Organising the machine: material-discursive practices and mobile medical equipment engineers

Lisa Anne Wood
Lancaster Medical School, Lancaster University, Bailrigg, Lancaster, UK

ABSTRACT
In this paper, I consider the mobile work of medical equipment engineers to reveal material-discursive practices during the installation of a Cone-Beam Computerised Tomography system. In doing so, I draw together elements of organisation studies and mobilities to explore movement in relation to matter, meaning and materialisation. I use the medical equipment engineers’ work to explore materialities of organising in physical spaces that are continually changing and examine how mobile work shapes, and is shaped by, context, ordering and potentiality. Drawing on ethnographic fieldwork with medical equipment engineers, the data are interrogated to elucidate these highly mobile working practices, specifically drawing out practices and materialities that relate to ordering and space making. The analysis describes the way in which engineers temporarily “own” spaces in which their work takes place whilst also being shaped by the organisation in which they are placed. I discuss the technologies of ordering (or control), which take the form of plans or protocols (physical or virtual), and material elements, such as signage, that shape, influence and control but also facilitate, enable and authorise mobile work to take place. Modes of ordering, or strategies, are unpacked to reveal how mobilities influence material-discursive becomings and thus how the mobilities of the engineers become internal to the sociomaterial ordering of the machine. Through this empirical paper, I demonstrate how the mobilities paradigm can help understand these circulations of knowledge and thus understand how mobile work shapes sociotechnical assemblages.

1. Background
1.1. Mobile work studies
Theorists and empirical analysts of movement use studies of mobilities to explore the mobility of people, ideas and information to reveal economic, social and political relationships. Drawing on a range of social science traditions and positions, mobilities research explores “… different forms of travel, transport and communications with the multiple ways in which economic and social life is performed and organised through time and across various spaces”
A key concept in considering place and space is that lives and actions, and thus work, is not carried out in places but “through, around, to and from them, from and to places elsewhere” (Ingold and Kurttila 2000). As such, mobilities has been important in studying the in-between and, for studies of work, it has provided valuable insights for exploring the threads of “wayfaring”: the embodied experience of movement between complex, overlapping and ambiguous spaces of home and work.

However, it is not just the movement between home and work that is of interest in mobile work practices. Mobile working has also been widely studied within the field of mobilities research (Ferguson 2011; Hislop 2012; Nóvoa 2012). These studies have explored the relational juxtapositions of work and mobility: work that is done on the move, work that is enabled by movement, and work that is movement. Mobile work and the work of mobility, uncover key sociological themes of technology and communication, place and emplacement, interaction and practice, narrative and account, affect and experience (Seamon 1980; Laurier and Philo 2003; Arp Fallov, Jørgensen, and Knudsen 2013). Following the pervasive use of mobile technologies in both work and private lives, highly complex technological environments have been established. These mobilities information systems, infrastructures and technologies lead on to further systems, infrastructures and technologies (Freudendal-Pedersen, Hannam, and Kesselring 2016). As part of this, mobile work practices emerge, developing and shaping organisations, communities and institutions.

The study of mobilities and mobile technologies within organisations are well documented – the use of mobile devices (Haynes 2010; Hislop 2012), international business travel practices (Beaverstock et al. 2009), use of mobile work space enabled by technology (Brown and O’Hara 2003) to name just a few. Yet, the fields of organisation studies and mobilities have not, as yet, been adequately theoretically connected. How do mobile work practices, mobilities and micromobilities configure organisations, technologies and their work?

This paper resonates with Harry Ferguson’s work on mobile work, in that it explores work done in multiple locations (Ferguson 2009) and also Barry Brown and Kenton O’Hara’s work on how mobile work changes places (Brown and O’Hara 2003). To build on this, I use theoretical concepts of ordering and organising from organisation studies to consider how medical technology engineers locate their practices in sites of work remote to their own organisations. In doing this, I add to the mobilities paradigm, and particularly the theme of work on the move, by considering modes of ordering or strategies that are carried and embodied by mobile workers.

1.2. Situated knowledge and mobilities

Whilst technical knowledge can be viewed as a socially distributed resource that is diffused and stored primarily through oral culture (Orr 1996), knowledge needs to be conceptualised as something that is experienced, rather than exchanged or held. Knowledge manifests through practices (Nicolini 2011) and thus mobile practices are entangled with the generation of knowledge. Phenomena such as knowledge, meaning, human activity, and sociality are aspects and effects of the total nexus of interconnected human practices (Knorr-Cetina, von Savigny, and Schatzki 2001), and their relations with others: artifacts, organisms and things (Schatzki 2010, 117).
In Orr’s work on photocopier engineers, he drew heavily on the work of Lave and Wenger (1991) to add to the practice-based approaches of knowing that have become widely known as Community of Practices. Scholarship within communities of practice have led to the conceptualisation that learning is not concerned with acquiring knowledge, rather it is a way of being in the world (Bourdieu 1990; Gherardi and Nicolini 2000). Being in the world and, more explicitly, being with others affords various collaborations amongst workers (Orr 1996). The advantage of co-presence has been widely discussed in mobilities work (see e.g. Urry 2002) and the “compulsion to proximity”, described by Boden and Molotch (1994), succinctly describes why travel patterns have not significantly changed, despite increased global connectivity.

Organisational strategies for controlling mobile work, such as territorial working, are used to shape these relationships and interactions. For example, to provide continuity between clients and mobile workers, serving to cement and maintain social and service relationships (Orr 1996). Such territorial working, shapes the relationships between co-workers and clients, generating responsibilities to machines and organisations and influences performance expectations (Orr 1996). Developing local connections, through repeated visits, facilitates the ease of mobile work, connecting people and places, and resonates with the notion that organisational knowledge is not about individuals and their actions but rather concerning practices and their relationships (Nicolini 2011). In this paper, I look at territorial working on the scale of owning spaces, specifically considering how the ownership of workspaces can be considered precarious.

Taking a material practice view to knowing, it is possible to see how mobility is a part of the interconnected knowing practices in geographically distributed, materially diverse and mobile locations. Spaces and movement form part of the set of associations shaping knowledge. As Nicolini (2011) states, “the knower and what is known – the knowing subject and the knowing object – emerge together in practice”. (Nicolini 2011, 604). Accordingly, the knowing subject and the knowing object emerge together in mobile practices. What I will go on to show in this paper is that knowledge is generated and shared, not just because the technicians move or because the machines are located remotely, but through the interactions of social or material actors, who and what mobile workers come into contact with. Interactions enabled by mobility.

Proximity and physical “brushings” create translation of ideas by contact and enable the transfer of specific courses of action, work arounds, approaches and fixes. As Gherardi and Nicolini (2000) state,

… organizational knowledge cannot be conceived as a mental substance residing in members’ heads; it can instead be viewed as a form of distributed social expertise: that is, knowledge-in-practice situated in the historical, socio-material, and cultural context in which it occurs. (Gherardi and Nicolini 2000, 330)

It is accepted that knowledge is socio-material. Local crafting practices based on resources to hand can be “disembedded”from their original context and made available through their transformation, legitimisation, institutionalisation and circulation (Araujo 1998) but not without challenge or without shaping the development of local systems. If “knowing is an ongoing social accomplishment, constituted and reconstituted in everyday practice” (Orlikowski 2002, 252), then moving resources between contexts not only shapes “knowledge” but also shifts subsequent sociomaterial assemblages.
Practice theory suggests social and organisational phenomena are assembled through the movement of entities in space and time and the establishment of associations between them (Nicolini 2011, 605). In this paper, I depart from Nicolini’s (2011) view that artefacts do not carry knowledge and take a more symmetrical approach to human and non-human agency, informed by the concept of agential realism of Barad (1999, 2007). Specifically I connect with how Orlikowski and Scott (2015) have used Barad’s work to develop material-discursive practices within organisation studies in describing how materiality and discourse are constituted through each other generating performative differences in practice.

The entanglement of discourse and materiality affords a view of sociotechnical practices outside of a constricting framework of pre-established social categories breaking down assumptions about the rigid social/technical binary (Callon 1986). Furthermore, it highlights the way in which the world is always in the process of becoming (Orlikowski and Scott 2015) and the ways in which materialisations are “effects” of the associations between actors within social worlds. Consequently, exploring material-discursive practices allows for the assembly and linkage of entities in material and social worlds without prioritising one actor or entity over another, assuming that everything is a consequence of its relations with other actants in that world. This paper adds to the literature on material-discursive practices by enfolding movement into matter and meaning, drawing attention to how mobilities influence becomings.

Thinking about mobile material-discursive practices enables a more inclusive conceptualisation, accounting for practices being made through performances and actions and through sociotechnical interactions on the move.

Nicolini (2011) calls for more work to be done to explore “how local regimes of knowing participate in wider institutional processes and how local circuits of circulation of knowledge participate in, and contribute to, wider often global forms of travel” (617). In this paper, I take a material discursive approach to understanding practices, that is that “practices are detectable and somewhat ordered sets of material-semiotic relations” (Law 2011, 157). What I proffer in this paper is an applied example of how the mobilities paradigm can help understand these circulations of knowledge and thus understand how mobile work shapes sociotechnical assemblages. To do this, I begin by considering the role of ordering.

### 1.3. Order vs. disorder

An organisation is not a static state; it is made up from the actions of organising (Cooper and Fox 1990; Cooper and Law 1995).

…”structure, function, norm, and role – are preconceived notions; they are conclusions that efface their origins … taken-for-granted states of being, human or organizational – are products or effects of complex social processes. (Cooper and Law 1995, 238)

In order to create order, there has to be a suppression of disorder (Cooper and Fox 1990) or “noise” (Mol and Mesman 1996). Noise can be interpreted as what might have been; the potentialities (see also Cooper and Law (1995)). As such, generating expertise (the unstable intertwining of order/disorder) is also generating noise as there is the potential to generate something that will not fit into the order or the patterning that has been assembled. By generating information, alternatives are created, there are more “what might have beens”
or threats to the order. Therefore, as Law and Singleton (2005) have stated, in order to attend to the presence of an object, you have to consider what “absences” the presence creates. In other words, once a system is in place and being used, this presence makes alternative orderings absent. Objects therefore become considered multiple (see e.g. Mol 2002; Denis and Pontille 2015). The multiplicity of objects arises through present and absent orderings that are dependent upon the networks and practices through which an object is enacted. As Law (2010) states, systems may be located in different sites but aligned or partially connected, added together, or even included in one another. In leading up to this point, however, presences and absences are repeated on different scales throughout processes of organising. Therefore, in order to create order, any potentialities that do not fit in with the proposed order, the “vulnerable objects” (Denis and Pontille 2015) need to be closed down or stabilised. Remembering, of course, that “order” is at best temporary, if not a fantasy.

In the present paper, I will show how the mobile work of manufacturer’s equipment engineers is important in ordering. I will discuss how their mobility practices, and knowledge collected from geographically diverse locations, play a part in this organising.

1.4. Partialities and possibilities

Given the role of absences and presences in ordering, studying an “object” is not to understand a finished or bounded entity, but to engage with partialities. In this paper, the object of thinking, an imaging system introduced into radiotherapy treatment, Cone Beam Computed Tomography (CBCT), is not an object at all, but made up of a number of partialities, it is a pattern of absences and presences (Law and Singleton 2005). In order for a phenomenon to exist (and I use phenomenon here to mean the heterogeneous assemblages of which an object is comprised), it relies on the repeated re-enactment of the associations that constitute it. Actions that take place around the machine are continuously redefining it. The action makes visible what was invisible and possible what was impossible (Spoelstra 2005). If we only think of the CBCT as a bounded thing, we lose sight of the formation and deformation processes of boundaries.

As I will go on to show, through the mobile installation work of the engineers, in order for the machine to make sense, in order for it to “work” within the department, the located negotiation of prescribed actions are needed to enable “order” to be created in situ. This work, or organisational action, serves to create the system as a bounded object and hence, exist within the department.

These orderings are materialised, not only in the materialisations of work arrangements, for example in protocols, but also in the machine itself. For example, ordering is told, performed, embodied and represented in materials and through materials i.e. the material heterogeneity of organising the machine (see Law 1994). The mobilities of the engineers provide a way to describe how space and time are “internal” to the ordering of the machine and help constitute objects. There is a complexity to knowledge production and the generation of expertise. It does not flow in a linear, predictable fashion. More it is complex and unpredictable with convergent interdependencies.

In this paper, I explore this further to consider how mobile work practices of the manufacturer’s engineers enable and facilitate the application of mobile knowledge and how this contextualised knowledge is supplementary or better than ‘official’ ways of knowing and organising.
2. Method

This paper is based on empirical research conducted in an English National Health Service (NHS) hospital, as part of a larger, three-year project exploring the emplacement of CBCT. The Sieverts Hospital (anonymised) had purchased the CBCT adaption for one of its radiotherapy treatment machines, linear accelerators. Observations at the hospital began the day before the equipment was delivered and continued through the delivery, unpacking, installation (performed by the manufacturer’s engineers), commissioning by the Sieverts Hospital medical physicists, applications training and early use. These were supplemented with observations at a second NHS hospital site. Using ethnographic methods, data were gathered relating to the mundane practices around installing and working with the CBCT system, revealing the interplay between machine and human. In “following the thing”, a name given to the process developed by Marcus (1995), the material object of the CBCT was traced through several different contexts. In addition, I examined documents such as training manuals, protocols, patient information leaflets, newsletters, local press and minutes of meetings in order to explore the way that these materials shape, and are shaped by, the technologies they are associated with. The fieldwork uncovered the mobilities of the machine as it was assembled from its constituent parts and moved from site of manufacture to site of use. This very mobile process required numerous socio-technical manoeuvres in order to complete the journey and ownership of the system. I describe this work as “organising” – the meaning of which is twofold. Firstly, the machine was made to cohere: it was organised to function and fit into the environment into which it was placed. Secondly, the system was transferred from the organisation of manufacture to the organisation of the hospital into which it was placed. In the present paper I specifically focus on the work of the manufacturer’s engineers who came to the Sieverts hospital to install (organise) the system. Present in the department over a period of 13 days, I observed the team of three engineers. I spent portions of my fieldwork observing the machine when no one was “doing” anything with it, learning how it became part of the establishment through action and non-action.

Throughout the fieldwork observations I took detailed notes, including sketches, which were later transcribed in full. Analysis of these transcripts, alongside other sources of relevant fieldwork material, entailed an iterative reading and coding to identify conceptual themes of interest. Throughout the machine installation, stories of the machine are told and created. It is within these stories that the boundaries of the organisation are performed and asserted but also other locations are implicated.

3. Empirical section and discussion

3.1. “Organising” the Sieverts’ machine: Mickey Mouses

In this first empirical section, I describe how the CBCT system was “organised” at the Sieverts hospital during the installation of the machine. The manufacturer’s engineers, Robin and Andy, arrived on the day of delivery, a Saturday, and immediately set to work unpacking the boxes and preparing the treatment room for installation. Both engineers have completed a training course on how to install the system and Robin has installed the CBCT in numerous UK hospitals previously, whereas Andy has only previously watched one installation.

This first excerpt, taken from field notes from the Sieverts Hospital, occurred four days after the boxes containing the CBCT system arrived. Robin and Andy have been installing
the machine, sometimes referring to the installation manual, and sometimes, mainly in the instances of the more experienced Robin, completing tasks without reference to the manual. Here, Robin and I are in the control area of the linear accelerator (the machine onto which the CBCT system is being installed). Andy is in the treatment room, down the corridor, installing part of the system.

I point to some diagrams on the bench in the control area and ask Robin what they are and where they had come from. Robin explains "Those? They're Mickey Mouses. The majority of the time we just break them [larger diagrams] down, do our own, make them simpler. So they [the Mickey Mouses] came from Andy's head". He then goes to get the larger diagrams out from the treatment room. He calls them the "system block diagrams". I say I haven't seen them look at these before. Robin says "No, they are only for [false?]" and he laughs. He says they are too complicated. He picks up the "Corrective Maintenance Manual" and explains that you get diagrams in here. He goes to some pages which are larger than A3; they are folded into the manual and he shows me the diagrams. He says that these are official drawings and that if an auditor came along they would have to get rid of, or hide, Andy's drawings because they aren't official. Robin jokes that making the "Mickey Mouses" is a hobby of Andy's, "He doesn't get enough at work, he likes to come home and make things like that [gestures to the Mickey Mouses]". I ask Robin if he has a set of his own drawings. He says no. He says he has his own notebook but it's not in as much depth as that. He says that at first you need things like that but, after a few times, you are quite happy to use the manual. I check with him, "Happy to use the manual after a few times?" Robin replies "Yeah". He smiles. I say "Even though it's for …" Robin interrupts me and says "Yeah".

(From field notes, Tuesday 7 October, 2008, 2)

The system block diagrams supplied with the CBCT system depict the "true" order of the machine and are produced with the expectation that the knowledge they contain will enable installation in any site. But they are too complicated. Robin explains that Andy draws the Micky Mouses at home. In the construction of "Mickey Mouses", Andy facilitates his own part in installing the system. Such personally produced and situated knowledge is needed to make sense of the system. Frank Blackler states that rather than studying knowledge as something individuals "have" it is more useful to consider "knowing as something that they do" (Blackler 1995, 1039). Knowing, according to Blackler, is mediated, situated, provisional (in that it is constructed and developing) and pragmatic (in that it is purposive). The system block diagrams do not facilitate knowing on a practical level as they do not allow for situated, provisional and pragmatic knowledge – they are fixed, unlike Andy’s diagrams which can be amended each evening to reflect the ongoing knowledge production during the installation of the CBCT system. Even the manual, designed to aid the installation of the system by an engineer with no previous experience of the CBCT, needs local or accumulated personal knowledge to enable this.

This is similar to what Lucy Suchman described from her observations of people using photocopiers (Suchman 2007). Suchman described how the expert help system, designed to anticipate users of the photocopier’s inquiries, has embedded within it the presumptions of normative imaginaries. It assumes that users, placing their paper on the photocopier screen, will know what is happening in the world of the photocopier. Suchman states that

Although plans presuppose the embodied practices and changing circumstances of situated action, the efficiency of plans as representations comes precisely from the fact that they do not represent those practices and circumstances in all of their concrete detail. (Suchman 2007, 72)

When the CBCT system was delivered to the Sieverts Hospital, there was a box full of instruction manuals delivered with it (see Figure 1).

I took the photograph in Figure 1 in order to capture “the knowledge” about the machine. Yet, repeatedly the installation engineers refer to inaccuracies or contradictions within the
manuals, the highly complicated nature of the “system block diagrams” is just one example of this. So despite the presumption that someone with engineering experience could pick up the manual and install the equipment, before it can make sense (the manual and the machine) what is needed is a prior understanding of the tasks required; a tacit understanding of what to look for and what is needed to be known. The manuals represent the order – or at least what is to be done to achieve that particular order. However, the ordering of the CBCT during the installation comes from the way in which those working with the system perform that order. This performance of order, ordering, enables (and shapes) the work that is subsequently done.

The “prescriptive representations” of the manuals presuppose actions that will take place within a context, which they cannot predict or specify (Suchman 2007). The “situated action” of the engineers is a process of translation from the “decontextualised” manual to the embedded, real world installation of the machine. These “docile texts” only become relevant when individuals experience the practical problem of following them in vivo (Garfinkel 2002). Obviously the manuals are produced in the context of “no-where” which in itself gives them a “context”. By decontextualised here I am attempting to convey the way in which the manuals are written to presuppose the context of which the actions they define should take place. This process of translation draws upon resources gathered by the engineers as they move between hospital sites and brush against other engineers, spaces and contexts (e.g. in the section described later in this paper on adapting a bung).

3.2. Taking work on the move

3.2.1. Precarious spaces
Outside every linear accelerator entrance there is a sign with a sliding bar (see Figure 2). The sign depicts who holds responsibility for that room at a given time. “Clinical” refers to the
clinical staff, “Physics” refers to the medical physics and engineering staff of the department and “no permit” (the central open position for the two sliding bars, not pictured in Figure 2) denotes a situation between these two states – for instance when the machine is between handover, or overnight. This sign depicts who has responsibility for the machine at any one time: clinical staff or engineering (physics) staff. The sign therefore represents the order of work and the delegation of jurisdiction within the department.

The manufacturer’s engineers who installed the CBCT at the Sieverts Hospital paid no regard to the sliding sign outside the linear accelerator by leaving the sign on “no permit” throughout their time in the department. Occasionally one of the department employed engineers would move the slider to “physics” at some point during the day, making a claim to the space, or to “no permit” at the end of the day. However, because of their lack of expertise in fitting the adaption and despite their claim to territory via the sliding bar, the workspace of the machine no longer belonged to them. Although throughout the installation the hospital engineers frequently try to learn the order of the machine, by watching and flicking through the manuals, they are displaced from the machine space by the activity and expertise of the manufacturer’s engineers. Their space was claimed by those who had the expertise to work within it.

Even for one of the manufacturer’s engineers, Andy, ownership of the space was unstable. Andy was learning how to install the equipment from Robin, a somewhat reluctant teacher. As he tried to keep up with the work and expertise of Robin, Andy would dismiss the hospital engineers (those who will be responsible for the machine after its installation) so he could type up his notes on his lap top or concentrate, once assertively exclaiming, “I need to understand this!”

### 3.2.2. Adapting a bung: using the end of a pencil

In this next excerpt, Andy is following the manual to fit part of the system onto the wall mount. He is referring to the manual but then remembers something which he had seen on the past installation he observed; something which isn’t mentioned in the manual.
… Andy says “But what is the book talking about, that’s the question?” He walks back over to look at the manual, which is on the treatment couch. He reads aloud from it “Right, ‘Fitting the Tube’. Ok, so how does it fit?” He crouches down to have a look at the tube. He says, “Oh, that’s another thing, we’ll have to replace this,” he points at something on the CBCT source head; he says “It’s in the way.” I don’t see what he is pointing at. Adam, one of the department engineers asks him “You want to take that off?” He does, whatever it is, it is apparently too long. Andy says they will have to use their own. He says that something is included, a screw I think, but that the end is not included. He whispers something to Adam and then asks him “Wouldn’t you say that is ridiculous?” Andy asks Adam if he has any suitable material, he says that Simon [another manufacturer’s engineer] “is using the end of a pencil [in other installations].” Robin concurs that the rubbers off the end of a pencil fit in [the hole]. Andy says that whatever they use, it would need to be glued in because, if it fell out, they would have to take the X-ray source head apart to get it out. They are all standing looking at the hole. Andy says “It has to be something professional, as far as I’m concerned, but we don’t have anything.” Andy goes on to say that at a different hospital, they made one out of “proper friction material”. Brian [another department engineer] says he could make something on the lathe and Andy checks he would be able to glue it in. Brian says there’s not a lot which will glue nylon. Adam takes the part of the machine that has the hole and leaves the room. Brian continues to describe what he could make to fit it then he leaves too. (Wednesday 8th October, 3)

The equipment for the CBCT is delivered to the hospital site fully labelled and prepared, ordered. Each washer, cable and screw is supplied in a way similar to a piece of flat-packed furniture.1 In the situation above, there was a need to fill a hole in the X-ray tube (although I never found out why they couldn’t leave this unfilled). Andy, in watching Simon install a system elsewhere, has learnt that this hole needs to be filled and that Simon has been using the eraser from the end of a pencil. His unease with this is voiced when he says it needs to be something “professional” that they use, in his opinion. The department engineers take on the task of creating something (perhaps spurred on by learning that a department engineer has managed this elsewhere), and later in the week they have filled the hole. But without this organising there is obviously a problem (although as Andy says, if they “organise” incorrectly and the “bung” falls out they will create more problems). There is no mention of this hole-filling in the manual, it is only through the experience of the engineers that it comes to light and is rectified, according to the location into which the CBCT is placed and the skills available to make the bung or the availability of an eraser off the end of a pencil!

3.2.3. Physical positioning of the footswitch

A further example of this occurred during this final observation from the installation stages of the CBCT, when decisions were made about the positioning of the equipment. As the installation was started over a weekend, when the department was closed, there were no clinical staff members present to make decisions. This may have been because it wasn’t anticipated that anything would need to be decided at this stage or that there was an assumption that none would need to be made at all (assuming that all technologies leave the manufacturers and are introduced into clinical sites in identical, unproblematic ways). The manufacturer’s engineers, Robin and Andy, often asked questions of Gary, the department engineer, and me.

Gary asks me where we want the CBCT terminal… We decide the CBCT should go where the broken printer is so Gary starts to remove the printer … The footswitch is on the work top in its clear plastic. Gary asks where it is going, “out here?” Andy says “yeah, out here”. Gary says “and that releases the generator?” Andy confirms it does … (5 October 2008, 1)
Robin is putting cable ties around the many cables going into the control PC. He then puts cable ties around the two cables that come out of the footswitch. There’s a black wire and a green and yellow earth wire coming out of the footswitch. He puts six cable ties around this. It seems like a lot but maybe these cables get a lot of wear and tear being by the feet. He trims the ends off with wire cutters and positions the footswitch neatly in line with the edge of the PC making the wires go around the metal support of the bench. I think this is going to be a problem but don’t say anything. The footswitch is a long way from the finger switches you need to use to rotate the gantry. I don’t see how you’ll be able to do both. (7 October 2008, 3)

Gary and I make the decision to put the CBCT PC in a space where there is currently a broken printer (Figure 3). We have no previous knowledge of locating CBCT systems – Gary has never seen the foot switch before and I have only ever seen it installed in a much smaller space at a different hospital.

After the installation of the CBCT, Robin moves on to another job elsewhere and is replaced by Simon. There are a number of acceptance tests that need to be performed before the manufacturers hand over the machine to the department. In this final excerpt, Simon and Andy are taking scan images.

Simon explains to Andy to hit the footswitch then the finger switches once the first image appears.

**Simon:** We may have to move this [the footswitch] for them.

**Andy:** It was Robin.

**Simon:** See if there’s any slack.

**Andy:** It’s where they asked. We asked them.

**Simon:** They obviously didn’t understand the functionality of it.

**Andy:** They were constantly asking about the new key pad.

**Simon:** There isn’t one. It will take two girls basically. (15 October 2008, 16)

Simon was right; we did not understand the functionality of it. Throughout my observations there are constant referrals to the foot switch being in the wrong place, by the manufacturer’s

**Figure 3.** Location of Footswitch in the control area outside the linear accelerator. The controls for moving the gantry during a CBCT scan are off the picture to the left. Taken 11 May 2009.
engineers, the department engineers, physics and clinical staff members. Initially I feel a
sense of guilt, being a conspirator in its incorrectness. Later, when the Radiographers are
working through the step-by-step planning process to begin to formulate a protocol for
clinical application, they decide that two different people better control the foot and finger
switches. There was a consensus that if the practitioner had to operate the footswitch and
the finger switch, requiring hand and feet co-ordination, they would not be “properly watch-
ing the patient”. In contrast, however, at other centres where the footswitch and the finger
switches are positioned more realistically closer together, one Radiographer controls the
whole system, rotating the imaging system using their fingers on the control switches and
exposing the patient to radiation using the CBCT footswitch.

The discussions regarding the footswitch show how the physical positioning of aspects of
the machine are part of organising the work which takes place with it. The lack of knowledge
concerning how the components of the system should be positioned, led to the footswitch
being put at an uncomfortable distance away from the finger controls. This ultimately shaped
the decision to write a protocol where two staff members are needed to take a scan.

4. Discussion and conclusion

The mobile work of the engineers, of incorporating orderings (manuals, specific materialities,
positioning of equipment) into the machine, is done in order to create a specific version of
that machine. This is what I term “organising the machine”. The ordering does not stop once
the engineers have gone but their role in shaping the machine continues as their work is
embedded in what they have left behind. As the engineers move between hospital sites,
the material environment changes. Their mobility changes their expertise and experience
and enables them to act in specific ways, which in turn shapes the ordering of the machines.

We see, throughout the ordering events presented in this paper, how “design work” takes
place in precarious spaces. Locally, defining and shaping technologies in order to incorpo-
rate them into existing practices enables machines to become obdurate (if this work is
successful). However, rather than focussing on unlimited possibilities for technologies, this
local design work, or organising, becomes shaped by the expertise and experience of those
involved and the very environments, practices and sociomaterialities into which it is to be
incorporated. Eventually, decisions are made useful and are made to work. In the last example
regarding the positioning of the footswitch, its positioning and the subsequent work prac-
tices with the machine, were dependent upon who was available to make those decisions
at the time and the resources they drew upon to make these decisions.

Previous work of Silvia Gheradi and Davide Nicolini (Gherardi and Nicolini 2000; Nicolini
2011) have explained that knowledge work is achieved through brushings. That knowing is
manifested through interactions in practices. In this paper, I have built on this to show how
knowing is manifested through mobility practices, how mobility enables knowing and also,
how these mobile practices shape the sociomaterial orderings of systems. Proximity and
physical “brushings” create translation of ideas by contact and enable the transfer of specific
courses of action, work arounds, approaches and fixes. How the machine is organised results
in different materialisations in each context, becoming, therefore, a product continuously
being re-generated from the telling, performing, embodiment and interaction between
different orderings: the organising of the machine. I therefore proffer that the ordering is
not solely dependent upon the context into which the system is being introduced; it is
dependent upon the previous located practices of those involved. As the heterogeneous 
relations in the different departments become embedded into the machine, what were sent 
from the manufacturers to the separate sites may become two different configurations with 
two different modes of work. How the installation is done in practice, how it is made to work, 
is from the mobility of the engineers – bricolaging their knowledge, ignoring aspects of the 
protocol and redrawing plans for action.

The mobile work I describe in the present paper demands mobility: work that is enabled 
by movement. There are site specific, physical practices that need to take place that cannot 
be replaced with remote working. These physical mobility demands create interesting sites 
of exploration for situated knowledge and mobilities. Not only are knowledge practices of 
these mobile workers shaped, informed and transformed through their mobilities but their 
mobility shapes work that is performed in the sites into which they arrive.

Despite protocols presenting one explicit description of a course of action; multiple pos-
sible trajectories lie underneath the course of action that is laid out in the text (Timmermans 
and Berg 1997). The protocol is an organising strategy. The protocol gives practice a purpose 
and acts as a legitimating force for practice, enabling practitioners to justify their actions 
within their organisational identity. However, based on levels of expertise and experience, 
the engineers see fit to disregard it, due to its complexity. Its presence enables the work to 
going on the move with a sense of order and instruction to the practices at hand. It formalises 
a common vocabulary and framework for making sense of the technical requirements and 
auditing practices but stultifies local action; it is too complicated.

For mobile workers entering new sites and temporarily claiming spaces to carry out their 
work, a tension emerges between making their work fit to the context in which they have 
been placed. Use of remote working technologies, email, call centres, remote log on from 
distant places, has made it possible for engineers to effectively use their resources as well 
as the provision of protocols, which give engineers legitimate plans for action, in the sense 
described by Suchman (2007). Protocols are provided to direct and determine action; they 
are implemented to prescribe “order” but are situated and therefore partial. Consequently, 
“personal touches” and negotiation, workarounds or a sense of localised autonomy are 
needed during remote working to enable “order” to be created in context.

What I have discussed in the present paper is an applied example of how mobilities influ-
ence material-discursive becomings. I have shown how the mobilities of the engineers become 
internal to the sociomaterial ordering of the machine. During the time of the installation they 
move into and make claims on physical space, prescribing who is inside and legitimate in that 
space. They also draw on previous practices and experiences to draw other places into the 
present space in which they are working. As such, their mobility warrants the embedding of 
other spaces into the sociomaterial ordering of the machine, the adaptation of a bung being 
an example. More work is necessary to explore this in a more theoretical and globally applied 
way. For example, what happens when “brushings” do not occur? How does local knowledge 
produced through UK engineers, travel beyond these geographical borders?

Notes

1. At various times of the machine installation, the engineers hint at the mobilities of the machine 
components. Each clear bag and the parts it contains have their own trajectory from design to 
manufacture to installation. The trails of these mobilities are erased by ordering the fractured 
system, loading the components into crates at the manufacturers depot and shipping as a whole.
Here, design work is used as per Suchman (2002), the appropriation of technology so as to incorporate it into existing material environments with their own sets of practices.

**Disclosure statement**

No potential conflict of interest was reported by the author.

**Funding**

This work was supported by the ESRC [grant number ES/G01860X/1].

**ORCID**

Lisa Anne Wood  [http://orcid.org/0000-0003-3870-8189](http://orcid.org/0000-0003-3870-8189)

**References**

Araujo, Luis. 1998. Knowing and learning as networking. *Management Learning* 29, no. 3: 317–36.

Arp Fallov, Mia, Anja Jørgensen, and Lisbeth B. Knudsen. 2013. Mobile forms of belonging. *Mobilities* 8, no. 4: 467–86.

Barad, Karen. 1999. Agential realism: Feminist interventions in understanding scientific practices. In *The science studies reader*, ed. Mario Biagioli, 1–11.

Barad, Karen. 2007. *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Durham, NC: Duke University Press.

Beaverstock, Jonathan V., Ben Derudder, James R. Faulconbridge, and Frank Witlox. 2009. International business travel: Some explorations. *Geografiska Annaler: Series B, Human Geography* 91, no. 3: 193–202.

Blackler, F. 1995. Knowledge, knowledge work and organizations: An overview and interpretation. *Organization Studies* 16, no. 6: 1021–46.

Boden, D., and H. Molotch. 1994. The compulsion to proximity. In *Nowhere: Space, time and modernity*, eds. R. Friedland and D. Boden, 257–86. Berkeley: University of California Press.

Bourdieu, Pierre. 1990. *The logic of practice*. Stanford, CA: Stanford University Press.

Brown, Barry, and Kenton O’Hara. 2003. Place as a practical concern of mobile workers. *Environment and Planning A* 35, no. 9: 1565–87.

Bourdieu, Pierre. 1990. *The logic of practice*. Stanford, CA: Stanford University Press.

Cooper, R., and J. Law. 1995. Organization: Distal and proximal views. *Research in the Sociology of Organizations* 13: 237–74.

Denis, Jérôme, and David Pontille. 2015. Material ordering and the care of things. *Science, Technology & Human Values* 40, no. 3: 338–67.

Ferguson, Harry. 2009. Driven to care: The car, automobility and social work. *Mobilities* 4, no. 2: 275–293.

Ferguson, Harry. 2011. Mobilities of welfare: The case of social work. In *Mobile methods*, eds. Monika Buscher, John Urry, and Katian Witchger, 72–87. London: Routledge.

Freudendal-Pedersen, Malene, Kevin Hannam, and Sven Kesselring. 2016. “Applied mobilities, transitions and opportunities.” *Applied Mobilities* 1, no. 1: 1–9.

Garfinkel, Harold. 2002. *Ethnomethodology’s program: Working out Durkheim’s aphorism*. Lanham, MA: Rowman & Littlefield.

Gherardi, Silvia, and Davide Nicolini. 2000. To transfer is to transform: The circulation of safety knowledge. *Organization* 7, no. 2: 329–48.
Haynes, Paul. 2010. Information and communication technology and international business travel: Mobility allies? *Mobilities* 5, no. 4: 547–64.

Hislop, Donald. 2012. Driving, communicating and working: Understanding the work-related communication behaviours of business travellers on work-related car journeys. *Mobilities* 8, no. 2: 220–37. doi:10.1080/17450101.2012.655972.

Ingold, Tim, and Terhi Kurttila. 2000. Perceiving the environment in finnish lapland. *Body & Society* 6, no. 3–4: 183–96.

Knorr-Cetina, Karin, Eike von Savigny, and Theodore R. Schatzki. 2001. *The practice turn in contemporary theory*. Routledge.

Laurier, E., and C. Philo. 2003. The region in the boot: Mobilising lone subjects and multiple objects. *Environment and Planning D* 21: 85–106.

Lave, Jean, and Etienne Wenger. 1991. *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Law, J. 1994. *Organizing modernity*. Oxford: Blackwell.

Law, John. 2010. “The materials of STS.” In *The Oxford handbook of material culture studies*, eds. Dan Hicks and Mary Beaudry, 173–88. Oxford: Oxford University Press.

Law, John. 2011. Collateral realities. In *The politics of knowledge*, eds. Fernando Dominguez Rubio and Patrick Baert, 156–78. London: Routledge.

Law, J., and V. Singleton. 2005. Object lessons. *Organization* 12, no. 3: 331–55.

Marcus, G.E. 1995. *Ethnography in/of the world system: The emergence of multi-sited ethnography*. *Annual Review of Anthropology* 24, no. 1: 95–117.

Mol, Annemarie. 2002. *The body multiple: Ontology in medical practice*. Durham, NC: Duke University Press.

Mol, Annemarie, and Jessica Mesman. 1996. Neonatal food and the politics of theory: Some questions of method. *Social Studies of Science* 26, no. 2: 419–44.

Nicolini, Davide. 2011. Practice as the site of knowing: Insights from the field of telemedicine. *Organization Science* 22, no. 3: 602–20.

Nóvoa, André. 2012. Musicians on the move: Mobilities and identities of a band on the road. *Mobilities* 7, no. 3: 349–68. doi:10.1080/17450101.2012.654994.

Orlikowski, Wanda J. 2002. Knowing in practice: Enacting a collective capability in distributed organizing. *Organization Science* 13, no. 3: 249–73.

Orlikowski, Wanda J., and Susan V. Scott. 2015. Exploring material-discursive practices. *Journal of Management Studies* 52, no. 5: 697–705.

Orr, Julian Edgerton. 1996. *Talking about machines: An ethnography of a modern job*. New York: Cornell University Press.

Schatzki, Theodore R. 2010. *Site of the social: A philosophical account of the constitution of social life and change*. University Park, PA: Penn State Press.

Seamon, David. 1980. Body-subject, time-space routines, and place-ballets. In *The human experience of space and place*, eds. Anne Buttimer and David Seamon, 148–65. Abingdon: Routledge.

Spoelstra, Sverre. 2005. Robert Cooper: Beyond organization. *The Sociological Review* 53, no. Suppl 1: 106–19.

Suchman, Lucy. 2002. Located accountabilities in technology production. *Scandinavian Journal of Information Systems* 14, no. 2: 91–105.

Suchman, Lucy. 2007. *Human-machine reconfigurations: Plans and situated actions*. 2nd ed. Cambridge: Cambridge University Press.

Timmermans, S., and M. Berg. 1997. Standardization in action: Achieving local universality through medical protocols. *Social Studies of Science* 27, no. 2: 273–305.

Urry, John. 2002. Mobility and proximity. *Sociology* 36, no. 2: 255–74.

Urry, J. 2007. *Mobilities*. Cambridge: Polity Press.