

# The Parameters of Common Information Spaces: the Heterogeneity of Cooperative Work at a Hospital Ward

Claus Bossen

Department of Computer Science  
University of Aarhus  
Denmark  
bossen@daimi.au.dk

## ABSTRACT

The paper proposes a refinement of the concept of ‘Common Information Spaces’ (CIS), which has been proposed as a conceptual framework for the CWCW field in order to provide analyses of cooperative work. The refinement is developed through an introductory discussion of previous analyses of CIS and on the basis of a thorough description of the CIS of a hospital ward based on ethnographic fieldwork. The initially definition is refined by the introduction of 7 parameters: (i) the degree of distribution of work; (ii) the multiplicity of webs of significance; (iii) the level of required articulation work; (iv) multiplicity and intensity of means of communication; (v) the web of artefacts; (vi) immaterial mechanisms of interaction; (vii) the need for precision and promptness of interpretation. These parameters provide a more detailed conceptual framework and can be applied to characterize the particularity of a given CIS.

## Keywords

Articulation work, artefacts, common information spaces, coordination mechanisms, health care, hospital ward.

## INTRODUCTION

‘Common Information Spaces’ (CIS) has been introduced as a concept in an attempt to construct a “coherent conceptual framework” for the CSCW field, which, according to the initial authors of the concept should “be concerned with the support requirements of cooperative work arrangements” [10:p7]. The value of the concept is its focus on the interrelationship between information, actors, artefacts and cooperative work. It highlights how information is presented to actors through different artefacts – e.g. written documents, schedules, and computers - and how these artefacts support the coordination of collaborative work. The aim is to provide analyses that can inform the development of systems that further support collaborative work.

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The concept of CIS is valuable and promising, but still loosely defined conceptually [1:p1; 10:p2-3]. This article aims to contribute to an elaboration of the concept and proceeds in the following way: the first section introduces the concept of CIS and discusses two previous analyses of particular CIS: an intensive care unit and a wastewater plant. The second section describes the CIS of a hospital ward based on ethnographic fieldwork. Based on these two sections, the third section presents 7 parameters that can be used as a framework for the analysis of CIS. The conclusion proposes that this refinement of the concept of CIS can be beneficial for analyses that are made of work setting in order to inform design of computer support for cooperative work.

## THE CONCEPT OF CIS

The concept of CIS is meant to designate both the material carriers of information, i.e. the representation of information, and the meaning attributed by actors to these representations. According to Schmidt & Bannon “a common information space encompasses artefacts that are accessible to a cooperative ensemble *as well as* the meaning attributed to these artefacts by the actors.” [13:p28].

The rationale of CIS is that actors engaged in interdependent activities of work need to coordinate their tasks as to where, when, why, for how long etc. it should be conducted. Such coordination requires *articulation work*, which designates “a set of activities required to manage the distributed nature of cooperative work” [13:p18]. Articulation work can be done face-to-face, but often requires the use of other means of communication, since the interdependent actors may be distributed in time and space. Thus *mechanisms of interaction* are applied to reduce the complexity of articulation and thus also reduce the amount of work it requires. Organizational structures, plans, schedules, procedures and schemes of categorization are all examples of mechanisms of interaction. Schmidt & Simone [14] use the concept of *coordination mechanisms* in an almost identical sense, but focus on material artefacts and seem to exclude organizational structures in their explication. However, organizational structures and

divisions of labour also facilitate coordination of work, since they explicate who does what and when (more on this in section 2 about the hospital ward). I will therefore use the term *immaterial mechanisms of interaction* for these, while the term *coordination mechanisms* designates material such ones.

In their elaboration of CIS, Schmidt & Bannon point to the problem of interpretation implicit in a CIS: since originators and recipients of information might be separated by time and space, a shared interpretation cannot be negotiated on the spot. This entails problems of identifying the originator of, the proper context for and the proper audience for disseminated information [13:p31-5]. Bannon & Bødker [2] argue that one solution to this problem is to ‘package’ aspects of context and rationale with information whenever it is transmitted across time and space [2]. They further argue that CIS are characterized by a combination of openness and closure, since they have to balance “the need for openness and malleability of information on the one hand, and, on the other, the need for some form of closure, to allow for forms of translation and portability between communities, ...CISs are both open and closed - in a word, they have a dialectical nature” [2:p85]. This dialectic of openness and closure, according to Bannon & Bødker, applies also to the single carrier of information, which, like the CIS, can be regarded as a ‘boundary object’ (they refer to [15]). CIS should be regarded as the result of ongoing processes of achieving mutual interpretations of single items of information that comprise in total a temporarily achieved communality for the actors involved. Constructing CIS demands the work of coordinating interpretations, a new kind of articulation work [2].

Such mutual interpretations are, of course, everyday achievements. We interact fluently as long as our actions (including speech) and interpretations ‘fit’, and when they do not, we talk and coordinate them all. Not necessarily in depth, but sufficiently to make social interaction flow. Human behaviour is symbolic action and “man is an animal suspended in webs of significance which he himself has spun” [7:p5]. Many people share large parts of the same ‘web of significance’, but whenever different webs have to be knitted together, problems may arise. Whenever cooperation has to be achieved by people suspended in webs that are different because e.g. differences in education, profession, gender, class, or culture, interpretative articulation work has to be carried out. The more heterogeneous a set of differences is found in cooperative work, and the more understanding has to be achieved across time and space, the more complex and non-trivial the achievement of shared understanding becomes and entanglements are more likely. Randall [10] has demonstrated how classifications threaten to or do break down when actors do not share sufficient common interpretations.

## Two elaborations of CIS

The spectrum of heterogeneity is of course vast, as is the variety of different CIS. The question arises by which concepts CIS should be analyzed and characterized, and whether they can be divided into different categories.

A tentative attempt at categorization of CIS is provided by Bannon & Bødker [2], who present 5 different cases through which they want to show how different CIS are constituted. They first present a ‘community of practice’ (exemplified by control rooms); go on to ‘working at an arm’s length’ (exemplified by bureaucracies) and end with the World Wide Web (www). For each case they comment on the particular combination of openness and closure found in that kind of CIS. Interspersed are furthermore two other kinds of CIS: organizations demanding trust (in the sense of the sociologist Anthony Giddens [8]) by their clients, and the role of human mediators. From these cases, Bannon & Bødker conclude that a variety of factors have to be taken into consideration when designing for new CIS: e.g. possibilities for sharing, looking over shoulders, rules of submission of information, the roles of human mediators [2:p94]. However, while probably all CIS rightly can be said to display a combination of openness and closure, there is a need to develop concepts that enable us to differentiate between different degrees and combinations of openness and closure.

There is apparently in the 5 cases of Bannon & Bødker an implicit order, since they seem to go from a closely defined and intensely interacting group of actors (the control room), to very loose and extensive groups of temporarily connected people (of the www). They remark that “Common information spaces are in some cases constituted for collaborators that are co-present in time and space, whereas in other situations they are constituted across time and space boundaries, and the mechanisms used to support holding in common the information varies accordingly.” [2:p93]. In this remark, the degree of distribution of collaborators across time and space is the central parameter with which the ‘mechanisms for holding in common’ varies. From the initial discussion in the previous discussion, we do also have, however, other parameters: the available coordination mechanisms and the variety of different webs of significance. The question is whether these parameters are sufficient and how they relate to each other. I will explore this and make two elaborations upon the concept of CIS by discussing two analyses of particular CIS.

The first elaboration takes its starting point from Reddy, Dourish & Pratt [11], who interpret Bannon & Bødker to say that physical proximity provides distinct advantages in the constitution of CIS. However, from their analysis of the use of an electronic patient record system at an intensive care unit at a hospital, Reddy, Dourish & Pratt argue that the work practices here were so diverse that many of the usual benefits of co-location were lost [11:p253].

“Physicians and nurses have only a limited and superficial understanding of each other’s work” [11:p255] and thus the close coordination of a control room is not possible. They conclude that the assumption that physical proximity is critically important in collaborative settings, only holds true if the co-workers are able “to interpret what is going on around them, through their familiarity with the work ... and the practices by which their colleagues organise that work.” [11:p255]. The loss of the benefits that physical proximity usually provides was, they argue, compensated by the ability of the electronic system to make different representations of the same information. “Unlike paper records, computer systems offer the ability to decouple information from its representations to help smooth coordination.” [11:p257].

Reddy et al. make an important general point: the advantages provided by physical proximity depend on the ability of the collaborators to establish a common interpretation. If the actors are spun into very different webs of significance, the interpretative articulation work to which Bannon & Bødker [2] point becomes demanding despite physical closeness. It is, however, still possible to argue, pro Bannon & Bødker [2] and contra Reddy et al. [11], that even in a situation where actors were part of distinctly different webs of significance, physical proximity offers far better means for bridging that divide. Not because of the minimized span of physical space separating them, but because there are more opportunities for knitting webs of significance together across existing differences when people can see, talk and gesture with each other face to face. A decisive factor in achieving shared interpretations and thus in constituting a CIS is thus not physical proximity itself, but the characteristics and number of means for communication available for actors. At one pole, we can envisage few and low-intensity means of communication, at the other multiple, high-intensity ways of communication. The former would apply to actors that were only capable of communicating by e.g. gestures whether they were situated at either side of a broad river, or working side by side in the noise-hell of an engine room. The latter would apply to actors in a meeting with the possibility of communicating orally, bodily, and sharing views of the same artefacts, or actors separated in distance but capable of doing the same through a combination of written and graphic documents, phone, e-mail, and on-line web- and video-linkage. In this conceptualisation, physical proximity plays an indirect role, since it enables immediate visual and auditory communication whereas distance requires augmenting means before the same intensity of communication is possible.

Reddy et al.’s more specific point with regards to the degree of common (non)understanding between nurses and physicians seems less straight forward than the general point. While different professions often imply different webs of significance, they also offer a division of labour which facilitates cooperation. Furthermore, even if

physicians and nurses do not understand each other’s work entirely, the concept of CIS only requires that they understand sufficient of each other’s work to enable collaboration to run smoothly. Moreover, Reddy et al. argue that physicians when prescribing medicine require a retrospective view in order to be able to evaluate treatment and decide upon how it should be continued, and that thus physicians need to see a total list of all medicine. Nurses on the other hand, Reddy et al. argue, need a prospective view since they have to see at what time which medicine has to be given, and nurses thus require a list where the medicine is listed according to the times of giving. It seems, however, that while the identity of information (dose and name of medicine) enables coordination between prescription of giving of medicine, the different representations of that information is less a question of coordination and more a question of what is most useful for the task at hand – prescription of medicine by a physician or giving of medicine by a nurse. There is, it seems, a need to go into further considerations of the implications of ‘packaging’ information.

Nonetheless, from Reddy et al.’s general point and the focus it entails on means of communication, a second elaboration of the CIS can be made: the extent to which augmentation of communication is necessary varies, I suggest, with the extent to which intensive coordination is necessary and with the need for precision of common interpretation of information. The case of control rooms often referred to in the CSCW literature shows a high need for coordination and precision, but Bertelsen & Bødker [5] provide us with an instructive contrasting case. They characterise the wastewater plant, which they researched, as a massively distributed CIS. 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.” [5:p6]. Bertelsen & Bødker argue that the characteristics attributed to ‘common artefacts’ [12] – provision of overview, predictability, peripheral awareness, and double level language – all apply to the wastewater plant. These characteristics are produced when workers move about and interpret information from a localized perspective. Thus in this sense the wastewater plant is itself a common artefact. Workers do cooperate and coordinate but mainly locally when they move about, and they only meet ‘centrally’ at the coffee-breaks. The wastewater plant is thus as a CIS characterised by different, partly overlapping zones within which workers mainly move. From this case, Bertelsen & Bødker argue that CIS may have several centres, peripheries and overlapping

regions and that further investigations of CIS should therefore not solely focus on control rooms.

It is, however, not only the vastly larger physical space and thus 'massively distributed' character that differentiates the wastewater plant from a control room. They are also different with regard to the intensity of exchange of information and of cooperation. Whereas the control room is characterised by the exchange of extensive, precisely interpreted information and intense coordination of work, the amount of information exchanged at the wastewater seems less, as does the need for intensive coordination. Therefore, there are less means of communication and they operate at a relatively lower degree of intensity.

To further strengthen the argument for the two elaborations upon the concept of CIS made above, I will present the case of a CIS of a hospital ward. This particular CIS, shares the need for precision of information interpretation and intense coordination with a control room, but is at the same time massively distributed with a number of centres and peripheries like the wastewater plant. I will return to the conceptual elaboration of CIS after having presented this hospital ward CIS.

#### **WORKING AT A HOSPITAL WARD**

The following description is based on ethnographic participant-observation at a hospital ward in Denmark. The ward is part of a haematology department treating blood diseases and is one of two wards taking in patients full-time. The haematology department also comprises an outpatients' ward, a admittance ward, a laboratory and a day-ward, which takes in patients for tests and short treatments.

The fieldwork was spread out over three months and consisted all in all of 28 stays of 5-8 hours. Extensive notes were taken while following the work of nurses, Social and Health Assistants (SHAs) and physicians and the notes were written out the same day or the day after. In addition, 12 open-ended interviews with SHAs, nurses and physicians were conducted.

In order to cure patients, hospital work puts a strong emphasis on accumulation of knowledge, transmission of information and coordination of tasks. Over the years, a wide range of common artefacts has been developed to facilitate this accumulation, transmission and coordination, and the patient record and the care-record are probably the most known artefacts by the broad public. The patient record has developed over the last hundred years in connection with the growth of large, central hospitals [4] and it is the physicians' most central document. The care-record has developed as nursing went from being a craft to become a profession and is today the central document of nurses and SHAs. While these documents are the most important ones for long-term accumulation of knowledge and for official documentation of patient treatment and care, there are a host of other documents that facilitate short-term accumulation and transmission of information

and facilitate coordination. There are, of course, material 'coordinating mechanisms' such as whiteboards and work-schedules, but there is also a host of other, immaterial ones such as procedures, routines and habits at the ward. Both categories are part of the CIS at the ward, and I will start by outlining this CIS in a broad perspective in order to show how the ward, like the wastewater plant, can be seen as a common artefact, a massively distributed CIS. It is also a CIS where different views of information are needed, but most obviously so within the care-personnel.

In the first part, I will describe the work through three broad categories: persons, time and space. In the second part, I will specify the characteristics of the CIS that is build and constantly rebuild at the ward. This will lead me to the conclusion where I will resume the general discussion upon CIS.

#### **Persons**

Differences between staff at the ward have a Janus-faced character. They provide on the one hand categories and criteria through which to identify who should do what and when. On the other hand, these more or less explicit categories and criteria have to be learned before they are of any help and they sometimes overlap.

Differences between staff due to profession form a basic division of labour in hospitals. Physicians take care of diagnosis and treatment, while nurses are in charge of the care-side of treatment. SHAs very much do the same job as nurses, but are not allowed to give IV-medicine, chemotherapy, administer medicine for more than one or two patients at a shift and never acquire the role of team-leader. Within each profession there are differences in competency, since some tasks require extra training. Thus, for example, only those nurses that have completed a 5-day course do the giving of chemotherapy. Differences in profession and competency entail a division of labour that facilitates coordination, since it is obvious who will for example diagnose, administer IV, or wash a patient.

This immaterial mechanism of interaction provided by the overall division of labour between physicians, nurses and SHAs is, however, countered by other factors. There are different kinds of physicians and nurses, since both groups specialise, and differences in experience and abilities complicate coordination. Thus there are nurses that have worked for more than 20 years at the ward and know more about the specific diseases and especially how to treat them than some of the young physicians. Similarly, also one SHA has worked at the ward for more than 20 years and has an experience that far out-classes the young nurses though these are placed higher in the hierarchy of professions. Difference in ability has the same effect, especially with tasks that can be done by either group, since young nurses or doctors are better at some task than even their experience colleagues. This means that an initially clear division of labour based on profession and competency is complicated by differences in experience

and ability. Gray zones arise where divisions of work and hierarchy become unclear. This may be illustrated as in figure 1 (Physicians, nurses and SHAs are represented by lines, squares and circles respectively. Difference in competencies is indicated by difference bold and non-bold; and overlapping of competence and skill are represented by grey areas).

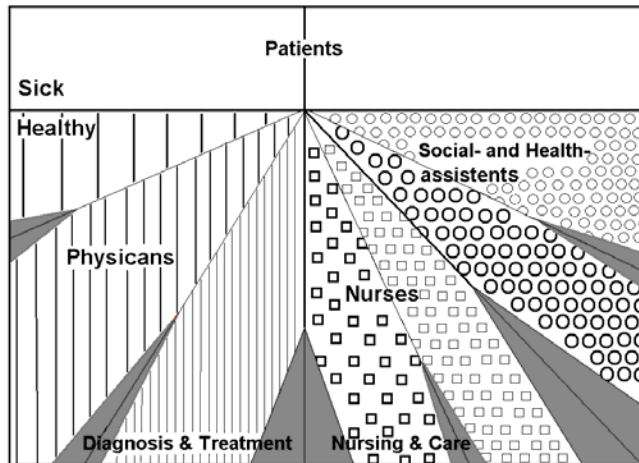


Figure 1: Professions, competencies, and grey areas.

As a consequence of these overlapping areas of profession, competence, experience and ability, there is a demand upon staff to learn and be aware of them. They need to know not only the division of labour between e.g. physicians and nurses, but also who has the competency to do certain tasks, who has the experience and who has the ability. The giving of chemotherapy, for example, demands two nurses with this competence in order to double-check the patient's identity, the drugs, and the calculation of doses. To accomplish this task a nurse thus has to know which other nurses are qualified to help her and locate them on the ward. Social skills on both sides are required when a experienced nurse collaborates with an inexperienced physicians. In order, to accomplish their work most fluently, hospital staff has to learn more about their colleagues than their profession.

### Time

Within the aspect of time an obvious first problem is encountered by the division of day into different shifts. While most physicians work from 8 a.m. to 4 p.m. and do their rounds to patients, one of them also has the duty (visually detectable by the wearing of a pager) of taking care of all acutely admitted patients during the day. From 4 p.m. to 8 a.m. the next day, another physician takes over the pager and has the duty of taking care of acute problems. He or she debriefs the ward's other physicians at their joint morning meeting, but otherwise the transmission of information is handled through the patient's record.

Nurses and SHAs divide the day into three shifts (day-, evening-, and night-shift). Most tasks are carried out during

the day when labour-time is cheapest and the number of staff hence highest. However, tasks and information have to be handed from shift to shift, which is handled by short debriefing meetings by one person from one shift to a person from the next. A second problem is the coordinating of the various tasks during and across shifts and ensuring that all tasks are taken care of.

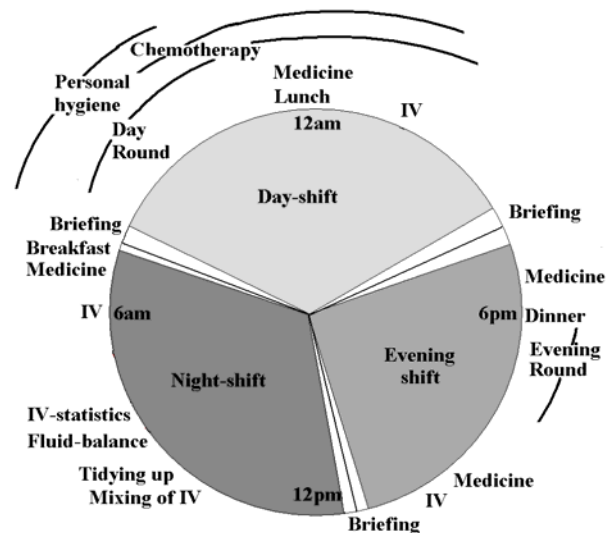


Figure 2. Nurses' shifts and most work-demanding tasks

The two most central artefacts for the transmission of tasks and information is the *care-journal*, which is the central artefact for nurses and SHAs parallel to the *patient's record's* central role for the physicians. Both physicians on the one hand and nurses and SHAs on the other hand have each a *work-calendar*, which is made for 3 months in advance and which lists who is working where and when. In the daily work of nurses and SHAs, however, the *work-schedule* is of central importance. The work-schedule comprises a list of all patients, which bed the patient occupies, which nurse or SHA is taking care of which patients on the actual day, and a detailed list of tasks that have to be taken care of or phenomena that have to be observed on that particular day.

This schedule is used in all briefing meetings between shifts and in the longer morning meeting of nurses and SHAs. Here the team-leader will go through all patients and associated tasks. Dependent on agreement with her colleagues, she will divide patients between nurses and SHAs. The aim during the day shift is that the same nurse or SHA should take of a patient during the whole shift. The division of tasks is complicated by the differences in competencies, experience and abilities amongst the nurses and SHAs, which have to fit with the amount of work required by a patient and the particular tasks to be taken

care of. As mentioned, chemotherapy, for example, can only be given by a nurse qualified to do so.

During the day, there is a need for continuous coordination of tasks and making status. This is handled by nurses individually through personal note-sheets on which they write down tasks and things to be remembered concerning their patient(s). Collectively, this is again handled by the work-schedule, where a special notational system has been developed. Thus, “/” signifies that a task still has to be carried out; if a half stroke added so that “y” is the result, means the task has been commenced (typically when infusion of blood, IV or chemotherapy has been started); while finally another half stroke resulting in “x” means the task has been accomplished. This notational system on the work-schedule accomplishes several things: nurses and SHA may centrally achieve an overview of how far their colleagues have come and thus assess where to help out; furthermore the team-leader can continuously re-allocate tasks according to the present status; and new shifts can easily get an overview of the status of tasks when they take over.

Figure 3 is a complex grid table representing a work-schedule. The columns are labeled: Patientname, Nurse, Day-shift, Night-shift, and Evening-shift. The rows are organized into sections for different patients or tasks. The table contains handwritten notes, symbols (like 'y' and 'x'), and some printed text. A legend on the right side indicates that 'Staff-list' and 'Date' are associated with the table.

Figure 3. The work-schedule

All in all, coordination of work and transmission of information is achieved through a combination of briefings, meetings and a range of artefact (patients record, care-record, work-plan, work-schedule, personal notes).

### Physical Space

Finally, there is the aspect of physical space. Even on a single ward like the one described here, locating people and things requires a lot of effort in terms of awareness and walking, as does making the right artefacts available at the right place.

The distribution of patients between rooms and beds is done by the head-nurse, who attempts to meet the criteria of differences in hygiene-requirements, single-sex rooms,

need for quietness and personal differences between patients, in that order. Since new patients come in everyday, the distribution has to be changed frequently and thus the staff relies on the listing of bed-number on the work-schedule. Another aid here is provided by three whiteboards of which two are found just inside the ward's two team-rooms, while a third whiteboard hangs in the secretaries' office. The two whiteboards in the team-rooms list the team's patients, their bed-number, their associated nurse, the patient's hygiene-regime (if any) and the main events for the day. The whiteboard in the secretaries' office lists the same for all patients, but excludes main events. While the repetition of this information on the work-schedule and the whiteboards seems redundant, these different artefacts actually have a central role in locating people. First of all patients, of course, but also of colleagues since the whiteboards in the team-rooms also list which nurse or SHA is associated to which patient(s) and a colleague might reasonably be assumed to be close to her patient. In contrast to the A4-sized work-schedule, the large whiteboards offer instant, at-a-distance overviews.

Another aspect of physical space is that of making the right artefacts available at the right place. Thus, the medicine scheme, which is part of the patient's records, is frequently needed at the medicine cabinet when medicine is poured into unit doses. The ward gives a lot of IV-medicine and thus has a special IV-medicine scheme which is needed at the flow-room, when IV is mixed or its giving is commenced. Patient's records and care-plans are needed in the team-room whenever the staff needs to check them for information or get an overview of a patient's present condition. All these artefacts are thus distributed on the ward and have their 'usual place'.

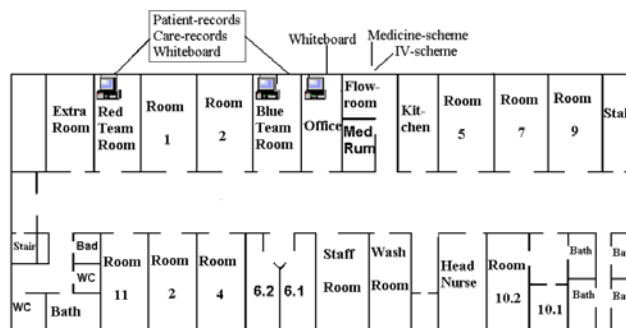


Figure 4. The Ward and usual place of artefacts

However, during the day-shift when these artefacts are most needed, they are also most difficult to find. The daily round to the patients is made by a physician and the team-leader in collaboration, and they need the patient's records, the care-records, the work-schedule and all the medicine-schemes. These are put on a small trolley which is pushed around and which disappears into patients' rooms with the physician and the team-leader, only to emerge on the alley again for a short time before the round disappears into another patient's room again. To help locating the trolley

and the artefacts upon it, a coloured sheet of paper is put up with a peg outside the room. The people on the round often forget this however, and their colleagues instead have to ask around for them. Alternatively, they can look on one of the whiteboards in the team-rooms. Here, as preparation for the round the team-leader has numbered the patients in a special column according to the order in which she thinks they should be looked at. The team-leader balances a number of considerations when she is making this order: the severity of the patients' present condition; whether the patients have to go somewhere else for examinations or tests; whether the patients are scheduled for leave or to be discharged; and, finally, the staffing on the day in question. The round now and then wipes out the number to get an overview of how far they have come and to signal this to their colleagues too. The status of the round has implications for the coordination of tasks, but is also used by the staff to make guesses at where the round and thus also the artefacts they carry around may be located.

A third perspective of place is the communication and transfer documents and patients to other wards. Again, the whiteboards in the team-rooms are useful since major event and examination at other wards are listed here ("x-ray", "CT-scanning City Hospital" for example). While the location of patients outside the ward is almost always known (unless they are discharged, of course), the location of the patient's records and care-journal is more complex and difficult. Old records are kept in an archive and brought to the ward whenever a patient is admitted. However, at this ward patients have long periods of interaction with the hospital and might visit the bed-wards, the outpatient's ward, the day-ward and other departments in more or less foreseeable succession. Records have to be sent around and be available whenever required, and the secretaries at the office and at the department spend a lot of time registering where the records are located (or ought to be located). Another aspect of exchanging documents with other wards is the exchange of requests for tests and examinations and the return of results. This does, however, not seem to offer too many problems: blood-samples are ordered and results returned electronically and there are pc's in the team-rooms and in the office. Other examinations are ordered and returned by fax or internal mail.

### THE CIS OF THE HOSPITAL WARD

The common information space of the hospital ward is heterogeneous with regards to space, persons and artefacts.

Spatially, the ward is a combination of centres, peripheries and overlapping zones. There are three centres, the two team-rooms and the office (four if the office of the head-nurse is included), three central work areas (the flow-room, the room with the medicine-cabinet, the wash room) and a number of separated peripheries (the patients' rooms) and one large common space (the central alley). Work is by necessity distributed, since some tasks have to be carried

out at specific places, and since the *raison-d'être* of the ward, the patients, are located in different rooms where they are talked with, cared for and treated.

The different professions of physicians, nurses, SHAs, and secretaries comprise another heterogeneity since each group has its own educational background, terminology and thus way of interpreting phenomena, but also in the sense, that they take care of different aspects of health care. Physicians are in charge of diagnoses and prescription of treatment, and nurses attend to care-tasks which demand medical knowledge and expertise (e.g. administration of IV & chemotherapy) from which SHAs are excluded on the basis of lack of knowledge and competency. Nurses and SHAs share however the basic tasks involved in taking care of patients. Secretaries, on the other hand, have nothing to do with medical matters at all, but have central tasks in writing out the physicians' diagnoses and prescriptions of treatment that have been recorded on Dictaphones; in keeping all records in order; registration of where records are presently located; and in making sure records are sent around to the right place for the patient's next assignment.

The ward's CIS is furthermore heterogeneous with respect to artefacts. In addition to the patient's records, the care-records, the medicine-schemes, there are also different kinds of whiteboards, the work-schedule, the electronic system for blood-sample ordering and receiving results, and the "green system" which the secretaries use for the registration of patients, their official diagnoses and the location of patient's and care record. On top of this, there is a wide range of formulas for the ordering of samples and examinations.

At the most general level, the ward's CIS is the result of the overall aim of treating and taking care of patients, which firstly requires accumulation, documentation and transmission of information over time and, secondly, requires collaboration between staff including coordination, articulation work and the work of achieving shared interpretations. The former, is primarily achieved by the patient's records and the care-records both of which have the status of legal documents. Both records offer opportunities for rich, elaborative information on patients since the notation part is entirely free-text. At the same time, initials at each entry indicate the originator of information (See also [6]). In the patient's record both the initials of the physician who made the entry orally on the Dictaphone *and* of the secretary who actually wrote the entry into the record are written. In the care-record, entries are made by hand and thus have only the initials of the nurse making the entry. Thus, not only do they provide rich information upon patients, they also offer the opportunity for contextualization or 'packaging' by indication who wrote the entry. These two records have the central role in the transmittance of information on patients over time and across changing staff, and provide the staff on work at the ward the opportunity to deepen their knowledge of their



patients. In addition, the records also have information on scheduled examinations and tests and thus moreover serve as coordination mechanisms. At this general level, coordination of staff is provided by the articulation work materialized in the work-calendar and the division of labour inherent in the different professions and competencies.

To achieve the overall aim it is, however, necessary with more minute transmission of information and coordination of work. This is achieved by a combination of different artefacts, meetings and immaterial mechanisms of interaction like peripheral awareness and knowledge about the staff's individual abilities and experience.

Whereas the primary artefact of coordination is the work-schedule, the whiteboards and personal notes also contribute to this. Neither of these artefacts has any legal status, but solely serves the purpose of articulation work, and there is no indication of the originator of information on these artefacts. In contrast to the patient's record and the care-records they are not archived either. The work-schedules are kept for a few days and the whiteboards are continuously cleaned and written upon again. In contrast to the entries in the patient's and care-record, numerous abbreviations and short notations are used in these artefacts to indicate tasks and information, and present status of tasks is indicated relatively simple: tasks either have to be done ("?"), are in progress ("y") or have been finalized (x). The information of the work-schedule, the whiteboards and the personal notes is thus closed and requires a high degree of on-the-spot contextualization. They are not designed for a broad distribution across time and space, and the accuracy of mutual interpretation depends partly on the very conventional notations and on the knowledge by actors of the context of that information: oral communication between staff is on-going and frequent, and the provision of necessary contextual knowledge is also provided by the morning meetings and the briefing meetings between shifts.

For the continuous coordination of tasks, the nurses and secretaries, and to a lesser degree physicians in addition to the information provided by the work-schedule and the whiteboards continuously observe, in the sense of peripheral awareness, where and what their colleagues and patients are doing. Also the location of things provides information of the status processes and tasks. This is evidently so in the case of the trolley brought along on the morning round, but also applies to the location of pumps for the administration of chemotherapy: the presence of many pumps in the aisle between the staff room and the wash room indicates, in the morning, that the administration of chemotherapy and IV has not generally been commenced and, in the afternoon, that this has been finalized. Similar conclusions can be derived from the position and state of the yellow boxes in which chemotherapy and IV medicine is delivered by the hospital

pharmacy: on the secretary's table (just delivered); opened in the flow-room (about to be administered); open and empty on the floor (administration accomplished). The hospital ward is thus similarly to the wastewater plant a common artefact that can be interpreted and provides information for the coordination of work.

The hospital ward offers a heterogeneity of different webs of significance, each of which are only understandable to a limited degree by outsiders. This is especially apparent to outsiders, e.g. newly admitted patients or a field-working anthropologist, who have a considerable amount of learning to accomplish before the daily work at the ward becomes comprehensible. Understanding the entries and notations upon artefacts takes even longer. Physicians, nurses, SHAs and secretaries share some common understanding through their health care training and the experience they build up over time, but differ in extent and focus of healthcare knowledge. However, even though members of one profession may not understand the minutia of the work and rationale of other professions, they do know this generally and in sufficient detail as to accomplish their work.

All in all then, the hospital ward is characterized by multiple, intensive networks of communication similar to the control room, while at the same time being more distributed. The ward is not a vast physical space, but it has the same multiplicity of centres and peripheries that characterizes the 'massively distributed' CIS of the wastewater plant. It can even, as the plant, be considered a common artefact. In contrast to the wastewater plant, however, the work at the ward requires more intensive coordination and precision of common interpretations. The hospital ward is thus at the same time similar and different to the concentrated CIS of the control room and the massively distributed CIS of the wastewater plant.

#### THE PARAMETERS OF CIS

The concept of CIS has been developed to designate that combination of information, its representations and interpretations that enable a common understanding of a work situation and its coordination. While a number of descriptions of specific CIS have been made, the conceptual elaboration of the concept is still somewhat under-elaborated. Based on the initial discussion of the concept and the description of the CIS of the hospital ward, I propose that the analysis of a CIS can be based on the following framework that outlines 7 parameters, whose specific character in a given work setting in combination characterise a particular CIS. Some parameters derive from aspects inherent in the concept itself – distribution of collaborators, articulation work, and differences in webs of significance. Other parameters have emerged from the discussion of the two specific CIS – the intensive care unit and the wastewater plant.

In total there are 7 parameters:



(i) *the degree of distribution*: collaborative work implies almost always a physical distribution of persons. Physical proximity offers the advantages of visual, oral and auditory communication without augmentation between actors, provided that this is possible. E.g. a noisy engine room or an office full of dividers would not offer these advantages. While these advantages are not immediately at hand whenever work is distributed over large physical areas, they may be achieved by the use of various means of communication (written documents, phone, e-mail, on-line video etc).

(ii) *the multiplicity of webs of significance*: we are all spun into nets of significance. We grew up with some of these; whereas others have been learned during education, work experience etc. The more different webs of significance are part of a CIS, the more work is required to achieve sufficient mutual understanding. The more different cultures, languages, and professions are present, the less can cooperation depend on already shared contexts of meaning and the more hermeneutical effort is required.

(iii) *the level of required articulation work*: cooperative work varies with the degree to which coordination is necessary and therefore the level of required articulation work to achieve sufficient coordination varies. At the wastewater plant a talk during the coffee breaks is sufficient to coordinate the workers' different tasks, whereas work at the hospital ward is dependent on a much higher need for continuous coordination.

(iv) *the multiplicity and intensity of means of communication*: the work of achieving mutual interpretations can be supported by a number of available means of communication. The best available means is that of face-to-face communication, but if the verbal and/or visual aspects are blocked, technical augmentation may be applied (e.g. phones, e-mail, video-conferences). The need for multiple, intensive means of communication varies with the extent to which continuous calibration of interpretations are necessary. The more the division of labour is detailed and explicated (immaterial mechanisms of interaction), the more schedules (coordination mechanisms) can be applied and the more different webs of significance overlap, the less is the need for intensive, continuous communication. The hospital ward, the control room and the wastewater plant all provide different examples of this.

(v) *the web of artefacts (material 'mechanisms of interaction' in [13]; 'coordination mechanisms' in [14] and here)*: plans, schedules, schema etc. are all material coordination mechanisms that facilitate coordination as previously described, and different CIS vary with the number and different sorts of coordination mechanism employed: at the wastewater plant workers only employed only plans, whereas there is a plethora of plans and schema at the hospital ward. The information on material coordination mechanisms may be presented in different spatio-graphic forms that help to stipulate actions to be

taken. Thus a checklist suggests that tasks should be performed in a given order, whereas a medicine-scheme attempts to ensure that all necessary information is entered. In these examples there is a high degree of standardisation whereas, in contrast, the central parts of the care-record and patient's record are organised around free-text spaces.

(vi) *immaterial mechanisms of interaction*: CIS rely to varying degrees upon habits, divisions of labour, organizational structures and other immaterial coordination mechanisms that reduce the need for continuous coordination. If you know what your colleagues usually do or if a team knows how they all should behave in a certain situation, there is little need to engage upon articulation work in that situation. This is of course why emergency units again and again simulate different situations of crisis. This is also the reason behind the multitude of standard procedures at the hospital ward. Immaterial mechanisms of interaction furthermore enable the interpretation of the work setting from minimal units of information: if you see your colleague at the fermentation tank, you know how far she is in her round on the wastewater plant and where you can find her in half an hour's time if she follows her *usual* way of working.

(vii) *the need for precision and promptness of interpretation*: some work settings demand a high degree of precision of information and the availability of this information. This is evident in safety-critical CIS like the control room of an airport or an airplane. The hospital ward rarely has the same need for promptness of information (except in crisis-situations like heart attack, of course), but precision is required as to the doses of medicine given to a patient and in the findings of a physician to explicate the basis of diagnosis and prescription. This is a matter of being able to evaluate treatment and a patient's response to this, but also a legal matter in the case that a patient claims medical maltreatment or neglect. Thus the findings are documented in free-text form with the initials of the physician to enable rich information and designation of the originator of that information. This applies also to the care-record. At the wastewater plant, however, there was little need for prompt action.

The precision of a physician's findings is facilitated the possibility of packaging a lot of information through written language. In the case of the control room of an airport, however, a different kind of precision is required, since information carried by free-speech or -text is too slow and imprecise. Thus information is often reduced to single words or numbers. In the former case, the information is open and relatively context-independent, whereas information of the latter kind is closed and requires a lot of contextual knowledge to be understandable.

## CONCLUSION

In this article, I have elaborated upon the concept of CIS in order to be able to provide a refinement of its conceptual

framework. The intent is to establish an analytical framework upon which the description of specific work settings can be based. While I find the concept of CIS valuable, it is in need of further elaboration and this article is meant as one contribution in that direction.

We have hitherto been presented with analysis of control rooms, construction sites, wastewater plants and hospital units which all have provided important insights, and the time has come to make an attempt at generalising these. It is doubtful whether it will be possible to generate a distinct categorisation, i.e. typology, through which specific work settings can be categorised into particular types of CIS. The possible combinations of the parameters outlined above are far too many. Such a typology might not even be helpful, since the development of computer support for cooperative work would always have to take into consideration the particular characteristics of a particular kind. Nurses, airport controllers, engineers, and operator of water purification plant all need different kinds of support. Instead, it might be better to have a framework through which specific settings can be analysed. The concept of CIS is proposed here as one such framework, and I hope the parameters presented here have elaborated upon the concept to make it even more valuable for system development.

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