

# Document Cycles: Knowledge Flows in Heterogeneous Healthcare Information System Environments

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## Abstract

*The paper expands our theoretical and empirical understanding of knowledge flows in heterogeneous information system environments. Through an ethnographic study of a U.S. based teaching hospital it was found that doctors and nurses organize a hodgepodge of information systems, some electronic, other paper-based or wall mounted into circular patterns. The data allows a description of how these cyclical organized systems oscillate between documents that address a broader and narrower configuration of participants, times, places and content. In doing so, organizational members continuously adjust their system use to meet the level of background knowledge held by their collaborators, that is, how intimately their collaborators know the context and the routine work practices at hand. The cyclical organization of information systems does not prevent breakdowns in knowledge sharing. To avert such problems each cycle starts and ends with a dialog and reflection among collaborators.*

## 1. Introduction

Many organizations employ a large array of information systems. State-of-the-art digital media often coexist with systems of various media introduced decades earlier. Formal integration of these heterogeneous systems, however, tends to be sparse; employees are left to fend for themselves and incorporate various systems as they struggle to accomplish their work [1]. Facing all these heterogeneous systems it often becomes difficult to determine how knowledge flows within and across organizational boundaries, even for people native to the work process.

Most healthcare institutions, relying on a hodgepodge of information systems, exemplify such processes. In a typical inpatient ward, the doctors may use one electronic record system that was initially developed by a local physician, while the nurses utilize a more recently implemented system bought from a large vendor. To complicate matters, the administration often uses an older legacy system, as do parts of the laboratory. In addition, doctors, nurses, and clerical

workers interact daily with a large variety of media: preprinted forms, paper-based records organized in large folders, whiteboards, e-mail systems, and so forth.

This lack of integration has far-reaching consequences for the entire industry in terms of patient safety, efficiency, coordination, cost, and reimbursement, to name a few [2]. In many Western countries, national-level initiatives have begun to address the issue; many have approached this process as an exercise in streamlining knowledge flows and standardizing care in the process of developing and implementing large-scale systems. However, before we engage further in large-scale integration efforts, we need to ask the question: how do doctors and nurses integrate heterogeneous information systems and facilitate knowledge flow in the course of their daily work?

By drawing on an ethnographic study in a large U.S. teaching hospital, this paper aims to answer that question. We will argue that doctors and nurses manage knowledge flows by linking the many heterogeneous systems together in cyclical patterns that follow either staff groups' daily shifts or the lengths of a patient's stay in a unit. Within each of these cycles, one finds an oscillation between systems that address a broader and a narrower audience. Thus, the doctors and nurses continuously write and read their patients' histories that offer broader and narrower answers as to which participants, places, times, and information are relevant to a particular patient's care.

In addition, it is argued that each cycle starts and ends with a dialog and reflection involving the relevant collaborators. These meetings allow the participants to raise questions pertinent to their particular practices and repair any misunderstandings that insufficiencies within the knowledge sharing may have caused. Lack of such dialogs often leads to conflicts. The analysis offers a view of not only how different records mediate medical work in different ways but also how these knowledge sharing practices relate to one another and to the larger institutional structures as well.

## 2. Theory

In parallel to the dissemination of increasingly complex information systems in organizational environments, there is an emerging literature studying knowledge sharing within and across communal boundaries. These studies tend to oppose a purely information-based perspective propagating the abstract meanings and immaterial data communicated via various information systems. Instead this body of work largely draws on a pragmatic and practice-oriented perspective theorizing the social practices going into the manufacturing of knowledge through the manipulations of various material forms. A number of terms attempt to capture the nature of the material forms and practices that go into knowledge sharing, e.g.: boundary objects [3-5], communication genres [6, 7], bricolage [8], rich representations [9, 10], adoptive structuration and IS [11], immutable mobiles and inscription devices [12]. In an effort to capture the broader sentiments of the literature and avoid the specific theoretical baggage embedded in each term we will draw on the broader notion of document. We define documents as typified and material communication, whether electronic, paper-based, wall mounted or set in stone, invoked in response to recurrent situations.

Organizational members work within a fluid field where purposes, goals, and practices often shift and compete [13]. Here, documents serve as sense-making and knowledge sharing instruments—the core of organizational integration—by facilitating the creation of shared meaning and purpose as well as the coordination of heterogeneous perspectives among different constituencies and competing demands and interests [14, 15]. In other words, the creation, distribution, and use of documents enable an organization to coalesce into loosely coupled alliances and allow people to establish a “rational” basis for choosing one course of action over another [16].

To understand how documents serve as key resources for knowledge sharing among organizational members, we need to look at the two closely intertwined ways in which documents interact with organizational practices. First, documents are self-explicating devices [14, 17, 18]; they denote their use by telling the reader how they are to be applied. To put it differently, documents are not solely accounts of work. They are also accounting for work. Documents offer models for practices and thus allow people to coordinate their distributed work [19, 20].

Second, these instructions are recognizable to people who are familiar with the settings in which these documents exist. The context provides a resource

whereby a user will know what to expect and how to use the document [14, 18, 21]. In other words, users need to know how those documents are bound up with certain kinds of organizational practices.

The literature on communication genres allows us to further articulate this double nature of documents. A document genre is typified by communicative actions that occur in response to recurrent situations [6, 7]. People engage genres to accomplish social actions. First, producers of a document try to invoke a particular genre in order to establish the context and conventions for their communication. They do so by denoting a particular purpose, content, form and set of participants, times and places. Second, documents users try to recognize which genre has been invoked and which conventions are in play, so that they may respond appropriately. They do so based on their familiarity with social arrangements and dominant genres in the setting wherein the document exists. Document users may draw on prior knowledge about typical communication and its purposes, content, form, participants, timing and places.

The dynamic relationship between documents as explicating devices and users as carriers of contextual background knowledge and genre expectations create an interesting dynamic—how much does a document explicate and how much does the user know about the context and genre conventions?

Take, for instance, a physician who is treating a patient in a large teaching hospital. When writing a summary of her care to other physicians on the ward, she assumes that her colleagues know the genre she is invoking and thus the general purpose of her summary, vocabulary, pertinent content and relations with other medical and technical staff as well as their work routines. Her colleagues will recognize the genre and make assumptions about the practices that went into the production of the document. However, the patient would most likely be confused if he were to read the document in the chart hanging at his bedside. He does not know the specific genre nor how it relates to the treatment routines and social organization of work on the ward. Even if he understands the medical terminology, he may not understand how the document fits into the work flow and activities of various doctors and nurses.

Asymmetric access to knowledge does not solely characterize the relationship between caregivers and patients. Even among healthcare providers, one does find various degrees of access to knowledge. Such access to knowledge often depends on the degree to which people are distributed in time and space. The more distributed and mobile people are, the less

background knowledge they tend to share, and the more documents need to explicate.

In short, organizational members create, distribute and use documents to form loosely coupled alliances and make sense of their own and others' activities. Specific documents tend to be tailored to a group of people with a particular configuration of shared contextual knowledge and genre expectations. Some documents are for people who need little content and clues to understand the purpose, form, place and timing of the communication, whereas other document types support communication among people with little common knowledge (e.g., patients and providers).

While such a perspective provides a helpful framework for the study of individual documents, it offers a rather static picture and does not specify the relations among multiple documents.

## 2.1 Relations among Documents

One finds an active relationship between documents and organizational members. As documents move among different communities across time and place, their meanings and uses change [14]. A number of scholars have addressed the issue by arguing that people do not rely on one document to fit all situations; rather, people engage in ongoing transformations of documents. They do so in an effort to recalibrate the relationship between the self-explicating powers of a document and the background knowledge that people bring to its use.

Several laboratory studies, most notably work by Latour and Woolgar [12] and Knorr-Cetina [22], depict the documents leading from laboratory observations to scientific publication and back to new laboratory observations as a series of small transformations or conversions from one document to the next. There are no great leaps in the evolution from a doctor's patient examination longhand notes or instrument printout on the one hand and an article in the *New England Journal of Medicine*, on the other hand, only a series of minute transformations made one document at a time. Each of these transformations adapts the former document to a new set of circumstances, social arrangements, and expectations.

Boland [23] takes the argument a step further by describing document transformations as a circular oscillation between broadly and narrowly framed documents. One can describe this continuous process as an oscillation between how much documents explicate and how much background knowledge readers bring to the situation. In situations where colleagues work closely together and know each other's routine practices, documents tend to become

terse, relying on nonverbal understandings. The documents do not denote their context or use in great detail. Writers and readers have no need for that level of explicit detail. For instance, a team of doctors on one ward share notes. Their descriptions of events and terminology become shorthand accounts, depending on nonverbal understandings, shared context clues and background knowledge. The integral complexity and self-explicating capacity of the documents are reduced through the writing process as the accounts come close to the experiences and practices of a narrow cohort. As this trend progresses, knowledge sharing with other teams suffers. Ward nurses and specialists do not have the background knowledge required to dissect the documents—communication between teams is hindered.

In the face of this breakdown, documents tend to become more explicit, thus adding contextual data and drawing on broadly recognized genres. They build a more iteratively complex argument to bring their local experiences into the work and experiences of a larger set of participants, times, and places. By strengthening the self-explicating capabilities of documents, however, new problems are created. Local practices start carrying the burden of highly explicit documents. The doctors find it ineffective to spend time articulating every detail and providing extensive contextual background knowledge to serve a broader audience. They are burdened by the attention to details, contextual clues, formatting conventions and elaborate genre conventions. At this point, a reverse shift begins. Ward doctors place greater reliance on the reader's background knowledge and implicit understanding of the situations. They place greater emphasis on narrowly recognized genres that focus only on participants, times and places relevant for their immediate practices.

## 2.2 Document cycles

From the organizational members' perspective, we can depict the integration of heterogeneous information systems as a cyclical process. To mitigate their need to support local practices and, at the same time, coordinate with other communities, organizational members oscillate between documents that provide a broader and narrower explication of the content. In doing so, they continuously recalibrate a fundamental dynamic in the relationship between documents and organizational members; how much does the document need explication, and how much can one rely on the background knowledge of its users? This is not an oscillation between two extreme positions—one local, the other global—but a continuous adjustment of communicative practices to address different configurations of participants sharing various degrees

of common knowledge about each other's work. Given the distributed nature of organizational work, such cyclical integration becomes central to organizational members and how they make sense of an organizational reality where goals, meanings, and practices often shift depending on the configuration of participants, times and places. One can expect document genres supporting the practice of a narrow audience to cover a limited configuration of participants, times, places, content, and formatting conventions. As people attempt to reach progressively broader audiences, their document genres will explicate these details in a much more comprehensive fashion.

These cyclical processes do not preclude misunderstandings and breakdown in knowledge sharing. The reciprocal relationship between documents, their producers and users is fragile and goes to the core of organizational members' sense-making. Document producers likely bring a great deal of background knowledge to their writing, reading, editing, archiving and distribution of a document; however, as a document makes its way through the organization, users may not be able to bring the same knowledgeable reading to the document. Instead they rely on other means of communication to make sense of the document. Dialog and reflection among collaborators may remedy breakdowns. Such reflexive dialogs allows the different parties to broaden the references to relevant participants, times, places, and content.

The key to the integration of information systems seems to lie in how organizations manage the continuous breaking down and repair of communication among people who are engaged in locally defined practices but still need to share their knowledge with broader audiences.

### **3. Method & Case Description**

To explore the integration among numerous information systems we draw our empirical case from a 15-month, multi-sited ethnographic study in a US based teaching hospital where one author followed pediatric nurses, doctors, and secretaries in their daily work. To protect the privacy of both healthcare providers and patients we have changed all names, dates, institutional identifiers, and sometimes the gender of our informants. One author spent approximately 2,000 hours in five primary care clinics, one ER, and two hospital wards, focusing specifically on the document related practices associated with patients' care as they move within and across healthcare settings. These documenting practices include recording, distribution, sorting, reading, and

interpreting; involving various note cards, preprinted forms, online record systems, flagging systems, racks, binders, and whiteboards. Our unit of analysis was the work practices of doctors and nurses in documenting patients' care. Documents saturate doctors' and nurses' work. Few activities avoid the need to record, sort, or read documents. Thousands of documents were reviewed in the course of the fieldwork and more than five hundred were gathered and analyzed in the course of the research.

Qualitative ethnographic methods guided our collection and analysis, both of the empirical observations of everyday work practices, and of informal and semi-structured interviews with participants regarding their intentions and perceptions of practice and documents [24-26]. Practice-oriented theories framed our understanding of how doctors and nurses produce and consume documents, and directed our analysis of transcribed interviews, collected documents, and handwritten and typed field notes [27-31].

For the purpose of this article, we focus on the documents used when an infant girl, Anna, is admitted to a general medical floor, 10 East with bronchiolitis. Anna has been sick for several weeks and was first sent to Common Hospital by her primary care doctor. Given her young age and complications with her bronchiolitis, Anna was transferred to Kiltham Hospital that specialized in pediatric care. Anna was admitted through the emergency room (ER) and spent 17 days in the Intensive Care Unit (ICU). From there she was transferred to a general pediatric medical ward, 10 East. By the time Anna is transferred to 10 East her history has been taken countless times and her history and care recorded in numerous documents. This process continues at 10 East, where doctors, nurses, clerical staff, social workers, and consultants track Anna's care in more than 15 information systems. The pressing question is how the hospital staff relates these systems to one another through their daily practices.

In an attempt to limit the scope of the present paper we focus on the corpus of documents utilized in the inpatient ward, 10 East. We found comparable relations among information systems in all other settings involved in this study. We chose Anna's case as a representative of document use repeated countless times daily during the winter months. The case is qualitatively representative in the sense that it reflects the majority of documenting practices by the inpatient ward staff.

### **4. Results: Document Cycles**

One finds many cyclical organized document sequences as Anna moves from primary care, through

Common Hospital to Kiltham Hospital and its emergency room (ER), Intensive Care Unit (ICU) and inpatient ward. On the Inpatient floor 10 East, the nurses, interns (1st year residents), and senior residents (4th year residents) each maintain their own document cycles. One is tied to the length of the patient's stay in the unit. The other follows the lengths of staff members' daily shifts. These two types of document cycles are empirically derived and characterize distinct but not exclusive communicative practices.

#### 4.1 Cycles: the lengths of a patient's stay

Each department across the hospital employs its own sets of document cycles tied to the length of a patient's stay in the particular unit. In each unit the various occupational groups or teams typically will manage their own document cycles. On 10 East one finds three primary document cycles linked to the length of Anna's stay in the ward. One is managed by the nurses, the other two by the interns and senior residents respectively. Each cycle can be broken into three phases: admission, care, and discharge. Figure 1 depicts this process exemplified by the 10 East nurses' document cycle.

**4.1.1 Admission.** Anna arrives in 10 East accompanied by a host of documents, some electronic and others paper-based. These include the discharge papers from each of the settings she traveled through from primary care, through Common Hospital, Kiltham ER and ICU to 10 East. These documents all summarize Anna's stay in a particular unit or setting, whether Primary Care, ER, ICU or 10 East.

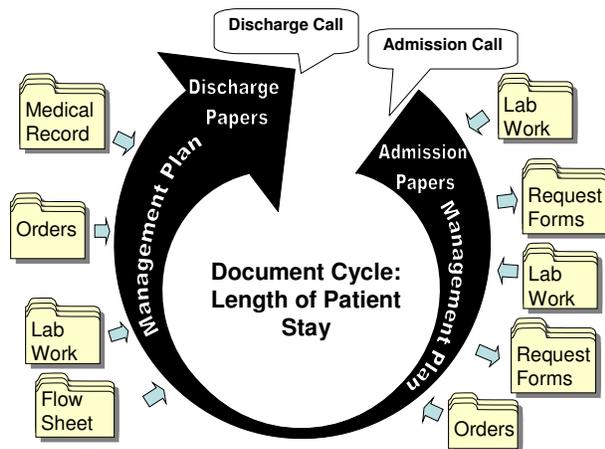


Figure 1. Nurse Document Cycle: Lengths of patient Stay in Unit

As an orderly wheels Anna down to 10 East from the ICU, three meetings take place involving staff from the two units. The ICU chart nurse goes over the ICU nursing transfer sheet with the 10 East chart nurse. The ICU intern in charge of Anna's care meets with the 10 East intern, Marc, in the cafeteria. They discuss the ICU discharge papers written by the ICU intern. The

ICU senior resident talks on the phone with the 10 East senior resident, Elisabeth, as they both look at the senior residents' online note system containing the ICU senior resident's recordings on Anna.

Each of the three 10 East staff members outlines the discharge summaries and conversations in separate documents. The chart nurse starts a "management plan" dedicated to Anna's nursing care on 10 East (see center of black arrow in Figure 1). She also assigns Karen, one of the registered nurses as Anna's main nurse. The intern, Marc, logs onto the "resident note system, an online system known as the resident note system. Elisabeth, the senior resident, logs into the "senior resident note system."

One can characterize these three systems as evolving documents. The recorded information changes over time and there is no record kept of prior recordings. For instance, the nurses' management plan folder contains a number of preprinted sheets in which the nurses pencil in demographic information, a review of Anna's family and social history and a list of current medications and activities related to Anna's current care. If changes occur, the nurse will simply erase an earlier entry and pencil in new information. Likewise, Marc and Elisabeth will edit the resident note and senior note as Anna's care changes with no traces of past entries. These electronic documents do not attempt to summarize Anna's care trajectory but simply list current pertinent tasks. These are not legal documents, nor do they go into the medical record.

**4.1.2 While at 10 East.** The nurses' management plans, interns' resident note and senior residents' senior note serve as a document backbone for the duration of Anna's 11 days stay on the ward. Many other documents "feed to" and "feed from" these three documents, as characterized by the outer rim of documents depicted in Figure 1. The nurses, for instance, draw from the physician orders and progress notes summarizing Anna's medication and care and social service evaluations often when updating the management plans on Anna. The interns may transfer vital signs and other notes from the nurses' flow sheet into their resident note. The senior residents and interns daily update their senior notes and resident notes with data from the labs online test result system or the radiology reports. Reversing the flow, the nurses regularly fill out forms for social service requests, psychiatric service, home care requests, and security officer requests based on the information kept in the management plan. Interns and senior residents write their progress notes, sub-specialty referrals, and pharmacy prescriptions based on the resident and senior note respectively.

**4.1.3 Discharge.** In the last few days before Anna finally goes home Karen, Marc and Elisabeth start working on her discharge papers. Marc is responsible for writing the discharge summary which is the official summary of Anna's stay on 10 East. He bases this document on the resident note as well as prior discharge summaries from Common Hospital, the ER and ICU. Elisabeth has to sign off on Marc's discharge summary and draws on the senior notes as a basis for evaluating Marc's summary. Karen writes discharge instructions to Anna's parents with support from the nurses' management plan and Marc's discharge summary. These discharge papers resemble in structure and narrative format the discharge papers that Anna arrived with at 10 East. In short, one document cycle has been completed.

#### 4. 2 Cycles following the lengths of shifts

Within the first document cycles we find a second type of document cycle following the length of doctors' and nurses' shifts. As illustrated in Figure 2, the nurses' 12 hour shift cycle starts and ends with a nurse report meeting bringing together the outgoing and incoming nurses. The management plans and piles of small pink and baby blue notes cards, known as "brain notes" fill the conference table. The tired night nurses sit with each of their piles of management plans and one by one go over the patients they have cared for overnight. The nurses briefly discuss each patient and Karen will fill out a pink note card on each of her female patients and a baby blue one for the boys. On Anna's pink note card she records Anna's name, age, record number, room number, weights, and "bronch, obstructions, O2, nebs Q2, No surgery consult today, social: mother today. This translates to: Anna's breathing is labored. She should be kept on oxygen (O2) and receive nebulizer treatments two times a day. The surgery consulting team was supposed to check if she needed to have her airways corrected but they canceled today. Anna's mother will be in today, which offers Karen an opportunity to talk with her about Anna's progress and when she is likely to go home. At the end of the meeting Karen and the rest of the day nurses slip small piles of notes cards into their uniform breast pockets and collect the management plans spread over the conference room table.

The rest of the day Karen uses the note cards to structure her work. When asked if she wants to join a small group of nurses for lunch she fetches her note cards and flips through them. "Give me 20 minutes, I just have to give the small bronch girl (Anna) a nebulizer treatment." As the day progresses Karen updates her note cards. For instance, she notes the surgery consultant's new appointment and the frustration Anna's mother expressed about Anna's long

hospitalization. Karen also uses the note cards when filling out her flowsheets and other documents or to record Anna's latest test results, changes in her medication and treatment plans.

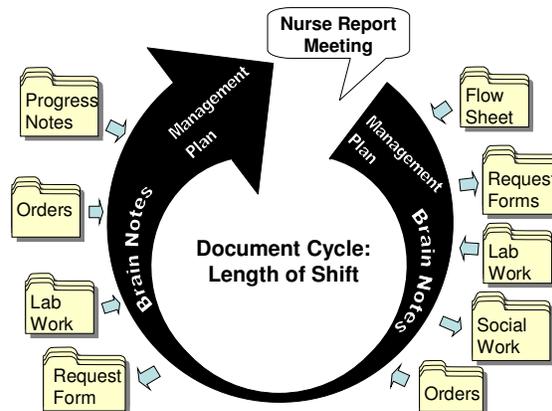


Figure 2. Nurse Document Cycle: Lengths of Shift

In the late afternoon Karen gathers her patients' management plans and updates them based on her note cards. There might be changes in medication, new procedures scheduled, test results, or treatment regimens. Just before 7PM, the night nurses start showing up and they gather in the nursing conference room with a clean pile of pink and blue note cards and newly updated managements plans. Karen drops her brain notes in a trash bin – heading home.

The interns and senior residents enact comparable document cycles entrained to their respective shift schedules. Marc and the other interns generate a fresh set of brain notes by printing individual patient entries from the resident note system. Elisabeth and the other senior residents organize their senior notes and private brain notes the same way. Thus, the management plan, the online resident notes, and senior notes get updated twice a day.

#### 4. 3 Oscillation: Broader & Narrower Framing

Within each of the document cycles performed by Karen, Marc, Elisabeth and their colleagues on 10 East we find an oscillation between documents targeting broader and narrower configurations of participants, times, places and content. Each of these four elements will be discussed in turn.

**4.3.1 Participants.** Each document targets a particular audience and demarcates a group of participants in Anna's and the other patients' care. As Karen, the nurse, creates her note cards based on the management plans, she moves from a communal audience consisting of all the nurses in 10 East to an audience of one – herself. Toward the end of her shift she reverses the movement by updating the communal document based on her private notes. Likewise, we

find a shift in the participants demarcated by each document genre. As seen in Figure 3, the management plan outlines not only the primary nursing team involved in Anna's care, but also the physicians, primary care providers, community agencies, and consultants involved in the care, as well as important phone numbers of relevant family members or legal guardians. Karen's private note cards, in contrast, denote only the people relevant for Karen's work that day. As illustrated in Figure 4, Karen includes Anna's name and a reference to her mother and the surgery consult. Similarly, Marc alternates between the private brain note and the resident note system used by the four interns currently working on 10 East. When Marc moves from the communal resident note system to the discharge summary he further broadens the audience and participants targeted by the document. The discharge summary encompasses a larger and relatively undefined audience, including primary care doctors, nurses, secretaries, possible clinical researchers, and future care givers, in the case that Anna should ever be hospitalized again.

**4.3.2 Time & Place.** The temporal and spatial references change as we move through each document cycle. Karen's note cards outline a relatively narrow temporal and spatial field for her activities within her 12-hour shift – guiding her unfolding practices: “is it time to go for lunch yet?” “Do I have time to take one more patient before I meet with Anna's mother?” Should I give Anna her nebulizer treatment while I care for Beatrice in the adjacent room?” When she updates the management plan she positions these in a

significantly broader spatio-temporal field. The management plan includes references to not only current activities, such as medication but also activities pointing to the past and future, as in the case of a concise medical history, tests, discharge procedures and training, or outpatient care arrangements (see Figure 3). Likewise, Marc switches between different temporal and spatial references as he uses his brain notes to update his resident note or when he writes Anna's discharge summary based on the resident note. Marc's brain notes demarcate a temporal and spatial field for his work during a shift. The resident note system encompasses Anna's stay on 10 East and her discharge summary narrates her care trajectory including care at 10 East and possibly recommended follow up care.

**4.3.3 Content.** As the doctors and nurses write and rewrite documents to address different participants, times and places they also oscillates between the type of content, i.e., facts, terminology, level of detail, and contextual clues appropriate for each audience. As Karen fills out her note cards during nurse report she crafts documents focusing on her immediate work practices and with minimal contextual clues. Karen's note card on Anna (see Figure 4) simply outlines the basic information Karen's needs to administer Anna's care. For instance, the card lists Anna's record number and weight – all central when Karen fills out a new flow sheet or check if Anna's medication dose is appropriate. The rest of the note card constitutes a simple itinerary of activities.

MANAGEMENT PLAN - PART 1				
Date Written:		Parent/Legal Guardian:		NAME _____
Allergies:		Telephone #:		LAST _____
		Communication Plan:		FIRST _____
				DATE _____
				DIV. _____
				MED. REC. NO. _____
Concise History _____				
_____				
_____				
Primary Nursing Team				
		Physicians:		Consultants:
		Community Agencies:		
NURSING / PHYSICIAN ORDERS				
Precautions	Activity	Lab/Test Plan	Daily	Weekly
Line Log	Diet			
	Vital Sign Frequency	Equipment	Personal Needs	
	Temp.			
	Pulse/Resp.			
	BP			
	Wt.			
Call HO for:	Checks			
	Intake			
	Output			
Patient's Name	Age	Date Admitted	House Officer/Service	Diagnosis

Figure 3. Nurse's management plan

Karen does not need to specify these activities in any more detail. With seven year tenure on the ward she knows the nurses' work rhythm by heart. There is no need to specify Anna's medical history, nor the times she requires oxygen or nebulizer treatments. Karen relies on a non-verbal understanding and simply uses her notes as a scaffold to support her unfolding practices. The doctors use their brain notes in a similar fashion. Referring to his brain notes an ER intern explains:

"No one else is going to understand what this means. This is very specific to what I do. Most people just jot notes to themselves -- you know: '5 year old, nasal foreign body, 10 days out of 21 days, thick discharge, yellow green, treat with XYZ, contact primary.' There is no time line in it; there is no thought process. I know what this means because I am here. But no one else will be able to make sense of it."

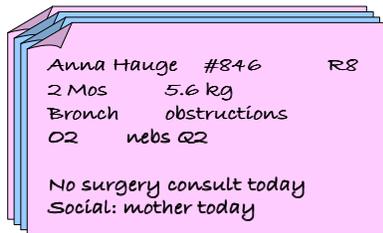


Figure 4. Karen's brain notes

As indicated by the intern these private notes only work for their author. By the end of a shift the intern will update the resident note and add clues which will orient his fellow interns. Still these remain rather vague and rely heavily on the interns shared knowledge of the patients and the rhythm of work on the ward. In Karen's case, she adds context clues as she edits the management plan. To motivate changes to Anna's diet or personal needs she may add to the "concise history" field of the management plan. She will only add changes that she deems important to her close community of nurses at 10 East. She writes when the surgery team meeting is scheduled, but she will only summarize her meeting with Anna's mother if information relevant to the nurses' comes to light.

Towards the end of Anna's hospitalization the same process takes place. The resident note system largely consists of a list of patient identifiers and activities. In the process of writing Anna's discharge summary Marc strips away these local coordination tools and adds contextual information by positioning Anna's care on 10 East as the culmination of a narrative starting with her past medical, family history, and diagnosis upon arrival in the hospital. The rest of the discharge summary reviews what is

considered relevant organ groups for Anna's case or rather relevant sub-specialties involved in her care while at 10 East. In the process of writing the discharge summary Marc adds genre clues broadly accepted in the medical community, involving formatting, and terminology. Senior residents and attending doctors often scold interns for using acronyms and lingo specific to Kiltham Hospital in their discharge summaries. Marc is literally making Anna's history public and portable by turning the resident note list into a narrative with full sentences and specification of authorship. The document cycle is completed.

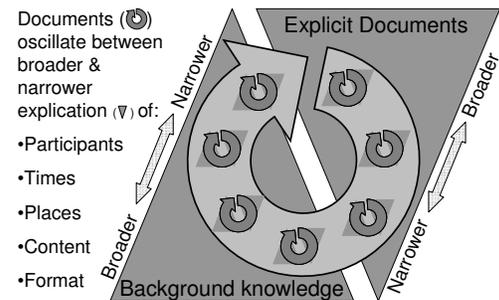


Figure 5. Document cycles and their oscillations

As summarized in Figure 5, we can depict the two document cycles as a continuous oscillation between a broader and narrower framing of Anna's care. The daily cycles (small cycles) are embedded in the larger cycle covering Anna's stay at 10 East. These oscillations involve changes to how broadly and narrowly the documents explicate participants, times, places, and content. The cyclical integration mitigates the tension between a documents power to explicate its use and the background knowledge people bring to the document. The two triangles in Figure 5 signify the inverse relationship between documents and users. In the top of the cycle we find documents broadly explicating the relevant participants, times, places, and content, thus facilitating understanding by people holding little background knowledge. As we move down in the cycle we see a shift towards documents leaning heavily on users' intimate knowledge of the work but which offers little guidance to the reader.

#### 4. 4 Dialog at Beginning & End of Cycles

At the beginning and end of each document cycle one finds interactions involving oral communication. The dialogs engage the participants in reflections about their patient's past and future care and stand out as central to the oscillation taking place within each cycle. Doctors and nurses place great emphasis on these meetings. When two interns were asked

what time of day they considered the most important, they answered in unison: “Sign-out.” Here, the doctors update their respective resident and senior notes. Each intern and senior resident will report on their patients to their on-call colleague, the doctor staying in the hospital over night. Their conversations focus on the patients that need the most attention during the night, difficult orders and other urgent tasks. It is a time to recount the work done in the course of the day and establish an itinerary for the night. Likewise, the other meetings engage the participants in dialog about individual cases and/or how to manage all patients under their collective care.

Tensions tend to escalate when a document cycle does not start or end with a reflective encounter. Interns quarrel locally about the content of their resident notes during sign-out and attending doctors scold residents during rounds; but it is nothing compared to the anger doctors and nurses express when receiving a document from another setting countering their expectations and with no chance to clarify the problem.

Primary care doctors regularly complain that the discharge summaries that they receive from other health care settings lack information significant to them. One primary care doctor, Frida, with 18 years tenure grumbled one afternoon about a discharge summary, she had received that afternoon from a surgeon who had set her patient’s leg after a skiing accident a few days earlier. The teenager, Jacob, showed up in her clinic with a swollen leg and a rash. After examining Jacob, Frida explained to the ethnographer:

“This is a crappy note [from the surgeon]. It’s no help to me. He [the surgeon] does not even tell me what antibiotic he gave Jacob [post operation] and how much. I have no way of telling whether the rash he presents with today is related to the antibiotics.”

Frida calls the surgeon’s office to clarify the issue. The surgeon has left his clinic at 3:00pm. His discharge summary does not provide her enough information to help her diagnose the problem. A flow sheet filled out during the surgery most likely contains the information Frida needs. However, in the discharge papers the surgeon summarized his setting of the leg but does not describe the administration of antibiotic post surgery – that to him is probably an inconsequential routine.

Dialog and reflective encounters play a central role in each document cycle. The dialog allows a heterogeneous groups of healthcare professionals

with different responsibilities and routines to mend the relationship between the background knowledge people bring to Anna’s care and the degree to which documents explicate relevant participants, times, places, content, and form. Such discussions also allow doctors and nurses to question patients’ history and their care. By engaging with patients’ histories, people with different perspectives on care can suggest changes to the configuration of participants, times, places and data relevant for the patient. Document cycles lacking routine reflective encounters often leave little chance for the different constituencies to clarify their position and repair the relations between documents and their users.

## 5. Discussion

More than ten years ago Star and Ruhdeler [1: 112] called for a practice-based approach to organizational infrastructure and knowledge flows – one that does not depict system integration as a substrate: something upon which something else runs or operates (e.g., railway system). Studying how doctors and nurses integrate documents, whether electronic or paper-based, in the course of their daily work allows us to extend such an approach to system integration.

We find that doctors and nurses continuously transform documents making them relevant to a particular set of participants, times and places. In doing so they adjust the relationship between how much documents explicate and the background knowledge required from the readers. Two such transformations stand out as central.

First, doctors and nurses engage in a number of cyclical transformations, within which they oscillate between documents addressing a broader and narrower audiences (see figure 1 and 2). In doing so, they manage to straddle the demands of local work practices and the needs to coordinate with other teams in other times and places.

Second, as summarized in figures 1 and 2 one finds a number of transformations between the cyclical organized documents (e.g., nurse management plans, brain notes, intern notes, senior notes, etc) and documents peripheral to the cycles (e.g., lab work, flow sheets, orders, etc.) Doctors and nurses use their document cycles as the clearing station for a host of document systems. The cyclical organized documents allow people to transform data from peripheral documents into something useful for their immediate work practices. At the same time, they draw from their cyclical documents to produce other non-cyclical documents. For instance, Marc and other doctors integrate test results from the laboratory

system into their brain notes and later the residence note system. Likewise, they write orders and other request information based on their brain notes.

The existing literature allows us to capture only parts of these cyclical transformations. Latour and Woolgar [12] and Knorr-Cetina [22] work describes the individual transformations well. The concept of communicative genres [6] offers insights to the individual documents and how they might be linked into sequentially organized genre systems. Likewise, we could conceive of the documents in the present case as boundary objects bridging the relations among different communities [3].

The cyclical patterns reported here, however, present an opportunity to integrate these related practice-based research streams. The concept of communicative genres, for instance, supplements descriptions of document transformation in document cycles. Furthermore, the findings suggest the existence of multiple document types playing different roles in knowledge flows. Boundary objects may not stand alone in knowledge sharing across communities. Rather, they seem to interact with a host of other documents. For instance, one could argue that lab results serve as a boundary object for many groups caring for Anna. As a repository each group can draw from and contribute to the lab result system. Yet, this boundary object does not stand alone. Only when we see the lab result system in relation to the use of nurse management plans, brain notes, intern notes and senior notes do we understand the intricate knowledge flow. The boundary object is but on cog in a larger document machinery.

Reflection and dialog play central parts in the cyclical integration of documents. Confirming findings in the boundary object literature, conflicts are prone to surface when people from different professions, sub-specialties, or local organizational cultures negotiate their often diverging approaches to patient care [3, 4, 32]. Reflective encounters allow collaborators to recalibrate the reciprocal relationship between documents and organizational members (i.e., document explicates and background knowledge). At the same time these interactions serve as a staging ground for questions that may broaden or narrow the collective work practices. Doctors and nurses may question whether they need more information about the patient's medical history or consider alternative treatment plans. The meetings secure an ongoing reflection on the appropriate course of Anna's care. Much like a hermeneutic process, doctors and nurses engage with parts of patients' care – only to return to a broader picture to interpret the integration of its

parts. The movement of their understanding and writing, then, is a constant moving from the whole to its parts and back to the whole [9, 33].

Finally, the document cycles offers a window into the institutional structure of the hospital and the temporal and spatial organization of work. We notice how the cycles support departmental divisions and the temporal structure of work in the institution. Without these document cycles it would be impossible to maintain the high level of complexity where multiple professions and subdisciplines work together, with somebody present to knowledgably care for Anna.

## 6. Conclusion & Implications

The study identifies a cyclical pattern to the knowledge flow in a heterogeneous information systems environment. Drawing on data from the healthcare industry we describe how doctors and nurses organize a host of document systems around a central cyclical pattern involving an oscillation between addressing a broader and narrower configuration of participants, times, places, and content. Numerous documents feed to and from the cyclically organized documents. The constant transformation from one document to the next allows organizational members to manage the reciprocal relationship between how much documents explicate their use and how much background knowledge readers need to bring to the document. This relationship is brittle and despite the many transformations among documents it often breaks down. The research suggests that organizational members build opportunities for dialog into the document cycles in an effort to patch any possible breaks in knowledge sharing.

The present research is not without limits. It relies on a single in-depth ethnographic study, thereby subjecting it to a set of well-known limitations, most notably restricted empirical generalizability. Despite the limitations, the research has implications for research and practice. First, to fully take advantage of our cyclical notion of documents and integrate the existing practice-based theories require more theoretical and empirical work. For instance, what cyclical patterns do we find beyond the healthcare industry? Second, future research will have to explore how efforts to standardize medical information and facilitate retrieval can coexist with cyclical documenting practices.

In regard to practice, system design may gain from supporting a host of document types and allow people to transform one document into another document characterized by different configurations of

participants, times, places, content, and form. Across documents the content may be deceptively alike. Yet, one must keep in mind that each document manages an intricate reciprocal relationship between how much the document explicate and the background knowledge people bring to its use.

Finally, system designers may distinguish circular integration of documents and documents feeding to and from the cycles. People use their central cycles to manage many other document systems. The cycle allows people to transform data from peripheral documents into something useful for their immediate work practices.

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