IRIS

Selected Papers of the

Information Systems Research Seminar in Scandinavia

Nr. 1 (2010): IRIS 33
Engaged Scandinavian Research

The IRIS Association is a chapter of the
Association for Information Systems

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Coordinating Editor

Judith Molka-Danielsen

Molde University College, Norway

Issue Editors

Hanne Westh Nicolajsen & John Stouby Persson

Aalborg University, Denmark

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Balancing Tradition and Transcendence in the Implementation of Emergency-Department Electronic Whiteboards

Rasmus Rasmussen

Roskilde University, Denmark
rasmura@ruc.dk

Benedicte Fleron

Roskilde University, Denmark
bff@ruc.dk

Morten Hertzum

Roskilde University, Denmark
mhz@ruc.dk

Jesper Simonsen

Roskilde University, Denmark
simonsen@ruc.dk

Abstract. We report from a case study of the implementation of an electronic whiteboard system at two emergency departments at Danish hospitals. The purpose of the whiteboards is to support the clinicians in maintaining an overview of the patients at the departments. The electronic whiteboard system was designed in collaboration with clinicians from the departments. Compared to existing dry-erase whiteboards, the electronic whiteboards present more information and allow some automated updating. Based on observations supported by interviews we describe how tradition and transcendence were balanced in the implementation of the whiteboards at the two emergency departments. The electronic whiteboards were initially configured to resemble the dry-erase whiteboards and then gradually reconfigured and extended through an improvisational process, along with changes in the clinicians' work practices.
Keywords: Electronic whiteboards; organisational implementation; improvisational change management; healthcare informatics.

1 Introduction

It has recently been decided to establish emergency departments (EDs) at hospitals throughout the five Danish healthcare regions. Initially, the newly established EDs adopted the manual patient-tracking and coordination systems used in the departments from which the EDs were formed. These systems consisted of a dry-erase whiteboard augmented with a matrix-like information structure used to display patient specific information such as name, age, diagnosis, attending physician/nurse, room number and clinical care plan – see figure 1. As part of the ongoing process of establishing effective and safe work procedures at EDs, it has become a political decision to develop and implement IT-based information systems to replace the previously used manual patient-tracking and coordination systems. This paper reports on such a development and implementation project at two hospitals in Region Zealand.

Previous research has shown that patient-tracking and coordination systems based on dry-erase whiteboards are central to effective and efficient work practices at EDs and hospital departments in general (Lasome & Xiao, 2007; Wears & Perry, 2007; Xiao et al., 2007). There are, however, certain drawbacks to the manual patient-tracking systems compared to the possibilities offered by IT-based patient-tracking and coordination systems (known as electronic whiteboards). Since the dry-erase whiteboards have no possibility of storing information they are at a disadvantage in terms of documentation and data retrieval. Hence, they cannot be used to retrieve information regarding previous patients. Also, the manual tracking systems cannot be accessed in a distributed manner and clinicians, therefore, have to return to the dry-erase whiteboard to view, add, delete or update information. This takes time away from patient care. Real-time tracking of patients and integration with other hospital information systems is also impossible with the manual patient-tracking systems, and this creates a risk of delays and errors in the information presented on the whiteboard. Besides these practical reasons for replacing the manual tracking systems, clinicians at the two EDs have expressed that they expect electronic whiteboards to have a positive impact on their work practices (Hertzum & Simonsen, 2010).

Together these circumstances have led to a region-wide initiative to develop and implement electronic whiteboards at the region's hospitals. In this paper we report from this development and implementation process. Our aim is to investigate how an implementation

Figure 1: A cut-out of the old dry-erase whiteboard at ED2.

process can unfold while obtaining an appropriate balance between tradition and transcendence. We adopt the concept pair of tradition and transcendence from Ehn (1988), who concludes that designing IT-based artefacts is a balance between not disturbing the essence of the existing work practices (i.e., tradition) but still changing or improving these practices (i.e., transcendence). Ehn argues that this can be achieved by designing IT artefacts that fit into the existing work practices but at the same time cause breakdowns that force the designers and users to re-evaluate the existing work practices and, thereby, discover new practices and new artefact designs. Balancing tradition and transcendence is particularly important in our case because the traditional dry-erase whiteboards are efficient and well liked by the clinicians, because the new electronic whiteboards are believed to offer important benefits, and because ED work is safety-critical and therefore calls for a cautious implementation process.

In the following we *first* relate our study to previous work. *Second,* we introduce the setting – the overall research project and the two EDs. *Third*, we describe the empirical method employed in the study. *Forth,* we briefly describe the interface design and functionality of the electronic whiteboards implemented at the two EDs. *Fifth*, we describe the implementation process at the two EDs. *Sixth*, we show how tradition and transcendence were balanced through an improvisational implementation process. *Finally*, we discuss and conclude on the implications of our findings for our future work and for the continued development and implementation of the whiteboard.

2   Related work

One way of achieving the right balance between tradition and transcendence may be to follow a development and implementation approach that initially presents a somewhat recognisable system design to the users and, subsequently, allows for spontaneous or improvisational changes to the IT artefact and associated work practices. Thereby, the system respects the users' traditional work practices but drives forward the change process by providing the users with new opportunities or causing breakdowns to the existing work practice. Such an approach is similar to Orlikowski and Hofman's (1997) organisational change-management approach. Orlikowski and Hofman introduced a model for improvisational change management, where they distinguish between three kinds of change that potentially occur when new technologies are introduced to an organisation: anticipated, emergent, and opportunity-based (Orlikowski and Hofman 1997). Anticipated change is planned ahead and occurs as intended by the originators of the change. Patients might, for example, experience less waiting time due to more effective coordination by means of the electronic whiteboard. Emergent change is defined as local and spontaneous changes, not originally anticipated or intended. Such changes do not involve deliberate actions but grow out of practice. Clinicians might, for example, meet less often at the whiteboard due to the possibility to update whiteboard information from any PC at the department. Opportunity-based changes are purposefully introduced changes resulting from unexpected opportunities, events, or breakdowns that might arise after the introduction of a new information system. This could, for example, involve the establishment of new procedures where the physicians, rather than the medical secretaries, update patient information in the system when contacted by paramedics upon arrival of a patient.

The literature about electronic ED whiteboards can be divided into three groups. The first group describes the practical aspects of designing, developing and implementing an electronic whiteboard system (e.g., Abujudeh et al. 2010; Aronsky et al. 2008; Bardram et al. 2006). Much of the literature in this group is based on case studies that detail the design and functionality of different electronic whiteboard systems used in different clinical settings. This literature often details what problems existed with the manual dry-erase whiteboards (e.g., no possibilities of storing old information, lack of distributed access, no real-time updating and no possibility of integration with existing IT systems) and how the electronic whiteboards have been envisioned to overcome these drawbacks. They also often contain brief descriptions of the technical implementation of the systems and their ability to integrate with other clinical IT systems. Finally, the literature also often discusses what advantages the new systems provide the departments. Bardram et al. (2006) also discuss the theoretical aspects of the design of the studied electronic whiteboard and detail how these have been brought into the design.

The second group is also focused on the design, development and implementation of electronic whiteboard systems and presents many of the same findings as the first group. However, the literature in the second group also details what effects the implementation of an electronic whiteboard system has had on different aspects of ED work. This includes positive effects on measurements related to patient treatment such as length of stay, patient satisfaction and similar measurements (Boger 2003; Jensen 2004). This group of literature also finds that electronic whiteboard systems have a positive impact on the communication and coordination of patient care and on employee satisfaction in general (France 2005; Wong 2009).

Finally, the third group focuses on more theoretical aspects of the electronic whiteboard systems (e.g., Bisantz et al. 2010; Fairbanks et al. 2008; Pennathur et al. 2008; Potter 2005). Bisantz et al. (2010) and Pennathur et al. (2008) analyse the changes that occur in the information displayed by patient-tracking systems when shifting from dry-erase whiteboards to electronic whiteboards. These analyses show that the same categories of information are present on both types of system but with substantially different frequency. In particular information used to coordinate the clinicians' work was more frequent on the dry-erase whiteboards. Also, the information on the dry-erase whiteboards was used more dynamically than that on the electronic whiteboards. Fairbanks et al. (2008) detail a usability study of the interface design of an electronic whiteboard. They show that the interface design violates basic usability guidelines and that these violations have potential negative effects on patient safety. Thus, they conclude their paper with call for more emphasis on usability evaluations of these types of system. Finally, Potter (2005) gives an account of how an electronic whiteboard was developed and implemented at one ED and the effects that the system has had on the department. This paper also details the strategy behind the implementation process and finds that staff buy-in is highly important to the successful implementation of such a system.

3   The setting

This study was conducted in the context of a research project that is a collaboration between Roskilde University, Region Zealand, Norwegian IT vendor Imatis and the hospitals of Region Zealand. The overall research project focuses on developing IT-based information

systems for supporting the clinicians at the newly established EDs in the region. In the description of the research project this focus is explained as supporting *clinical overview* at two levels: ward level and patient level. Overview at the ward level regards, amongst other things, keeping track of the patient-treatment progress, the number of patients, the clinical resources available (in terms of ED staff, rooms, and equipment), and the resource allocation at any given time. At the patient level, overview is about obtaining and maintaining knowledge regarding the individual patient's condition and about integrating patient information from a range of information sources. The two levels are interrelated, but the present study concerns overview at the ward level.

A total of four EDs are involved in the research project. Two of the EDs, termed 'development departments', are involved in the development and pilot implementation phases. The two other EDs, termed 'research departments', will be involved in studies evaluating the effect of the electronic whiteboards. The present study was conducted at the two development departments – ED1 and ED2. Both EDs were established in the spring of 2009 as independent departments combining a number of previously separate departments into one. The overall rationale for the EDs has been to establish and provide a single point of entry to the hospitals for all acute patients. This includes patients who have been referred to the hospital by their general practitioner, patients who arrive at the department themselves, and patients who are brought to the hospital by ambulance, for example from traffic accidents. The main task of the EDs is to receive these patients, asses their general state of health (triage), diagnose them, start initial treatment and, depending on their state of health, either discharge them or admit them at one of the hospital's specialty departments, such as the medical ward. Table 1 shows the resource allocation for the two EDs.

Allocation of resources	ED1	ED2
Annual Patient Expectancy	N/A	40,000
Fast-Track No. of Beds/Trauma rooms	5-7/1	4/1
Waiting room	Yes	Yes
Acute No. of Receiving/OBS beds	6/4	10
No. of Acute-medical beds	16	None
No. of Physicians	11	29
No. of Nurses	69	27
No. of Secretaries/Assistants	13	10.5

Table 1: Allocation of resources at ED1 and ED2

ED1 consists of three patient areas: fast track, acute, and acute medical. The fast-track area handles patients that only need a relatively superficial treatment such as stitching cuts or attending a sprained ankle. Patients expected to be transferred to another department or sent home on the same day are handled at the acute area. The acute-medical area receives patients whose total hospitalisation is expected to be maximally two days. ED2 consists of two distinct areas: a fast-track area and an acute area. Both areas resemble the corresponding areas at ED1. At ED1 the chief physicians, nurses, and secretaries are employed directly by the department, whilst the younger physicians are associated with the hospital's specialty

departments and brought in on an on-call basis. At ED2 all clinicians are employed directly by the department.

The development and implementation of the electronic whiteboard system has been organised around an *implementation group* with representatives from ED1, ED2, the region and the IT-vendor. Throughout the development and implementation process the implementation group has met about once every second week to plan future development and implementation activities, follow up on progress, correct errors and improve the interface and functionality of the whiteboards. Early on, the main role of the implementation group was to gather user requirements from the clinicians and communicate these requirements to the IT vendor. Subsequently, the implementation group has been responsible for the mutual adaptation of system and work practices, thereby enabling an on-going, iterative, and improvisational change-management process.

4 Empirical Approach

Our methodological approach has mainly consisted of observations and interviews at the two EDs, supplemented with document analyses and partaking in the meetings of the implementation group. Over a period of 1.5 months we conducted 14 observation sessions, each lasting about 7 hours. The observation sessions had different foci depending on which work functions we observed. At each observation session we have been two researchers present, one focusing on the activities in the control room and the other following clinicians on the ward. We did this because we suspected that the influence of the system would in multiple ways depend on the clinicians' role, work function and the need for close contact with either the patient or a colleague. We started by observing the activities at the whiteboard in the control room and the work of the medical secretaries to get an overall understanding of their work practices. The following observations concentrated on the coordinating physician and the triage nurse and were mostly carried out in the control room. In parallel to these observations, we made observations of nurses and physicians by following them around on the ward. Our recordings of these activities comprise about 65 pages of handwritten notes, 30 pages of field diary notes, 15 hours of video, and 40 pictures.

In addition to these observational activities, we collected different artefacts that are used for obtaining an overview, mostly in the form of paper documents. We also conducted two qualitative interviews with a senior clinician from each ED. These two clinicians have been involved in the configuration and implementation of the electronic whiteboards and were interviewed about this process. Finally, during the one and a half months we followed the practices at the EDs we also participated in the meetings of the implementation group. During this period the implementation group worked on adapting the electronic whiteboards and clinical work practices to each other by reconfiguring and extending the electronic whiteboards and by adjusting work practices. We took part in this work.

In analysing our empirical data we focused mainly on the observations and interviews. First, we read through all our observational notes and sorted them into initial categories. These categories included errors in the functionality of the system, breakdowns in work procedures as a result of the opportunities offered by the system, and consequences of the system on the clinicians' ways of obtaining or losing an overview. After categorising our observations, we looked at our diary notes and interviews to see what they told us about the

implementation process and, in particular, about the reasons for the differences between ED1 and ED2 in terms of how they approached the implementation process. Combined with our experiences from the implementation-group meetings, the overall theme that began to emerge from the data concerned a recurrent tension between changing too little out of respect for the clinicians' existing work practices and changing too much in trying to exploit the technological possibilities all at once. Following Ehn (1988) we see this tension as an effort to balance tradition and transcendence, and following Orlikowski and Hofman (1997) we see the implementation process devised by the implementation group as an example of improvisational change management.

5   System description

The electronic whiteboard system is web-based and placed on a server outside the hospital. It is accessible through a web-browser, which offers the flexibility of accessing the system from any device with access to the server. It is possible to interface the system with other clinical IT systems, thus allowing automatic updating of the information shown. However, at the time of our study the system was only integrated with the regional social security number (SSN) database and therefore only names and ages were updated automatically. The users can interact with the system through large touch screens in the ED control room, via a mouse and keyboard connected to the PC running the touch screen, or via other PCs connected to the system. The clinicians used all options of interacting with the system but they had a tendency to access the system when they were in the same room as the large touch screens.

5.1 Interface design

The basic layout of the whiteboards is a row for each patient, divided into a number of columns with selected information about the patient – see figure 2. This layout is purposefully

Figure 2: The electronic whiteboard at ED2. Names are concealed for privacy reasons.

copied from the old dry-erase whiteboards to ensure a certain degree of recognisability – see figure 1. The order of the columns follows the average flow of a patient from when (s)he is announced at the ED and until (s)he is discharged.

The order of the patients can be rearranged via sorting functions corresponding to the columns. Thus, the patients can be sorted according to their age, name, room number, attending physician/nurse, and so forth. This functionality is especially intended for sorting the patients according to the severity of their condition. The clinicians also have the possibility of filtering the information on the electronic whiteboard using predefined filters. This way the information can be filtered to show only patients in specific patient areas, to show only the patients who have been reported to the ED or to show only the patients in the ED waiting rooms. The system also supports cursor hovering enabling the system to provide additional information when the clinicians hover the cursor over a whiteboard cell. Thereby, it is possible to conceal for example social security numbers or patient surnames and only present these when the cursor is hovered above the corresponding cells.

Above the matrix of patient information is a menu bar showing the on-duty clinicians. For each clinician their name and title are presented as well as their role during the current shift. The system also supports pictures of the clinicians but at the time of our study the clinicians did not yet use this feature.

At the time of our study the main input mechanism was manual input through either the large touch screens or the PCs connected to the electronic whiteboard system. Future versions of the system include automatic presentation of the results of lab test and monitoring of vital signs. The names of the clinicians associated with the ED are stored in an alphabetical list and can be brought out when adding a clinician's name to the whiteboard. The intended clinician is selected by clicking on the field, to which the name is to be added.

5.2 System functionality

In the following we describe how the whiteboard is used for a generic patient trajectory at ED2. The patient trajectory at ED1 is very similar. The description of system is based on our observations, and due to the iterative nature of the implementation process the system functionality may subsequently have evolved.
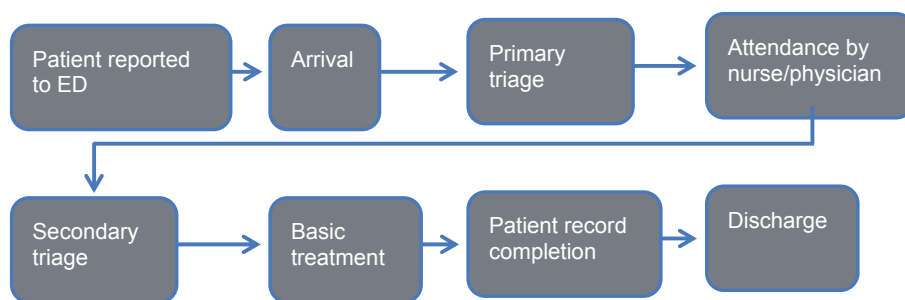

Figure 3: A basic patient trajectory.

A generic patient trajectory is shown in figure 3. Initially, a patient is reported to arrive at the ED. This normally happens via a telephone call from the patient's general practitioner or

paramedics in case of an emergency arrival. At this point initial information about the patient is recorded on paper and then typed into the corresponding whiteboard fields by the clinician receiving the call. The patient's social security number is entered into the Age field and based on this the system calculates the patient's age and retrieves his/her name from the SSN database and automatically fills in the name field. If the system cannot retrieve the patient's name the clinicians enter a name manually. The Age field also indicates the patient's gender by colouring the age blue for male and red for female patients. The preliminary health status, diagnosis and vital signs are entered into the Problem, Note and Vital-Signs fields. Additional free-text details about the patient's medical problem or diagnosis can be entered into the Note field. The patient is also set as being 'en route' in the Room field. Finally, the Awaiting field is set to be waiting for the patient's arrival at the ED. This field includes a timer, showing how long the patient has been awaiting the next step in the patient trajectory, which currently is 'awaiting arrival of patient'.

In the case where a patient walks into the department (i.e., patients with minor injuries) the medical secretary receives the information mentioned above and enters it on the electronic whiteboard. The patient is then asked to wait in the waiting room and the electronic whiteboard is updated to show when the patient arrived at the ED and that (s)he is waiting for primary triage.

When a patient arrives by ambulance two actions are carried out: The medical secretary updates the Arrival field with the current time. Simultaneously, the triage nurse assesses the patient's medical condition and updates the Triage field to reflect this. The information in the Triage field is indicated by a number between 1 and 5 as well as by colour-coding the number. For patients in the waiting room the triage process is identical to the process described above. As multiple patients can have the same triage level there is often a need to prioritise among patients with the same triage level. This can be done in the Priority field. The triage nurse also assigns the patient to a room that suits the patient's needs (Room field), and decides which nurse will be responsible for the patient (Nurse field). After updating these fields, the triage nurse changes the Awaiting field to show that the patient is now awaiting a physician. This notifies the coordinating physician to take action.

The coordinating physician assigns a receiving physician to the patient by updating the Physician field and notifies the physician about this. Before the physician attends the patient, the Awaiting field is once again updated, this time to indicate that the patient is now waiting for the completion of the patient record prior to discharge from the department. In the meantime the nurse responsible for the patient performs any nursing tasks in relation to the patient. This includes having bio-analysts take different samples from the patient or having any radiology tasks performed. If a bio-analyst has been called this is also indicated on the whiteboard by updating the Lab field. When the samples have been taken, the bio-analyst updates the Lab field to reflect this. During this time either the triage nurse or the attending nurse performs the secondary triage.

The physician and nurse assigned to the patient decide whether to transfer the patient to another ward or discharge the patient. If the patient is to be hospitalised the clinicians must decide what ward to transfer the patient to and notify this ward. Notification of the transfer has to be given at two levels: to a nurse at the receiving department and to a physician at the receiving department. The Transfer field is updated to show who has been notified at each of the two levels. Also, the Ward field is updated to show to which ward the patient is to be transferred. When the patient is ready to be transferred a hospital porter is called. This is

indicted by updating the Porter field to reflect that a porter has been called. The Porter field also serves the purpose of giving the clinicians an estimated time of departure from the ED, since the clinicians know that it takes approximately five minutes for a porter to arrive and retrieve the patient. This is important for the logistic administration of the ED. When the patient is physically moved out of the ED the patient entry on the whiteboard is removed, while the information is kept in a database of the ED patients.

6   Implementation of the Electronic Whiteboards

In the spring of 2009 both EDs were invited to participate in the *Clinical Overview* project. In the summer of 2009 the project entered a planning phase where a large amount of time was spent discussing what information the system should display, what other clinical IT systems it should be interfaced with, and similar topics. The configuration of the system was based on the results from the planning phase and was done in close cooperation with the IT vendor Imatis. The system was ready to be used in the winter of 2009/2010 and was effectively taken into use in December of 2009 at ED1 and January of 2010 at ED2.

Both EDs decided to follow an experimental approach to implementing the electronic whiteboard system. This has meant that the system was implemented in an early version to allow the clinicians to use the system and gain experience with the system. Based on their experience with the system the clinicians have continuously provided the implementation group with feedback leading to iterative revisions of the system, its configuration and the associated work practices. As a starting point both EDs decided to configure the system layout to resemble the old dry-erase whiteboards. This was done to ensure that the system could easily be taken into use by the clinicians and fit relatively well into their normal work practices. To prepare the clinicians for the arrival of the new system different paper documents were prepared and on-site training was also provided. At ED1 the chief physician involved in the project had written a description of the system's information content, detailing what information the different columns display and the importance of this information. The chief physician was also present during the first week of usage to provide support in case the other clinicians needed assistance in using the system. Otherwise no training was provided in this case. At ED2 the system was introduced to the clinicians on the daily morning meetings. During these sessions the system's functions were demonstrated and the clinicians were able to see how the ED management intended the system to be used. Also, an instructional guide was written, detailing how the system was to be used and how the new work practices regarding the whiteboard were to be. At ED2 on-site support was also provided during the first week of usage and the daily shifts were carefully planned to ensure that there was always a clinician present who was familiar with the system.

The main difference between the implementation processes at the two EDs was that the management at ED1 made the adoption and usage of the new system voluntary whilst the management at ED2 made the usage of the system mandatory. At ED1 the rationale was that when the clinicians knew of the intended use of the new system they would by themselves explore the opportunities as long as they had the possibility of returning to the dry-erase whiteboards, which remained available. The clinicians could at any time choose to use one system or the other. At ED2 the rationale was that an immediate and definitive shift from dry-erase to electronic whiteboards was needed in order for the clinicians to adjust to the new

system and work practices. Colleagues more experienced with the use of the system supported the clinicians in this shift. While ED1 and ED2 organised the implementation process of their electronic whiteboards differently in this respect, the end result has in both EDs been widespread and consistent use of the electronic whiteboards.

7   Balancing Tradition and Transcendence

As mentioned previously in this paper, the implementation of the electronic whiteboards at the two EDs was a balancing act of respecting the traditions of the existing work practices and at the same time progressing or transcending these practices by providing new possibilities to the work routines. One of the clearest examples of respect for the existing work practices is seen in the interface design of the electronic whiteboard where the matrix-like information structure was copied from the dry-erase whiteboards. Also, the intended use of the electronic whiteboards was envisioned to follow the existing work procedures in some aspects whilst transcending the existing practices in others. An example of how the use of the electronic whiteboards followed the traditional working practices was seen in how patient information was updated on the electronic whiteboard. With the dry-erase whiteboards, this was the responsibility of whoever had the needed information. This tradition has been carried over to the new electronic whiteboard system with the slight alteration of being able to update information in a distributed manner.

The distributed access also provided the possibility of transcending the existing work practices. An example of this was seen in the way the procedure regarding registration of new patients was changed during the implementation process. As described shortly in section 6, an instructional guide to using the system and the work procedures for this use was formulated as part of the implementation process at ED2. This guide details a generic patient trajectory similar to the one described in section 5 and also details who has responsibility for updating the electronic whiteboard at any given step in the treatment process. In the original version of the guide the medical secretaries were charged with the responsibility of registering new patients in the system. With the dry-erase whiteboards this was previously the shared responsibility of the chief physician (receiving the initial patient information) and the triage nurse (entering the patient information on the whiteboard) and thusly, the new instructional guide can be seen as an attempt to transcend the existing working practices. However, it quickly became clear that the new electronic whiteboards provided opportunity for an even more extensive change to this practice due to its possibility of distributed access. Thereby, the chief physician could, upon receiving the initial patient information, enter the information directly into the electronic whiteboard system and thereby save time and minimize the risk of errors or delays.

Other changes to the clinicians work practices were also made possible due to the system's option of distributed access. An example of this was seen at ED2, were the clinicians conduct so-called *time-outs* three times during a shift to discuss the patients currently at the ED. Before the electronic whiteboards were introduced the clinicians would hold these time-outs in front of the dry-erase whiteboards using them as a shared point of focus in the discussion of the patients. This was problematic since the whiteboards were placed in the ED control room and discussions regarding patients could potentially interfere with work in the control room. However, after the implementation of the new system it has been possible to move these

meetings to another room with more space and seating options and more importantly away from the control room. This has only been possible because the system allows access from all devices with access to the central server. In the lens of balancing tradition and transcendence this is an example of how the existing working practices (holding time-outs) has been improved or transcended due to the possibilities that the new electronic whiteboard system provides.

Besides changes to the working practices of the EDs, there were also made changes to the system itself after its initial implementation. As described in section 5, the electronic whiteboard system contains a field displaying how long a patient has waited for the next step in the treatment process. This was not possible with the dry-erase whiteboards and this feature can therefore be seen as an attempt to transcend the existing practices. However, the initial design of the electronic whiteboards only supported the steps up to the point in the treatment process where the patient is awaiting the attending physician. Recognizing the advantages of being able see how much time is spent on the different steps, the physicians expressed a desire of being able to see how much time they spent on attending patients. Because of the system's possibility of easy reconfiguration this option was added to the list of steps in the Awaiting field and further transcended the work practices of the ED.

As described above the system provided different possibilities of transcending the existing working practices of the EDs. However, some features of the electronic whiteboard system, intended to improve the working practices, were experienced to be too extreme in the sense of respecting the existing working practices and therefore caused breakdowns in the working practice. This was especially seen in the system's patient-centred approach to administering the ED patients. In practice this approach creates a matrix of patient information that expands and retracts vertically when patients are hospitalised or discharged from the ED. This creates a very dynamic display of information since there is a constant flow of patients through the EDs and thusly, this display is very efficient for keeping an overview of the number of patients currently present at the ED. However, it is not efficient for keeping an overview of the number of vacant rooms since these are not shown on the electronic whiteboard. At the two EDs we saw that different types of workarounds were initially employed in order to compensate for this e.g. manually counting how many rooms are occupied or using the old dry-erase whiteboard as a supporting tool. These problems were reported to the implementation group as feedback and following the iterative nature of the implementation project, changes to the system were made in order to provide support for an overview of vacant rooms e.g. static rows for each room in the matrix information structure. Thereby, the system returned to supporting the traditional working practices. However, following this return to the traditional working practices it has become apparent that the attempt to transcend this practice, via the patient-centred approach to administering patients at the EDs, was valid in terms of the improving working practice – at least over time. This became apparent when the clinicians at ED2 later on requested that the system should be reconfigured (back) again to only show the occupied rooms and thereby transcend the working practices associated with administering the ED patients.

Another example of how the system did not fully respect the traditions of the EDs was found at ED1. Due to ED1's organisational structure it is necessary to divide the patients according to what type of physician their treatment requires. With the dry-erase whiteboards, this was previously done by writing the patient information with different colours. However, this has been down prioritized in the design of the electronic whiteboards, and this

information is only visible in a single cell of a patient row placed too far to the right to be noticed by the clinicians and named in a manner that does not correspond to its intended purpose. A reason for configuring the electronic whiteboard in such a manner could be a preparation for the future organization of ED1, since this department is supposed to be organized in the same way as ED2, thereby removing the need to differentiate patients. However, this need will not cease to exist in the nearest future and therefore the clinicians have had to devise a workaround to compensate for the systems lack of respect for the current tradition.

8 Discussion

As described in the previous section, a number of changes to the working practices of the EDs followed as a result of implementing the electronic whiteboards. Some of the changes were anticipated and purposefully introduced. Others simply emerged and evolved as a result of using the system. As the analysis of the examples in the previous section shows, some of the changes respected the traditions of the working practices whilst others attempted to transcend these practices. Also, the analysis shows that it was not only the changes that respected the traditions that went on to be successful changes. In other words, some changes successfully transcended the existing traditions and became part of new work practices.

The difference between the changes that succeeded and the ones that were rejected can be related to the manner in which they were introduced. Some changes were initiated by the clinicians after they had experienced the system while others were introduced as part of a planned change in work organization needed to use the new system. The analysis shows that most of the changes initiated by the clinicians went on to become successful. A planned change introduced with the system (the patient-centred approach) was first rejected but later accepted – after the clinician's were allowed to experience both alternatives (representing tradition and transcendence, respectively).

This leads us to suggest that a viable strategy for balancing tradition and transcendence is using an implementation approach where the users of the system are allowed to work with it, develop their working practices, and make alterations to the system and work organization as they gain experience using the system. Such a strategy is very similar to the improvisational change management approach introduced by Orlikowski and Hofman (1997). In line with Orlikowski and Hofman (1997), many of the changes to the EDs work practices and the electronic whiteboards described, could be categorized as changes similar to the concepts of opportunity-based and emergent changes. For example, the change to the available choices in the system's Awaiting field can be seen as opportunity-based change since the system's functionality provided the clinicians with an opportunity to improve their work practice. Another example is the emerging change that evolved from using the electronic whiteboards when reconfiguring the work practice regarding registering new patients. This change was made possible by the distributed access to the system but was not actively planned or anticipated.Instead it emerged over a short period of time using the system and became a part of the working practices.

We believe that an improvisational implementation approach is a viable strategy when implementing IT systems in safety-critical settings such as the ED involved in our study. Such an approach strives to let the users of the system influence the configuration of the system and

the associated work practices. The implementation at both EDs have resulted in a widespread acceptance and use of the electronic whiteboards. It is important to note that this result has been achieved through an on-going iterative process in which the implementation group continued to work throughout the implementation project. Based on continuous user feedback the implementation group has taken the action to alter the work practices and the configuration of the electronic whiteboards throughout an implementation period spanning several months.

9 Conclusion

The findings reported here illustrate that it is possible to implement new IT systems in safety-critical settings and at the same time improve work practices without imposing radical change or causing critical breakdowns. This can be achieved if the intended users are allowed to work with early versions of the system, gain experience with the system and provide feedback to an implementation group that is willing to receive the users' response and rapidly incorporate it into new versions of the system.

A way of balancing tradition and transcendence when implementing a new IT system is by following an implementation approach that allows changes to evolve based on the users' experiences from using the system. Changes might be a result of new possibilities supported by the system and/or a result of effectively balancing old practices with the new opportunities provided by the system. The implementation strategy introduced by the implementation group was a deliberate on-going and iterative one of changing procedures and practices one small step at a time. Thus far, the result of this strategy has been a successful implementation of the new electronic whiteboards keeping the well-liked practices while gradually gaining the benefits of the new system without compromising safety-critical issues.

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