
Information and Communication Tools as Aids to Collaborative Sensemaking

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Abstract

Collaborative sensemaking occurs when multiple actors engage in understanding an unfamiliar, information-rich environment. We present preliminary results from a field study of the collaborative activities of healthcare providers in an emergency department. The goal of our study was to explore the nature of collaborative sensemaking and the role various information and communication tools play in the process. We describe how paper, whiteboards, and the computerized provider order entry system support common external representations to enhance collaborative sensemaking; but at the same time gaps in collaborative sensemaking occur, leading to representation shifts.

Keywords

Collaborative sensemaking, representations, ethnography, emergency department, ICTs

ACM Classification Keywords

H5.3. Group and organizational interfaces: collaborative computing, computer-supported cooperative work.

Introduction and Background

Sensemaking involves finding structure in a seemingly unstructured situation [1] and is an integral part of the work of healthcare providers in the emergency department (ED). The ED provides care to critically ill and injured patients. Work in the ED is information-

intensive and requires rapid response to dynamic and novel situations. *Collaborative sensemaking* occurs when multiple actors with different thoughts about the world engage in the process of understanding 'messy' data or information [2]. Given the variety of patients, the time-criticality of action, the unavailability of information and the need for collaboration among healthcare providers, collaborative sensemaking is an important aspect of work in the ED.

Weick [3] described organizational sensemaking as having seven characteristics - it is grounded in identity construction, retrospective, focused on and by extracted cues, enactive of sensible environments, social, ongoing, and driven by plausibility rather than accuracy.. Russell et al. [4] proposed that sensemaking consists of cyclic processes of searching for external representations and encoding information into these representations to reduce the cost of tasks to be performed. When information cannot be fit into representations in use, or when representations go unused, 'representation shift' takes place and sense-makers create new representations to encode information into.

At the group level, few studies have examined the process of collaborative sensemaking and how existing workplace technologies aid sensemaking. Our goal in this study was to examine the role information and communication tools (ICTs) play as aids to collaborative sensemaking. We also explore Russel et al.'s [4] idea of external representations in collaborative sensemaking, and how these representations are supported by ICTs.¹

¹ Though the role of external representations in cognition has been studied in other domains, in this study we are concerned

Methods

HMC is a 500-bed teaching hospital in sub-urban Pennsylvania with nearly 50,000 ED visits a year. The hospital is serviced by emergency medical services (EMS) consisting of medically-equipped helicopters and ambulances. The ED at HMC uses an electronic medical record and a computerized provider order entry system, called FirstNet, which interfaces with the electronic medical record. FirstNet is available on all ED computers and is primarily used to order tests and medications for patients. ED staff use a variety of communication tools such as phones, pagers and radios. The ED is organized as three teams – the red, white, and blue teams. Each team is headed by an attending physician and has 4-5 nurses assigned to it.

We conducted an ethnographic study which included 80 hours of fieldwork inside the ED. We observed staff work, shadowed them, and conducted interviews. In our observations, we defined collaborative sensemaking by drawing on two complementary perspectives – Weick's [3] organizational perspective and De Jaegher et al's [5] enactive cognition perspective. Weick [3] highlights several definitions of sensemaking, the common thread in these definitions being that sensemaking is the act of *finding meaning* in a situation. De Jaegher et al [5] stress that sensemaking is a core aspect of enactive cognition and as cognizers, humans try to find significance or meaning in their interactions with the world. Another important aspect of sensemaking is that it is enacted. Humans do not passively receive information from the environment that they translate into internal representations; they

only with the role of external representations in sensemaking, and hence we draw only on Russell et al.'s [4] work.



figure 1. Whiteboard showing nurse assignments

participate in the generation of meaning *from their actions* [5]. The finding of meaning must be *enacted*, it is not merely about the extraction of information from the environment. Thus, sensemaking is not only about noticing and extracting cues from an ongoing flow of experience but it is also about the creation of those cues [3].

Finally, sensemaking is social. Weick [3] emphasizes the role of interaction in sensemaking by stating that "sense is generated by words that are combined into sentences of conversation to convey something about our ongoing experience" (p. 106). De Jaegher et al. [5] propose that in socially interactive situations, the dynamics of the interaction often change the sensemaking of individuals.

Drawing on the above aspects of sensemaking, we defined collaborative sensemaking as "the process by which the meaning or understanding of a situation is generated via 1) interaction with another and 2) interpretation of the actions of another, as part of a collaborative task ". Thus, we noted instances of healthcare providers interacting with others to accomplish collaborative tasks and how meaning was being generated via these interactions. The observations were recorded as field notes and later transcribed and analyzed. In analyzing the transcripts we used a grounded theory approach [6] to categorize the use of various ICTs as aids to sensemaking.

Findings

Sensemaking in the ED consists of finding answers to the questions "what is the situation?" and "what do I do next?". In a group context, answering these questions involves not only creating representations and encoding

information into them [4] but also sharing information with group members and being aware of others' activities. We found that providers use several ICTs as described below.

The Whiteboard

The whiteboard is primarily used by the charge nurse (who is the head nurse in the ED) to assign patients to nurses. It displays the names and phone numbers of the charge nurse, the triage nurses, and the three ED attending physicians. It is divided into three columns for the three ED teams, with each column listing the names of nurses on that team and their phone numbers (figure 1). Stickers with room numbers are placed next to each nurse's name to indicate the patients assigned to her. Thus, the whiteboard provides a snapshot of the state of the ED at any time and acts as a common external representation [4] that is used to encode information that is of importance to the entire group.

Different charge nurses use the whiteboard in different ways. One charge nurse uses the whiteboard to keep track of shift changes so she can plan ahead and assign new nurses before current shift nurses leave. She does this by writing the letters a, A, e, E etc. (which stand for different shifts) next to the names of the nurses. Another charge nurse writes "NEW" next to every new room sticker that she places on the whiteboard when she assigns a new patient to a nurse. This also lets nurses know at a glance that a new patient is waiting for them. When a nurse goes on lunch break, she places a "Lunch" sticker next to her name on the whiteboard. Thus, the whiteboard not only provides a common external representation [4] to organize information, it also provides flexibility to encode information that does not fit this common framework.



figure 2. FirstNet on an overhead display (above) and the charge nurse using FirstNet on her computer (below)

FirstNet: Computerized Provider Order Entry

The FirstNet interface is displayed on large overhead displays in all main areas of the ED and is available on all computers (figure 2). FirstNet lists patient information in a spread-sheet like view with the following fields: bed number, triage level, name of patient, chief complaint, nurse, MD, resident, events, lab, radiology, comments, and length of stay. This spreadsheet view provides a common framework for entering and reviewing information about patients; each patient is reviewed along the dimensions corresponding to the fields in FirstNet. For instance, during 'handoff' or shift change, incoming and outgoing charge nurses together go through the list of patients in FirstNet and discuss each patient's recent events, lab and radiology test results etc.

FirstNet aids sharing of information among care providers. When registration staff enters information about a patient waiting for a room, the patient appears under the "waiting" tab. The charge nurse, who is not co-located with the registration staff, periodically looks at the waiting tab and moves waiting patients to "red", "white" or "blue" tabs as rooms become available in these areas of the ED. Similarly, the "comments" column in FirstNet enables providers to enter and view comments about procedures or consults that a patient requires and allows free-form text entry. For instance, the charge nurse might insert a comment "oncology consult" meaning that the patient needs consultation with oncology specialists. When oncology consults visit the ED, the patient's ED doctor reads this comment and is able to make sense of their role in the case.

Paper

In spite of the computer-based technologies available in the ED, paper plays an important role in aiding sensemaking. While interacting with each other and with patients, care providers note information onto paper charts, Post-it notes, and forms. These paper artifacts are later used to transfer the information to digital form or to share the information with others.

Paper plays an important role in sensemaking for trauma cases. Trauma patients are the most critically injured patients brought to the ED. When registration staff is alerted about an incoming trauma patient, they print sheets containing temporary patient numbers such as "TRAUMA 75000052" and stick the sheets on the doors to the trauma room. This helps providers know which trauma room a particular patient is in. Once the trauma patient has been stabilized, the patient is moved to a regular ED room and a similar piece of paper is stuck to the door of this room. Also, in the first few minutes of treating a trauma case, patient information is mostly noted on paper forms.

Paper artifacts displayed at various locations in the ED serve as reminders or reference material for staff. To handle excess ED patients, several beds have been placed in the hallways and are referred to as 'hallway beds'. Since these beds are not in numbered rooms, pieces of paper bearing numbers have been stuck to the wall next to hallway beds. Unlike room beds, hallway beds are not tracked by the FirstNet system. So, housekeeping staff place paper with "clean" written on the beds to indicate that they are ready to be used.

Discussion: Gaps in Sensemaking

The dominant model of how sensemaking takes place is that people, when faced with vast amounts of information, create external representations [4] like diagrams, maps, and tables to organize information and make sense of it. We found that in collaborative sensemaking, common or "group" representations are used to organize information that is critical to the functioning of the group. In the ED, these group representations are provided by tools like the whiteboard and FirstNet. However, in spite of these group representations, we found several "gaps" in collaborative sensemaking, i.e. instances where group members were unable to collaboratively make sense of a situation, even with the aid of the ICTs available to them.

One such gap occurred during shift change between charge nurses. The outgoing charge nurse was briefing the incoming charge nurse about each patient in FirstNet. This crucial information exchange was frequently interrupted by phone calls and both charge nurses were feeling frustrated; this finally led to miscommunication of information. The outgoing charge nurse told the incoming charge nurse that a patient was 8 months pregnant whereas in reality she was 8 weeks pregnant. The correct information was available in FirstNet but not in the main interface and would have required several clicks to find. The outgoing charge nurse did not have the time or patience to find it and was recounting details from memory. Here FirstNet failed to aid collaborative sensemaking.

Another instance of this was when an EMS member asked a registration associate about a patient she had brought in a little while ago, "Do you know what the

trauma number is for the patient that just came in?." The registration associate looked through FirstNet and could only see one record with the "TRAUMA 750XXXX" number. She asked, "Is that the one? Came in about 30 minutes ago." EMS replied, "No, this just came in a few minutes ago. 17-year-old motor vehicle accident."

The registration associate searched FirstNet again and could not find any other "TRAUMA 750XXXX" patient number. No other identifying information was available about the trauma patient in FirstNet. So, the EMS member went off with this patient number even though no one knew if this was the patient being sought.

Finally, a crucial gap in sensemaking was observed to occur during the first contact between the patient and his doctor. When a waiting patient is assigned a room by the charge nurse, the patient appears in FirstNet in the corresponding "blue", "red" or "white" tab. However, it takes some time before the patient is physically brought from the waiting room into the assigned room. In the meantime, the doctor sees his patient in FirstNet as having been assigned a room and goes to the corresponding room, only to find the patient "missing".

Representation Shifts

The whiteboard and FirstNet provide group representations for collaborative sensemaking. However, gaps in sensemaking occur when individuals are not able to fit their task-specific or role-specific information into these group representations. For instance, the spread-sheet view of patient information offered by FirstNet is not detailed enough for the charge nurse to access and convey information about every patient to the incoming charge nurse during shift

change. Similarly, registration staff is not able to disambiguate trauma patients, and doctors are not able to make sense of when the patient is in the room, based on the information encoded in FirstNet.

The inability of group representations to support task-specific information encoding leads to representation shift [4]. Group members, whose tasks are not supported by the group representations, create alternate representations for sensemaking. Since different representations are supported by different ICTs, representation shift often leads to switch in tools used for sensemaking. If the tool allows flexibility (e.g. the whiteboard) to change the representations, then group members merely make small changes to the representations to fit their individual tasks – such as the charge nurse noting shifts or “new” beside names of nurses on the whiteboard. If the tool does not allow such flexibility (e.g. FirstNet) and group representations cannot be easily adapted to suit individual tasks, sensemakers switch to paper or even verbal communication. Thus, paper notes are stuck to doors of trauma rooms and hallway beds to note information that could not be stored in FirstNet, and doctors verbally communicate with charge nurses about “missing” patients. Also, in time-critical work, representation shifts occur if current representations fail to support sensemaking due to time pressure and interruptions. This explains why paper plays a crucial role in trauma cases where time is of the essence.

Conclusion

Our study highlights the use of representations in group work and how ICTs aid sensemaking by providing these representations. Russell et al. [4] noted that “sensemakers change representations either to reduce

the time of overall tasks or to improve the cost versus quality tradeoff.” (p. 272). Our study found that in collaborative sensemaking representation switch can occur when group representations do not support task-specific encoding of information for group members. Technology can enhance sensemaking by providing representations for coding information. In designing systems to support collaborative sensemaking, we must consider how group representations can be made flexible for individual use while still providing a framework for organizing common information.

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