

# Large Public Display Boards: A Case Study of an OR Board and Design Implications

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## Abstract

*A compelling reason for studying artifacts in collaborative work is to inform design. We present a case study of a public display board (12ft by 4ft) in a Level-I trauma center operating room (OR) unit. The board has evolved into a sophisticated coordination tool for clinicians and supporting personnel. This paper draws on study findings about how the OR board is used and organizes the findings into three areas: (1) visual and physical properties of the board that are exploited for collaboration, (2) purposes the board was configured to serve, and (3) types of physical and perceptual interaction with the board. Findings and implications related to layout, size, flexibility, task management, problem-solving, resourcing, shared awareness, and communication are discussed in an effort to propose guidelines to facilitate the design of electronic, computer driven display boards in the OR environment.*

## INTRODUCTION

Hospital workers are aided by a variety of tools in coordinating their activities. Increasingly human collaborative activities are mediated by tools with computing capabilities. One useful source of insight into how collaborative tools should be designed comes from observing ways in which non-computerized artifacts are exploited for supporting collaboration. Past studies of computer systems<sup>1</sup> have shown that systems fail because of inadequate understanding of existing work practices.

An important class of collaborative artifacts is public display boards. These boards are used to represent tasks, materials, personnel and other scheduling and status information. More and more such boards are electronic and are driven by computers<sup>2</sup>.

In this article, we first present an ethnographic study of a public display board in an operating room (OR) unit. Coordination needs arise because of the unpredictability of incoming emergency surgery patients admitted to the trauma center as well as other contingencies. The board has evolved into a key component for supporting collaborative work. We then discuss design implications for large, computerized display boards.

## DOMAIN DESCRIPTION AND METHODS

The setting of this ethnographic study was a busy, urban Level-I trauma center with over 6,000 admissions per year. The center has a dedicated trauma resuscitation unit (TRU) with ten patient admitting bays and six ORs for treating trauma-related injuries. The entire operative process, from initial identification and planning for a surgical procedure through disposition from the OR to the post-anesthesia care unit (PACU), is captured on a large public display board.

As with any highly complex and dynamic work environment, uncertainty arises when changes are introduced, regardless of the source. In the study setting, change is constant and unpredictable. Examples of change that lead to uncertainty include cancelled surgeries, unexpected additional surgeries, multi-patient trauma situations in which demand exceeds resource supply, and external variables impacting OR operational status such as unavailable or malfunctioning equipment, lack of supplies, and changes in staffing patterns.

## Data Collection

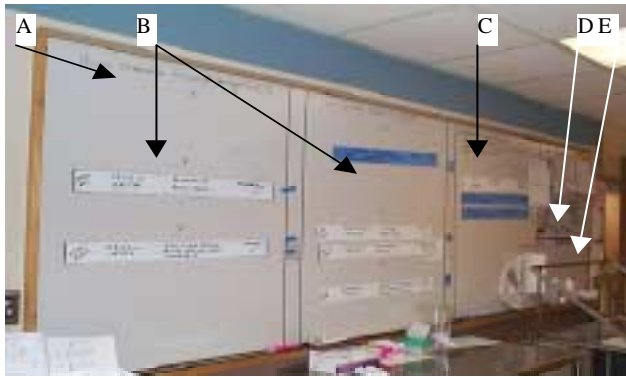
Data presented below represents the findings from an ethnographic study of a public display board in the OR unit as part of a larger overall study of communication and coordination through the trauma care process. Data were gathered by direct observation, interviewing, photographing, and researcher logs at various points in time from early morning (most intensive coordination time) to late evening (least intensive coordination time). The following are major findings from these research activities.

## VISUAL AND PHYSICAL PROPERTIES OF THE BOARD

### Layout and Size

The OR whiteboard measures 12 feet by 4 feet and is partitioned into four major areas (Figure 1). The two left-most areas hold patients scheduled for surgery in ORs one through six. The third section of the board is used to hold those surgical cases that were not planned and therefore were not given a start time for surgery (add-ons). The far right section of the board is used to hold magnetic nametags for all OR staff as well as magnets for indicating shift assignments and isolation cases. Across the top of the board are various other messages to announce

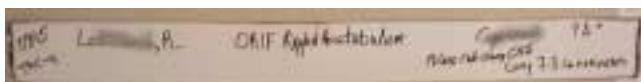
important items. These additional messages may be posted in paper format or annotated via erasable marker directly on the board.



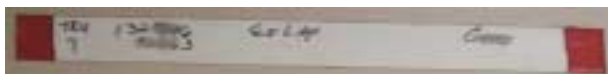
**Figure 1.** Overview of OR board. (A: General staff information/announcements; B: Magnetic case strips for all six ORs in the unit; C: Holding place for case strips, especially unscheduled add-on cases; D: Magnetic staff name tags for off-duty staff; E: Magnetic staff name tags for on-duty staff).

### Color and Textual Descriptives

Magnetic strips used to indicate particular task activities (one strip per patient surgery) are represented in a variety of colors, each serving as a visual cue even in the absence of more detailed written explanation. A white magnetic strip is used to annotate all previously scheduled surgical cases (Figure 2a). For those patients who are added to the day's surgical schedule (add-ons), a blue magnetic strip is used. Emergency cases that have superseded ("bumped") both scheduled and add-on cases are noted by white strips with red tape at both ends (Figure 2b). With all cases (scheduled, add-on, and emergency), the strip contains vital information for the OR team. From left to right, the following information is noted: expected surgery start time, patient location within the facility, patient name, surgical procedure, surgeon, specialized equipment or supplies, and expected duration of the procedure.



**Figure 2a.** Surgical case strip for scheduled operative procedure (in white). (The patient and surgeon names are blurred to protect privacy.)



**Figure 2b.** Case strip for emergency surgery (in white). The ends of the strip are marked with red tape.

### Flexibility

Beyond the mere visual cues offered by the color of the strips as well as their relative location, the OR whiteboard is rendered highly flexible by the use of removable magnetic strips, tags, and dots. As the task situation and

surgical environment changes, staff members are able to quickly and easily move the magnetic components to accommodate new constraints or opportunities. Further, because erasable markers can be used to write directly on the strips, room, equipment, and personnel changes can be noted directly on the magnetic strip for each individual patient.

## PURPOSES OF THE BOARD

### Task Management

Scheduled, add-on, and emergency cases are placed on the board under a number corresponding to an operating room. As necessary, strips are moved around the board to indicate the planned activities for each operating room.

For patients who have not arrived for surgery, a small piece of paper is placed under their magnetic strip on either end (Figure 3). This paper (Patient Call Slip) is prepared by the OR Charge Nurse and serves as a resourcing and reminder tool for OR technician staff. The Patient Call Slip includes the date, time, patient name, current location, assigned operating room, whether or not the current unit has been contacted, isolation status, and any transfer considerations and equipment that will be necessary while moving the patient to the OR area (oxygen, monitors, medication pumps).

When the OR is ready for the patient, the Charge Nurse notifies the appropriate unit that they will be coming for the patient, then assigns an OR technician to pick up the patient. The OR technician removes the Patient Call Slip and reviews it to determine if additional assistance with transporting the patient is necessary. When the Patient Call Slip is no longer under the patient's magnetic strip, this sends a signal to all staff that the patient has been retrieved for surgery and is either enroute to the OR or is currently in surgery.

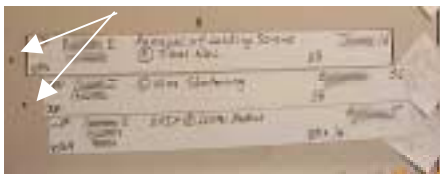
When a surgical case is near completion the corresponding OR magnetic strip is placed at a slanted angle on the OR board (Figure 3a). Slanting the magnetic strip alerts staff that an operating room will soon be vacant and that OR staff can notify nursing personnel to prepare the next patient for surgery.



**Figure 3a.** Patient Call Slip placed behind the corresponding surgical case strip for OR #5 (unable to see #5). A slanted case strip indicating that the patient is still in the room but that the surgical case is almost complete and staff can begin to prepare for the next patient.

Patient arrival status for same day surgery cases (same day surgery patients arrive early morning on the day of

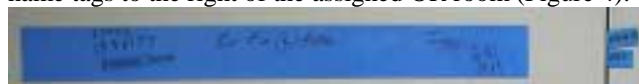
surgery) is also noted. Since task scheduling is critical to overall operations, it is important to know whether or not a patient has arrived to the hospital. To keep track of when patients arrive for same day surgery, the Charge Nurse confirms with the registration desk and annotates arrival by placing a black dot to the left of the case strip (Figure 3b).



**Figure 3b.** A list of same day surgery cases. Dots to the left of the case strips were made after the Charge Nurse confirmed that the patients had already registered in the facility and were ready for surgery.

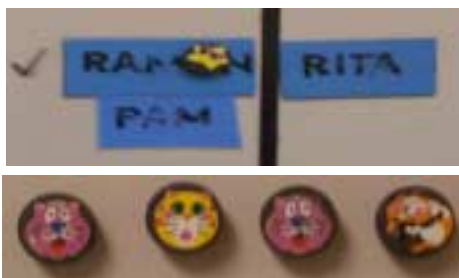
### Resourcing

Resourcing issues may include personnel, equipment, and time. Staff assignments are made at the beginning of the shift. Staff names are initially located in the farthest right section of the board. The current shift Charge Nurse places all names for the oncoming shift on the bottom part of the right side of the board based on names listed on the time schedule (Figure 1). When the oncoming Charge Nurse makes assignments, he or she simply moves the name tags to the right of the assigned OR room (Figure 4).



**Figure 4.** Nursing staff assignment “displayed” on the right side of the case strip using name tags.

Staff members work a combination of eight and twelve hour shifts. Those staff members working eight-hour shifts will have a magnetic dot with either sunglasses or a cat face next their name (Figure 5). This indicates that the staff member is working an eight-hour shift and will need to be relieved for lunch earlier than those working twelve-hour shifts. Patients with a green smiley face (Figure 6) next to their strip require isolation precautions (due to a communicable disease) and may require additional staffing.



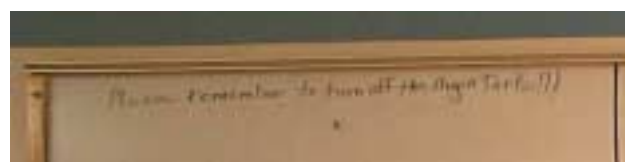
**Figure 5.** A nametag with a “sunglasses” or “cat face” logo indicates the nurse works an eight-hour shift. The name tag next to it on the right (RITA) indicates the

person who is scheduled to cover the person on the left (RAMON).



**Figure 6.** A green dot (the top case strip) indicating the patient was on special isolation precautions for a communicable disease.

Another resourcing function of the OR board is to communicate vital equipment and supply issues. Notes are easily written in empty space to alert all staff to critical issues (Figure 7).



**Figure 7.** Sign on top of the board serves as a reminder to staff: “Please remember to turn off the argon tanks.”

Using the board in this manner, it is easy to see that both supply and demand are graphically represented in one central location. Surgical candidates represent demand and personnel, equipment, and time represent supply. Demand and supply are manipulated on the board until the appropriate balance has been achieved for all patients and staff.

### Shared Awareness and Orientation

The OR board serves to facilitate several interpersonal processes of import. Most significant is the ability to visually depict the entire surgical environment in one consolidated location. The board therefore serves as a means to create a shared mental awareness among all staff members.

Surgical personnel typically study the OR board at the beginning of their shift to glean a perspective of the day’s work. Individuals from all disciplines can immediately ascertain the status of the various ORs, dedicated personnel and equipment, and pending task activities and orient themselves within the larger context.

### Reliability

Beyond the fact that magnetic strips are flexible and movable, they are reliable. Unlike computers, telephones, pagers, or other electronic devices, magnetic strips do not break down. In the rare event that any electronic system should fail, the OR whiteboard can continue to serve its intended purpose with little interruption.

## **PHYSICAL AND PERCEPTUAL INTERACTION WITH THE BOARD**

### **Interpersonal Communication**

The OR board is the nerve center for communication and coordination among health care providers in the OR and TRU. Two modalities are readily apparent; synchronous and asynchronous. Synchronous communication among and between a variety of surgical personnel can occur directly in front of the board for the purposes of task scheduling, resourcing, and any of the other aforementioned intended board purposes. Asynchronous communication occurs when individuals update the OR board and other staff members and facility personnel view the board to determine current information in the absence of synchronous communication with other personnel. Accurate and timely communication is not dependent upon face to face communication nor time. When looking at the whiteboard, all personnel have an instant understanding of the current state of the OR environment without talking to or interrupting each other.

### **Staff Collaboration, Planning & Problem-Solving**

The board area is accessible to a multitude of healthcare personnel and facilitates communication and coordination in front of the OR board. Communication is ongoing and ebbs and flows as patients arrive into the TRU and OR. This communication is both written and verbal and is added, amended, edited, or deleted on the board and magnetic strips by all providers as information about patient status is ascertained. At any given time, the accuracy of the whiteboard can impact the overall functioning of the OR.

On those occasions when complex and dynamic situations require multidisciplinary input, the OR board serves as an excellent site for negotiations. Surgical and support staff can use the overall perspective of the current environment coupled with new knowledge of changing events to problem-solve task management activities. The board became an effective supporting tool for joint cognitive activities. The magnetic pieces on the board were moved to reflect tentative solutions to scheduling problems<sup>3</sup>, much like the pieces of a puzzle until the proper complement was achieved.

## **DESIGN IMPLICATIONS**

In assessing the use of the TRU public display board, one cannot help but liken the events that transpire among members of the health care team to those that occur in a football huddle. Team members gather, share information, then finally disperse with a plan of action. At numerous times throughout the day, various team members reassemble to get updates, share new strategies for completion of tasks, then again disperse to continue with the newly revised plan. The ability to hold virtual huddles throughout the trauma care life cycle could potentially amount to vast improvements in performance

using design principles garnered from the study of the task environment.

### **Layout and Size**

Perhaps the most significant and useful feature of whiteboards are their configurability. The TRU whiteboard is merely a large white space that has been partitioned and configured based on need and staff preference. Once the overall look is configured, relatively few changes occur beyond those day to day aspects of surgical care. The ability to tag key data elements are evident. This can be seen when staff write directly on the board to bring attention to some point. Color, symbols, and textual cues such as strike-through capabilities provide additional information. Each of these aspects must be afforded in any computerized public display solution.

### **Flexibility**

The whiteboard in the TRU uses magnetic strips, dots, and tags that are easy to move. Further, there is the ability to place paper notes behind the magnetic strips as additional information points and compose directly on the board. To encourage and afford adaptive uses of collaborative artifacts, any electronic public displays should allow flexible uses of objects to facilitate maximum flexibility for task management in a rapidly changing environment.

### **Task Management and Problem-Solving**

Just as the magnetic components of the public display are currently manipulated, the ability to drag and drop all necessary resources on computerized public display would facilitate problem-solving. Because the potential exists to have simultaneous cases in progress, it is imperative that computerized public display boards accommodate multi-user input.

### **Resourcing**

A major weakness of public display boards is their lack of integration with other information systems. While personnel may write next to a case the need for a particular piece of equipment, there is no guarantee that the piece of equipment is available and serviceable. A computerized whiteboard that interfaces with the central material supply information system or biomedical maintenance could readily provide this information. Only available equipment should show up in the pick list. Further, in the case of equipment, any time a particular piece of equipment is used, it should be automatically linked to the appropriate patient. This would facilitate accurate billing for services.

### **Shared Awareness and Orientation**

The sheer physical size of the public display board facilitates collaborative work and can provide an overall sense of all activities. Therein lies a significant problem; individual members of the health care team must be physically present to garner the valuable information that

is present. Only then is the awareness shared and team members oriented to the current situation.

### **Communication & Collaboration**

Because events and circumstances can change rapidly in the TRU and OR, the need for asynchronous distributed communication is vital. At any location, new information updates should be afforded.

### **DISCUSSION**

Public displays are common coordinative tools used in many settings. There are two inter-related lines of research relevant to the role of public displays in the context of collaborative work. One line is the efforts in ethnographic studies of collaborative work. In these studies, researchers often notice the central role public displays perform<sup>4-5</sup>. Another line of research focuses on the mediated collaborative work through communication technologies including the WYSIWIS system, *LiveBoard*<sup>6</sup> and *Cognote*<sup>7</sup>. The basic premise of these systems is that a computerized version of a board can do more than its non-computerized counterpart.

Many of the efforts in studying group communication support systems (GCSS) have been directed towards overcoming spatial<sup>8</sup> and temporal obstacles, such as in the case of electronic mail and voice mail<sup>9</sup>. In domains such as trauma surgical care, the challenge for team members to coordinate is not space or time, *per se*. Rather, multi-tasking, multiple sites of activities, and unpredictable task loads demand easy, flexible access, with little spatial or temporal constraints to information regarding task situations.

In designing intelligent public displays, previous attempts seem to focus on individual operations of objects on display. In the board we studied, the manipulation of the display objects can be accomplished jointly. Our study suggests that computerized public displays should consider the possibility of inventive use of coordinative artifacts. Changes over time make it important to consider the possibility of adaptation, or "design enhancement", by the users.

The current study is limited in that only one board was studied. The framework needs to be tested in future studies of other public displays. The study also calls for future studies to pay close attention to details in how artifacts are used in support of collaborative work.

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