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Temporal coordination through communication: using genres in a virtual start-up organization

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Abstract

Purpose – To explain how genres structure temporal coordination in virtual teams over time.

Design/methodology/approach – The first year e-mail archive of a small distributed software development start-up was coded and analyzed and these primary data were complemented with interviews of the key participants and examination of notes from the weekly phone meetings.

Findings – In this paper, it is found that members of a small start-up organization temporally coordinated their dispersed activities through everyday communicative practices, thus accomplishing both the distributed development of a software system and the creation of a robust virtual team. In particular, the LC members used three specific genres – status reports, bug/error notifications, and update notifications – and one genre system – phone meeting management – to coordinate their distributed software development over time.

Research limitations/implications – The study confirms the various suggestions from prior virtual team research that structuring communication and work process is an important mechanism for the temporal coordination of dispersed activities. In particular, an attempt has been made to show that the notions of genre and genre system are particularly useful to make sense of and analyze how such structuring actually occurs over time.

Originality/value – In this paper, the research focus is shifted from how a given set of temporal coordination mechanisms affect team performance to how coordination mechanisms emerge, are stabilized, and adapted over time. It is also shown how the notion of genre may be used to shed light on the practices through which temporal coordination is accomplished in geographically distributed teams.

Keywords Communication, Virtual organizations, Electronic mail

Paper type Research paper

Introduction

The possibilities for distributing work across time and space have been the subject of growing interest in the literature (Lipnack and Stamps, 1997; Maznevski and Chudoba, 2000; Markus *et al.*, 2000; Montoya-Weiss *et al.*, 2001; Massey *et al.*, 2002, Panteli, 2004;

Yoo and Alavi, 2004). Today, many people are involved in various forms of virtual, or geographically and temporally dispersed, work. For example, teams are increasingly composed of members who are spread across different cities or countries and who mediate their collaboration with various communication technologies. One of the critical questions raised by such distributed work arrangements is how people use technology to coordinate and align their work with colleagues at a distance.

Prior research suggests that the temporally and geographically dispersed communication environments of virtual teams pose significant challenges to coordinating team activities (Sproull and Kiesler, 1986; Ocker *et al.*, 1995/1996; DeSanctis and Monge, 1999; Cramton, 2001). In comparison with teams working in co-located environments, virtual teams are reported to experience difficulties with insufficient context cues, feedback delays, and long interruptions or pauses in communication. Such research concludes that workable solutions for accomplishing distributed coordination are critical to the quality and success of virtual collaboration.

While we have learned much from existing research on virtual teams, some of this research on temporal coordination within virtual teams is underdeveloped in two ways. First, by framing "virtual" as a context that is lacking qualities present in co-located environment, many researchers focus primarily on the limitations or constraining aspects of technology used to accomplish distributed coordination, thus underestimating the enabling aspects of such technology. Second, much of the research is based on short-term (often student) teams whose work context and task differ significantly from those of organizational teams working on real-world projects. To understand what virtual team members actually do to temporally coordinate their dispersed activities, more longitudinal research on virtual teams in their "natural habitat" would be helpful.

In this paper we report on an attempt at such research, an empirical study of a small software development start-up (which we call Little Company or LC), whose members were geographically dispersed across four different cities and three different time zones in the USA, and who relied primarily on electronic mail and telephone to conduct their distributed work[1]. To address the question of how members of LC used technology to coordinate and align their distributed work, we draw on the notion of genre as typified social action to examine the e-mail exchanges among the members as they collaborated to develop a software product. In our study, we found that their recurrent enactment of three genres and one genre system was particularly useful in structuring their distributed work over time.

In what follows, we first establish the theoretical basis for using genre and genre system analyses to make sense of electronic communication over time, and argue that this lens can shed important light on understanding the temporal coordination of virtual work. We then describe our research site, data collection, and analysis methods. Next, we empirically examine how LC members temporally coordinated their work through enacting genres and genre systems in their e-mail communication. We conclude with implications of our analysis for the temporal structuring and distributed coordination of work in virtual teams.

Theoretical background
In this section, we draw on literature from two different research domains to situate our study: research on temporal coordination, and research on communication genres.

Prior research on temporal coordination
Distributed coordination depends critically on the possibilities for actors to structure their activities across time and space. While limited work on spatial coordination has appeared in the organizations literature (for recent exceptions, see Hinds and Kiesler, 2002, and O'Leary and Cummings, 2004), interest in temporal coordination has been growing (Ancona and Chong, 1996; Ancona *et al.*, 2001; Barley, 1988; Bluedorn and Denhardt, 1988; Blyton *et al.*, 1992; Clark, 1985; Gersick, 1988, 1989, 1994; McGrath, 1990, 1991; Orlikowski and Yates, 2002; Perlow, 1997; Staudenmayer *et al.*, 2002; Walther, 2002). Zerubavel (1981, pp. 64-9) presents two basic patterns of temporal coordination in communities, which he labels "temporal symmetry" and "temporal complementarity." The former achieves temporal coordination by synchronizing the activities of different individuals (i.e. when all group members engage in the same activity at the same time), whereas the latter is based on a temporal division of labor where group members participate in one temporal order yet they do so differently from one another (e.g. when members work in shifts, or when group members work in parallel on different pieces of a joint product). While virtual teams may be able to enjoy increased temporal flexibility by developing their use of temporal complementarity (e.g. allocating working globally to accomplish "follow-the-sun" software development), maintaining temporal symmetry becomes much more difficult, particularly when members are distributed across many time zones (e.g. arranging a video-conference for an important team discussion).

In his work on temporal coordination, McGrath (1990, pp. 36-44) identifies what he sees as three critical temporal problems in any organization: temporal ambiguity, conflicting temporal interests and requirements, and scarcity of temporal resources. He suggests that organizational responses to these temporal problems can be characterized in terms of three types of activities: scheduling, synchronization, and allocation. By implication, virtual teams are expected to respond to these problems as well, in addition to dealing with the opportunities and challenges that arise from their temporal dispersion. Massey *et al.* (2003) adopted McGrath's typology of temporal coordination mechanisms in their experimental setting in order to examine the role of these mechanisms as a means to pace and synchronize the efforts of global virtual project teams. Their findings suggest that successful enactment of temporal coordination mechanisms was more often than not associated with higher performance, reducing the time needed to convey ideas and manage the process, and increasing the time allowed for critical discussion.

Massey *et al.* (2003)'s study is one of the few that directly addresses the issue of temporal coordination in virtual teams. In their study, however, the temporal coordination mechanisms were designed by the researchers and imposed on the virtual teams, instead of emerging over time from the activities of the virtual teams. In research on co-located groups, Okhuysen and Eisenhardt (2002) followed a similar strategy of studying the temporal coordination associated with process interventions of the researchers. While this kind of research helps us understand the role of imposed temporal coordination mechanisms in team interactions and processes, it leaves unanswered the equally important question of how temporal coordination arises and is developed by team members themselves.

Whether concerning co-located or virtual teams and organizations, increasing attention has been paid to the importance of temporal patterns or rhythms in

coordination. For example, Reddy and Dourish (2002), in their ethnographic study of a surgical intensive care unit (SICU), found that different workgroups made use of their understandings of the temporal structure of work in order to help coordinate their various activities. Similarly, Maznevski and Chudoba (2000) found that effective virtual teams were distinguished by a strong, repeating temporal pattern. Unlike Reddy and Dourish's co-located unit, Maznevski and Chudoba's virtual teams did not have the luxury of well-established, institutionalized temporal rhythms that guided their members' activities from the start. Instead, their virtual teams had to establish a basic temporal pattern through periodic, two-day, face-to-face coordination meetings. However, as Massey *et al.* (2003, p. 132) note, not all virtual teams are able to have face-to-face meetings to discuss coordination issues up front, and the central question of how to achieve effective temporal coordination of distributed work remains.

On the question of how "self-managing" or "self-organizing" virtual teams coordinate their work temporally, the study of dispersed software development teams by Ocker *et al.* (1995/1996) provides useful insights. They identified two general approaches to temporal coordination within these teams: mechanisms for organizing group communications; and mechanisms for sequencing or structuring work and problem-solving activities. While instructive, this distinction does not address the reality that, in practice, communication within virtual teams is – by definition – implicated in the work, and vice versa. Thus, what needs further exploration is how virtual team members "actually" develop coordination mechanisms, that is, how do members structure their daily communication and work to temporally coordinate their dispersed activities.

Prior research on communication genres and genre systems

In organizations, the communication and work practices of members are structured temporally. Not only do members' everyday communication and work shape their experiences of time, but their communication and work practices are also recursively guided and structured by the shared temporal norms and expectations of members (Orlikowski and Yates, 2002). As Ballard and Seibold (2003) point out, "communication lies at the nexus of the relationship between time and work." Using Giddens' structurational perspective, we can see that actors communicate in order to temporally structure their daily work practices, but, at the same time, their communication is in turn, guided and structured by their ongoing work and temporal practices.

Given this recursive relationship between communication and temporal structuring of work, we can learn how members construct and experience their temporality by examining their communication practices. The focus on communicative practices is especially pertinent to the study of virtual teams, which typically depend on more frequent and explicit communication about the temporal aspects of work than do co-located teams. In co-located contexts, for example, checking in and out of the office signals the start and end of a workday, and members learn what others are doing by looking over their shoulders or from casual chats during coffee breaks (Nardi and Whittaker, 2002). In virtual contexts, making oneself "visible" (e.g. signaling when one is working, or off for a break, or available for a phone conversation) requires additional explicit communication (Panteli, 2004). In virtual work, it is through team members' communication that a shared "temporal map" (Zerubavel, 1981, p. 14) emerges.

Members' perceptions, constructions, and experiences of time are reflected in their languages and patterns of communication. For instance, the content of e-mail messages can tell us how members coordinate their work chronologically (e.g. "I need to finish this by 9.00 am tomorrow"), or by events (e.g. "We will discuss this during our phone meeting"), or how they establish boundaries between work time and non-work time (e.g. "Please don't call too late"), or how they blur these (e.g. "I'll bring my laptop so I can work while the car is being fixed"). Also members' patterns of communication – when, why, how, how often, and with whom they communicate – reveal much about the temporal organization of work, such as its span, pace, sequence, and timing. Consequently, a careful examination of communication practices can identify important work routines and events that shape as well as reflect the temporal structures of the group or organization. Furthermore, because temporality in organizations is neither unitary nor static, it is continually being negotiated by members through their communication. Thus by examining the everyday communication practices of members, we can learn how members' ongoing micro-interactions shape the dynamic negotiation and renegotiation of their multiple temporal interests and expectations.

For studying the communication practices that reflect and shape temporal structures in virtual work, the concept of communication genres offers a useful analytical lens. We draw on a structurational perspective (Giddens, 1984) to understand genre as a social structure constituted through individuals' ongoing communicative practices (Miller, 1984; Yates and Orlikowski, 1992; Orlikowski and Yates, 1994). Typical genres of communication in organizations include memos, letters, meetings, expense forms, and reports. These genres are socially recognized types of communicative actions that are habitually enacted by organizational members over time to realize particular social purposes in recurrent situations (Yates and Orlikowski, 1992). Through such enactment, genres become institutionalized templates that shape members' communicative actions. Such ongoing genre use, in turn, reinforces those genres as distinctive and useful organizing structures for the community (Orlikowski and Yates, 1994).

As organizing structures, genres shape beliefs and actions, and in doing so enable and constrain how organizational members engage in communication. Whether used explicitly or implicitly, genres powerfully influence the discursive norms of organizational interaction (Yates *et al.*, 1999). One way of understanding these discursive genre norms is to examine the socially recognized or sanctioned expectations around key aspects of communication: purpose, content, participants, form, time, and location (Yates and Orlikowski, 2001, 2002). In this view, genres reveal what communities do or do not do (purpose), what they do and do not value (content), what different roles members of the community may or may not play (participants), and the conditions (time, place, form) under which interactions should and should not occur.

As enacted social structures, genres change over time (Yates and Orlikowski, 1992). They may be reinforced and stabilized as members routinely draw on existing genres to engage in communicative action. But genres can be altered or changed as members make modifications to existing genres or introduce entirely new genres, leading to changes in the group's discursive expectations. A genre lens thus offers a window onto

the creation, reinforcement, and change of a group's communicative practices, and how it structures its work temporally.

In order to capture more of the interactions among members, however, we need to extend the focus beyond individual genres to include the interdependent sets of genres that are routinely mobilized to structure work and communicative practices. The notion of genre system – a series of interrelated communicative actions (Bazerman, 1994) – is useful for this purpose, because it focuses on how members use sequences of communicative actions to coordinate their activities (within or across organizational boundaries) over time and space (Yates and Orlikowski, 2001, 2002). For example, the genre system around job applications might consist of a firm's published advertisement of a position, an applicant's letter and resume, a manager's call inviting the person to be interviewed (or a rejection letter), one or more interviews with the manager and others, and a job offer (or a rejection letter) from the manager to the job applicant. The components of this genre system are not all used each time, but when they are used, they occur in a particular sequence and each communicative action is enacted by the designated individual. The genre system coordinates or choreographs the interaction between job applicant and hiring manager. Using a genre system lens enables us to view group interactions as paced and meaningful sequences of events, rather than as single, isolated occurrences, thus directing our attention to the very process of temporal structuring, and the coordination of communicative and work practices.

In this paper, we use the notions of genre and genre system as analytic tools to examine the temporal coordination of a highly collaborative and distributed software development team (LC). While this team enacted multiple genres and genre systems in the course of their ongoing work, we focus here on those genres and genre system whose socially recognized purposes in the team are more directly related to the problems of temporal coordination (McGrath, 1990) – that is, the scheduling of meetings, the synchronizing of individual effort, and the allocation of time to tasks. The importance of temporal coordination for the effectiveness of virtual teams has been recognized, but we still know little about how it actually occurs in practice, under what conditions and with what consequences. Our analysis of one virtual team's use of genres to accomplish distributed temporal coordination should help to further understanding in this direction.

Site and methods
Research site
Our research site, LC, is a small, primarily self-funded, software start-up company developing a programming language product, the LC system. At the time of our study, three of the members (Dan, Keith, and Robert) worked full-time and two (Martin and Fred) worked part-time. The full-time members worked primarily on the technical part of the software development, while the part-time members were primarily responsible for developing LC's marketing and business strategies. The two part-time members eventually left the company some time after the period covered in this analysis.

The members of the company were geographically dispersed in four different cities across the USA, and temporally dispersed across three different time zones. Two of them lived in the Eastern Time Zone, in different cities but within a day's driving distance, one lived in the Mountain Time Zone, and the other two (the part-timers) lived in the Pacific Time Zone, in the same city. This virtual company had no central

physical location, and its central computer server was located at a regional ISP in a town near the home of one of the East Coast members. The three full-time members worked from home and the two part-time members worked out of private offices. Although they were geographically dispersed, there were multiple existing interpersonal ties among the members of this company: three of the members – Dan, Keith, and Fred – had gone to college together; Dan and Keith were friends and had written papers together; Keith and Robert were friends and had worked together at the same company prior to joining LC; and Fred and Martin, who had worked together many years ago, were friends who lived in the same city.

The primary communication media used by the LC members were electronic mail (with 56K modems) and telephone, both of which could be used for dyadic and group communication. Face-to-face meetings were very rare. During the period studied, face-to-face meetings occurred only three times, and only among subsets of LC members. Keith did not meet Martin until long after the period covered by our study, and to this day, Dan and Robert have never met Martin.

For the purpose of this study, LC provides a valuable research site. LC is a self-organizing virtual team and organization that allowed us to observe how communication and temporal practices were structured and evolved over time. In particular, LC gave us access to the e-mail archive of the company, affording us a rare opportunity to scrutinize and analyze internally generated everyday communication.

Research methods
The primary data for this study consist of a subset of the comprehensive electronic mail archives saved by one of the full-time members of LC from the inception of the company[2]. While some members of LC began to organize the company several months earlier, the analysis of e-mail archives in this paper starts in early 1997, when all members of the organization were in place and work on the LC system product began. The analysis ends at the time of the *alpha* release of the product, approximately thirteen months later. The subset was comprised of all messages that were sent to all five LC members – a sample consisting of 2,319 messages[3]. The distribution of messages sent by members over this period is shown in Table I.

Based on close reading of the e-mail archive, we developed a coding scheme to identify the six aspects of communicative expectations discussed above: purpose (why), content (what), form (how), participants (who/m), time (when), and location (where). We conducted inter-rater reliability tests for all categories on a subset of the messages, and these averaged 0.92 on Cohen's Kappa. One of authors then used the coding scheme to code all the e-mail messages. See the Appendix for the complete coding scheme and inter-rater reliabilities for all the categories.

Once the data were coded, we used them in several ways. First, we used them to identify and retrieve those messages with content relevant to the issues of temporal coordination, allowing further textual analysis. Second, we used them to analyze the patterns of communication that were closely related to the temporal organization of

Sender	Dan	Keith	Robert	Fred	Martin	Other	Total	
Count	633	649	712	281	39	5	2,319	Table I. Distribution of LC
Percentage	27.9	28.0	30.7	12.1	1.7	0.2	100.0	messages by sender

work (e.g. span, pace, sequence, timing, and feedback cycle). Third, we used them to identify and examine the genres and genre systems enacted by the LC members over the 13-month period. To perform the genre analysis, we used the coding scheme to construct genre definitions on the basis of the frequencies of various coding categories as well as common paper-based and electronic genres identified in previous genre studies (Orlikowski and Yates, 1994; Yates and Orlikowski, 2001, 2002). As we also expected that some of the genres might be modified over time in response to task characteristics or experiences with the electronic medium, we paid additional attention to finding variant or new genres through an iterative analysis of message texts and coding categories. Table II briefly describes each of these genres, and summarizes the coding categories used to define the genres and genre system used for temporal coordination in LC.

These primary textual data were supplemented by other data as well. First, interviews with the three full-time LC participants were conducted during the initial phase of the coding scheme development, and these focused on the members' communication, work, and temporal practices. These interviews, tape-recorded and transcribed, supplied important background information for the subsequent analysis. Second, we had access to the minutes of LC's weekly phone conferences, which helped us understand members' communication practices in other media as well as their temporal practices in a broader context. Third, other documents produced and distributed by the company (e.g. business plan, white paper on the LC system) provided important information about the organization's temporal rhythms (e.g. project schedules and deadlines, product presentations to outsiders, interactions with prospective customers, etc.). Fourth, we had ongoing access to one LC member who served as a key informant, allowing us to ask additional questions over time as our analysis progressed.

Genres and genre system in LC	Definition of genre
Status report	Report the status or progress of work (purpose = status report, content = work-related and technical, participants = all LC members)
Bug/error notification	Notify about a bug or an error encountered (purpose = bug/error notification, content = work-related and technical, participants = all LC members)
Update notification	Notify about an update on server (purpose = update notification, content = work-related and technical, participants = all LC members)
Phone meeting management	
Meeting logistics	Communicate the date and time of a proposed meeting (purpose = scheduling, content = work-related, participants = all LC members)
Meeting agenda	Propose or announce the purpose and content of a meeting (purpose = proposal, content = work-related, participants = all LC members)
Phone conference	Actual phone meeting

Table II.
Definition of LC genres

Temporal coordination in LC

LC members worked flexible and fluid hours, and their communication pattern reflects this (see Figures 1 and 2). During the 13-month period of our study, about a half of the messages (46.6 percent) were sent outside of the conventional 9.00 am to 5.00 pm "work day," and about 18 percent of the messages were sent over the weekend. As a company, LC operated almost around the clock, every day of the week. While these were the overall temporal patterns, each member enacted different individual temporal patterns reflecting variations in such factors as personality, habits, media preferences, work tasks, and family situation.

In addition to time zone differences, members' flexible work hours and their different temporal patterns necessitated coordination. In this section, we examine LC's temporal coordination of work by analyzing the genres and genre systems that members enacted in their electronic mail communication. In particular, we were interested in those communications that were used to temporally structure LC's work, whether explicitly or implicitly. We found that three genres and one genre system were primarily involved in facilitating the temporal coordination of work within LC.
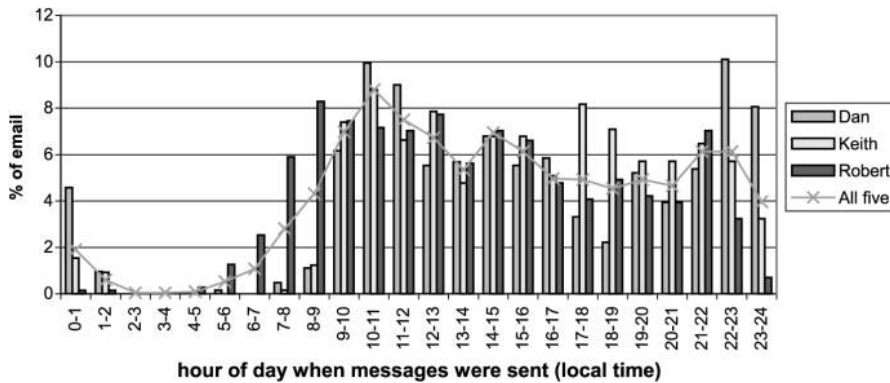
Figure 1.
Daily pattern of e-mail communication in LC
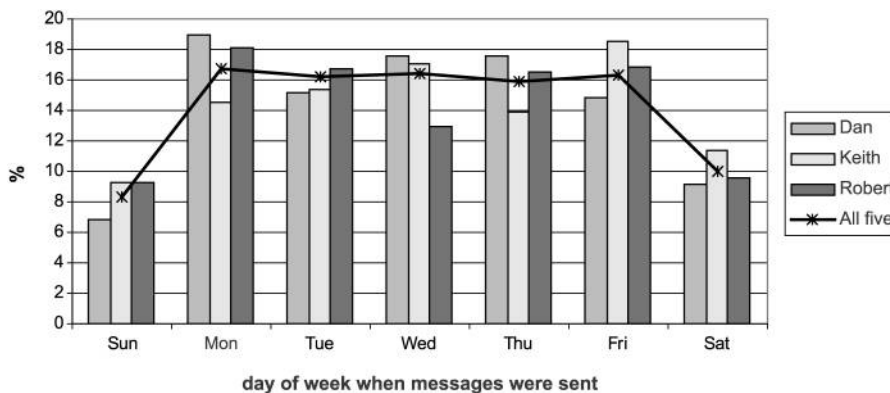
Figure 2.
Weekly pattern of e-mail communication in LC

Genres used in temporal coordination

Of the many genres that LC members used in their distributed work, three genres were used explicitly for temporal coordination: status report, bug/error notification, and update notification. All three were related to the technical work of building LC's system product, and thus were enacted almost exclusively by the three full-time members. These three genres address all three types of activities identified by McGrath (1990) as predominant temporal problems in organizations: scheduling, allocating, and synchronizing work.

Status report genre. In the status report genre, the sender of a message reported progress on his current work task. A typical status report briefly summarized the current status of the task (e.g. how particular subtasks were progressing), how much time had already been spent on it, and how much more would be needed to complete the task, what problems (if any) had been encountered in tackling the task, and what kind of collaboration with other members might be needed to complete the task or solve an identified problem. Consider the following example of an LC status report message[4]:

Date: Sun, 23 Mar 1997 09:31:53 -0500 (EST)
From: Keith
To: LC
Subject: status

I just updated the server with attempts get the IntCode to zero errors. I have one more bug to fix (I am not doing the merge between a reference to an atom and a reference to an array properly.) There is only one place in all of the sources that we have that does this. LC has never written code that did this. In fact, Dan and I were unsure that this could ever arise in type correct code until we saw this case. It is not discussed in the specification at all. However, dan and I were able to assign a meaningful type assignment for this operation.

I will fix this tonight or tomorrow.

I would like robert to check Parser and TypeEncoder carefully when he does his next update.

We were both hacking on these files at the same time. I think that cvs did the right thing since we were hacking different parts of these files. As I did updates, I saw changes to my copies that I did not do. However, a second check is not unreasonable until we get more comfortable with cvs merging.

Keith

As is evident in this example, the status report genre relates to all three of McGrath's (1990) mechanisms of temporal coordination – scheduling, synchronizing, and allocating. When Keith reported his progress to fix bugs in the LC system, he was scheduling his own work tasks and allocating his temporal resources accordingly toward fixing another bug ("I will fix this tonight or tomorrow"). He was also trying to align his pace of work (synchronize) with that of another member ("I would like Robert to check …"), asking him to check some files when he next updated the system in order to make sure that they continued to work consistently on the same version of the code.

In general, successful team coordination is based on members' awareness of tasks (e.g. what steps need to be taken next) and team (e.g. who knows what among the members) (Walther, 2002). To make distributed collaboration successful, members also

need to keep up with information about demands for their work: what other members are doing; who is communicating with whom; what kinds of problems concern their tasks directly or tangentially. Status report messages provided such task awareness to the LC members, and helped them manage the complex temporal dependencies between tasks assigned to different members. A close monitoring of their partners' activities and a clear understanding of the impact of those activities on their own work were also necessary. The following message – a request for status reports – demonstrates this awareness well:

Date: Mon, 10 Nov 1997 13:49:11 -0700
From: Robert
To: LC
Subject: All quiet on the eastern front...

Keith, Dan . . .

Could you mail me an indication of when you expect to commit code for your current problems? I'm trying to make some plans for my time.

–
robert

In order to assign tasks appropriately and solicit and offer help effectively, team members depended on information about each other's knowledge, skills, and motivations. LC was in a favorable position in that members shared similar technical, educational, and cultural backgrounds, and some of them had had prior collaboration experiences (both distributed and co-located) with each other. But virtual work requires ongoing alignment of members' perceptions about the roles and responsibilities of each member, the interdependencies among them, the current status of each member's assigned tasks, and their availability for interaction (Cramton, 2001). For instance, in the status report message below, Robert is ready to update his code on the server ("I've about got the *make* stuff ready"), but asks the other members for approval to proceed as he wants to ensure that his plan does not conflict with theirs:

Date: Fri, 24 Oct 1997 10:52:29 -0600
From: Robert
To: LC
Subject: make stuff about done

I've about got the make stuff ready . . . I'm just doing some final testing.

I will soon be updating my code with the changes on the server. If you want to get anything into the initial porting version, please tell me and I'll wait a bit to do my update. Otherwise, I plan to update my world, build a link-only version of the front-end and link manager, feed it to the system, watch it crash, and then commit all of this stuff to the server.

Let me know if this does not work with your plans . . .

–
robert

LC members enacted the status report genre to maintain ongoing awareness of their distributed tasks, individual progress, plans, and schedules, and their collective work context. As they noted in interviews, members found that the frequent status reports helped them get some sense of "who's still busy on that problem" or to decide "whose court the ball is in now." Members used these status reports to determine which collaborative actions were required when, and how they should adjust their different individual temporal schedules, expectations, and plans accordingly.

Bug/error notification genre. Individual LC members used the bug/error notification genre for reporting on bugs or errors that they had encountered in the course of conducting their tasks. A typical bug or error notification had a subject line identifying the problem, and in the body, a detailed description of when and how the problem or error occurred. As their dispersed geography precluded members from observing what was happening over each others' shoulders, any technical problems had to be extensively documented so that each member could reproduce them on his local machine. The bug/error notification thus served two specific functions. The first was to report the precise location in the source code where the bug/error occurred and to identify the exact moment in execution time when the bug/error was triggered. The second was to provide sufficient details about the nature of the bug/error to allow the other members to independently replicate it.

Keith sent the bug notification message reproduced below to Robert (with a copy to all LC members). This bug involved the linker, an area of the code for which Robert was responsible. Keith included the stack trace of a bug he had encountered, described the problem, and gave step-by-step instructions of how to replicate the bug. As such replication was only possible when the "context" of the bug/error occurrence could be properly reproduced, members took extra care to specify any possible differences between their local computing environments. In this example, Keith added an additional instruction (step 4) to remind Robert of a possible discrepancy in their respective machine directory structures:

Date: Tue, 6 May 1997 16:33:03 -0400 (EDT)
From: Keith
To: LC
Subject: linker bugs

Robert,

N→Q
RO → Q
R → RO
LAny; → RO
V → Q
Link.InternalLinkError
    at Link.ObjectFile.addRelocationTranslation(ObjectFile.java:710)
    at Link.ObjectFile.processRelocations(ObjectFile.java:574)
    at Link.ObjectFile.processRelocations(ObjectFile.java:638)
    at Link.ObjectFile.processRelocations(ObjectFile.java:638)
    at Link.ObjectFile.processRelocations(ObjectFile.java:638)
    at Link.ObjectFile.processRelocations(ObjectFile.java:567)
    at Link.ObjectFile.processRelocations(ObjectFile.java:567)
    at Link.ObjectFile.processRelocations(ObjectFile.java:567)

```
          at Link.ObjectFile.processRelocations(ObjectFile.java:567)
          at Link.ObjectFile.processRelocations(ObjectFile.java:638)
          at Link.ObjectFile.processRelocations(ObjectFile.java:638)
          at Link.ObjectFile.link(ObjectFile.java:262)
          at Link.ObjectFile.link(ObjectFile.java:182)
      at Link.ObjectFile.linkDriver(ObjectFile.java:1359)
          at LC.Compile.main(Compile.java:136)
      make: *** [link5] Error 1
      /lc/src/boot/Tests(19)
```

Here is what you have to do to recreate this bug.

1) cvs update
2) cd whereever/LC/src/boot/
3) make clean all
4) *if you did not install sun's java at /java,*
add a symbol in your environment called SUNJAVA that points to where you did install it.

5) cd whereever/LC/src/boot/Platforms/i386win32/LClib
6) type make
7) cd whereever/LC/src/boot/lib
8) type make
9) cd whereever/LC/src/boot/Tests
10) make link5

it should fail just like the above.

sorry for the complicated procedure, we are a little behind on getting the makefiles into shape as we have started linking with real libraries. I will be working on this while you hack the linker.

I will be leaving for hiking at 5:30edt, so if you have troubles recreating this, get me soon.

Keith

In contrast to tasks that could be planned and divided up among members ahead of time, bugs or errors had unpredictability as their primary temporal characteristic. They were thus quite disruptive to the orderliness of members' workdays. Their occurrence meant that a new task of fixing the bug or error had to be allocated to someone. For the individual made responsible for this task, it meant an adjustment in priorities and work schedule to accommodate this unexpected demand on time. For the member who encountered the problem, it meant suspending the current task until the problem was solved. In short, a bug or error notification message signaled the necessary readjustment of members' task schedules. In his interview, Robert commented on this need to dynamically readjust his expectations about how he was going to allocate time to his tasks for the day:

> The first thing I do in the morning is just kind of look at the massive quantities of e-mail that we get and I have to sort through and just kind of decide the thing that I have to do deal with right now. Are there any disasters going on, any new stuff that, you know, somebody found a bug that is something that I should be fixing? And so, I kind of go through that and decide whether there's something there that's going to really change what I thought I was doing

today. And then, after I've taken care of that, then it's kind of back to remembering, OK, now what was I going to do today?

In most cases, LC members seemed to assign these emerging tasks among themselves with little difficulty, based on the mutual awareness of each other's expertise and generally agreed-upon division of labor. As Keith noted in his interview:

There's lots of just finding a bug when we are just sitting there and … it's not territorial but we all know our expertise. We know who is the real expert on any kind of a thing, and we've gotten good enough so that we can kind of smell a bug. You know, just put your hands down on the computer and close your eyes and the Force will tell you [laughter] – it's Dan's, Robert's or my bug and we get it right most of the time.

In this way, whenever members notified each other of a problem they implicitly allocated emerging tasks, such as fixing bugs or errors, based on their understanding of each other's technical expertise (their ability to "smell" whose bug it was), and this tentative decision was explicitly communicated by enacting the bug/error notification genre, and confirmed via the ensuing e-mail discussion. Over time, LC members developed a simple way of tossing problems to one another, as evident in the following examples of subject lines from bug/error notification messages:

Subject: The next bug has Keith's name on it.
Subject: I think that the ball is now in Robert's court.
Subject: live problem has Dan's name all over it.

Typically, a bug or error notification indicated that the sender needed assistance from other members. The member asked to provide assistance needed to put aside his own work for the time being to assist with another member's work. In this sense, the bug/error notification genre played an important role in coordinating the team's collaborative efforts. Because a delay in fixing bugs or errors could result in the long interruption of other tasks, all requests of such kind were dealt with as priorities. Thus, a bug or error notification message punctuated the rhythms of individual members' daily schedules, requiring them to dynamically readjust and recalibrate their work tasks and time allocation, on a daily or even hourly basis.

Update notification genre. LC members used the update notification genre to report the completion of a task and to indicate an update to the LC system as the result of the completion. A typical update notification had a distinctive subject line of the structure, "new [type of update, e.g. file, code] on [location, e.g. server, web]," plus a short description of the update in the message body. This update notification genre facilitated version control for the system they were building. In the example below, Robert was notifying the others that he had uploaded a new code file to the server that fixed some previously identified errors:

Date: Thu, 13 Nov 1997 13:01:59 -0700
From: Robert
To: LC
Subject: new code on server

I just checked in changes to the dependency generation/tracking code that fixes the problems with too many dependencies in the database.
–
robert

In the early months of the LC organization, update notifications were generally reported as a part of the status report, along with a list of other tasks, both completed and still in progress (see the first example of a status report where Keith began his message with "I just updated the server with …"). Over time, the LC members distinguished the update notification as a separate genre from the status report to help them keep track of the latest system updates and synchronize their work around them. In his interview, Dan recalled that this new genre's emergence was prompted by a discussion the LC members had in one of their weekly phone meetings about keeping track of changes in a more timely and efficient manner (italics added):

> We just tried to be, I think, a little more stylized … And so, there's this whole big folder of the "new on server" messages. And I don't remember when we started that, but *we said that it was really important for purposes of just being able to figure out when something happened.* Because you need to know when you go to make a release, you need to know what you did.

The update notification genre emerged as members tried to structure their communication to highlight relevant temporal information. As system updates typically affected all members' work, the distinctive subject line on the update notification genre ("new … on server") functioned as an alert to foster timely sharing of information about system changes. With this common format, members could easily identify the update notification messages, both in real-time and over time, allowing them to track changes more efficiently in versions of the code and related documents.

Often, one member's new update was a precursor to someone else's task. For example, it was through the update notification genre that fixes to previously reported bugs or errors were announced. Thus, promptness in announcing information about fixes and system updates was a critical component of the update notification genre. Reflecting this, update notification messages were sent at approximately the same time as the actual updates were implemented on the LC system. This temporal proximity of action and communication about the action was indicated by the various temporal references prevalent in update notification messages, for example, "now," "just," "I am about to." In this way, the temporality embedded in the update notification genre along with the implicated update event helped LC members achieve a form of "virtual temporal symmetry"(Orlikowski and Yates, 2002) in their distributed work.

The update notification genre thus functioned as a synchronization mechanism for distributed work. LC members achieved a limited form of actual temporal symmetry, despite their geographic and temporal dispersion, through their weekly phone conferences, which allowed the members to achieve temporal symmetry for a short time (approximately an hour) using conventional synchronous media. But members also created the effect of temporal symmetry through e-mail, even though individual members might have read the messages at different moments. As noted above, the temporal proximity between the actual system update and its notification helped to maintain temporal alignment among members by guiding them to work on the most up-to-date code or object. Together with the synchronous phone conference meetings, the virtual temporal symmetry created by use of the update notification genre helped LC members maintain adequate temporal coordination to support their distributed collaborative software development.

Interweaving genres in practice. Given the technical nature of LC's work content, the three genres–status report, bug/error notification, and update notification–were enacted mostly by the three full-time members. However, it is important to note that

the members had a norm of sending these messages to all LC members, including the part-time members who were not directly involved in the technical aspects of software development. The members clearly recognized these genres as a means of enhancing all members' task and team awareness, thus facilitating coordination at the team level.

Combined, use of the three genres constituted 29.5 percent of the total e-mail exchanges sent by the three full-time members (status report 11.7 percent, bug/error notification 7.8 percent, update notification 13.0 percent). The use of the three genres not only reflected the temporal flow of members' tasks, but also coordinated their daily work. Using McGrath's (1990) terms, we can see that by enacting these three genres, members actively scheduled, synchronized, and allocated their ongoing work.

In addition to each genre's particular role in coordinating distributed work, members' interconnected use of the three genres provided a strong temporal structuring influence within LC. This influence can be observed by looking at the relational use of genres in members' everyday practices. For this purpose, we selected one particular, relatively typical day (October 17, 1997) and analyzed the messages sent by members during that day. Table III and Figure 3 summarize the results. On this day, four members (Dan, Keith, Robert, and Martin) sent a total of 13 group messages,

Subject line	From	Episode	Genre
gc problems	Keith	Episode 1	Bug/error notification
Problems compiling (any suggestions)	*Martin*	*Episode 2*	*Bug/error notification*
Re: Problems compiling (any suggestions)	*Robert*	*Episode 2*	*Reply*
Today's GC bugs	Dan	Episode 1	Status report
Thanks Re: Problems compiling (any suggestions)	*Martin*	*Episode 2*	*Reply*
Confirmation of bug hypothesis	Dan	Episode 1	Status report
Re: Confirmation of bug hypothesis	Robert	Episode 1	Status report
Re: Confirmation of bug hypothesis	Keith	Episode 1	Reply
Re: Confirmation of bug hypothesis	Dan	Episode 1	Status report
Stuff checked in	Dan	Episode 1	Update notification
More stuff checked in	Robert	Episode 1	Update notification

Table III.
Genres enacted by LC members on a typical day (October 17, 1997)

Figure 3.
Timing and sequence of genres enacted by LC members on a typical day (October 17, 1997)
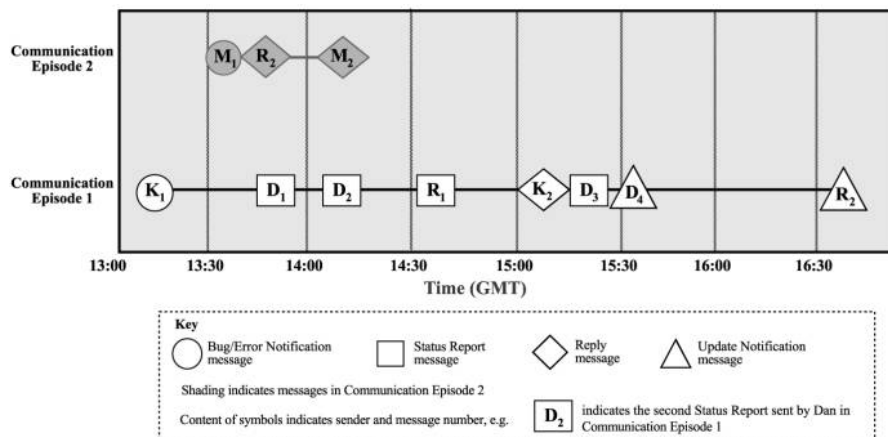
comprising two communication episodes (defined as a unit of temporally and topically bounded communication activities). In these two communication episodes, the three genres were interspersed with related reply messages.

Episode 1 (non-italic rows in Table III) was initiated by Keith's bug/error notification, describing some problems he had encountered with the GC function of the system. His e-mail message indicated that he had also been discussing these problems with Dan on the phone while writing the notification ("Dan has a grand theory of what is going on. He thinks it is gc related and is formulating mail even as we speak"). It was through e-mail, however, that the problems were officially announced and communicated to all the members in LC. About an hour later, Dan sent around a status report to the members providing a detailed description of his "grand theory" of the likely GC bugs and an approach to fix them. Dan and Robert then divided up the task of fixing these bugs and continued to "hack" them separately, while staying informed about each other's progress through their ensuing status reports. Finally, Dan and Robert sent two separate update notifications indicating that the problems had been fixed and the new code updated to the server. This communication episode took roughly 3 hours 20 minutes from the initial notification of the problems to the final announcement of the updated system.

Episode 2 (italic rows in Table III) was much simpler. Martin, one of the two part-time members of LC, initiated the episode by reporting on some difficulties in compiling and soliciting assistance. Robert immediately acted on this error notification, as the full-time LC members already knew the cause of and solution to the problem ("I sent mail when Dan had this problem and we talked about it on Wednesday"). Martin had either missed the weekly phone conversation when this problem had been discussed or forgotten about it. This communication episode, which lasted only 25 minutes, concluded with a short "thank-you" note from Martin.

As evident in these two communication episodes, it was the norm rather than the exception within LC that emergent problems in need of urgent response interrupted broadly defined individual work schedules, requiring readjustments. Indeed, coordinating these exigencies by enacting a series of genres shaped individual members' "loosely structured day" into a concrete form. Also it was through the enactment of these genres that new tasks were identified, assigned, worked through, and closed. Thus, the distributed collaboration of LC members was structured dynamically through members' ongoing and interconnected enactment of these genres.

We also analyzed use of the three temporal coordination genres over the 13-month period (see Figure 4). The bars show a fairly steady increase in the proportion of total e-mail messages represented by these three genres. Taken together, the three genres, which accounted for only 6 percent of total message volume in February 1997, increased to more than 40 percent by the end of the first year. Thus these three specific genres became more prevalent in LC's genre repertoire (Orlikowski and Yates, 1994), both as their software development activities advanced (thus generating more bugs, progress updates, and code releases), and as their communicative practices stabilized to reflect an increased familiarity with each other, a greater understanding of the work at hand, and their emergent work norms.

Use of the three temporal coordination genres over time is clearly related to the product development schedule of LC. The general increase of the three genres reflects that the first year activities were geared toward advancing the technical work on the
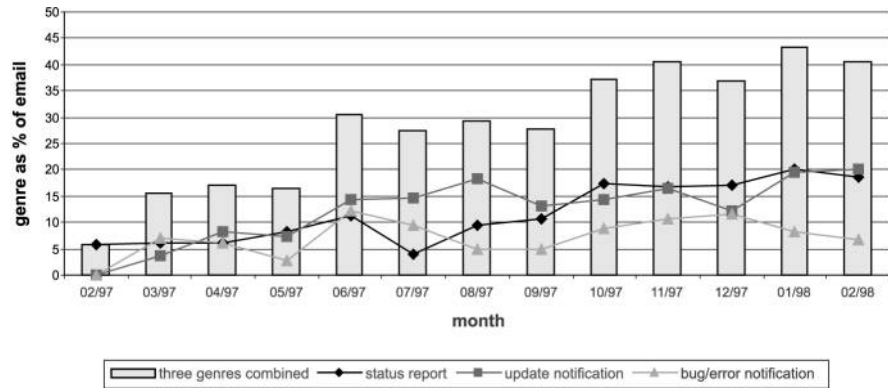
Figure 4.
The use of three genres in
LC over time

system in order to deliver the prototype. In particular, during the five months preceding the prototype release, the proportion of e-mail exchanges represented by these three genres reached around 40 percent of the total e-mail exchanges. As the project progressed and the deadline neared, the complex interdependency between individual members' tasks and the need to temporally coordinate those activities increased accordingly.

The absence of bug/error and update notifications in February 1997 reflects the initial phase of the project that was focused on overall planning rather than actual code writing. By comparison, during the last two months of this period, the members were in the final phase of developing the prototype, and most of their efforts here were concentrated on integrating and testing related parts of the system. Thus, members enacted the status report and update notification more frequently. Interestingly, the use of bug/error notification decreased during this same period, just before the release of the prototype, suggesting that members temporarily suspended work on less critical bugs so that they could focus only on those issues critical to the timely delivery of a functioning prototype. Such a deliberate decrease of bug/error repair work would reflect a form of opportunistic structuring (Orlikowski and Yates, 2002; Yates *et al.*, 2001), where members chose to provisionally halt work on some aspects of their ongoing project, so as to concentrate on achieving the impending deadline of their first prototype release.

Genre systems used for temporal coordination
Temporal coordination of work typically involves a series of interactions through which different temporal structures and interests of individual members are enacted, contested, and negotiated. Among the several distinct sequences of communicative actions routinely enacted by LC members, one genre system was particularly relevant to LC's temporal coordination: the phone meeting management genre system. Scheduling and conducting meetings are mundane but essential tasks of organizing work within organizations. Given the dispersed nature of the LC members, and their varied individual temporal patterns, most of their group phone meetings had to be scheduled in advance.

We focus here on internal LC meetings because, during the first year of the company, internal coordination requirements were dominant, whereas external coordination demands (e.g. meetings with customers) were few and infrequent. LC

members used telephone conference calls to create opportunities for weekly synchronous interaction. These meetings were organized and enacted through what we identified as the phone meeting management genre system. This genre system was comprised of three interrelated and interlocking genres that were enacted in sequence to accomplish weekly phone meetings: meeting logistics, meeting agenda, and the phone conference. The first two of these genres were enacted within e-mail, and the third via the telephone medium. Not all occurrences of the phone meeting management genre system involved the use of all three genres. Sometimes, members enacted only two of the three constituent genres, for example, when they utilized the meeting logistics genre and phone conference but omitted to send around a meeting agenda, or when they scheduled a meeting, and set its agenda, but then failed to hold the proposed phone conference.

The first genre, meeting logistics was typically used to communicate the date and time of the proposed phone meeting, and (sometimes) alternate phone numbers to use to connect with certain members. The meeting logistics genre included messages not only proposing or announcing a meeting but also clarifying or trying to change the planned meeting times. As a result, this genre was the most frequently invoked of the three genres making up the phone meeting management genre system.

As a phone conference requires the temporal co-presence of members, the meeting logistics genre was important in scheduling and communicating a meeting time that would allow maximum member participation. As members recurrently enacted this meeting logistics genre, some genre norms for its use gradually emerged. For example, members began to routinely specify the meeting time in three different time zones, after experiencing some confusion in earlier messages, as evidenced in the excerpt below:

> 2:30-4:30 works for me.
is this edt? mdt? or pdt?
is this carved in stone?

LC members also began to follow the announcement of the date and time of the meeting with a specification of the sequence of calls to be made – that is, who was to initiate the conference call and in what order it would proceed – because without such specific instructions, the phone conference might not even get started as everyone waited for someone else to initiate the call[5].

The meeting agenda genre was used to propose or announce the purpose and content of the meeting. In many cases, the meeting logistics genre and the meeting agenda genre were both enacted within a single message, as seen here:

Subject: Technical meeting agenda

Technical meeting today at 1pm pdt, 2pm mdt, 4pm edt.
I'm assuming that we will use the same calling sequence as last time.

1) Alternate dates/times for technical conference call
2) symbols at runtime
3) special string notation for object format
4) initialization of types

–-
robert

These two e-mail genres – meeting logistics and meeting agenda – that preceded the actual phone conferences offer interesting examples for observing the dynamic and negotiated nature of temporal coordination in LC that allowed members to accomplish temporal symmetry, even if only for a limited time. Sometimes, the e-mail part of the phone meeting management genre system included a long thread of messages, with each constituent genre appearing repeatedly. Take for example, the communication episode shown in Table IV. It involved twelve messages over a period of 52 hours and 29 minutes.

As an attempt to regularize their weekly meetings, members initially decided to have the meeting at the same time as the previous week. As shown in the messages below, it was Robert's schedule conflict with this provisional timetable that initiated the next round of messages just the day before the planned meeting time. Dan, struggling with dental appointment conflicts, responded with suggested alternate times for the meeting:

Wed, 09 Apr 1997 05:04:38 -0600
From: Robert
To: LC ⟨all@LC.com⟩
Subject: Technical meeting

Much to my chagrin, I've got a schedule problem with the technical meeting at 9:30pdt, 10:30mdt, 12:30edt on Friday. Which of the following options is best for you?
1) Do it at the scheduled time without me.
2) Do it friday afternoon (send times).
3) Do it thurday morning (send times).
4) Do it Thursday afternoon (send times)
5) Skip it this week.

Wed, 09 Apr 1997 10:09:21 -0400
From: Dan
To: LC ⟨all@LC.com⟩
Subject: Re: Technical meeting
At 05:04 AM 4/9/97 -0600, Robert wrote:

Subject line	Date/time	From	Genre
Technical meeting	09 Apr 1997 05:04:38 -0600	Robert	Meeting logistics
Re: Technical meeting	09 Apr 1997 09:03:11 -0400	Keith	Meeting logistics
Re: Technical meeting	09 Apr 1997 10:09:21 -0400	Dan	Meeting logistics
Re: Technical meeting	09 Apr 1997 10:45:31 -0700	Fred	Meeting logistics
Re: Technical meeting	09 Apr 1997 14:36:48 -0400	Keith	Meeting logistics
Technical meeting	09 Apr 1997 15:50:34 -0600	Robert	Meeting agenda
Re: Technical meeting	09 Apr 1997 18:16:12 -0400	Keith	Meeting logistics
Re: Technical meeting	09 Apr 1997 18:52:57 -0400	Keith	Meeting logistics and agenda
Re: Technical meeting	09 Apr 1997 20:54:52 -0400	Dan	Meeting logistics
Technical meeting agenda	11 Apr 1997 12:17:09 -0600	Robert	Meeting logistics and agenda
Re: Technical meeting agenda	11 Apr 1997 14:58:35 -0400	Dan	Meeting logistics
Re: Re: Technical meeting agenda	11 Apr 1997 15:33:53 -0400	Keith	Meeting agenda

Table IV.
Example of phone meeting management genre system (date of meeting: April 11, 1997)

> 1) Do it at the scheduled time without me.
Or me, since I am probably on my way back from 1.5 hrs at the dentist,
With a jaw full of novocain and probably not in the best moods (I'm having a crown replaced).
> 2) Do it friday afternoon (send times).
2:30-4:30 works for me.
> 3) Do it thurday morning (send times).
>
> 4) Do it Thursday afternoon (send times)
Thursday is bad, especially this Thursday.
> 5) Skip it this week.
That fits my schedule, too.
Dan

It was not easy to find an alternative time with this "short" notice. Dan's dental appointments limited options further. As Robert was the one who needed the meeting most, he furthered his effort to find an appropriate meeting time. He finally managed to announce a new meeting schedule, but it went on without Dan who withdrew at the last moment due to pain from his dental treatment.

Although this episode of the phone meeting genre system failed to achieve the full participation of all members, it highlights how members strove to create a regular temporal structure for meetings within LC. The following message illustrates such an attempt very clearly:

Date: Tue, 01 Apr 1997 15:08:33 -0700
From: Robert
To: LC ⟨all@LC.com⟩
Subject: Technical discussions

Fred and I would like to start having regular technical discussions. Fred proposed having the first one on thursday morning. Please send me a list of times that fit your schedule and any items for the agenda.

Proposed agenda:
0) schedule for technical discussions. Every week? Every other week?
1) Strategy and timetable for bolting together the parts
that we've almost finished.
2) writing white papers on our technology
3) general Q and A on current activities.

–
robert

With these efforts to establish a regular meeting time, the weekly meeting gradually emerged as an organizational routine within LC, associated with a particular calendar time (i.e. Wednesday 19:00 GMT or 3pm EDT/1pm MDT/12pm PDT). As this new temporal regularity was stabilized as a norm, it functioned as an anchor that LC members often referred to when scheduling more spontaneous meetings. In the following example sent later in the year, the "regular time" is mentioned as a point of reference to schedule a meeting, thus reproducing and reinforcing the existing temporal patterns in LC (italics added):

Subject: meeting Thursday

Keith asked me to send mail asking for a meeting tomorrow (thursday). He spoke with Gus today and would like to talk about it.

He suggested the *regular time*. If this does not work for you, send some alternate times and we'll try to arrive at a common one via e-mail.

–
robert

The presence of an established meeting schedule is important in creating temporal regularity in organizational life. Within LC, it reduced temporal ambiguity and conflict by providing a common ground of temporal expectations around which other individual schedules and personal commitments could be planned.

The third genre in the phone meeting management genre system was the phone conference itself, the actual meeting that the two other genres were enacted to coordinate. Meeting time was seen to be a scarce resource (typically running from 45 to 90 minutes) that had to be utilized efficiently. It did not take long before members recognized that, to gain some efficiencies, it was useful to impose some structure on their multi-way phone conversations. Keith commented about this point in his interview:

> If we don't structure it, we will get on the phone and just have an ad hoc unstructured meeting. But, for the Wednesday meetings that we've had, we learned very quickly that, if we didn't structure those, there was ramble and rant.

Members thus began structuring their phone meetings by announcing the agenda and turn-taking format before the meeting. After proceeding through the agenda, members would report on their work status in the agreed-upon order. At the conclusion of the meeting, all members would participate in scheduling the next meeting, starting a new cycle of enacting the phone conference meeting management genre system. The e-mail genres preceding a meeting, particularly the meeting agenda genre, can be seen as attempts to decrease the burden and time of coordination during the actual meeting. Furthermore, the agenda genre often instigated e-mails describing issues related to the suggested agenda, and it sometimes led members to engage in a preliminary round of e-mail (or dyadic phone) discussions before the actual meeting. This practice allowed members to inform each other about critical information ahead of a meeting. As a result, members could utilize their meetings to focus on the issues that involved key negotiations or urgent decisions, the kinds of interactions that, as one member told us, were "hard to do over e-mail."

The phone conference was an important temporal coordination mechanism through which members aligned their individual work efforts. Although members shared much information about the tasks and each other's progress by enacting the status report and update notification genres, the phone meeting was the central mechanism for accomplishing the micro-coordination of the team, and for making critical formal decisions for the company. The meeting management genre system with its three interlocking genres of meeting logistics, meeting agenda, and phone conference helped members achieve an increased level of temporal symmetry through coordinating and structuring such meetings.

From the meeting notes and close readings of e-mail messages, we found a total of 51 phone meetings, almost half of which were coordinated through enactment of the meeting management genre system over the period of this study. The role of the fixed Wednesday meeting schedule in reducing coordination work is evident. Figure 5 shows that both the absolute number of e-mails and the number of e-mails per meeting decreased after April when members decided to follow a regular meeting schedule. The existence and stabilization of such a schedule decreased the need to enact constituent parts of the genre system for the coordination of regular meetings.

Indeed, an analysis of the meeting data reveals emerging temporal patterns associated with LC meetings. Figure 6 shows that the time and day of meetings were regularized over time. For the 49 meetings for which date and time information was available, 73 percent (36 cases) occurred around the "regular" or "standard" meeting
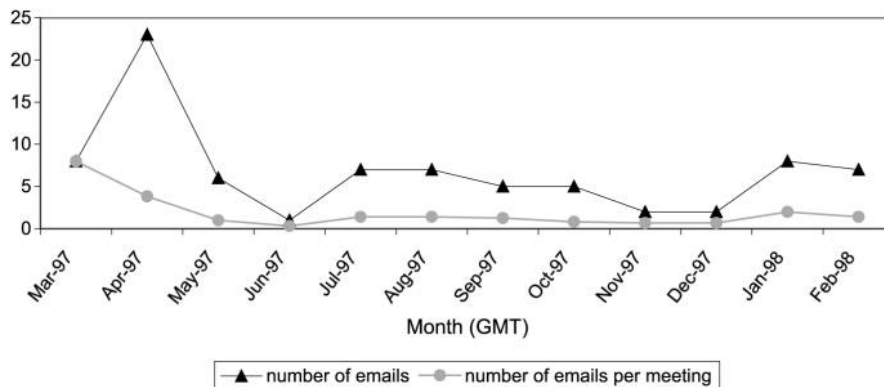
Figure 5.
Change in the use of the phone meeting management genre system
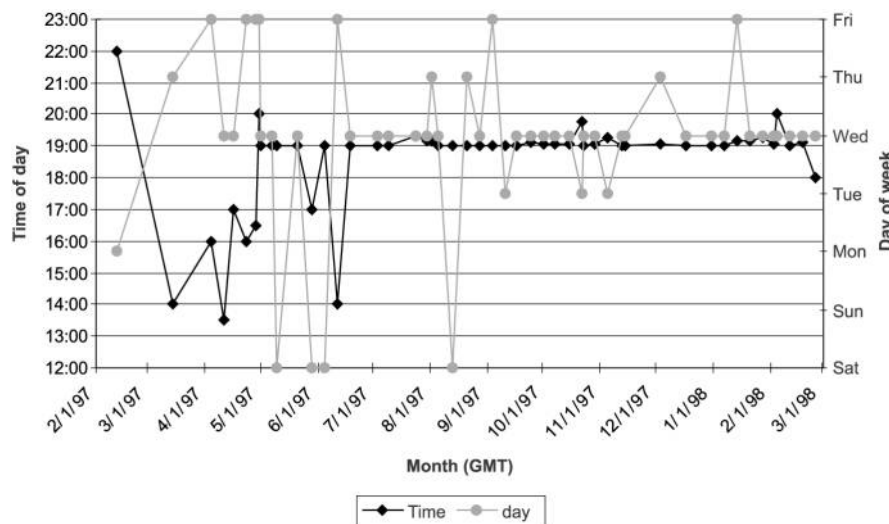
Figure 6.
Change in the meeting time and day over time

time of 19:00 GMT and all of these were enacted after the adoption of a regular schedule in April 1997. Also, over time, it is evident that more of the other LC meetings were also held on Wednesdays.

The analysis indicates that LC members enacted an increasingly stable, recurrent temporal structure around their weekly phone meetings. Maznevski and Chudoba (2000) found that successful virtual teams had strong, repeating temporal patterns. The weekly LC phone conference was an example of such a repeating temporal pattern that emerged and was stabilized over time, and around which multiple temporal structures and different member's individual temporal constraints could be adjusted and coordinated. Anchoring an important organizational event with a specific calendar and clock time and a regular cycle reduced the burden of explicit and time-consuming coordination. More importantly, LC's establishment of a "regular time" or "standard time" represented their expectations about the "appropriate time" for activities that required the temporal co-presence of all LC members. This shared temporal expectation made the scheduling of any ad hoc meetings or events much easier.

Implications

In this paper, we have described how the members of a small start-up organization temporally coordinated their dispersed activities through everyday communicative practices, thus accomplishing both the distributed development of a software system and the creation of a robust virtual team. By focusing on the genres and genre systems enacted by the LC members to structure their e-mail communication, we have identified some means through which virtual team members can use their communication to accomplish the temporal coordination of their distributed work.

Within LC, the status report genre, bug/error notification genre, update notification genre, and phone meeting management genre system emerged as key communication structures that both reflected and shaped members' temporal and work practices. These genres were enacted by members in recurrent situations that reflected both the nature of their collective software development work, as well as the unique local contexts within which each individual member was embedded. Through enacting temporal coordination genres, the full-time members shared important temporal information that allowed them to schedule work, synchronize efforts, allocate tasks, and coordinate their dispersed activities accordingly. The phone meeting management genre system not only demonstrates the dynamic and negotiated nature of temporal structuring in LC, but also shows that a strong organizational temporal structure can emerge through such processes. The habitual enactment of these genres and genre system facilitated the coordination, coherence, and continuity of dispersed electronic collaboration over time in this virtual start-up organization.

Our study confirms the various suggestions from prior virtual team research that structuring communication and work process is an important mechanism for the temporal coordination of dispersed activities. In particular, we have tried to show that the notions of genre and genre system are particularly useful to make sense of and analyze how such structuring actually occurs over time. These concepts shift the research focus from how a given set of temporal coordination mechanisms affect team performance to how coordination mechanisms emerge, are stabilized, and adapted over time. Most of the prior research on temporal coordination in virtual teams has stressed the importance of formal temporal structures for more efficient coordination and better performance within virtual teams. However, in real settings, imposing temporal structures at the outset is often neither possible nor practical. In many cases, such formal temporal structures are

too abstract to guide everyday activities or too rigid to accommodate different and dynamic local situations. Rather, it is through the shared experiences members gradually accumulate as a team that they discover more appropriate temporal structures and useful temporal coordination mechanisms for their ongoing work.

Clearly, there is a trade off between temporal flexibility and tight coordination. Imposing a rigid temporal or process structure may reduce the pressure for coordination, but it hampers temporal flexibility, which is often an important advantage of virtual organizing. Pre-planned and imposed structures are, by definition, limited in their capacity to deal with emerging local exigencies and accommodate the multiple temporal structures in which members are embedded. As we have seen in the LC case, it is not possible to predict or schedule when a bug will be found in code or when a computer might break down. And as members participate in multiple temporal structures – for example, work time, family time, personal time – that often blur together or conflict with each other, ongoing and dynamic temporal negotiation is inevitable. Thus, in practice, situated micro-coordination becomes critical for the accomplishment of effective temporal structuring of distributed work. Our investigation of members' ongoing e-mail communication suggests that their recurrent use of specific genres and genre systems affords them such dynamic and flexible coordination mechanisms. These coordination mechanisms structure communication around shared temporal expectations and norms, but are flexible enough to allow members some opportunities for negotiation and adjustment. Furthermore, as organizing structures, genres and genre systems evolve and change as members modify them or invent new ones in response to emerging situations.

A focus on genres and genre systems is also useful in understanding how virtual teams that lack the temporal symmetry and visible temporal cues of co-located organizations can create shared temporal structures and rhythms that help coordinate their different activities. Reddy and Dourish (2002) note that knowledge about temporal rhythms is itself an important resource for workers to help them accomplish their work and guide them through future activities However, in contrast to the co-located medical workers in their study, whose main coordination challenge was to learn and adapt to institutionalized temporal rhythms, virtual team members such as those in LC, have to actively produce knowledge about temporal rhythms and make it available to the rest of the team through communication. Genres and genre systems facilitate this communication, helping members make critical information available "at the right place at the right time," where "the rightness" is based on different genre norms established implicitly or explicitly over time. In the LC example, the update notification messages were expected to be sent almost simultaneously with the actual update, whereas the status report was less tightly linked to a particular moment in time. The content and timing of these genres provided critical information to members, helping them create and adapt their own work rhythms in accordance with those of other members. Furthermore, enacting genres and genre systems also contributes to creating more routine organizational rhythms, as seen in the example of the phone meeting management genre system. Genres and genre systems, thus, help temporal coordination by directly or indirectly generating collective work rhythms, not in the sense that they are enacted on some fixed schedule, but in the sense that they shape shared expectations regarding the team's collective work rhythms to which individual members can orient.

The implications of this paper are not limited to the topic of temporal coordination. Some researchers have observed that temporal issues (e.g. deadlines, schedules) often

create second agendas that contribute to the general improvement of group processes by redirecting members' attention from the principle activities of the team to more process oriented tasks (Gersick, 1988, 1989; Okhuysen and Eisenhardt, 2002). For example, Gersick (1988, 1989) found that, in response to deadlines, members occasionally interrupted the efforts of the group to discuss time-related issues. Similarly, Okhuysen and Eisenhardt (2002) argued that a temporal agenda can be an effective formal means of team intervention to improve the integration of knowledge. The implication of genres and genre systems for these findings is that as part of the team's genre repertoire, they allow members to bring second agendas into ongoing discussion and negotiation. Furthermore, while temporally coordinating their work through genres, members inevitably attend to other issues of coordination that go beyond temporal issues For example, the bug/error notification genre not only notifies members when a bug has been found or an error has occurred and how urgently the solution is needed, but typically also discusses who should take care of the job and how best to proceed. By adding second agendas as a critical part of daily communication, genres and genre systems can contribute to enhancing members' awareness of issues beyond the primary task, thus improving overall group processes.

The role of communication genres and genre systems in providing awareness of others' activities also speaks to some additional issues raised in coordination theory. Crowston and Kammerer (1998) noted that coordination theory is useful for identifying the cause of coordination problems but that it is less useful in identifying solutions. For example, knowing whom to consult to solve problems is as important as knowing the cause of those problems. They suggest that successful coordination depends as much on members' capabilities and willingness to develop shared understandings of the team's tasks and one another as on identifying dependency problems. The importance of a kind of "collective mind" (Weick and Roberts, 1993; Crowston and Kammerer, 1998) or "mutual knowledge" (Cramton, 2001) in temporal coordination can be repeatedly observed in LC. For example, members' ability to "smell a bug" (i.e. knowing whose expertise is needed to fix a particular problem) was the basis of timely task allocations. Awareness of tasks and team expertise is thus a precondition for successful temporal coordination. Yet, it is also a dynamic capability that members have to learn and develop through ongoing communication and collaboration. Our analysis of communication practices in LC strongly suggests that the recurrent use of certain genres and genre systems can be very useful in developing this awareness over time. Through enacting status reports, bug/error notifications, and update notifications, LC members constantly articulated and checked discrepancies of understanding or expectations among members about appropriate tasks or requirements. As organizing structures of e-mail communication, these genres and genre system can facilitate the processes of socialization, conversation, and recapitulation suggested by Crowston and Kammerer (1998) as crucial for the development of collective mind in dispersed teams.

We should note that this study is exploratory in nature and based on a single case study. The virtual organization examined in this paper was unique in several aspects: first, it was a small organization composed of white males in a similar age group; second, it was based on collaboration among peers with very little hierarchical structure[6]; third, all members possessed a very high level of technical expertise; and finally, the members shared a complex web of personal, educational, and work

experiences that predated their collaboration within LC. All these factors contributed to the LC members' successful coordination in a technologically mediated environment across time and distance. In particular, the high level of commonality and prior experiences of collaboration provided a strong basis of mutual trust and enhanced team awareness, which facilitated active collaboration among the members.

The insights generated from this exploratory study should form the basis for additional research. This paper reports how a particular virtual team developed and used temporal coordination practices, extending research into the "real" virtual team context over time. We expect the critical role of genres and genre systems in temporal structuring to be evident in other types of distributed or virtual teams and organizations. However, the actual practices of temporal coordination and specific genres and genre systems in use will undoubtedly differ across teams and organizations, depending on differences in goals, tasks, technologies in use, and members' local situations. We hope that our account here has opened the way for further research that explores the possibilities of temporal coordination through the enactment of genres and genre systems in different virtual contexts.

Notes

1. Names of the company, product, technology, and members have been disguised for confidentiality reasons.

2. This LC member saved all of his incoming and outgoing e-mail. We eliminated from his files those e-mail messages that were unrelated to LC (e.g. his file of messages received from a list discussing his hobby). All messages related to the company, its members, or its product were kept in the archive.

3. Although our data is from only one member's e-mail archive, it includes all messages sent to all five LC members. And because work-related e-mails were typically sent to everyone in LC, our data comprises the majority of LC e-mail exchanges during the company's first year.

4. When quoting from LC e-mail messages, we have changed wording and details as needed, to disguise the company's technology. We have also cleaned up obvious typos to aid readability, but retained the discursive conventions of the LC participants (e.g. some members rarely capitalized).

5. During this period, LC used a chain of phone calls rather than a teleconferencing service to set up the meeting.

6. A little informal hierarchy resulted from the fact that one full-time member invested considerable personal funds in the LC company.

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Appendix

Coding category	Definition of coding categories	Cohen's k	n	%
A. Why (purpose)	Purpose of message			
A1. Response	Reply to previous message(s)	0.98	1,077	46.4
A2. Query/solicitation	Ask question(s) or request ideas, information, or participation	0.88	430	18.5
A3. Scheduling	Scheduling meetings or events	0.92	74	3.2
A4. Coordination	Coordinate tasks or work between members	0.95	268	11.6
A5. Report	Document an event, trip, or meeting	0.94	41	1.8
A6. Status report	Report the status or progress of work	0.84	273	11.8
A7. Update notification	Notify an update on server, web, etc.	0.85	273	11.8
A8. Bug/error notification	Notify bug(s) or error(s)	1.00	196	8.5
A9. Announcement	Indicate an event or change in affairs	0.92	171	7.4
A10. FYI	Offer information	0.95	122	5.3
A11. Proposal	Propose ideas, solutions, procedures, projects	0.88	299	12.9
A12. Request	Request something to other people	0.88	215	9.3
A13. Discussion	Discuss a specific topic	0.94	669	28.8
A14. Other	Residual purpose category	n.a.	72	3.1
B. What (content)	Content of message			
B1. Work-related	Projects, product, or company		2,220	95.7
B1.1 Technical	Technical aspects of product or technology	0.92	1,926	83.1
B1.2 Administrative	Running of the company	0.91	462	19.9
B2. Not work but relevant	Not directly deal with, but is relevant to work	0.88	116	5.0
B3. Personal	Personal matters	0.93	45	1.9
B4. Other	Residual content category	n.a.	29	1.3
C. Who/m	Sender and recipients of message			
C1. To	Recipient(s) of message	n.a.		
C2. From	Sender of message	n.a.		
C3. CC	Recipient(s) of the copy of a message	n.a.		
C4. FWD from	Sender of an original message that is forwarded	n.a.		
D. Where	Any reference to the location of members or work			
D1. Reference to travel	Any reference to a travel	0.95	23	1.0
D2. Reference to physical space	Any reference to physical locations of members or work	0.98	103	4.4
D3. Reference to virtual space	Any reference to virtual space	0.93	517	22.3
E. How (form)	Format of message (multiple coding)			
E1. Code	Presence of code	1.00	408	17.6
E2.1 Dialogue	Previous message(s) edited before inclusion	1.00	383	16.5

Table AI.
Definition, reliability, and distribution of coding categories ($n = 2,319$)

Coding category	Definition of coding categories	Cohen's k	n	%
E2.2 Mosaic	Previous message(s) unedited before inclusion	0.97	563	24.3
E3. 1 subject line only	No body content or signature/attachment/code/cvs log only	1.00	18	0.8
E4. Standardized	Format based on a standardized protocol	0.85	46	2.0
E5. Machine-generated	Generated and sent automatically by the system	0.85	0	0.0
E11. Other	Residual format category	n.a.	36	1.6
F. When	Indicates temporal patterns of work and communication			
F1. Time stamp	Date, time, and day of week of message	n.a.		
F2. Temporal reference	Indicates the instances of specific temporal practices		798	34.4
F2.1 External event-based	Indicates temporal rhythm based on external events	0.89	54	2.3
F2.2 Internal event-based	Indicates temporal rhythm based on internal events	0.82	263	11.3
F2.3 Clock-based	Indicates temporal rhythm based on clock or calendar	0.96	380	16.4
F2.4 Work/personal life	Refer to work time and family time	0.91	75	3.2
F2.5 Sequencing	Indicates sequence of things to do for a task	0.85	289	12.5
F3. Other	Residual temporal practice category	n.a.	136	5.9

Table AI.

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