Why It Is Hard to Support Group Work in Distributed Healthcare Organizations: Empirical Knowledge of the Social-Technical Gap

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Abstract
We used a participatory design process to understand and to support the group work of cancer clinical trial protocol design within a distributed organization, the Southwest Oncology Group (SWOG). We also designed a collaborative writing system to facilitate its protocol reviewing and revising processes over the Internet. After a series of iterative prototyping and formative evaluations over the past two years, we identified a social-technical gap in our group work support research at SWOG. This gap consists of technical challenges, expanding user needs, conflicting user needs from different roles, insufficient incentive for using groupware technology by certain members, subtle organizational nuances, and the changing organizational structure. This paper describes our longitudinal evaluations results and elaborates on the social-technical gap. We think this gap may generalize to other healthcare group work settings.

1. Introduction
The growth of healthcare specialties makes it common and sometimes indispensable for healthcare professionals to work in a group in varied settings. In particular, many clinical research organizations try to improve the quality of their research results by leveraging resources at distributed sites; therefore, multidisciplinary clinical researchers often collaborate across time zones and geographical distances as well as across cultural and organizational borders in their work. Currently informatics research that supports clinical trial protocol design is quite limited [1]. It is largely unknown what essential challenges exist and how informatics support might be helpful.

Cancer clinical trial design is one good example of healthcare group work over distributed organizations. The vast majority of cancer research conducted in the United States is designed by The Cooperative Group Program sponsored by the National Cancer Institute (NCI). A cooperative group is a large network of thousands of researchers, physicians, and other health care professionals from public and private institutions across the country. Currently more than 60% patients who participate in cancer clinical trials in the United States are enrolled through cooperative groups [2].

This research aims to improve the group work of clinical trial protocol design at one of the eleven cooperative groups, the Southwest Oncology Group (SWOG). At SWOG, each protocol design group includes three major roles: statistician, protocol coordinator, and principle investigator (PI), as well as several other supportive roles such as data coordinator or protocol review committee (PRC) [3]. Each role may involve more than one person. In addition, statisticians reside in Seattle, protocol coordinators are located in San Antonio, and PIs can be anywhere all over the country. Currently Microsoft Word and email are used as the primary technology for collaborative protocol design over distances. There has been little informatics support for clinical trial protocol design from the perspective of Computer-supported Cooperative Work (CSCW).

Over the past two years, we have used a socio-technical approach to understand and to support the group work for clinical trial protocol design at SWOG. We have conducted ethnographic fieldwork to understand the current work practice of protocol writers [3] and used a participatory design process to engage the SWOG users into the design of a web-based collaborative clinical trial writing system [4, 5]. We have also carried out iterative prototyping and formative evaluations from the outset of the project. Feedback from our users has been consistently positive and constructive. However, to date we have not been able to deploy our system at SWOG.

Ackerman defined the “social-technical gap” for CSCW research as “an inherent gap between the social requirements of CSCW and its technical mechanisms; the great divide between what we know we must support socially and what we can support technically” [6]. Upon reviews of our design process and system evaluation results over the past two years, we identified a social-technical gap that challenged the group work support at SWOG. This paper aims to describe our longitudinal evaluation results, to share our understanding of the social-technical gap in our research at SWOG, and to demonstrate how it may hinder medical informatics support for group work in distributed healthcare organizations.

2. A Brief System Description
Iterative protocol reviewing and revising is the most challenging part during the writing process of clinical trial protocols [3]. We designed a web-based, database driven system to support groups of clinical pro-
protocol writers collaborating on electronic protocols over the Internet [5]. They can open a shared protocol, review the protocol by making inline comments, review or respond to comments made by others, and revise the protocol by incorporating the suggestions in comments. In addition, the system supports group activity monitoring, progress tracking, and version control for both protocols and review comments. The underlying annotation design in this system enables protocol writers to stay aware of the status of the comments [4]. They can browse which comments have been read, responded to, or incorporated into the newer version of the protocol. Commented protocol content can be highlighted in different colors to indicate reviews made by different reviewers.

3. Evaluation Design

Our evaluation objectives include (1) to evaluate the system features that affect system uses and (2) to measure the perceived usefulness of the system. We took a staged evaluation procedure using both qualitative and quantitative methods as follows. Prior to data collection, we had received an Institutional Review Board (IRB) approval from the University of Washington for this research.

First, we demonstrated the system under development to our participatory design users every month between April 2003 and August 2004 to elicit user feedback for the interface designs and to understand how the system might fit into their daily work.

Second, we carried out a scenario-based case study [7] in early 2004 by inviting a protocol design group to use the system to complete some protocol design tasks following a scenario. The scenario defined a series of user interactions with the system in the context of work to assess the system features that support these interactions. Four users in three roles participated in the evaluation for two days.

Third, in late 2004 we conducted a field trial in a real work setting. We asked a protocol design group to use the tool for about a week to support their daily protocol design tasks. We extended the participants to some members from PRC of SWOG. Eight users in four roles, including two statisticians, two protocol coordinators, one data coordinator, and three PRC members, participated in this evaluation.

We documented ten major formative evaluation meetings with written notes, excluding informal meetings with the SWOG users. For the case study and the field trial, we conducted a one-hour semi-structured interview with each participant. We partially transcribed and partially constructed notes for the interviews. For the field trial, we also used a Likert Scale survey (1-5) to ask the participants to rate the usefulness of the system features.

4. Evaluation Results

Our longitudinal evaluation results are presented from the following perspectives: (1) users’ rating for the system features; (2) users’ comments for the design; and (3) changing users’ feedback over time.

4.1. Useful features for collaborative reviewing

In our survey during our field trial, the eight participants rated the usefulness of the system features by assigning a score ranging from 1 to 5 to each feature, where 1 represents “useless” and 5 represents “very useful.” The survey results are shown in Table 1.

<table>
<thead>
<tr>
<th>Ranked System Features</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinpoint text for annotations</td>
<td>4.75</td>
<td>4.50</td>
<td>5.00</td>
<td>4.75</td>
</tr>
<tr>
<td>Highlight annotated text in color</td>
<td>4.63</td>
<td>5.00</td>
<td>3.50</td>
<td>5.00</td>
</tr>
<tr>
<td>Address annotations to people</td>
<td>4.13</td>
<td>5.00</td>
<td>4.50</td>
<td>3.50</td>
</tr>
<tr>
<td>Share annotations during reviews</td>
<td>3.88</td>
<td>4.00</td>
<td>5.00</td>
<td>3.25</td>
</tr>
<tr>
<td>Thread annotations for discussions</td>
<td>3.88</td>
<td>4.50</td>
<td>4.50</td>
<td>3.25</td>
</tr>
<tr>
<td>Generate print-friendly annotations</td>
<td>3.88</td>
<td>3.50</td>
<td>3.50</td>
<td>4.25</td>
</tr>
<tr>
<td>Respond to annotations</td>
<td>3.75</td>
<td>4.50</td>
<td>5.00</td>
<td>2.75</td>
</tr>
<tr>
<td>Browse annotation status</td>
<td>3.63</td>
<td>4.50</td>
<td>5.00</td>
<td>2.50</td>
</tr>
<tr>
<td>Email notification service</td>
<td>3.13</td>
<td>4.50</td>
<td>2.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Sort annotations by properties</td>
<td>3.00</td>
<td>2.50</td>
<td>3.00</td>
<td>3.25</td>
</tr>
<tr>
<td>Filter annotations</td>
<td>2.75</td>
<td>3.00</td>
<td>3.50</td>
<td>2.25</td>
</tr>
<tr>
<td>Incorporate annotations</td>
<td>2.63</td>
<td>3.50</td>
<td>2.00</td>
<td>2.50</td>
</tr>
<tr>
<td>Set up response deadline</td>
<td>2.63</td>
<td>4.50</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Categorize annotations</td>
<td>2.38</td>
<td>2.50</td>
<td>3.00</td>
<td>3.00</td>
</tr>
</tbody>
</table>

Table 1. System features ranked by usefulness based on average user ratings. Column I is for all the participants, II is for all the statisticians, III is for all the protocol coordinators, and IV is for all the PRC members.

Table 1 shows that overall the top three most popular system features are pinpointing the text in a document for an annotation, highlighting annotated text in different colors for different reviewers, and enabling reviewers to address annotations to certain people for coordinating the group work. The least useful features are incorporating annotations during editing, setting up response deadlines for annotations, and categorizing annotations based on their content.

Categorization of annotations had been a focus of our participatory design for a few months, but was rated as the least useful feature. Both users and we thought such categories would be very useful to help protocol designers understand the common problems in protocols and filter information. The filtering feature is also used less than what we expected. Our interviews showed that users found it difficult to select a category. This result teaches us that when introducing a new feature, we need to make sure no extra work is added and the person doing the work could benefit.
Some features have a low overall average rating but a high average rating for some individual role. For example, “set up response deadline” is not generally welcomed but highly preferred by statisticians. Feature ratings vary from role to role. Both statisticians and protocol coordinators prefer to share annotations while reviewing protocols, but PRC members do not like this feature. Also, statisticians prefer to get email notifications to monitor the status of their discussions in threaded annotations; whereas protocol coordinators dislike this feature because most incoming emails only remind them of the new editing tasks.

### 4.2. Users’ Comments for the Design

Our qualitative evaluation results provided rich information to help us interpret the above quantitative results. Here are two examples showing how the system impacted the users.

#### (1) Does sharing annotations help or not?

We thought that the system would enable protocol reviewers to share review annotations online and hence alleviate some group members’ efforts to distribute annotations to the group. Although this design improved information sharing among all the roles, it unexpectedly increased the workload for some roles. Here I provide some of the quotes from the users in the study. In the quotes below, comments and annotations refer to the same concept.

**A PRC member:** “Overall, I do not believe this is a useful tool for PRC members. It requires too much time and effort for individual reviewers. Each person has to wade through other people’s comments to make sure that they are not repeating something. And then you have to take the time to type out what you want to say. And each comment requires you to go through a series of menus and to select options, which is very time consuming.”

**A PRC member:** “This tool is shifting the workload. Traditionally, we just need to talk about our comments in the face-to-face meetings. It is the responsibility of the leading statistician to compose all the comments for us. Now we have to do the work, he just needs to read the annotations in the system.”

**A protocol coordinator:** “Is it helpful to look at other people’s comments? It is sort of a double-edged sword. By looking at other people’s comments, you may see how other people phrase a comment in a better way so that you can learn. However, I cannot stop myself from looking at other people’s comments; therefore, I have to spend more than double the time on the system. I cannot get my job done in the limited time. Also, not every comment applies to me.”

**2) Is it easy to do the review online?**

The users expected a system that supports a smooth transition between physical and digital documents, but our current technology does not support this well.

**A PRC member:** “Computer-based commenting interface implies a formal process, not as comfortable as on paper. On a computer, I feel that I have to know what I have to say, but on paper I can feel more relaxed. I don’t like to read protocols online. I will print a hard copy, read it and type comments online.”

**A data coordinator:** “I often do cross-section checking. Therefore, I have to look at multiple sections together to identify inconsistency. It is easier for me to lay out paper copies for these sections on a table and read them together. On a computer, I have to switch between windows and it is not quite easy. By the way, Can I add a comment for multiple sections? Can I change the anchor text for an annotation?”

#### (2) Is formatting important or not?

In March 2003, we consulted the participatory design users on what file formats should be supported in the system. Our users emphasized:

“The content of a protocol was more important than the format; as long as we can lay down texts so everybody can see the text and give comments, it would be fine. We can leave the formatting to the very end of the design.”

Therefore, we did not put much consideration to the formatting support in our design. However, later we encountered some obstacles for evaluations in the field trial because of the various formats of protocol content that protocol writers used. Protocol reviewers have to review content in multiple file formats including Word, Excel, and PDF files. Both they and the protocol coordinators got frustrated about the insufficient formatting support in our design, as indicated in these quotes.

“People are accustomed to commenting on well-formatted documents. The PIs might not like use unformatted text for their comments.”

“I think formatting is important for understanding the content of the protocol in some sections. The loss of
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provide formatting features consistent with MS Word.
5.1. Technical Challenges
There is a fundamental discrepancy between the ca-
abilities of available technologies and users’ needs
for support of their habits, ideals, and nuanced behav-
ors. In our research setting, the users expected digital
documents to support their contextualized reviewing
behaviors on physical documents such as annotating
multiple sections concurrently and creating annota-
tions anchored to multiple texts. In addition, the users
are used to MS Word and expect the online editor to
provide formatting features consistent with MS Word.
Moreover, users are used to reading paper copies
while making comments, but there is no current tech-
nology that supports smooth a transition between
physical and digital documents. These challenges
hinder the further system uses and evaluations.
5.2. Expanding User Needs
Our initial system design was centered on the support
for iterative reviews and revisions. Our later designs
include progress tracking, web email, user manage-
ment, and many other features. All of them have been
developed to meet the expanding user needs. In our
annotation design, we defined “unread”, “read”, “re-
responded”, “incorporated”, and “resolved” statuses for
an annotation. In our recent field trial, our users sugg-
ested adding another status: “agreed” so that some
reviewers can simply acknowledge existing com-
ments without creating new comments. We foresee
that if we implement this feature, we still need to
define a “disagree” status and support some voting
mechanisms for annotations. Then this design re-
finement process may continue. We learned that in a
participatory design process, users naturally grow
mature and savvy at the same pace as the design. But
as users become savvier, it is more difficult to satisfy
their changing and expanding needs. The end point of
a participatory design process may become uncertain.
5.3. Lack of Incentive for Certain Group Members
Throughout our designs and evaluations, we did not
get sufficient access to one major role, the PI, in the
group work of protocol design because of two chal-
enges. First, PIs are unlike statisticians or protocol
coordinators, who belong to the same organization.
PIs are affiliated with various organizations. They
come and go because designing clinical trial protocol
is not their profession, but a once or twice in a life-
time experience. Understanding the user needs of this
fluid population of PIs can be a big research project
on its own and goes beyond the scope of this re-
search. Second, PIs seem to have little incentive to
use a group work support technology. According to
the user feedback, the PIs are currently at a high level
in the group work. To avoid overwhelming PIs with
too much information, protocol coordinators often
send composed and filtered messages to PIs. Accor-
ding to our field study, some PIs do not know the tedi-
ous work that other group members do and few of
them have a clear picture about the whole group work
process. It is hard to motivate the PIs to participate in
a technology design that may threaten their power.
5.4. Group Work among Non-peers
The multidisciplinary protocol writers seem to be
non-peers in this group work. Protocol coordinators
are supposed to support other people. They do most
of the work, but they do not get the authorship. Simi-
lar to other healthcare settings, the people involved
in protocol designs have disparate training backgrounds
and sit at different levels in the hierarchical health-
care research system. This situation creates confusion
for system designers. Should our groupware technol-
ogy support the lower level workers or those at
higher levels such as the PIs? Should we increase the
difference in the work load of different roles or
should we strive for a balance? In the group work at
SWOG, some roles such as protocol coordinators are
subordinate to other roles. It appears there will be
constant conflicting needs from these different roles.
Group work support technology often subtly changes the group structure and interpersonal relationships, which is one of the eight classic challenges for CSCW designs identified by Grudin [9].

5.5. Subtle Organizational Nuances

Healthcare organizational settings are complex and full of nuances. Our evaluations reveal some subtle feelings that some users have. A data coordinator says, “I am a senior protocol developer. I definitely welcome shared annotations. But if I were a new protocol developer, I would not like my comments to be seen by others. I do not want other people to think my comments are stupid and that I know nothing. I can read other’s comments, but I would not like to share mine.” Protocol designers have disparate training backgrounds and sometimes do not have shared cultures. They have subtle concerns toward the concept of group learning. Another example, our system tries to facilitate direct communication among group members to minimize unnecessary efforts for manual information relay, like what PCs do currently most of the time. But the evaluation results show that the users think direct communication may impose commitment on the receivers. They prefer the currently loosely-coupled collaboration and coordinated communication within the group through protocol coordinators. Nuanced behaviors like these are often hard to perceive. Designers need to thoroughly understand users and their work with insights and over time.

5.6. Changing Organizational Structure

Not until our recent field trial did we learn that most protocol coordinators do not make changes directly on protocols, but a new role, word processor, does this job. The word processors were not ready to use the system both because they were less trained and because they were occupied with editing tasks. Our participatory design users at SWOG did not think this organizational change was relevant to system design so they did not tell us earlier. But in fact this change interfered with our design and evaluation. As Table 1 shows our survey results, the feature “incorporate annotations” was lowly rated. One possible reason could be that the feature was never used by the protocol coordinators since they did not have to incorporate the suggestions in annotations. Ongoing organizational changes could happen without being noticed by system designers in distributed organizations, which could cause big design problems.

6. Summary

This research contributes to the field of CSCW and the field of Medical Informatics by attesting the existence of the social-technical gap in healthcare group work support at a distributed organization SWOG. This research exemplifies many classic challenges for group work support as defined by Grudin [9], such as disparity in work and benefit (e.g., work load shifting among multiple roles), disruption of social processes (e.g., supporting peer work among non-peers during protocol designs), and the difficulties in groupware design due to uninformed organizational changes.

The research further strengthens our belief in the importance of using socio-technical approaches to design healthcare information systems. Also, group work of multidisciplinary healthcare professionals is common in various healthcare settings. For instance, electronic medical records are group work results by physicians, nurses, lab result analysts, and many others. Similar social-technical gap may exist in group work support in other healthcare settings. We hope to explore, understand, and ameliorate such social-technical gap in other healthcare group work settings in the future.

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References