might have us believe. Our data suggest that such rhetoric is naively optimistic. Being ‘armed’ with an arsenal of mobile technologies does not mean that it is possible to do any work anywhere. Instead of mobile technology allowing workers to transfer work behaviours into any situation, we saw that a combination of technical limits, contextual and organisation factors led to very different work and communication patterns when on the train. In particular, external pressure from the organisation (and its customers) may motivate individuals to overcome local contextual and technological limitations to conduct their socially interdependent, confidential or demanding tasks during less than conducive times within less than conducive places.

Fig. 1 illustrates a dual context framework for understanding such adaptive mobile behaviour. At the centre, it has the mobile worker who acts and reacts to both the contextual constraints of the immediate train context and the remote expectations of the work context in deciding which work tasks to carry out. Arrow 1 shows that in general, the local and technological resources and constraints strongly affect the mobile workers’ actions (as indicated by the thicker arrow), leading them to choose socially independent tasks, pen and paper, or undemanding tasks. So, for instance, people are less likely to make confidential phone calls due to the lack of privacy and the unreliable network coverage on the train. However, the framework also shows how the organisational context with its expectations for working and communication whilst mobile can moderate the impact that the local context and technology has on the way the mobile worker reacts (Arrow 2) and thus the tasks he or she decides to undertake. So, if there are strong norms and expectations for conducting work on the train and being contactable, then mobile workers are more likely to try to overcome any technological or local (train) constraints—so that they can conduct socially interdependent work, or work that requires high concentration or privacy. For instance, they may conduct private communicative tasks but make adaptations so that they conduct the tasks and use the technologies in an unobtrusive way. If privacy is the only concern then they may develop communication protocols so that they can make sensitive phone calls, but if network coverage is also a constraint then they may be more likely to send a text rather than make a phone call if the requirement to communicate is high. However, if the organisational context does not exhibit high expectations for working and communication whilst travelling, then mobile workers are less likely to try to overcome the local and technological constraints to conduct their work. These people will tend to conduct socially independent work that does not require privacy or concentration. So, they are less likely to attempt a private phone call on the train and will defer this task until later. They may even not work at all whilst travelling (i.e., switch their phone off, not get their laptop out) if local conditions are prohibitive.

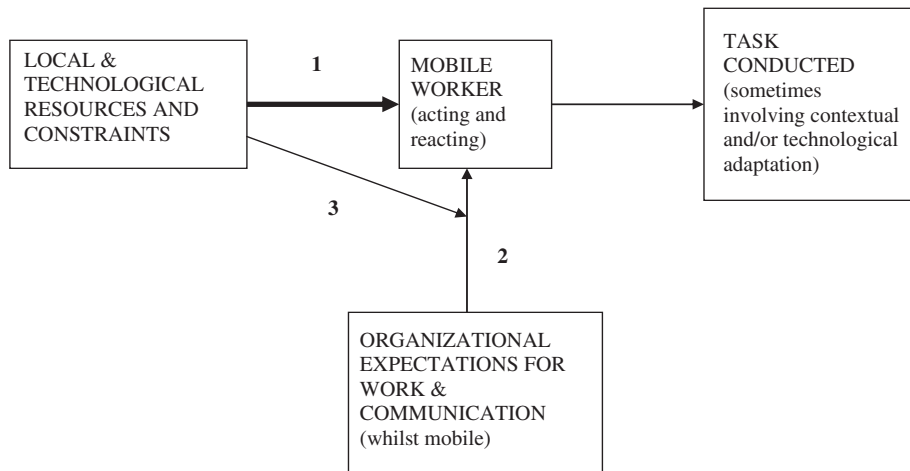


Fig. 1. A framework for understanding mobile work whilst travelling (by train).

Nevertheless, even for those who are not normally expected to work whilst mobile, the organisational requirements and expectations may vary in different circumstances, such as during busy periods when there may be more urgent need for contact. Thus, the organisational context may influence mobile work more during some periods than others. So, for instance, urgent private phone calls are more likely to be made than non-urgent ones. Finally, the impact of the organisational context can be reduced if people are able to rely on local and technological constraints as an excuse not to work (Arrow 3). For instance, they may use the typically poor network coverage as an excuse to defer private calls until later. Although not explored in detail in this study, individual motivations are also likely to play a role here, as to whether people decide to take advantage of these limitations or not. Thus, the framework might be expanded through future research to include individual differences likely to affect the decision to overcome local and technological constraints to conduct work in less than conducive conditions.

This framework will be helpful when thinking about the design of mobile technologies for use whilst travelling by train (or other transport). The ‘anytime, anywhere’ rhetoric of technology providers has led them to focus on certain global properties of mobile technologies (e.g., ubiquitous access, portability), rather than the sorts of local constraints that were also shown to be crucial in this study. Technology providers have also ignored the need to simultaneously inhabit local and remote contexts and to manage transitions between these. Nor have they addressed the preplanning that is currently needed to ensure that key documents and sometimes devices are available for mobile working. We now discuss how new technologies might better focus on these factors.

How might new technologies better address local constraints of micro-mobility, privacy and connectivity? For socially independent tasks such as working on documents, new technologies might improve the flexibility

of work arrangements in limited spaces, by allowing much greater flexibility in laptop configuration. Users should be able to decouple and much more flexibly configure screen and keyboard orientations to better fit the cramped spaces in which they work, as well as to shield screen contents from curious fellow travellers. For socially interdependent tasks, local constraints could be better satisfied by providing direct support for private conversations. For example, mobile phone providers might support new forms of hybrid phone/text interaction to allow users to standardly reply to incoming phone calls in real-time via texts, allowing reasonably flexible social interaction without the need for stilted conversations that not only run the risk of being overheard but are intrusive to fellow travellers.

Holding remote conversations relates directly to the issue of managing dual contexts, and managing the requirements of both local and organisational settings. Technologists need to think more deeply about how to help mobile workers in this regard. Our informants wanted much more sophisticated ways to filter and manage remote calls for socially interdependent tasks. They talked about the need to distinguish genuinely urgent interaction requests from more routine calls that unnecessarily disturbed both them and their fellow travellers. At the moment, they are reliant on callerID—which obviously does not inform the call recipient about the purpose or urgency of the call. Exploration of new technologies that allow callers to supply more information about their call’s purpose (possibly using texting or instant messaging) might allow mobile recipients to better judge a call’s urgency and hence reduce the locally disruptive effects of the incoming call. A related set of filtering technologies might also allow mobile call recipients to set up specific availability profiles, so that incoming callers are made aware of the fact that the recipient is in transit, possibly encouraging incoming callers to use asynchronous methods to get in touch, unless their call is truly urgent.

A different aspect of managing multiple contexts relates to preplanning which is a major problem for participants. Those relying on laptops must ensure that relevant files are transferred to their laptop before the journey and then reassimilated with corporate resources if they have been worked on during the journey. Others print and carry many documents in anticipation of a trip (some of which are never used). Better techniques are needed here to allow synchronisation of organisational and mobile resources. For example, software might detect which documents were worked on between connections of the laptop to the corporate network, and help the user reintegrate these into the corporate system. And other techniques might allow users ‘just in time’ access to corporate resources, using texts or phone calls to access remote documents from their organisational repository that they have forgotten to bring with them.

This study contributes to our theoretical understanding of mobility (in relation to the modality of ‘travelling’—cf. Kristoffersen and Ljungberg, 2000) by highlighting the fact that there is more than one context at play whilst mobile. This dual context is likely to affect the work that is undertaken. The local context that the mobile workers find themselves in whilst travelling (e.g., a train) and the affordances of the technologies themselves are not the only determinants of the tasks mobile workers will conduct. The distant organisational context and pressures that mobile workers experience will also play a part in their efforts to overcome the local constraints and technological difficulties so that they can work on different tasks. This finding differs somewhat from Kakihara and Sørensen’s (2002) notion of contextual mobility whereby workers are considered to be relatively free of the contextual constraints on human interaction. Here, instead we find that there are still constraints on human interaction that need to be overcome whilst travelling by train (e.g., limited space, privacy, network coverage). These local constraints mean that social interdependence is often deferred, such that emails are read, messages are listened to and replies are prepared but are not actioned or sent until later. On the positive side, this might allow greater time for reflection (cf. Schön, 1983). To overcome these constraints to human interaction, a certain amount of reconfiguring or adaptation may be required to the local context/space, the technology, or the task itself. The study therefore also adds to the technology adaptation literature (e.g., Orlikowski, 1992, 2000; DeSanctis and Poole, 1994) by explicitly recognising that with mobile workers, there is more than one work context in operation at any one time: (a) the local temporary work space and (b) distant, more established organisational norms and expectations. Whilst our data derives from the context of the train, this ‘dual context’ framework is likely to be applicable to other locations that mobile workers work in. Finally, another contribution is that this study focuses specifically on train travel and has tried to understand that context in detail whereas previous studies have tended to consider either multiple contexts

(e.g., Perry et al., 2001; Brown and O’Hara, 2003; Felstead et al., 2005) or specific contexts that are different from the train (e.g., Heath et al., 1999; Laurier, 2004; Andersson and Lindgren, 2005). Thus, some further insight has been gained into how mobile workers use the train for work.

Of course, this study has some limitations in its generalisability. First, the study is conducted on a relatively small sample of train users in a relatively narrow range of occupations on one small section of the British rail network. However, whilst the sample might be considered small and focusing mainly on white-collar professional workers, the survey is fairly representative of the rail travellers on that particular stretch of rail and efforts were taken to ensure that the interviewees covered a range of occupations and technology usages as representative of the survey. Another limitation is the relatively low use of Blackberry email devices and PDAs in the survey, which were not widespread in the UK at the time of the study. Therefore, limited insights regarding the use of these technologies can be made from the data. This highlights a difficulty with survey data which can only provide a snapshot of general use across the group surveyed. By using additional interviews we have gained a much richer description to flesh out the general survey findings, and highlight issues that were not asked about on the survey (such as time limitations and privacy) or which may not have seemed important from the survey alone (e.g., the usefulness of Blackberries). However, a final limitation of the study is that there might be recall difficulties among the interviewees when describing their use of technologies and conduct of tasks. However, given that the interviewees tended to be frequent rail travellers, the experiences they recounted are likely to be fairly current for them rather than in the distant past.

5. Conclusion

This study enhances our understanding of the determinants of mobile workers’ activities whilst on board a train, and provides a new framework for understanding the use and design of technology in this setting. In particular, technology designers need to consider the local constraints within which mobile workers are trying to operate the technology, the influence of the distant organisational context and the transition between these two environments. The pre-planning required for travel and re-integration after travel also needs attention.

A key finding of the paper is that the ‘anytime, anywhere’ rhetoric perpetuated by the advocates and manufacturers of mobile technologies significantly underestimates how contextual factors (such as connectivity, space constraints, noise levels and concerns about sensitive conversations being overheard) constrain the work tasks that mobile workers can carry out in locations such as train carriages. But, importantly, another key conclusion of the paper is that mobile workers are not powerless victims of

the contextual circumstances they find themselves in. However, in attempting to deal with such contextual constraints, they are required to undertake work in adapting either the technologies they have, or the context they inhabit, to make it amenable to their needs. Examples of such adaptation work range from choosing where to sit (and how to organise baggage, technology and paperwork) to taking account of mobile phone network coverage in planning what tasks to carry out when. Thus, in aspiring to achieve the ‘anytime, anyplace’ ideal, mobile workers travelling on trains are often required to undertake (sometimes significant levels of) preparatory, adaptation work, before they can even begin to attempt to carry out the work task that is their ultimate objective.

Our work also provides a possible framework for understanding other non-traditional work situations. Many of the problems described here occur in other mobile work situations such as working remotely in a café or hotel, where there may be reasonable connectivity, but scarcity of informational resources along with differing noise and privacy constraints. This leads to predictions about the tasks and technologies used in these different settings and at different times. For instance, if a mobile worker is in a café within range of a Wifi hotspot, having arrived early to visit a client, there might be considerable expectation that he or she is contactable and conducts work at this time. Therefore, despite the café being busy and relatively noisy, the mobile worker is more likely to try to conduct socially interdependent tasks (make phone calls or send emails, etc.) and make local and technological adaptations so that s(he) can do that. The pressure to work in a hotel room (at least during normal working hours) may be even stronger as it is known that the local context is relatively free from interruption, power is available and connectivity more guaranteed. However, here there will be less need for any adaptations as the local context is less prohibitive. We intend to explore these predictions in future work.

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