

# Implementation of Electronic Whiteboards at Two Emergency Departments

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**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 such whiteboards is to support the clinicians in maintaining an overview of the patients at the department. The electronic whiteboard system was designed in collaboration with clinicians from the departments, present more information, and allow some automated updating, as compared to the existing dry-erase whiteboard. Based on observations supported by interviews we describe the implementation of the whiteboard at the two emergency departments, the improvisational process following the implementation, and the use and reconfiguration of the system and work practices by the clinicians.

*Key words: Electronic whiteboards; organisational implementation; improvisational change management; healthcare informatics.*

## 1 Introduction

Emergency departments (EDs) are being introduced at hospitals throughout the five Danish healthcare regions, and the process of establishing effective and safe work procedures at these departments involves the development and implementation of information systems supporting ED work. This paper reports from a project aiming to design, implement, and evaluate information systems, referred to as electronic whiteboards, that support clinicians at EDs in maintaining an overview. The project targets overview at two levels. At the ward level, overview concerns keeping track of the progress of the treatment of all patients at the ED, about the clinical resources available, and about their allocation at any given time to the ever-

changing number of patients. At the patient level, overview is about obtaining and maintaining knowledge regarding the individual patient's condition and about integrating patient information from a host of sources. The two levels are interrelated, but the present paper concerns the ward level and consists of an analysis of the implementation of an electronic ED whiteboard at two hospitals in Region Zealand.

During fall 2009 and spring 2010 initial versions of the whiteboard were iteratively developed, implemented, used, and evaluated at two EDs. During fall 2010 and spring 2011 the latest version of the electronic whiteboard will be deployed at two other EDs to evaluate it at departments that have not participated in the design process. In this paper, we present results from our preliminary studies of the implementation and early use of the electronic whiteboard conducted over a period of approximately one and a half months during spring 2010. The work presented concerns many of the same aspects as the work presented in previous articles (Aronsky et al. 2008; Bardram et. al 2006; Bjørn and Hertzum 2010; France et al. 2005). However, these articles report on studies that are focused on the everyday use of electronic whiteboard systems (Aronsky et al. 2008; France et al. 2005) or present guidelines for designing these types of systems (Bardram et. al 2006; Bjørn and Hertzum 2010) and as such do not touch upon the subject of implementing these systems. The work presented here contributes to this body of knowledge by reporting on the implementation of an overview system and how this implementation can be structured. This has also been studied previously in articles such as Boger (2003) and Wong et al (2009), where many of the same topics that we report on are also found. However, whilst these articles give a detailed chronological account of how the implementation process in these studies has proceeded, they do not relate this to a theoretical framework to explain the events observed during the implementation process. In this article we will relate the events that we have observed during our studies to the theoretical framework outlined in the following.

In the following we *first* introduce the theoretical framework used to analyse and discuss the results of our study. *Second*, we introduce the setting – the two emergencies departments, the research project, and our empirical method. *Third*, we briefly describe how the electronic whiteboards have been implemented at the two emergency departments. *Fourth*, we describe the whiteboard and its use. *Fifth*, we present experiences of the emergent and gradual way in which the opportunities and consequences of the whiteboard are learned, resulting in an improvisational process. *Finally*, we discuss the implications of our findings for our future work and for the continued development and implementation of the whiteboard.

## 2 Theoretical framework

The theoretical framework used to analyse and discuss the results from our study is composed of ideas from three different sources. The first is Lucy Suchman's concepts of 'plans' and 'situated action'. In Suchman (1987) the concept of 'plans' is used to describe the visions of how a work practice is to be carried out. Suchman points out that these 'plans' act only as rough guidelines or 'maps' for the way that the work is actually carried out and that the actual execution of action can deviate considerably from the original vision – known as 'situated action'. This description of a working practice fits very well with the working practices at the EDs where work is carried out by clinicians, who are highly skilled, autonomous and engaged in complex working situations that are hard to describe in advance.

The concepts of 'plans' and 'maps' are further elaborated in Schmidt (1999), where the concept of 'scripts' is introduced. Schmidt uses this concept to describe incidents in working practices where the predefined plans are followed more closely than Suchman's 'plans' and 'maps'. Schmidt uses the example of a system being introduced at a factory to coordinate the work of the production employees. In this example Schmidt describes how the employees

follow the system's protocol under normal circumstances – they use the system as it is intended. However, when the system's protocol does not fit the current situation the employees at the factory deviate from the protocol to accommodate the situation and then return to the normal protocol once the situation is normalized. Furthermore, Schmidt argues that such alterations of protocols will follow the implementation of any new system in any organisation because the formal protocols associated with a system will always be underspecified and therefore subject to change during the initial phase of usage (Schmidt 1999).

In our research we have seen that these changes can be of a more or less permanent character with the former resembling genuine organisational change. Orlikowski and Hofman have introduced a model for improvisational change management, where they distinguish between three kinds of change that 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. This includes, for example, that the clinicians expect the patients to experience less waiting time during hospitalisation, resulting from 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. This might be, for example, that the clinicians meet less often at the whiteboard due to the possibility to update information at the electronic whiteboard 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 in order for the clinicians to be aware of relevant changes in patient status. To experience and learn from anticipated, emergent, and opportunity-based change the system must be implemented.

### 3 The setting

In this section we describe the two EDs, the overarching project, and the method used to produce the data presented in this paper.

The two EDs are located at two hospitals in Region Zealand, one of five healthcare regions in Denmark. Both EDs were established in the spring of 2009 as independent departments combining a number of previously separate departments into one. The overall aim 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 physician, patients who address the departments themselves, and patients who are brought to the hospital by ambulance e.g. from traffic accidents. The main task for the EDs is to receive these patients, assess their general state of health (triage), diagnose them, start initial treatment and depending on their state of health either discharged them to go home or to be hospitalised at one of the hospitals specialist departments e.g. the medical ward.

Although the EDs at the two hospitals share a common goal and work tasks, there are however some differences between the two concerning their organisational structure.

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. The acute area handles patients that are expected to be discharged to another department or sent home the same day. 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. The fast-track and acute 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 medical or surgical departments and brought in on an *on call* basis. At ED2 all clinicians are employed directly by the department.

Allocation of resources	ED1	ED2
Annual Patient Expectancy	N/A	40,000
Fast-Track		
No. of Beds/Trauma room	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**

Work at the EDs is highly cooperative, often hectic, and requires that the clinicians maintain an overview of the patients at the ED. This overview has until now been supported by large dry-erase whiteboards with a row for each room and columns giving selected information about the patient in the room – see figure 1. It has, however, been decided to replace the dry-erase whiteboards with an electronic whiteboard system with more information and automated updating of information. This is where the project *IT Support for Clinical Overview* has its origins and is the focus of the research presented in this paper. The project is a collaborative project between Roskilde University, Region Zealand, and Norwegian IT-vendor Imatis with the main goal of researching and developing IT solutions that support the clinical overview and aid the clinicians in their everyday work with treating patients. Up to now a prototype of an electronic whiteboard has been developed in cooperation with representatives from the two EDs. This prototype has recently been taken into use at the EDs to gain experience with it and iteratively improve it.

	TID	NAVN	LÆGE / SYGELÆ	MELDT / SKADE	PRIORITERING	LAB KALDT	MELDT ATD	PORTOR	DIAGNOSE
STUE 1	950			M					bolken fraktur
STUE 2	956			M		<del>9-30</del>			abd smerke
STUE 3									
STUE 4									
STUE 6									
STUE 7				SK		<del>9-29</del>	Ring Alghem	Korsel best N kl 17:00	Slæt ug GRM (Obs se PSP svar) DEMOJT
STUE 8									
STUE 9									
STUE 10									
GANG									
TRAUME									

**Figure 1: This figure shows the old dry-erase whiteboard at ED2.**

The empirical data presented in this paper are qualitative and consist of observations and interviews at the two EDs, supplemented with reviews of documents about the EDs. Over a period of 1.5 months we have conducted 14 observation sessions, each lasting about 7 hours. The sessions have been spread across the two EDs and across a range of different roles and groups of clinicians, including coordinating physicians, triage nurses, receiving physicians, receiving nurses, medical secretaries and a number of general observations of the whiteboard itself. During the observation sessions we have taken general notes, videotaped different situations regarding use of the electronic whiteboards and taken photographs of situations where clinical overview was important. Also, we have collected different artefacts that are used at the two ED in obtaining an overview, mostly in the form of paper documents. We have also conducted two qualitative interviews with one senior clinician from each ED. These clinicians have been involved in the configuration and implementation of the electronic whiteboards and were interviewed about this process.

## 4 Implementation of the Electronic Whiteboards

In this section we describe the implementation of the electronic whiteboards at the EDs where we have conducted our research. The findings presented here are primarily based on the qualitative interviews with the senior clinicians. Since the implementation processes have been quite similar for the two EDs we describe the processes as one and highlight any major differences. Also, the implementation processes have followed a common timeline, which we will outline shortly in the following.

Both EDs were established in the spring of 2009 and they were at the same time invited to participate in the project: *IT Support for Clinical Overview*. In the summer of 2009 the project entered a planning phase where a large amount of time was spent on discussing what information the system should display, what other clinical IT-systems it should interact 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 January/February of 2010.

Both EDs decided to follow an experimental approach to implementing the overview 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 project group and IT-vendor with feedback leading to an iterative alteration 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 the normal working practices of the EDs. To prepare the clinicians at the EDs 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 a number of 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 there was also given on-site support during the first week of usage and the daily shifts were carefully planned to ensure that there was always a clinician familiar with the system present at the ED.

The biggest difference between the implementation processes at the two EDs was the fact 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. Management at the two EDs had different reasons for choosing their respective approaches to implementing the system but interestingly our research efforts have shown that the end result has been the same at both EDs – namely a widespread and consistent use of the new electronic whiteboard systems.

## 5 The Layout and Use of the Electronic Whiteboards

In this section we describe the whiteboards being implemented at the two EDs. 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 Figures 2 and 3. As mentioned in section 4, this layout is purposefully copied from the old dry-erase whiteboards to ensure a certain degree of recognisability – see figure 1. The order of the columns supports the average flow of a patient from when (s)he is announced to the ED and until (s)he is discharged. Below, we describe the system and explain its use for a typical patient trajectory.

The electronic whiteboard system is a web-based system placed on a central server outside of the hospital. It's 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 this point the system is only integrated with the regional social security number database and therefore only names and ages are 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. At the hospitals we observed that 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.

In the following we describe how the whiteboard is used for a generic patient trajectory, which basically consists of the following steps: Arrival; triage (assessing the severity of the patients' condition); attendance by nurse and physician; basic treatment; completion of patient record; and discharge (either by transfer to another ward or back home).

ARRIVAL	ARRIVAL_TYPE	TRIAGE	ROOM	FIRST NAME	SSN	AWAITING	PROBLEM	NURSE	PHYSICIAN	PLAN	NOTE	VITALS	DEPARTURE	NEXT STOP
14:55	Selvhenver		1-1		34		Blø, fin							
12:33	Selvhenver	3	2-1		9	0:02:38 Ro ...	HOV			ct				
14:05	112	2	2-2		67	0:01:03 Portør	obs			Røn				
14:50	Selvhenver		3		8		hov							
14:05	112	2	4		55	0:01:15 Ro ...	tom			Røn				
11:15	egen læge	4	6 - 2		30	0:03:35 Læge	HÆM	●	●			(1/2)		or ...
13:40	112		8 - 1		69	0:00:56 Læge	c.p	●	●			(2/2)		me ..
	egen læge		8 - 2		90		dys	●						me ..
13:05	112		9 - 1		48		blo	●	●			(2/2)		
14:50	egen læge		9 - 2		82		fas	●						me ..
	egen læge		10 - 1		80	0:00:22 Læge	c.v	●				(2/2)		or ...
12:02	egen læge		10 - 2		1 ...	0:03:35 Læge	cho	●	●			(2/2)		or ...
	egen læge		11 (avn)		27	0:01:25 Læge	CVC	●				(2/2)		av ...

Figure 2: This figure shows the configuration of the new ED electronic whiteboard at ED1

Initially, a patient is announced 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. The system then calculates the patient's age and displays this. The Age-field also indicates the patient's gender by colouring the age blue for male and red for female patients. If the patient is registered as a citizen of Region Zealand the system automatically retrieves the patient's name from the SSN-database. Otherwise, the clinicians type in the name manually. The preliminary health status, diagnosis and vital signs are entered into the Problem-, Note- and Vital\_Signs-fields. Multiple problems can be entered in the Problem-field and are abbreviated to three letters each. Additional free-text details about the patient's medical problem or diagnosis can be entered into the Note-field. If the text is longer than the width of the field it is possible to show the full text by tapping the field. At ED1 the Vital\_Signs-column indicates if the patient's blood pressure, pulse, respiratory frequency temperature or oxygen saturation has been registered.

The patient is also set as being 'en route' in the Room-field (ED2) or by choosing type of arrival in the Arrival\_Type column (ED1), which indicates whether the patient was referred to the ED by his/her general practitioner, is an emergency arrival (112), or arrives by walking in. Finally, the Awaiting-field is set to be waiting for the patient's arrival at the ED (ED2). 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'.

ARRIVAL	ROOM	TRIAGE	PRIO	FIRST NAME	AGE	PROBLEM	AWAITING	NURSE	PHYSICIAN	LAB	TRANSFER	PORTER	NOTE	PLAN	WARD
15:36	GANG			...	91	anae	0:00:07 1. Tria							gen	
	MELDT			...	91	AMI	0:01:24 Ankorr						utilpas ...		
	MELDT			...	52	kon	0:01:14 Ankorr						konfus ...		
	MELDT			...	74	Col	0:01:00 Ankorr						obs ho ...		
	MELDT			...	33	app	0:00:49 Ankorr						app ac ...		
	MELDT			...	18	app	0:00:14 Ankorr						fra de ...		
	MELDT			...	35	ape	0:00:05 Ankorr						pancra ...		
13:19	Stue 2	4		...	55	cho	0:01:14 Journz	●	●	Taget	L/spl		9.3 st ...		A2
14:04	Stue 3	2		...	46	BA	0:00:04 Journz	●	●	Taget			Kendt ...		
13:05	Stue 4	4		...	79	hof	0:02:17 Læge	●	●	Taget	L/		rtg vis ...		M5
	Stue 6						0:00:15 RENG								
13:13	Stue 7		3	...	69	Her	0:00:59 Læge	●		Taget			Irrepo ...		
14:44	Stue 8			...	23		0:00:12 Journz	●	●				smert ...		

Figure 3: This figure shows the configuration of the ED electronic whiteboard at ED2.

When the patient arrives, the medical secretary updates the Arrival-field with the current time and the Awaiting-field to show that the patient is waiting for the next step in the patient trajectory: Triage. Unless the case is a critical patient (e.g. a trauma patient from a car accident) the Room-field is set to show that the patient is in the waiting room. Then the triage nurse takes action. The triage nurse determines the patient's triage level and updates the Triage-field to show this. The information in the Triage-field is both indicated by a number between 1 and 5 and by colour-coding the number. 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. In the meantime, the triage nurse will inform the nurse responsible for the patient of what needs to be done in relation to the patient. This includes having bio-analysts take different samples from the patient. If a bio-analyst has been called this is also indicated on the whiteboard. At ED2 this is done, by updating the Lab-field to show that a bio-analyst has been requested. At ED1 the same indication is given in the Plan-field. When the samples have been taken, the bio-analyst indicates this by updating the Lab-field to reflect this status (ED2) or the triage nurse updates the Plan-field and removes the lab request (ED1). Besides this function the Plan-field can also be used to indicate if specific steps in the patient-treatment process are to be carried out e.g. X-ray photography or CT-scans.

The overall goal for the EDs is that a patient does not spend more than two hours before (s)he is discharged. The physician and nurse assigned to the patient decide whether to transfer the patient to another ward or send the patient home. If the patient is to be hospitalised the clinicians must decide what ward to transfer the patient to and notify this ward. At ED1 it is determined early in the process to what ward the patient should be hospitalised, since this is relevant in deciding which type of physician the patient requires. At ED2 this is not decided until later in the process and notification of the transfer has to be given at two levels: Nurse-to-nurse and physician-to-physician. 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. At ED2 this is indicated by updating the Porter-field to reflect this and at ED1 this action is indicated in the Plan-field. At ED1, the configuration includes a Depart-field, which shows the patient's estimated time of departure from the ED to help the clinicians keep track of when rooms become available for new patients. This is important for the logistic administration of the ED. The Porter-field serves the same function at ED2 because the clinicians know by experience that it takes approximately 5 minutes for a porter to retrieve the patient. 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 Improvisational Change Management

In this section we illustrate how use of the system at the two EDs have led to changes in both the system and in the work practices regarding the system. This is done by describing a number of situations that we observed at the EDs.

As described shortly in section 4 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 entering new patients into the system. However, we observed a clear deviation from this work procedure during our first observations at ED2. Here, we discovered that the senior physicians on watch undertook the task of entering new patients into the system. This was done because the senior physicians often were the ones to receive the initial information about the patients and due to easy access to the system they could easily enter the information themselves. This alteration quickly became the normal working practice regarding entering new patients.



At ED2 we observed another change in the clinicians work practice that was enabled by the system's distributed access. At this ED the clinicians conduct so-called *time-outs* three times during a shift to discuss the patients currently in the ED. Before the electronic whiteboards were introduced the clinicians would have these time-outs in front of the dry-erase whiteboards using them as an aid in the discussion of the patients. 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 important away from the control room where such discussions would interfere with the work. This has only been possible because the system allows access from all devices with access to the central server.

We also observed changes that were made to the system itself after its initial implementation. One observation we made was a need and desire for time registration to be shown on the electronic whiteboards. This helps the clinicians keep an overview of the patient flow in the EDs by showing how much time has been spent on the different steps of the treatment process and also aids the clinicians in their effort to maximise their efficiency. At the time when the system was introduced at ED2 this was partly supported by the Awaiting-column, which shows how long a patient has waited for the next step in the treatment process. However, not all steps of the treatment process were available at this time. This was observed in a situation where a physician wished to indicate that he was attending a patient. At the time it was only possible to indicate that a patient was waiting for a physician but not that the physician had actually gone and attended the patient. At ED2 this was solved, by adding an extra option in the Awaiting-column called Record. This allows a physician to indicate that the next step in the treatment process is completion of the patient record when (s)he is attending the patient. Again this alteration became a permanent feature in the system.

The same issue was observed in relation to the arrival of patients at the ED. When a patient is announced at the ED (s)he is immediately registered in the electronic whiteboard system. However, it can take a long time before the patient physically arrives at the ED and this can have an impact on how the coordinating physician and triage nurse choose to distribute the EDs resources. Therefore the clinicians' need an indicator showing how long a patient has been underway and when the patient can be expected to arrive at the ED. To support this work practice the clinicians at ED2 added yet another option to the Awaiting-column called Arrival. This allows the clinicians to indicate that the patient is currently waiting to arrive at the ED and by having a timer in the field it is also possible to estimate from experience when a patient will arrive.

During our research at the EDs we also observed some problematic issues regarding the structure of information displayed on the electronic whiteboards. As mentioned previously, the layout of the electronic whiteboards is intentionally copied from the old dry-erase boards. However, there are certain differences between the two types of whiteboards that have an impact on the work practices at the ED. One of these differences is the fact that the electronic whiteboards are highly patient-centred whilst the dry-erase boards were room-centred. In practice this means that the matrix of patients expands and retracts 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. This dynamic display of patient information provides the clinicians with an overview of how many patients are currently at the ED or en route but it makes it difficult to indicate that the rooms are occupied by other activities than patient treatment e.g. cleaning or isolation. This could easily be done with the old dry-erase whiteboards by writing directly next to the room in question that the room was somehow occupied by an activity. With the new electronic whiteboards there is no easy way of indicating that a room is occupied since the rooms are not fixed rows on the whiteboard. We observed a couple of ways of circumventing this issue. One way was by registering the activities as fictive patients in the system e.g. creating a patient called *Cleaning* with no other information than the name. Another way was to keep patients registered to their room until the room was actually ready to receive a new patient. This means keeping the room occupied even though the patient has physically been moved to allow the clinicians to ready the room for the next patient.

Another way in which this dynamic board structure has made daily practice more troublesome is when the clinicians have to maintain an overview of room vacancy. During one of our observations at ED2 we discovered that the triage nurse had to sort the list of patients by room number and then manually count the rooms to determine which rooms were vacant. This is caused by the fact that the new electronic whiteboards do not show vacant rooms. At ED1 they have solved this issue by using the old whiteboard with the fixed room numbers as a supporting tool for the clinicians. With the rooms represented on the dry-erase whiteboards it was possible for the clinicians to create an overview of which rooms were vacant and which rooms were occupied.

We also observed another supporting function of the dry-erase board. Due to ED1's organisational structure it is necessary to divide the patients according to what type of physician their treatment requires. Previously, this was done by writing the patients on the dry-erase boards with different colours but with the new electronic whiteboards this is no longer possible. However the need to differentiate the patients still remains and the clinicians have therefore found another way of doing this. With the old dry-erase whiteboard hanging next to the new electronic boards, the clinicians have adapted the dry-erase boards to show the division of patients by hanging the patient registration forms in fields according to the specific medical expertise needed. Actually the new electronic whiteboard does have a field indicating the same information but it is named in a way that does not correspond to its intended purpose and it is placed too far to the right on the screen to be noticed by the clinicians.

## 7 Discussion

In this section we discuss the findings presented in the previous sections and evaluate what implications for practice and research these findings can have. In particular we discuss the effects that the experimental implementation and change management strategy have had for the outcome of the implementation process and the system now taken into use. In this discussion we draw upon the theoretical framework presented in section 2.

As described in section 4 both EDs had prepared some sort of written material as part of their implementation process, describing the use of the new electronic whiteboards. In the terms of Schmidt (1999) this can be characterized as a formal procedural construct detailing how the work practice regarding the system is envisioned. The system itself also contains a sort of formal procedural construct in the Awaiting columns options, since the options in this column indicate a generic patient trajectory. However, constructs like these will always be underspecified when compared to everyday practice and as such cannot contain all details of the action in this practice (Schmidt 1999; Suchman 1987). Therefore, it is inevitable that changes will be needed when taking these constructs into use. The changes that we have observed and described in section 6 resemble this category of changes, as they have arisen from the use of the formal constructs. However, when compared to the changes of the formal constructs that Schmidt (1999) discusses there is a certain difference between these and a number of the ones we have observed. Schmidt (1999) describes how changes to formal constructs often occur when the construct cannot handle certain situations in the work practice e.g. a breakdown in a work routine. At this point the construct is altered to handle the problematic situation and afterwards the construct returns to its default configuration. However, this is not the case for a number of the changes that we have observed in our research. Here the formal constructs were reconfigured to incorporate the changes and as such the formal constructs were permanently altered to handle the situations that caused the changes in the first place. Since these changes emerged through the use of the new system and the formal constructs associated with the system and because they became a permanent part of the work practice, these changes could be categorised as organisational changes in line with Orlikowski and Hofman's (1997) concepts of opportunity-based and emergent changes. For example, the described changes to the choices in

the system's Awaiting column can be seen as opportunity-based changes since the system's functionality provided the clinicians with an opportunity to improve their work practice. Also, we observed changes to the work practice that more or less grew out of using the electronic whiteboards e.g. reconfiguring the work practice regarding registering new patients. This change was made possible by the distributed access to the system but was not actively implemented. Instead it emerged over a short period of time using the system and became a permanent part of the formal procedural construct.

Besides these permanent changes to the formal constructs we also observed situations where the clinicians deviated from the constructs in a less permanent manner than the ones described earlier. This is exemplified by the situations where the clinicians devised 'quick fixes' or work-arounds for certain problematic aspects of the electronic whiteboards e.g. entering fictive patients to indicate cleaning activities in a room or use the old dry-erase whiteboards for supportive functions. These examples of changes to the formal protocol are similar to the changes that Schmidt (1999) discusses i.e. they are changes that are performed to overcome a specific problematic situation and afterwards the work practice again follows the formal construct. Although these changes to the formal constructs did not become a permanent part of the construct, the reason for deviating from the construct still existed. Therefore, performing the temporary changes to the construct did become part of the working practice and can as such be seen as 'situated action' where the clinicians use the formal construct of the system as a 'plan' but act differently in order to perform their tasks in the face of local needs and contingencies.

It is important to point out that the temporary changes to the formal constructs were caused by system inefficiencies that could not be corrected by the clinicians themselves. In other words the clinicians were not able to perform an adaptation of the system by themselves. Therefore the 'quick fixes' and work-arounds had to be introduced to the work practice. Because changes like these tend to quickly become a part of the normal working routine (Tyre and Orlikowski, 1994) it is important that researchers and developers are able to identify and distinguish between changes that have occurred to adapt to desired system functionality and those that have occurred to work around unsolvable system inefficiencies. This should be done in order to correct the system inefficiencies and thereby prevent that the 'quick fixes' and work-arounds become permanent bad habits, whilst sustaining the changes that have arisen from the users adaptation to the system. To identify these different types of change there is only a relatively short window of opportunity for doing this (Tyre and Orlikowski 1994) and therefore it is important for researchers and developers alike to be engaged in the early stages of the implementation process, where these changes have not yet become engrained in the routine work practices.

## 8 Conclusion

The findings reported here illustrate some kind of pattern, which indicates that certain changes to the formal procedural constructs associated with a new IT system can have two characteristics. The first is a temporary change to the construct to handle a problematic situation whilst the other type is a permanent change that becomes part of the formal construct. In this article we have categorized this sort of change as a genuine organizational change. Also, we have found that the permanent changes were enabled by the system's opportunities for adaptation whilst the temporary changes were performed in situations where it was not possible to adapt the system to the work practices of the EDs. In following this line of thought we argued that it is necessary for researchers and developers to be engaged in the early stages of the implementation process, in order to counteract tendencies to introduce work practices that circumvent system inefficiencies by introducing bad habits rather than specifying needed system revisions. Thus, the discoveries we have made during these two implementation processes point to a necessity of finding a balance between facilitating rapid system development iterations and at the same time striving to limit the disruption of and changes to the

daily work practices (system wise) for the clinical personnel. Hence, a future challenge in this project is to clarify how to study these conditions and implement the electronic whiteboard system at the other two hospital wards in such a way that it interrupts daily work practice to the least extent.

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