Moving to get aHead: Local Mobility and Collaborative Work

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Abstract: Local mobility is a central aspect of collaborative work that is in need of close analysis. Between the face-to-face interaction of offices or control rooms and long-distance interaction facilitated through e.g. telephones, e-mail, the www or teleconferences lie a number of work-settings in which actors move about continuously in order to accomplish their work. They do so because they need to get access to knowledge, resources, persons and/or places. We analyze the integral nature of mobility to this kind of work practice from the ethnographic description of a hospital department, and the challenges that actors have to face to accomplish their work. Based on this ethnographic case, we propose a set of concepts for understanding local mobility as an intermediate field of distributed cooperation between centres of coordination and remote collaboration. Finally, we introduce the concept of 'mobility work' as complementary to the concept of 'articulation work'.

Introduction

In this paper, we look at *local mobility*. Local mobility as we understand it occupies the intermediate space between working together over distance on the one hand and working face-to-face in an office or a control room on the other. As such local mobility takes place in cooperative work settings where actors constantly are on the move to get ahead with their work: maybe because they need

the knowledge inside a head of an expert, or because they need special equipment, a certain person or access to a particular room.

In recent years, there has been an emergent literature on local mobility, which has argued that despite the technological achievements of computers and their ability to communicate over distances, their effect has been to make work ever-more static since they all focus on the desktop computer and fix the actors to their desks (Bellotti and Bly 1996; Luff and Heath 1998). Recent developments in cell phones, tablet computers and wireless networks promise to bridge this ambiguous situation of being able to link across vast distances and yet still be fixed to the desktop. If however, these promises are to be realized, we think that a more thorough understanding of local mobility is needed. Local mobility needs special attention and its problems are not just solved by introducing technology that enables remote collaboration into a setting of local mobility.

We argue our case in the following way. In section one, we look at the existing literature, and go on, in section two, to present our case of local mobility: the description of mobility in a hospital department based on ethnographic fieldwork. In section three, we propose, in the spirit of 'grounded theory' (Glaser and Strauss 1967) to look at local mobility as a result of attempts by actors to achieve the right configuration of people, places, resources and knowledge and we discuss the challenges involved in such a pursuit. Finally, we look beyond the hospital department and discuss local mobility more broadly, and propose the concept of 'mobility work' as complementary to that of 'articulation work' (Strauss 1985).

Background – Local Mobility

The term 'local mobility' within the CSCW literature gained its present currency through Bellotti and Bly (1996) and Heath and Luff (1998). A critical review of these shows, however, that local mobility tends to get out their central focus.

Belotti and Bly argued that local mobility enhances local collaboration while at the same penalizing remote collaboration severely, since it takes actors away from their desks where their phones and emails are found (Bellotti and Bly 1996:p209). They found that previous research had focused on 'desktop collaboration' only and aimed to show that "…mobility may be critical to many work settings that have been traditionally considered non-mobile and that its existence and purpose must be accommodated by CSCW design" (Bellotti and Bly 1996:p209). In their case of a consulting firm of product designers with a remotely located sub-branch, local mobility arose as a result of a pursuit of resources and other people and supports local collaboration because it enabled the sharing of resources, face-to-face communication, and shared awareness between collaborators (Bellotti and Bly 1996:p210-1). At the same time, however, local mobility took people away from the desktops upon which the resources that enabled communication and collaboration over vast distances (e.g. phones or e-

mail) were found. Their design efforts were accordingly directed towards a reproduction of the advantages that local mobility provided for remote collaboration, and towards reducing the penalties for being away from the desktop – i.e. the penalties for remote collaboration. Thus, while they focus on getting away from the desktop, they direct their attention towards linking local and remote collaboration rather on local mobility and collaboration itself.

Luff and Heath (1998) similarly lament the fact that new technologies that promise to provide new spaces and environments for collaboration are only "…available on devices which are static and tied to the desk" (Luff and Heath 1998:p305). The static nature of then present technologies entailed the risk of "…undermining an important resource in collaboration, namely, and individual's ability to reconfigure him or herself with regard to ongoing demands of the activity in which he or she is engaged" (Luff and Heath 1998:p306). A point which is well illustrated by Kristoffersen and Rodden (1996) who argue that the introduction of a video consultation between bankers and customers tied the former to their desks and hence restricted their opportunities to consult with colleagues for advice and managers for decisions as well as looking into archives. Luff and Heath (1998) found a lack of studies devoted to mobility and provided three cases in which the importance of mobility was analyzed: a medical practice, construction sites, and stations in London Underground. The central problem in the two former instances however, is that of micro-mobility: the ability of paper to be "…handlable, manipulable, portable, dismantlable and can easily be reordered and reassembled…" (Luff and Heath 1998:307). Under the label 'micro-mobility', they describe the face-to-face interaction between physician and patient at a medical practice and focus on the 'ecological dexterity', i.e. the handability of paper. Likewise, in the case of a construction site under the label 'remote mobility' they argue that the provision of an electronic allocation sheet used for coordination and status making by the foreman, failed in part because the computer did not support the sharing between the foreman and the local workers like its paper-version did. Its micro-mobility was too limited (Luff and Heath 1998:p308).

Only in the London Underground case, labelled 'remote and local mobility', is local mobility a central concern in the analysis of movement around stations which often consist of a central operation room and several platforms, passageways, entrances etc. In the ensuing analysis of what we think is a good case of local mobility, Luff & Heath give good empirical examples of the challenges that technological support has to meet and argue for a "heterogeneous combination of technologies" (Luff and Heath 1998:p311. See also Nielsen and Søndergaard 2000). In the end however, micro-mobility - the "…local and detailed uses of objects-in-interaction…" (Luff and Heath 1998:313) - becomes the central concern rather than local mobility as such.

Another study of local mobility is provided by Bødker & Bertelsen (2001) who describe collaboration on a wastewater plant. The wastewater plant does not have

a control room as such and instead the people working there gather information as they move around and inspect the various parts of the plant.

> "They retrieve information as they move about, and their information needs depend on where they are, who they are, as well as on what they are doing. They do not need access to the entire information space independent of location and purpose, on the contrary. This is what we have called zooming with the feet." (Bertelsen and Bødker 2001:p6)

The need to be mobile derives from the fact that the workers have to access things locally: the smell and colour of the water, reading meters, and judging the viscosity of polymer. Workers do cooperate and coordinate but mainly locally when they move about through ad hoc face-to-face meetings on the plant and during coffee-breaks. This dominance of decentralised, ad hoc coordination in daily routine is probably possible because of the slow processes at the plant where exact, prompt information is not needed with regards to the fermentation processes. The insights derived from this analysis of local mobility are directed towards the concept of common information spaces, and Bertelsen and Bødker label the wastewater plant a 'massively distributed information space'

There are other studies which have taken up the issue of mobility: Fagrell et al (1999) focus on knowledge management and give a case where a laptop is driven around while being connected to the internet and a GPS system, while Bergqvist et al (1999) focus on support for informal meetings.

We acknowledge these contributions, but want to pay closer attention to local mobility itself. However, we do not think that the challenge is to understand local mobility through its consequences for remote collaboration or through the importance of micro-mobility. Local mobility is not only about what happens when people leave their desktop computer, but also about understanding what goes on if collaborators do not have their own desktop at all, why people constantly move about and how they accomplish their work in such circumstances. We will attempt to achieve this through the case of a hospital department, which we think is a case of local mobility par excellence. From this case, a set of concepts emerge that we suggest as a starting point for developing an understanding of local mobility and which might lead to a comprehensive framework for the analysis of local mobility.

Mobility in Hospital Work

For many people working at hospitals, mobility is an ever-present aspect of their work. Not just page boys and hospital orderlies move around all the time, but so do nurses, physicians and patients. At a trivial level, this is necessary because bed rooms, conference rooms, meeting rooms, and offices are distributed in space, and hence force people at the hospital to cover a lot of physical space with their

feet. At another level, the need for moving around is caused by the ongoing process of specialization that has characterized the development of hospitals since the beginning of the last century and which seems to continue into the future (Vallgårda 1992). The expansion of knowledge about human body, deceases, medicine and care has entailed an accompanying contraction of the field in which individual clinicians can have expertise. Another kind of specialization has occurred through the development of technologies of introspection and intervention into the human body and for analyzing human tissue. These technologies are mostly concentrated in specific places. Either because of the room they require, the special kind of environment they need or because of the cost of construction, maintaining and using them. MR-scanners (magnetic resonance), CT-scanners (computer tomography) and PET-scanners (positron emission tomography) are all recent example of this process in which laboratories, operation room etc. are older ones. A consequence of this specialization of knowledge and technology is the continuous subdivision of hospitals into dedicated departments, which entails a need for moving about between people, things and places in order to get ahead with work. Strauss et al. (1985) point out, a special feature of medical specialization and technological innovation is that the two are simultaneously parallel and interactive, creating an impetus to further technological innovation and specialization.

Research Site and Methods

In the following, we describe collaborative work at haematology department (labelled department B) at a large Danish metropolitan hospital. The case is based on an ongoing research project which has lasted 2 years and includes 2 periods of ethnographic field work, each lasting 2 months, and including 12 open-ended interviews. Furthermore, 11 workshops have been conducted, which have focused on technological support for hospital work and in which nurses, physicians, an anthropologist and computer scientists participated. Finally, 10 hours of video-recording of specific episodes, like medical conferences, and the following personnel around a whole day have been made. Field notes were transcribed and videotapes logged.

Department B treats blood related diseases of which the most severe are various forms of cancer including leukaemia. The department presently consists of two bed wards, an outpatients' ward, an ambulatory, a laboratory, an admittance office with two adjacent consultancy rooms, and a section with rooms for the secretaries, physicians, teaching and meetings. The main part of the haematology department is situated in a three storey building: the floor level consists of the admittance office, conference rooms and auditoriums, and offices for physicians, while the two bed wards comprise the first and second levels. The two bed wards are identical in terms of staff and number of patients. The ambulatory and the outpatients' ward are located in another part of the hospital 5 minutes walk away.
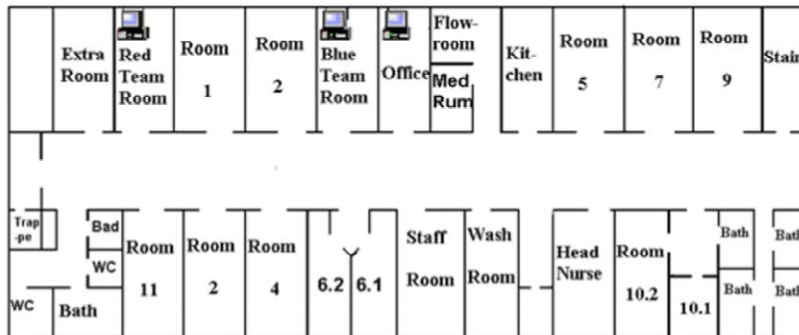
Figure 1: The physical layout of a ward at department B.

The department can have 46 hospitalized patients at a time and treats approximately 11.000 patients a year in the outpatient clinic. The department employs about 167 physicians, nurses, clinical assistances, laboratory workers, etc. The ground plan for one of the bed wards is illustrated in figure 1 and figure 4 shows a picture from the ward.

A Physician's Typical Day at Department B

To illustrate the degree of mobility covered by clinicians, figure 2 shows the movements between 5 different places by one physician followed around at a typical day. The physicians meet at 8 am for the morning conference at the ground floor where they are briefed on the night's events by the physician who was on night shift. After the conference, they take the staircase to the bed ward where they meet with the nurses in the team room. Here, the nurses' team leader reports on the patients associated with the team, emphasising the last days' events and the nurses' assessment of the situation. Later, when the team conference is over, the physicians walk down to the radiology department located in the centre of the hospital, where they meet for the radiology conference. All physicians at department B (not just the ones working at the ward) meet at the radiology conference to hear the radiologist's assessment of the X-ray and CT images made the day before. Going back to the bed wards, four physicians commence making their ward rounds in collaboration with the team leader by moving from patient to patient in their bedrooms, bringing the often voluminous records along on a trolley (see figure 5). The cooperation between the physician and the nurse during the ward round pivots around the physician having the knowledge and authority to make diagnosis and prescribe treatment, whereas it is the team leading nurse who has an overview of the patients and updated knowledge upon their state. At noon, the physicians meet again in department B's conference room to discuss special patient cases upon which a physicians would like to consult the collective knowledge of his colleagues and the expertise of the leading physician. If the physician

Place	Time in min.																					Sum	%
Conference room, physicians	11																				24	35	13%
Team room		32		2								7				3						44	17%
Radiology conference room			15																			15	6%
At the trolley - the aisle					3	6	8	4	7	7	5	13	2	5	9							69	27%
At the patient					10	10	6	11	14		16	6			10	2						85	33%
Transportation	2	5	4																		1	12	5%
																						260	100%

Figure 2: The location of a physician over the duration of a ward round. Transportation covers the physician walking between locations and he is in this period of time physically located in corridors, staircases, hallways, lifts, etc.

has finished the round which occasionally lasts until 2.30 pm, the afternoon is spent doing paperwork in his office or attending meetings.

Local Mobility

In the following, we will frame our findings about mobility as an essential and integral aspect of cooperative work at hospitals in four categories (see figure 3): the need for mobility caused by the need for being at different *physical places*; the need for mobility to access *general (medical) knowledge*; the need for mobility to access or use different *shared resources*; and the need for mobility to get in contact with *specific persons*.

Places

Places are often specialized in the sense that they have a purpose or that certain types of activities can take place in there. For example, the radiology conference takes place in a conference room equipped with light displays that can hold the large amount of images to be analyzed. As a consequence the physicians have to move to the radiology conference room.

Looking closer at the spatial layout of a ward (figure 1), it is on the one hand obviously subdivided into a number of rooms for patients to ensure some degree of quietness and privacy for these. On the other hand, the staff has its own rooms for their work. Secretaries need a room to receive and guide relatives to admitted patients, and to receive and distribute incoming mail, phone calls and fax. They also take care of sending records around the department. Their place thus centralises communication and traffic in and out of the ward. Nurses and physicians each have their own rooms for coordinating work and for discussing treatment and care of patients. They need special places for the common reasons of having a place to meet and talk undisturbed, to ensure confidentiality of information upon patients and in order to enable clinicians to discuss patients freely: patients rarely want to listen to discussions about prospects for recovery, pro and cons about the suitabil-
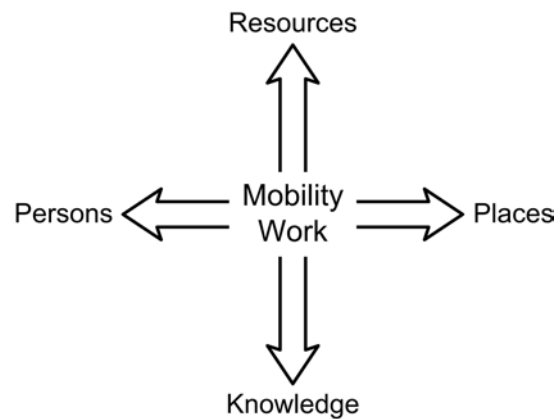
Figure 3: Four aspects of Mobility Work – Resources, Places, Knowledge, and Persons.

ity of particular chemotherapies, etc. There are, however, also places that are special because of their intrinsic qualities of which hygiene is one of the most pertinent: a special room for cleaning patients' urine bottles, wash bowls etc; rooms for showering and special patient's rooms for those who have undergone a bone marrow transplant, or whose immune system has to recover after chemotherapy.

Mobility at the ward in the perspective of place arises from the need for quietness, privacy, different hygiene regimes and to ensure close cooperation between different groups.

Knowledge

Medical diagnosis and care is an intellectually complex task, which is a product of a complex social process involving individuals who vary in status and area of expertise (Cicourel 1990). The idea of socially distributed cognition (Hutchins 1995) refers to the observation that participants in collaborative working relationships are likely to vary in the expertise they posses and must therefore engage each other in dialogues that allow them to pool resources and negotiate their differences to accomplish their tasks. Because of the specialized nature of organizing work in modern hospitals, such cooperative solution of problems is made by a decentralized and loosely coupled collection of knowledge sources located in different medical specialities. Hence, 'problem solving' becomes distributed in terms of both knowledge (mentally in different 'heads') and space (physically in different 'locations'), which in many instances implies that there is a need to move to get together and engage in cooperative problems solving – the need for mobility to 'get a head'.

The pooling of knowledge and hands takes place routinely at Department B. The team conference, for example, is a central source of knowledge sharing and coordination of the treatment and care of the patient, because it is an event where physicians, nurses, SHAs, physiotherapists, and other experts involved in the care

of patients meet. To assemble the collective knowledge of the department, all these experts move physically to combine the mentally distributed expertise. Similarly, the medical conference at noon is a central source of knowledge sharing and development. In these conference situations, clinicians do not move in order to access specific knowledge, but participate in these conferences in order to acquire and contribute to a more general knowledge sharing. Often in these conferences a question is raised by one physician and is discussed by several people at the conference, each contributing with central knowledge and information. This knowledge is not only medical knowledge, but also more mundane things like knowledge about the family background of the patient, his mental wellness, and whether he has been travelling. In addition to the routinely held conferences, there are a host of ad hoc pooling of knowledge, as, for example, when a physician requests another specialized doctor (e.g. a surgeon or a dentist) to have a look at a patient. Patients often have complicated sets of more or less inter-related deceases that need to be attended to by different experts. Hence, the mobility caused by the need for meeting expertise works both ways – moving to get to the expertise, and the expertise moving as such.

The perception of a patient's condition and state of treatment is thus contingent on several sources of distributed expertise which assembles to cooperatively produce an accumulative knowledge base. A fundamental premise for this accumulation to take place is the local mobility of the physicians, nurses and other professions at the hospital. While it is possible to enable such pooling by phone, e-mail or videoconferences, face-to-face meetings are yet still the most efficient means of achieving this.

Resources

Modern hospitals employ a wide range of different resources – especially medical equipment and machinery – which are essential to patient diagnosis, treatment, and care. At the very core of medical work is the need for moving the patient to a medical device. Central to the treatment of haematological patients is the monitoring of the degree of deterioration of the skeleton and they are therefore frequently taken to the radiology department where there is a subsequently need for moving patient in and out of the X-ray machine. Similarly, there is often a need for more advanced types of radiology images – e.g. MR, PET, and CT scanning - which are located in other hospitals in the city and hence require the patient to be transported by ambulance or car. On the other hand, there are several types of mobile equipment within a hospital that need to be moved (by someone) to the patient. For example, intravenous chemotherapeutical cures are often infused by pumps, which are taken to the patient's bedside..

In addition to these medium sized and large artefacts, there are a host of smaller artefacts which are constantly moved around such as equipment for measuring basic physiological data like weight, pulse, blood-pressure, and tem-

Figure 4: Two nurses in a conversation while moving around at the ward. Notice that they are carrying a lot of stuff, both in their hands and in their pockets. Furthermore, notice the 'mess' in the hallway – it illustrates how a lot of things constantly are moved around within a hospital, like beds, tables, food, medical records, etc.

perature. On the medical ward, the different records, medicine schemas and work schedules are central for coordination and documentation of patient treatment and care, and physicians and nurses have difficulties (and legal problems) if they treat a patient without having the proper documentation. At present these records and plans are paper-based and the mere work of locating and getting hold of these documents is a source of much mobility at the ward. Nurses, for example, constantly walk between the trolley and the medicine room in order to locate and get their hands on the medicine schema, which at the same time is needed by the physician making the round and by the nurses for administrating medicine. Evaluation of treatment by the physician takes place either at the trolley in the hallway in front of the patient's room or at the patient's bedside, whereas the preparation of medicine takes place in the medicine room. Sometimes nurses take the medicine plan from the round trolley to the medicine cabinet and the round team then has to locate and get hold of it when attending that particular patient. The mobility of artefacts creates mobility of persons, and vice versa.

Persons

In the example above, the physicians attended the radiology conference to consult an expert on radiology – not to meet a specific radiologist. In contrast to this, an-

other source of mobility arise due to the need to access persons as *specific individuals* and not as keepers of roles such as being the radiologist on duty.

The need for getting hold of a specific person arises when this person is the central source of information or authority. It is, for example, sometimes important to get in contact with the physicians who made an entry in the medical record, in order to get more details of the exact reasoning behind a decision. Similarly, there is a need for getting hold of the person(s) who have the latest information 'in their head' because it has not yet been documented and distributed, such as the images described at today's radiology conference. Finally, the need for a specific person may arise when the highest expertise and authority upon a question is personalised in one individual.

Another specific person of central importance is clearly the *patient*. Because of the individual nature of diagnosis, treatment and care, *the* patient is the central source of information. Patients are distributed to different departments within the hospital according to their main diagnosis and again within the haematology department according to a mix of criteria: according to hygiene regime; the attempt to ensure single-sex rooms; the attempt to ensure care by the same team of nurses and physicians to achieve continuity in their trajectory (Strauss, Fagerhaugh et al. 1985); the attempt to ensure that newly diagnosed patients are not put next to terminally ill patients with the same diagnosis, and with respect to the respective personality of the different patients. Since patients are continuously admitted and discharged, their distribution between the different rooms on the ward has to be reordered quite often. Patients are often mobilized locally at the ward for the exercise of it, and to go for examination or treatment at other wards. Critically ill patients are moved to the intensive care unit, which is situated in another building. For these reasons, patients are distributed and moved around, and locating them in order to make diagnoses, examinations, give treatment or provide care is not a trivial issue.

All in all, local mobility from the perspective of persons arises from the fact that patients, who are a central source of information and essential of subject of work, are distributed within the department and even, at times, within the hospital and move about; and when specific persons are carries of information that has not yet been distributed.

Mobility and its Challenges

Above, we have described how local mobility arises because clinicians' tasks are accomplished by the presence of a combination of people, places, resources and knowledge, whose configuration changes from task to task. Clinicians move from patient to patient, from place to place, from one piece of technology to another, and from one source of information to another to *make the right configuration of people, places, resources and knowledge emerge*.

Achieving this configuration entails then again several challenges as to move and locate any of the four "corners" in figure 3 – e.g., how to move and locate relevant knowledge. This is basically a coordination problem, but the mobility of persons and things within a hospital puts further stress on the challenge of coordinating the work done. As put by one of the physicians, when explaining what was going on after the morning conference: *"Now everybody [the physicians] is literary spread out all over the hospital. Most of us will not meet again before the conference at noon"*. He was referring to the fact that ad hoc coordination and social awareness of the work of other colleagues is very difficult because they are on the move constantly. Strategies for meeting this challenge of coordinating while moving is to meet on a regular basis for conferences, as shown in figure 2. These regular morning and noon conferences are very efficient means through which to coordinate, and the overhead of arranging them is minimal since they are done routinely.

Complementary to this kind of institutionalized coordination work, there is a need for constant informal coordination during a shift. In these cases, there is a substantial challenge in getting the work of mobile clinicians synchronized. Asynchronous communication can be done by writing post-its, email, sending a fax, or leaving a message with a secretary. But some issues need to be handled in dialogue – urgent matters and in situations, where authorization is required. This however creates a contradiction between the need for being contacted and being able to do one's job. Clinicians do not carry cell phones or pagers because they have a reasonable fear of being interrupted constantly if this was the case. Phones are only found in the secretaries and team rooms and hence people can be called to the phone, but also have the option of fitting the call into their own schedule and call back later. This might be a major obstacle to the one calling since she might not be able to go on with her job before having spoken with the other person. There is hence a constant negotiation of the balance between acknowledging the necessity of interrupting and ensuring a smooth flow of work, between being accessible and being able to plan one's work.

Let us consider how clinicians (and patients) at department B deal with the challenges associated with moving and locating places, people, resources, and knowledge.

Moving Resources, Persons, and Knowledge

As simple as it might sound, there are often challenges associated with the sheer movement of things and persons. As described above, somebody and something has to move and move on in hospital work. Physicians, nurses and other staff at the hospital move themselves around and while it may take some time to learn the geography of a hospital and people occasionally get lost, the movement itself poses no problems to these except of course for sore feet. If we look at patients and medical records the picture is different.

Figure 5: The trolley used to move records around during the ward round.

While some patients are capable of walking around internally at the ward or inside the hospital, quite a lot have to be moved around while they are in their beds or in a wheelchair. The transport itself is taken care of by the hospital orderly who have an impressive knowledge about 'getting around'. While banal, it is not always trivial to ensure that the right patient arrives at the right place at the right time, and it happens in some occasions that a patient waits in the corridor for hours at the wrong examination room.

Looking at moving artefacts, the paper-based medical record is a nice example. The medical record needs to be present when treating a patient. Hence, there is a need for physically moving the record around as the patient is transferred to and from other departments and hospitals, and in and out of the archive when the patient is discharged and admitted. A record cannot be copied, because the existence of several copies could create doubt as to which copy was updated most recently and whether it contained all information. The information in the record would not have the authoritative and authentic status that is needed for proper diagnosis, treatment and care. The secretaries organize the movement between the archive, the wards and the teams and try to keep updated files upon their present location. The actual movement of the record between departments and files is primarily accomplished by a page girl or an orderly. The movement around the ward during e.g. a wards round is done by having all the records on a mobile trolley, shown in figure 5. This trolley is use to move the often voluminous records around, because they are too bulky and heavy to carry.

However, knowledge cannot always be carried around as written documentation in medical records. First of all, it is impossible for clinicians to carry with them all the records and documents for the different patients they are treating. Second, due to the typical delay between oral and written information, most recent information is provided orally and stored mentally. X-ray physicians, for example, give their assessment of the images in the morning orally to the physi-

cians, but it takes to the afternoon or even next morning before these are available in writing. Similarly, the decisions made by the physician making the round during the day may not be written before the next morning by the secretaries. Hence, we learned that clinicians seem to have a remarkably good memory. Due to the mobility of the work, much information simply needs to be in the head of the clinicians.

Locating Resources, Persons, and Knowledge

In a mobile environment where people and things move about locating these becomes a major challenge. Important artefacts for locating people are the whiteboards. They list, for example, to which patients a nurse is associated. Thus, it is reasonable to look for her in one of her patient's rooms. They furthermore list the order in which the round will take the patients and ideally the round would check off patients as the go along, in which case the round can be located by looking at the bed number of the next patient. Often, however, the list is not updated and since the round brings the trolley into the rooms finding it may be difficult. Therefore, the round has a written sign that is hung highly visible outside the room into which the round has gone. Also by the help of the whiteboard, nurses may locate patients since it lists their bed numbers and, in addition, the major examinations of a patient. Hence, nurses can see that a patient has gone for X-ray, MR or CT for example.

This, however, is only approximations of the whereabouts of people. Since clinicians, patients, records etc. are constantly on the move, the exact whereabouts of these have to be assessed by moving around and finding them. Hence, mobile persons create more mobility (Bellotti and Bly, 1996). But mobile artefacts as well create more mobility, as the following excerpt from our field notes shows.

> While following a nurse around on the ward, the team leader comes running around the corner. "Where is the medicine plan?" she exclaims. She is doing the morning round with the physician and they have come to a patient whose medicine plan is not with all the other plans which they have brought along on the trolley. She runs into the cabinet rooms where the medicine plan ought to be, then into the room for intravenous medicine and out again. It turns out that the medicine plan is with patient's associated nurse, who, however, has taken the medicine plan with her to another room where she was needed.

Turning to the location of knowledge, we have already seen how the medical record and the care record exist in one copy only. Taking their mobile nature into account, locating and getting access to them is a constant challenge. In some instances, however, information can be replicated and distributed. This applies for a patients name, bed and room number, primary diagnosis and associated nurse which are all listed on large whiteboards in the team rooms and in the secretaries rooms and updated during the day by nurses as patients are moved. In addition this information is also found on the nurses' work schedule which covers a day

and also lists all major actions to be taken with regards to individual patients and the status of these tasks. Via these whiteboards and the work schedule information is distributed within the bed ward.

As we have argued above, information is mobile because the artefacts (documents) that contain information are often moved around. A common strategy at the ward for increasing the probability of locating and accessing information is to make social agreement about the 'right place' for things. For example, the medicine schema is usually found in the medicine room, and records on the trolley. When things are not at their 'right place' a second strategy can be applied, which is to decipher the temporal rhythms of the department and ward (Zerubavel 1979; Bossen 2002; Reddy and Dourish 2002). If you know when a physician makes his round, when blood-test results arrive, or when nurses pour medicine, then you know where and when to find records, examination results and medicine schemas. Yet another strategy is to use the division of work to find the most update information. For example, the nurse and physician has the most recent information about the treatment of a patient, the secretaries knows the latest about the transportation and whereabouts of patients, and a patient's primary nurse knows about the social background and family-relations of the patient. In these circumstances, clinicians need to seek out and locate persons that have the latest information 'in the head'.

Mobility Work

In this paper we have analyzed mobility work at a hospital, and we have analyzed how local mobility is caused by the need for bringing together people, places, resources, and/or knowledge – as illustrated in figure 3. Mobility work is the work that needs to be done in order to make *the right configuration* of people, places, resources and knowledge emerge. We also analyzed the number of challenges that mobility work implies with regards to moving and locating people, places, resources and knowledge.

Based on our analysis we argue that each of the four aspects of mobility work shown in figure 3 can be further subdivided into two aspects, as illustrated in figure 6. People are different to the degree in which they are needed because of the role they have (e.g. physician on round; team leading nurse) or because of their specificity (patients, carriers of non-distributable information). Places are different as to whether they have inherent qualities (sterile environment) or ordinary character (meeting room), while resources differ as to whether they are mobile or stationary. And knowledge differs as to whether is can be distributed (patients' bed number) or has to be authentic (singular records, expert judgement).

The specific configuration of the 'corners' in figure 6 emerge as a response to carrying out a specific work task. But the configuration is also premised by the given order of things and people – an order, which is the result of a social, politi-
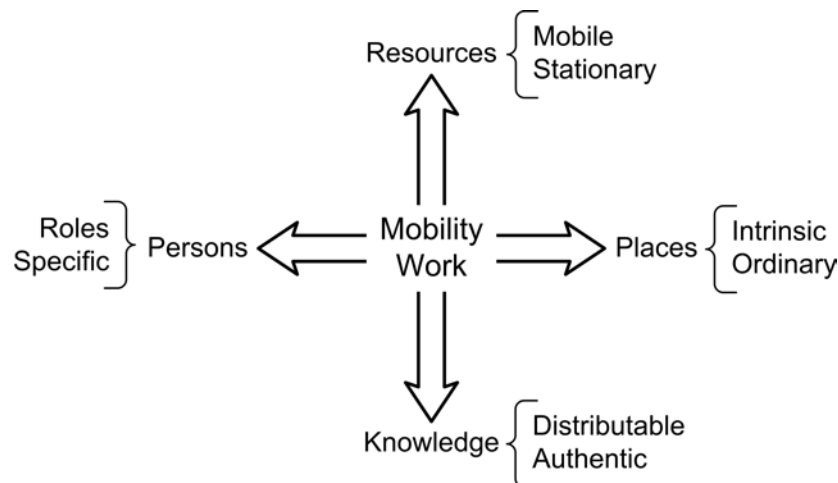
Figure 6: Aspects of Mobility Work.

cal and cultural process (Tellioglu and Wagner 2001; Prior 1988). Looking at department B, changes in e.g. the division of work, available technology, established routines, cultural norms or specific requirements have changed the specific pattern of local mobility. With respect to the division of work, for example, nurses were previously not allowed to give chemotherapy, which instead was done by physicians which imposed a lot of mobility on these because they normally are further away from the patients. Giving chemotherapy was then handed over to nurses on the provision that they had passed a special course, alleviating physicians to move to the ward for setting up chemotherapy. As for technology, the introduction of an electronic patient record (EPR) in some Danish hospitals has made the record more stationary, because the EPR is only accessible through desktop PCs. While the EPR has enabled updated information to be available at multiple places at the same time and thus has distributed the records, it has simultaneously meant that these records are more fixed to desktops. The clinicians can no longer bring the records to the patients, and they either have to read the records in an office before seeing the patient and subsequently oscillate between that office and the patient's bed if questions arise, or give up making a round and instead bring the patients to a consultancy room. With respect to cultural norms, confidentiality of personal information requires nurses and doctors not to discuss a patient in the presence of other patients, just as considerations to the individual patient requires that the internal discussions between clinicians of a patient's case is not done in the presence of that particular patient.

Looking into the future, one can envision technology that would change the need for mobility: video-conferences could replace face-to-face discussions with experts; smaller, mobile CT- and MR-scanners could bring the examination equipment to the patient instead of vice versa; efficient bacteria- and virus annihilators in the whole department could do away with places for special hygiene requirement, etc. However, even if the attempts to achieve a certain configuration

of persons, places, resources and knowledge are configured by a historical process, it is exceedingly difficult to envision a state in which local mobility would disappear: experts often have to look at the patients themselves; EPRs tie the records to desktops and to particular rooms, mobile CT-scanners still require the interpretation of data by collaborating staff; etc. Whatever new organisation of work comes up or whatever new technology is introduced, some kind of local mobility will prevail.

The contingent character of local mobility becomes even more evident when it is realised that its specific pattern is also premised on the balancing of sets of *contradictory* concerns which may be changed by reorganisation of the work and/or through the introduction of new technology. As described, there is balance to be kept between *availability and seclusion* for clinicians. For example, a technological solution that tries to reduce the penalties for remote collaborators, who try to communicate by suggesting portable computers or video-based awareness systems (Bellotti and Bly 1996) would imply severe penalties for the work of clinicians. If they became constantly available to other, they would be interrupted constantly. On the other hand, total seclusion is not an option either since they very often carry authentic information in the sense that they have expertise upon a certain disease, carry oral information not yet distributed, or posses the latest information about a certain issue. Another balance to be considered exists between *mobility and localisation*: the more mobile people and things are the more difficult they are to locate. Hospital work inherently necessitates mobility and in order to accomplish their work, clinicians rely on the mobility of e.g. the records and patients, but which at the same time demands orderly registration of their movement in order to be able to locate them. Finally, a balance has to be achieved between *orderliness and flexibility* of work processes: ordering is highly efficient for coordination in a mobile work setting, but the cost of a rigid order is a system that cannot absorb unforeseen events and the cost of ordering into too much detail is a great overhead on articulation work. As described, order in the form of procedures, routines, coordination mechanisms is central to hospital work right down to detailed documentation of the status of giving of e.g. blood. At the same time, however, there is no formal planning of when two nurses have to assemble to give blood since such scheduling would lock their multi-tasking and constant replanning because of unforeseen events into a rigid scheme (See e.g. Bowers, Button et al. 1995).

Discussion and Outlook

Even though we suggest the above set of concept in the spirit of 'grounded theory' and have pointed to the contingent nature of the specific pattern of local mobility at the haematology department, we believe that our analysis reaches beyond the specific case. The application of the concepts on the cases of local mobility

described initially is rather straightforward. In the case of the wastewater plant (Bertelsen and Bødker 2001), workers were 'zooming with their feet' because they had to look at intrinsic qualities found only at specific places (e.g. the smell and colour of water), to exchange knowledge and coordinate with other workers (ad hoc meetings around the plant), pool knowledge (the coffee break) or access resources (polymer, machinery). Similarly, in the case of the construction site (Luff and Heath 1998) a major concern of the foreman was to roam around to monitor problems as they occurred, check on the status of tasks and get information from gangers and colleagues, which in turn relied in their work on him to passed by frequently. Here people, places and knowledge figures centrally, while the main resource was an allocation sheet that was brought along. In contrast, resources posed a central problem in the case of London Underground, since the necessity to become mobile took personnel away from the control room where most means of communication and surveillance was found. Thus, whenever employees had to move to specific places, e.g. in order to monitor platforms in times of congestion or cases of 'suspect packages', they lost access to central resources.

The concepts we have introduced might even be used to look at mobility in general, which raises the question to which extent they apply specifically to *local* mobility. There are two ways of addressing this question. One is to look more closely into the defining characteristics of local mobility and the developed set of concepts presented above. Another, possibly complementary option would be to first look more generally at mobility and then return to more specific instances. Here we think that it might be fruitful to introduce the concept of '*mobility work*' in parallel to the concept of 'articulation work' (Strauss 1985). 'Articulation work' refers to the fact that collaborative action requires a lot of working-out in terms of coordination and reaching common understanding, and can only at a superficial level be understood through a rational means-end scheme (Strauss 1993:p20). In CSCW this has lead to a focus on coordination (Bardram 2000, Schmidt & Simone 1996), which has a temporal as well as a spatial dimension – the latter of which is often overlooked. As Strauss (1993), amongst many other authors, points out, actors not only have minds but also bodies and feet and have to move around in space in order to act and interact. This entails gaining the right view, placing oneself in the right position with regards to place, things and other actors – in short *mobility work*. Action is intrinsically not only temporal but also spatial.

To sum up, we have looked at local mobility, which occupies the intermediate space between centres of coordination (e.g. control rooms) and remote collaboration and communication (using e.g. mobile phones or video conferencing). We have analysed local mobility at a hospital ward, proposed that local mobility can be understood as an attempt to make the right configuration of person, places, knowledge, and resources emerge, and pointed to the challenges that such at-

tempts face. Finally, we have introduced the concept of 'mobility work' as worthy of further investigation.

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