

UNIVERSITY OF CALGARY

Capturing and Visualizing Histories of Multimedia-based Casual Interactions

by

Shui Chun Charlotte Tang

A THESIS SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER OF SCIENCE

DEPARTMENT OF COMPUTER SCIENCE

CALGARY, ALBERTA

DECEMBER, 2003

© Shui Chun Charlotte Tang 2003

THE UNIVERSITY OF CALGARY  
FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled “Capturing and Visualizing Histories of Multimedia-based Casual Interactions” submitted by Shui Chun Charlotte Tang in partial fulfillment of the requirements for the degree of Master of Science.

---

Supervisor, Saul Greenberg  
Department of Computer Science

---

Sheelagh Carpendale  
Department of Computer Science

---

External Examiner, Larry Katz  
Department of Kinesiology

---

Date

# Abstract

Many groupware systems now allow people to converse and casually interact through their computers using multimedia—text, images, video and etc. A visualized history of these interactions can help group members reflect on their past interactions, and can help researchers investigate the nuances of online communities. In this thesis, I address the problem of how one can capture and visualize temporal histories of multimedia conversations. First, I built a tool to capture the conversations that occur on the Notification Collage, a computer-mediated communication system that lets people post multimedia items into a public communication space. Second, I built VisStreams, a system that lets people visualize and review past multimedia conversations. Third, I identified through end-user participation a taxonomy of tasks and visualizations. These become guidelines for developing visualization tools for multimedia histories of casual interaction. I evaluate VisStreams against this taxonomy to better understand its potential use and direct its future iterations.

# Publications

Materials, ideas and figures from this thesis have appeared previously in the following publications:

Tang, C. and Greenberg, S. (2002). **VisStreams: Visualizing Temporal Multimedia Conversations**. Presented as a poster in *Graphics Interface 2002*, May.

Tang, C., McEwan, G. and Greenberg, S. (2003). **A Taxonomy of Tasks and Visualizations for Casual Interaction of Multimedia Histories**. *Proceedings of Graphics Interface 2003*, (June 12-13, Halifax), pp. 225-236, distributed by Morgan-Kaufmann.

# Acknowledgments

Thanks to my supervisor, Saul Greenberg. You have given me invaluable guidance and drive over the past two years.

Thanks to my friends from the Interaction Laboratory. Your friendship, valuable ideas, feedback and support have made my grad school life enjoyable.

Thanks to Mike Rounding. Without the Notification Collage you built, I would not have the multimedia communication tool to capture data for my research.

Special thanks to Carman, Michael Boyle, Tony, and Gregor for the invaluable amount of time you have spent in editing my thesis chapters. Without you, my thesis writing process would have been much more difficult.

Thanks to River. Despite miles away, your friendship, encouragement, belief in me, and of course, the goodies, have meant a lot to me.

Thanks to my late father. No one can replace you in my heart and thank you for the trust you had in me ever since I was a little girl. It meant everything to me. I cherish all the fond memories of you, your humour and our late-night chats.

# Dedication

I dedicate this thesis to my family: Raymond, Zoe and Jethro. Without your love and support, I would not have done this.

# Table of Contents

Abstract .....	iii
Publications .....	iv
Acknowledgments .....	v
Dedication.....	vi
Table of Contents .....	vii
List of Tables .....	xiii
List of Figures .....	xiv
Chapter 1. Introduction.....	1
1.1 Setting the Scene .....	2
1.1.1 Casual Interaction and Collaboration .....	2
1.1.2 Computer-mediated Communication Tools .....	3
1.1.3 Conversation History.....	6
1.1.4 Challenge of Capturing Multimedia Casual Interactions .....	7
1.1.5 Visualizing a History of Multimedia Casual Interaction.....	9
1.2 Problem Statement .....	12
1.3 Overview of the Thesis.....	14
Chapter 2. Casual Interaction and Visualization .....	16
2.1 Casual Interaction.....	16
2.2 Technologies for Casual Interaction.....	18
2.2.1 Instant Messaging.....	18

2.2.2 Media Spaces.....	20
2.3 Meeting Capture .....	22
2.3.1 Time-stamp Events.....	23
2.3.2 Allow Indexing of Captured Materials.....	23
2.3.3 Allow Query .....	24
2.3.4 Provide for Different Media Types .....	25
2.3.5 Be Unobtrusive.....	25
2.4 Visualization Techniques .....	25
2.4.1 Timelines .....	26
2.4.2 Details on Demand .....	29
2.4.3 Focus and Context.....	30
2.4.4 Dynamic Filtering.....	33
2.4.5 Animated Presentation.....	35
2.5 Summary .....	35
Chapter 3. Conversation Capture .....	37
3.1 Notification Collage .....	37
3.1.1 Interface.....	39
3.1.2 Implementation.....	41
3.2 Issues in Capturing NC Information.....	45
3.2.1 How to Deal with Multimedia Data?.....	45
3.2.2 What are the Implications of the NC Notification Feature?.....	46
3.3 The Conversation Capturing Tool.....	48



3.3.1 The Conversation Capturing Tool as an NC Client.....	48
3.3.2 Conversation Information is Stored in a Database.....	48
3.3.3 Filtering Evolving Texts.....	49
3.3.4 Filtering Repeating Images .....	51
3.3.5 Capturing other Multimedia Data.....	55
3.4 Discussion .....	55
3.5 Summary .....	58
Chapter 4. Conversation Visualization.....	60
4.1 Functionality of VisStreams.....	60
4.1.1 Timeline Overview.....	61
4.1.2 Timeline Detailed View .....	63
4.1.3 Episode Replay.....	64
4.1.4 Timeline Filtered View.....	67
4.1.5 Dynamic Zooming.....	69
4.1.6 Auxiliary Features .....	70
4.2 Implementation Issues.....	72
4.3 Usability of VisStreams v.1.0.....	74
4.3.1 Methodology .....	74
4.3.2 Results .....	75
4.3.3 Discussion.....	76
4.4 Summary .....	77
Chapter 5. Exploring Multimedia Histories of Casual Interactions .....	79

5.1 Methodology .....	80
5.1.1 Study Data .....	81
5.1.2 Participants .....	81
5.1.3 Methods and Materials .....	82
5.2 Results .....	84
Stage 1: Pre-test Questionnaire .....	84
Stage 2: Brainstormed Tasks .....	85
Stage 3: Data Manipulation and Visualization .....	88
Stage 4: Post-test Questionnaire .....	91
5.3 Discussion .....	92
5.3.1 Task-centered Views .....	92
5.3.2 Supportive Features .....	93
5.4 Summary .....	94
Chapter 6. An Evaluation of VisStreams .....	97
6.1 Detailed Views of Short Time Segments .....	97
6.2 Conversation Views .....	100
6.2.1 The Difficulty of Identifying Conversational Threads .....	100
6.2.2 Conversation View Prototype .....	103
6.3 Rhythms and Trends Views .....	106
6.4 Community and Social Structure Views .....	108
6.4.1 The Difficulty of Visualizing NC Social Structure .....	109
6.4.2 Visualizing Social Networks .....	109

6.5 Summary .....	111
Chapter 7. Conclusion .....	113
7.1 Research Problems and Summary .....	113
7.2 Contributions .....	115
7.3 Future Work.....	116
7.3.1 Extending Beyond In-house Research.....	116
7.3.2 Prototyping Visualization Tools.....	116
7.3.3 Field Study of VisStreams.....	117
7.3.4 Further Investigation of Tasks and Visualizations .....	117
7.3.5 Visualization Techniques .....	118
7.3.6 Interaction and Privacy.....	118
7.4 Conclusion.....	119
References .....	120
Appendix A. Pilot Study .....	126
A.1 Protocol for the Experiment .....	126
A.2 Consent Form .....	128
A.3 Pre-Test Questionnaire .....	130
A.4 Post-Test Questionnaire.....	132
A.5 Task List .....	134
Appendix B. Exploratory Study .....	135
B.1 Protocol for the Study .....	135
B.2 Consent Form for Use of Conversation Data.....	137

B.3 Consent Form for Study Participants.....	139
B.4 Pre-Test Questionnaire .....	141
B.5 Post-Test Questionnaire.....	143
Appendix C. Ethics Approval.....	145
Appendix D. Co-Author Permission .....	147

# List of Tables

Table 5.1: Task categories and perspectives .....	85
Table 5.2: Task categories and specific questions.....	86
Table 5.3: Parameters of visualizations.....	89
Table 6.1: A matrix display of a social network (the numbers showing the frequency of messages directed from the participants named in the column to those in the row).....	111

# List of Figures

Figure 1.1: Notification Collage (Greenberg & Rounding, 2001) showing various media items for communication : Video, Privacy-aware Video, Sticky Note, NC Sketches, Availability, Desktop Snapshot, Photo Show, Web Link, and NC Chat.....	4
Figure 1.2: A recorded log (a small segment only) of casual interaction occurred on the Notification Collage .....	10
Figure 1.3: A 1280 x 1024 pixel display showing a total of 49 media items in full fidelity .....	11
Figure 2.1: MSN Messenger interfaces: the left interface shows availability status of buddies; the middle interface shows a 3-party chat between Charlotte, Carman and Nelson; the right interface displays a video stream of River as seen on Charlotte's monitor, although River is not a participant in the chat dialog .....	19
Figure 2.2: A 'piano-roll' representation of document annotations made over time. (Source: Smith et al., 2000) .....	26
Figure 2.3: Lifelines for visualizing patient records—horizontal timelines are used for duration of diseases (top circle) and details of the disease is shown as inset (bottom circle) (Source: Plaisant et al., 1998).....	27
Figure 2.4: Work Rhythms—Visualization of a user's computer activity. (Source: Begole et al., 2002).....	28
Figure 2.5: Conversation Landscape (Donath et al., 1999). Each vertical line represents a login session of one participant, the horizontal lines are conversations, their lengths represent the conversation duration. (Re-created for better image quality) .....	29
Figure 2.6: The concept of focus-and-context technique used in Table Lens (Rao & Card, 1994; figure created for illustration).....	30
Figure 2.7: A Table Lens showing baseball statistics. The selected rows are expanded to reveal detail information; each expanded row shows the player name, batting average in the season, career average, team name and salary in 1987. (Source: Rao & Card, 1994).....	31
Figure 2.8: A multi-scale timeline slider—the focus area (shown covered by an inverted bucket) on an upper timeline determines display range on the lower timeline, events that are clustered in the upper timeline are more spread out in the lower sliders. (Source: Richter et al., 1999).....	32

Figure 2.9: The FilmFinder. (a) an initial overview display (b) a reduced result set after adjusting the query components (i.e., sliders) on the right (c) detailed description of a movie .....	34
Figure 3.1: The Notification Collage (Greenberg and Rounding, 2001) showing various media items for communication: Videos, Sticky Notes, NC Sketches, Availabilities, Desktop Snapshot, Photo Show, Web Link, and NC Chat (starting from the rightmost) .....	38
Figure 3.2: System architecture of the Notification Collage—changes on the Notification Collage (NC Client) are passed to the NC Server (Collabrary Shared Dictionary) where the corresponding <key, value> pairs get updated and notification of the changes will be passed to other clients.....	43
Figure 3.3: Notification of changes made to all connecting clients when Tony types “Howdy!” and Carman replies “How’s it going?” .....	46
Figure 3.4: 10 similar head-shots of a NC user captured from his video item in 10 seconds .....	47
Figure 3.5: Entries captured using a timer interval of 5 seconds.....	49
Figure 3.6: Entries captured using a timer interval of 20 seconds.....	50
Figure 3.7: A code fragment using the methods in the Collabrary toolkit to estimate the difference between a pair of images (Boyle and Greenberg, 2002) .....	53
Figure 3.8: Only 11 snapshots out of 42 are captured and stored when images are filtered by key frame comparison (threshold PSNR value = -25).....	54
Figure 3.9: A code fragment for storing the values for all the event changes in Base-64 format in the database.....	55
Figure 3.10: Real data collected from the Notification Collage—showing that adding or removing characters inside a message on Sticky Notes beats the substring algorithm .....	56
Figure 4.1: Start-up timeline overview of VisStreams .....	61
Figure 4.2: All media items that are posted on 7/16/2002 are expanded (only a portion is visible here)—images are recognizable and texts are readable .....	63
Figure 4.3: All the media items are expanded (left); past interactions are played back and media items are rearranged on the ‘playback’ NC (right) while the time-traveller travels from left to right. (The time-traveller here has been re-positioned for illustration.) .....	65
Figure 4.4: A full-size play-back Notification Collage showing an example arrangement of media items .....	66

Figure 4.5: VisStreams showing a Timeline Filtered view with two focal rows embedded among rows of minimized icons .....	68
Figure 4.6: A Timeline Filtered View showing a portion of the conversation between Tony and Michael on 7/16/2002 .....	69
Figure 4.7: Dynamic zooming enables viewers to casually examine the details of each media item .....	70
Figure 4.8: Search results are highlighted and brought to the leftmost of the display as indicated by the small circle .....	71
Figure 4.9: VisStreams allows renaming names as a way to manage the dataset .....	72
Figure 5.1: A participant manipulating the history log (reconstructed for better picture quality) .....	83
Figure 5.2: (a) A participant restructuring the data, and (b) a close-up of the visualization he is creating .....	84
Figure 6.1: Lifelines for visualizing patient records—horizontal timelines are used for duration of diseases (top circle) and details of the disease is shown as inset (bottom circle) (Source: Plaisant et al., 1998).....	98
Figure 6.2: A timeline detailed view showing logon sessions and life spans of media items .....	99
Figure 6.3: An interface that supports grouping media items into conversation threads .....	103
Figure 6.4: A prototype conversation view—conversation detail view (left) and conversation overview (right) .....	105
Figure 6.5: An example of visualization to reveal daily temporal patterns (Source: Begole et al., 2002).....	106
Figure 6.6: Visualizing communication by categories—availability and greeting (left), and non-work, humor, and work (right) (Source: Handel and Herbsleb, 2002) .....	107
Figure 6.7: (a) An egocentric view (Source: Chin et al., 2002) (b) An entire-network view (Source: Brandes et al., 2001) .....	110



# Chapter 1. Introduction

---

The purpose of the research described in this thesis is to present the difficulties in capturing multimedia casual interaction, and to place the challenge of designing a history visualization system for the captured *multimedia casual interactions* on a more empirical footing. In particular, I will present a taxonomy of task and visualization requirements for such history systems, which I believe will help designers who are working on similar tools. To ground this taxonomy, I will also present a prototype tool called VisStreams that helps people visualize and review the captured interaction history.

The motivations of this research can be summarized as follows:

1. *Both group members and researchers can benefit from a system that lets one review histories of casual interactions conducted over computer-mediated communication tools.*
2. *An examination of the tasks people intend to perform with these histories can provide insight into a principled design of a visualization tool to fulfill their respective purposes.*

This research entails investigation in the fields of human-computer interaction, computer supported cooperative work, and information visualization. In this chapter, I first set the scene by discussing the importance of casual interaction to effective collaboration and how existing computer-mediated communication tools help support casual interaction. I then discuss why conversation history is necessary, followed by characteristics of multimedia conversation that I have identified. Next, I describe how information visualization techniques can help visualize the rich information space of interaction histories. Finally I state the problems this research addresses and outline what is to come in the remainder of the document.

## 1.1 Setting the Scene

### 1.1.1 Casual Interaction and Collaboration

A wealth of research into *informal workplace communication* has shown repeatedly that casual interactions are a vital component of effective collaboration (Whittaker et al., 1994; Kraut et al., 1988; Nardi et al., 2000). These interactions are generally characterized by being impromptu, brief and context-rich (Whittaker et al., 1994; Nardi et al., 2000). Topics of conversation usually vary between task-oriented work contexts and socially-bonded contexts. In addition, they often involve small groups of people, and are often triggered by the proximity of the participants.

The glue behind these interactions is *awareness*, where people naturally track and maintain a sense of who is around and what others are up to (Kraut et al., 1988; Whittaker et al., 1994). Maintaining awareness is easy when others are in close proximity because a rich variety of sensory cues, particularly visual cues, are available. For example, cues such as an open door, or seeing another in a coffee room can help identify both opportune and appropriate times to initiate conversations.

In today's workplaces, team members are increasingly separated by geographic distances, severely curtailing opportunities for casual interactions. This is a problem, because studies have shown that an office worker spends 25 to 70% of one's time in face-to-face interaction, and almost a third of this time is spent in casual interaction (Whittaker et al., 1994). As such, impediments to casual interaction due to the geographic separation amongst team members significantly decrease effective collaboration (Kraut et al., 1988).

As co-workers become separated by distance, *computer-mediated casual interaction* plays an important role to bring collaborators closer together. The aim of technologies that support these interactions are to increase the *frequency* and *quality of communications*, and to decrease the personal *cost of interactions* among collaborating teams so that people can easily move into purposeful interaction such as work collaboration. To achieve this, the technology should give collaborators awareness of opportune times to contact others, and should allow them move from awareness to work,

e.g., by providing *means for sharing work objects* such as documents and diagrams (Kraut et al., 1988; Fish et al., 1993).

### **1.1.2 Computer-mediated Communication Tools**

Current technologies offer a range of computer-based methods that support casual interactions. Email provides the most rudimentary means, where asynchronous, near real time rapid message exchange may result when both parties are at their computers. More recently, instant messaging services like ICQ, Yahoo! and MSN Messenger offer limited real time awareness information of others' availabilities for conversation by displaying 'activity icons'. The computer monitors how much time has passed since a person has last used one's keyboard or mouse and transmits this as an estimate of one's availability (Nardi et al., 2000).

At the other extreme, media spaces (Mantei et al., 1991; Bly et al., 1993; Finn et al., 1997) leverage audio and video to connect spatially distributed collaborators and offer them rich awareness and easy communication through always-on video and audio links. In general, the goal of media space systems is to provide a virtual shared space that imitates the physical environment facilitated by close proximity. The audio/video link in media spaces provides awareness among distributed collaborators so that subsequent conversations may take place.

I selected the Notification Collage (Rounding and Greenberg, 2000; Greenberg and Rounding, 2001) as the tool to capture multimedia conversations for my research as it represents a new genre of communication in a more versatile multimedia paradigm. As we will see, the multimedia communication not only provides high degree of awareness but also a variety of medium-rich artefacts in addition to text. The description below is only a summary of how Notification Collage can be used to casually interact among distributed collaborators.

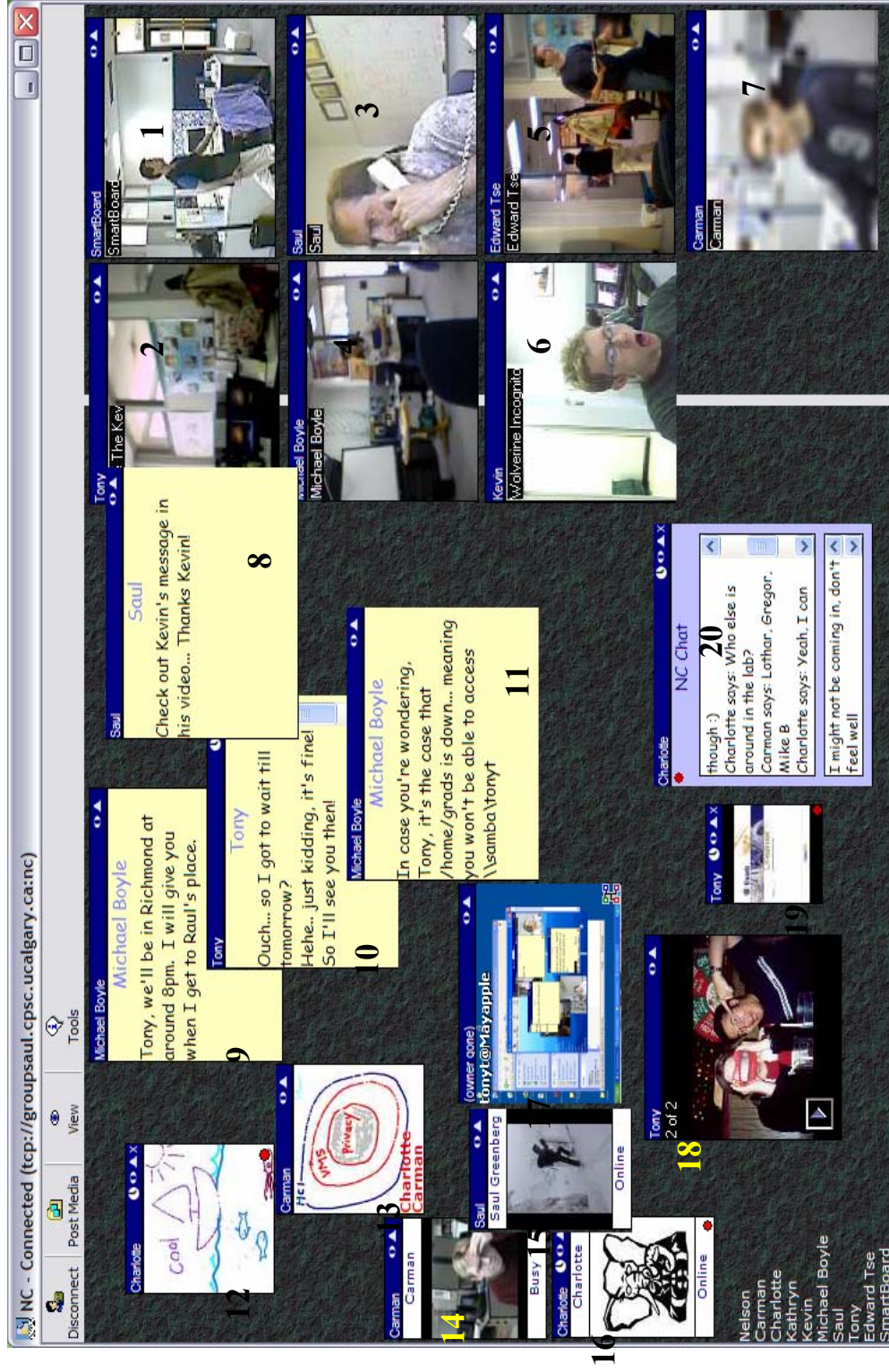


Figure 1.1: Notification Collage (Greenberg and Rounding, 2001) showing various media items for communication : Video, Sticky Note, NC Sketch, Availability, Desktop Snapshot, Photo Show, Web Link, and NC Chat.

Notification Collage (NC) is a groupware communication tool embracing features of instant messaging and media spaces. Its basic goal is to provide a modest-sized group (e.g., between 10 and 20) of intimate collaborators with a public electronic bulletin board where group members can post information that every one can see. Ideally, the NC emulates characteristics of work areas such as research laboratories, i.e., it shows who is around, what they are doing, the artefacts of interest, and it lets them move easily into conversation around these things.

For example, Figure 1.1 shows that ten people have logged on to the NC to communicate; their names are shown in the bottom left corner. Members of this group create and broadcast *media items*. Each person may post a variety of media items to share information with others in the group and to let others interact through them.

I will describe how each type of media item is used for interaction; each media item has been numbered for easy reference. Seven people are using the *Video* media item to post periodically updated video snapshots taken from cameras connected to their workstation (1 to 7). The second row of the images shows that Saul is talking on the phone (3) and Stacey is on her way out as seen from Michael Boyle's camera (4). Other video snapshots are captured from cameras situated at different workstations. While most video images are high-fidelity, one person (i.e., Carman) prefers to post his image in lower fidelity (7) to preserve some privacy while still providing others with awareness information. Next, Saul uses a *Sticky Note* to make an announcement inviting people to check out Kevin's video (8) while Michael Boyle and Tony converse via other sticky notes (9 to 11) about Mike's trip to Vancouver where they are going to meet as well as a parallel conversation about a system problem. On the top left, Charlotte draws a playful picture on a *Sketch Pad* media item (12); Carman responds by sketching his thesis context on another and Charlotte joins in to help him (13). Three *Availability* media items show additional activity status information for Carman (14), Saul (15) and Charlotte (16). Charlotte uses the default image on the icon (the thoughtful elephant) while both Carman and Saul put in their own images to visually indicate their availability state. The *Desktop Snapshot* (17) beside the availability icons cyclically exhibits

regularly-taken but scaled snapshots of the desktop displays of all the online people who choose to participate. Near the bottom left, Tony posts some photos on the *Photo Show* media item (18) and a link to an interesting site through the *Web link* (19) to share with his online friends. Finally, Charlotte uses the *NC Chat* (20) to enquire who are present in the laboratory (she is working from home). In this way, the whole community can communicate and share information using the media items.

The NC has proven effective in providing opportunities for casual interaction by attracting people's attention and thus arousing their interest, as illustrated by the above example (Greenberg and Rounding, 2001). More detail about the NC will be discussed in the next chapter.

### 1.1.3 Conversation History

Much research in casual interaction is focused on creating technology to support conversation, e.g., *CAVECAT* (Mantei et al., 1991), *Portholes* (Dourish and Bly, 1992), *Cruiser* (Fish et al., 1993), *Montage* (Tang et al., 1994), *Peepholes* (Greenberg, 1996) and *Notification Collage* (Greenberg and Rounding, 2001). In essence, these technologies focus on the present: how people find, receive and respond to messages. In contrast, my interest is on the past, where conversations are captured as a history and then offered to people in a manner that makes them easy to review.

***Why is it important to research histories of conversation?*** Activities such as negotiating a deal or making business decisions no longer have to take place in formal business meetings—in fact, a significant portion of idea generation and decision development occurs outside formal meetings (Minneman et al., 1995). Today, many business decisions as well as social activities occur via computer-mediated casual interactions. The lack of meeting records for these interactions represent a significant loss, as future users should be able to benefit from previous work in order to better solve and understand current problems (Wexelblat and Maes, 1999; Smith et al., 2000). Therefore, from an end-user perspective, a retrievable record of these discussions and decision processes would be valuable. From a researcher perspective, human factors

researchers often examine data to isolate meeting events, identify trends and patterns, and use the distilled data to illustrate theories and phenomena (Mackay and Davenport, 1989). Therefore, examination of the conversational histories may uncover the interaction dynamics and culture embedded within a group which in turn may be useful to understand organisational collaboration. From a usability engineering perspective, a history may also reveal the more subtle requirements for a computer-mediated casual interaction tool, and these requirements can then be used to guide improvements.

### **1.1.4 Challenge of Capturing Multimedia Casual Interactions**

For clarity, the term ‘conversation’ used in this thesis does not limit to textual utterances, but also include other media involved in the communication. Unlike ordinary text-based chat, conversations occurring over multimedia systems akin to the Notification Collage have several distinguishing characteristics that should be considered in a conversation capturing tool.

1. ***Episodes of varying time spans.*** Unlike formal meetings, the duration of casual interactions is variable. Particular interactions can be extremely brief, such as the quick wave over a video link to signal a greeting. They can last several minutes, e.g., a textual exchange over some topic, or be running dialogues that people contribute to sporadically over the course of hours or even days. Finally, episode sequences may span weeks and months, as they reflect the group’s evolving relationships and work duties.
2. ***No formal start and stop point.*** Casual interactions are often unplanned and impromptu. They often happen regularly, yet spontaneously, over the course of a relationship (Whittaker et al., 1994). Thus, there are no formal start and stop points for casual interactions. Unlike formal meetings where agendas determine the beginning and ending of the conversations, casual interaction in general often occurs disjointedly. In everyday life, for example, two people may casually converse while riding together in an elevator, then when they come out of the elevator, they head to their own offices without formally signalling the end of the conversation; they may

pick up the conversation again when they run into each other the next time riding in the same elevator or when they meet in the coffee room. This phenomenon is even more pronounced with the NC: when people see communications made by others on the NC, they may then join in to continue the conversation, or start a new one on a related topic.

3. ***Self-contained vs. multiple communication channels.*** Some casual interactions are completely self-contained, where a particular topic is introduced and dealt with in a single communication medium. An example could be a textual note on where to meet for lunch. Other interactions can persist over a series of dialogues via different channels of communication (Nardi et al., 2000). For example, collaborators could start a topic on software development of the NC and continue with a face-to-face discussion over lunch. The discussion could continue again on the NC perhaps across several media items, or through another communication channel like instant messaging. Such interaction sequences can be very complex. Since media switching is common, it is very difficult to capture the complete sequence of conversation, particularly episodes containing face-to-face encounters.
4. ***Many interleaved public conversations.*** When a person posts a media item on the NC, others can see and may then act upon it by posting other media items. For example, several people may be discussing their research on the NC. Other observers find the conversation interesting, and decide to join in by posting different media items to contribute their ideas. On the other hand, other separate conversations may be taking place simultaneously on the NC, and people may participate in multiple conversations concurrently. As such, conversational threads may become heavily interleaved with contributions made through a variety of media items from different people.
5. ***Awareness, artefact exchange, and/or conversations.*** Casual interaction made through computer-mediated tools is much more than conversations. People use awareness-rich media to indicate their availability to others, who may then act upon it to move into a conversation. The lightweight and real-time communication offered by the medium-rich interface often offers people low-cost means to communicate. To



complement on-going conversations or to initiate one, people may then bring sharable artefacts into a public view.

6. ***Media items differ considerably in terms of what they contain and how they are used.*** Currently, some media items are text while others are image-based. Some are discrete elements (e.g., a single web page thumbnail), some are bursty (e.g., a sticky note containing evolving fragments of a text conversation), some are composites (e.g., a photo slide show), and some are continuous (e.g., the sequence comprising a video stream). Future media items may also include other forms of media such as audio clips and video/audio streams.

In general, people use these media items for different purposes. Some actively interact by sharing information through a choice of text notes, images (e.g., their own snapshots or interesting artefacts for sharing) or other combinations. Some prefer to be aware of the happenings in the community through the changes in the media items without actually contributing to the conversations. Some prefer to post interesting information so others can interact with it in depth, e.g., web thumbnails invite interested people to examine the posted web page.

These properties make it a much more challenging task to create a conversational history tool for multimedia groupware interactions than for simple chat tool system.

### **1.1.5 Visualizing a History of Multimedia Casual Interaction**

Because computer-mediated conversations are very often lengthy and interleaved with threads, the information space that evolves over time will therefore be huge. Smith et al. (2000) reported in 1999 that there were 430 million instant messages exchanged each day on the AOL network and 330 million exchanges on ICQ. As mobile messaging services, e.g., short message systems (SMS), become more prevalent, communication volumes will continue to increase dramatically (Smith et al., 2000). As this information space becomes overwhelmingly large, the use of good information visualisation techniques becomes increasingly important for re-visitation and exploration of the data.

I believe that the conversational histories and the visualizations of them are valuable from two different end-user perspectives:

1. **Group member's perspective.** A group member can browse and review his own conversation history to remind himself of what has transpired, or to retrieve critical details. As well, members can review missed conversations that are relevant to them, and new members can easily familiarize themselves with project work and the workgroup culture by reviewing such histories.
2. **Researcher's perspective.** Researchers can analyze group activity using a conversational history. This is crucial from a sociological perspective as it helps to understand how conversations are affected by new communication media, and from a usability perspective because it can help fine-tune the groupware interface and functionality.

Although there has been some work on conversational histories, most concentrate

ID	Date	Time	Key	Value
4598	7/17/2002	2:35:19 PM	Charlotte	\\ImageFolder\07172002_143519.jpg
4601	7/17/2002	2:35:49 PM	Charlotte	\\ImageFolder\07172002_143549.jpg
4604	7/17/2002	2:36:19 PM	Charlotte	\\ImageFolder\07172002_143619.jpg
4605	7/17/2002	2:36:34 PM	Charlotte	Just let everybody know that if VisStream is on to capture conversation or when I try t
4607	7/17/2002	2:36:49 PM	Carman@Microsoft	\\ImageFolder\07172002_143649.jpg
4614	7/17/2002	2:38:19 PM	Charlotte	\\ImageFolder\07172002_143819.jpg
4692	7/17/2002	3:29:58 PM	Carman@Microsoft	mine was like a yo-yo
4694	7/17/2002	3:31:44 PM	Carman@Microsoft	mine was like a yo-yo
4696	7/17/2002	3:31:46 PM	Eric	hehe is the demo that Saul wanted to do over? That would be Murphys Law ... when
4721	8/2/2002	2:22:29 PM	Mike R@Home	\\ImageFolder\08022002_142229.jpg
4722	8/2/2002	2:23:07 PM	Carman@Microsoft	\\ImageFolder\08022002_142307.jpg
4723	8/2/2002	2:23:07 PM	Demo	\\ImageFolder\08022002_142307.jpg
4724	8/2/2002	2:23:07 PM	Edward Tse	\\ImageFolder\08022002_142307.jpg
4725	8/2/2002	2:23:56 PM	Charlotte	Thank you, I finally see the VisStream in RED :-)
4726	8/2/2002	2:24:12 PM	Carman@Microsoft	hey, cool -> red
4727	8/2/2002	2:24:19 PM	Mike R@Home	it's good! happy mike, happy charlotte. :)
4728	8/2/2002	2:25:29 PM	Mike R@Home	\\ImageFolder\08022002_142529.jpg
4729	8/2/2002	2:26:10 PM	Mike R@Home	\\ImageFolder\08022002_142610.jpg
4730	8/2/2002	2:26:35 PM	Charlotte	I have got to go out but I'll leave VisStream to work until it dies :( If it crashes your ma
4731	8/2/2002	2:26:40 PM	Mike R@Home	\\ImageFolder\08022002_142640.jpg
4732	8/2/2002	3:41:32 PM	Carman@Microsoft	\\ImageFolder\08022002_154132.jpg
4733	8/2/2002	3:41:39 PM	Mike R@Home	\\ImageFolder\08022002_154139.jpg
4734	8/2/2002	3:41:49 PM	Demo	\\ImageFolder\08022002_154149.jpg
4736	8/2/2002	3:46:57 PM	Carman@Microsoft	let it snow, let it snow, let it snow ;)
4737	8/2/2002	3:47:30 PM	Michael Boyle	It looks pretty cloudy out here right now. I don't think we'll have all that great weather
4738	8/2/2002	3:47:57 PM	Mike R@Home	now there's wicked wind. a friend downtown said it was snowraining down there
4739	8/2/2002	3:56:55 PM	Mike R@Home	*ugh* my house is being pelted by slush
4740	8/2/2002	4:14:40 PM	Mike R@Home	yep
4741	8/5/2002	12:00:38 PM	Saul@home	\\ImageFolder\08052002_120038.jpg
4742	8/5/2002	12:00:42 PM	Demo	\\ImageFolder\08052002_120042.jpg
4744	8/5/2002	12:12:50 PM	Demo	\\ImageFolder\08052002_121250.jpg

Record: 1 of 1027

Figure 1.2: A recorded log (a small segment only) of casual interaction occurred on the Notification Collage

on either formal meeting capture, e.g., video/audio capture tools (Minneman et al., 1995), or asynchronous text exchanges, e.g., such as threaded chat (Owen et al., 1994; Smith et al., 2000). These approaches do not cover groupware systems that support both awareness and long-term casual interactions in a rich multimedia setting.

Since casual interactions are characterized by being opportunistic, brief and context-rich, and the conversational threads are often lengthy, interleaved and prolific, a record of these exchanges over time creates a substantial information space. For example, the recorded raw log of an NC conversational fragment is shown in Figure 1.2. It somewhat resembles an unedited transcription of speech (Donath et al., 1999; Smith et al., 2001). This particular log fragment preserves the temporality of the events as they occurred, e.g., new events appear at the bottom of the list. Displaying the time-ordered interactions as an abstract textual list of media may conserve screen real estate, but it also makes the interaction very hard to understand because communicated images are not shown in recognizable picture format. One way to get around this problem is to display

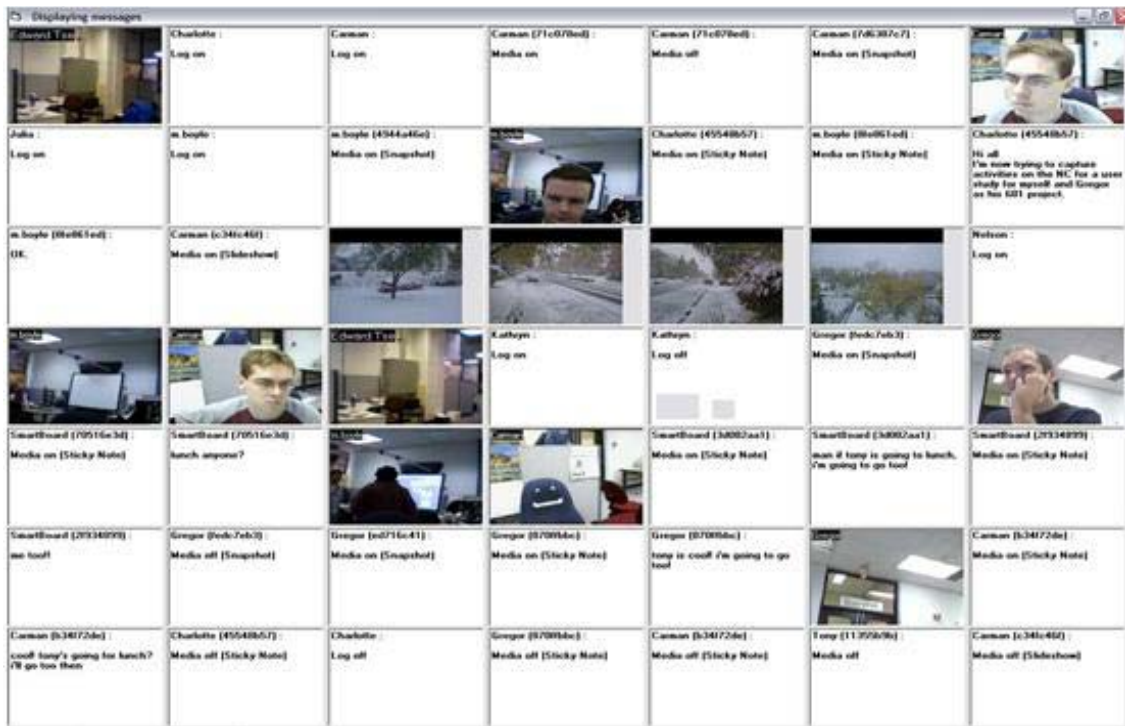


Figure 1.3: A 1280 x 1024 pixel display showing a total of 49 media items in full fidelity

the interaction in full fidelity (Figure 1.3), with items time-ordered in row/column order. Yet this visualization greatly restricts the display to show only a small segment of the interactions at a time, as images are space-intensive. Another alternative is to replay the interaction as a ‘video stream’ where items appear and disappear on the board to re-enact what happened during the NC conversation. This solves the problem of displaying space-intensive images; yet, it only focuses on what happens at a particular point in time and it does not offer any abstract view of the interaction.

I believe it is necessary to develop visualization techniques and tools that will support navigation and analysis of these temporal histories. In particular, visualization techniques of casual interactions will provide a valuable new tool for various disciplines—social-psychology, human-factors engineering, and computer science—and will help researchers understand the impact of technology on distance-separated group works.

While much effort has gone into developing novel computer-based systems for casual interactions, there is surprisingly little effort in investigating how and what people will do with the history of interactions that have occurred within these systems.

## 1.2 Problem Statement

I will address several existing problems in the area of capturing and visualizing multimedia conversation histories.

1. **We do not know how to effectively capture the information communicated through a multimedia conversation tool.** Information posted to current media-rich casual interaction tools, such as the Notification Collage, is ephemeral. When an item is deleted from the tool interface, there is no way to retrieve it later: no permanent record is kept. This prevents researchers from analyzing these casual interactions, and participants from retrieving and reviewing conversations. To solve this problem, I will design and build a conversation capturing tool to capture the interaction history. I will track any issues that emerge and propose solutions to these issues (Goal 1).

2. **We do not know what people want to use these interaction histories for and how they want to go about these tasks.** In order to effectively help people navigate and examine the interaction histories, we must find out what tasks people want to perform over the captured history and how people want to visualize this interaction history to help them perform these tasks. To do this, I will perform an exploratory study to uncover a taxonomy of tasks and visualizations favoured by group members and researchers for conversational histories (Goal 2)
3. **There is no visualization tool that helps people review and analyse histories of multimedia casual interactions.** Large information spaces and small screen real estate available on our computer displays are the major issues that must be considered when designing the visualization tool. I believe that the ideal strategy for presenting different kinds of information varies according to the characteristics of the information itself (Section 1.1.4). To solve this problem, I will design and implement a prototype tool called VisStreams that addresses the properties of the multimedia casual conversations (Section 1.1.4) and that lets people visually navigate the captured interaction history (Goal 3). The prototype will employ a spectrum of information visualization techniques including dynamic filtering, detail-in-context and selective zooming. We do not expect this tool to be the final ‘solution’ of conversation visualization. Rather, it will serve as a ‘straw man’ that will help us understand what these systems should offer.

To summarize, the goals of my research are to present the difficulties in capturing histories of multimedia casual interaction, and to place the challenge of designing a history visualization system on a more empirical footing. I will present a taxonomy of task and visualization requirements for such history systems, which will help designers who are working on similar tools. I will also present and critique a prototype tool called VisStreams that allows people to visualize and review captured interaction history.

## 1.3 Overview of the Thesis

Chapter 2 provides background on the fundamental issues of this research—casual interaction, computer-mediated communication tools, meeting capture and visualization of temporal data. I consider how casual interaction leads to effective collaboration and how technology facilitates casual interaction. I investigate techniques used in existing meeting capture tools and visualization systems for temporal data.

In Chapter 3, I describe the Notification Collage interface and its system architecture. I then present the issues that emerged while developing the conversation capturing tool. Finally I describe the conversation capturing tool, and my solutions to the issues (Goal 1).

In Chapter 4, I describe the conversation visualization prototype, called VisStreams v1.1. I present a scenario of how a person uses the VisStreams prototype to examine and navigate the conversation history (Goal 3). I also discuss several issues pertinent to the implementation of VisStreams. Next, I briefly summarize the results obtained from a pilot user study performed on a previous version of the prototype.

In Chapter 5, I describe in detail an exploratory study that uncovered the tasks that people would perform on the conversation histories, and the visualizations that would help people perform these tasks (Goal 2). I then use the study findings to recommend several task-oriented views that may be incorporated into the visualization tool for reviewing and analysing the histories of multimedia casual interactions.

In Chapter 6, with the results obtained from the exploratory study described in Chapter 5, I evaluate the VisStreams prototype based on the task-centered views recommended in Chapter 5. I discuss if and how each of these views is supported by VisStreams and where and why VisStreams fails to address them. I also provide low-fidelity prototypes, that, although not implemented or formally evaluated, serve to direct the next design iteration and to identify open research areas.

Finally in Chapter 7, I summarize the main findings and contributions of the research, and suggest directions for future study.

## Chapter 2. Casual Interaction and Visualization

---

My research focuses on visualizing multimedia histories of casual interactions, which in turn requires me to bring together knowledge from three areas. The first area, briefly introduced in Chapter 1, is casual interaction and the technology supporting it. I will show the importance of casual interaction in workplaces and how technology can help facilitate casual interaction. The second area I will look at is meeting capture. Since there is no existing tool for capturing multimedia casual interactions, I will review current technologies for capturing formal meetings. From these, I will identify the design principles that can be applied to capturing tools for multimedia casual interactions. The last area is visualization of time-based interaction histories; while the domain differs from meeting capture, methods used to visualize temporal data may be relevant.

### 2.1 Casual Interaction

*Casual interactions* are spontaneous and one-person initiated meetings that occur over the course of the day. They are characterized by being brief, unplanned and frequent (Fish et al., 1993; Whittaker et al., 1994). Casual interaction is also known as informal communication; it is distinctively different from the structured and planned nature of traditional formal communication (Fish et al., 1990).

While informal communication may seem mundane and unimportant, it actually plays a significant role in fulfilling work-related task activities, co-ordinating work groups, fostering knowledge, and sharing social and cultural communications (Kraut et al., 1988; Fish et al., 1992). This is important, for social relationships in the workplace



are crucial for providing job satisfaction and a sense of belonging to co-workers (Root, 1988), as well as bringing about collaborative research activities (Kraut et al., 1988).

*Informal awareness* is a naturally gained understanding of who is around, what they are doing, or who is available for interaction. This awareness holds casual interaction together by allowing people to decide if and when to move into conversation (Kraut et al., 1988; Dourish and Bly, 1992; Bellotti and Sellen, 1993). It comes naturally when people are in the same physical environment (Greenberg, 1996); however, people lose this sense of awareness when they are spatially distributed unless technology is there to support it.

*Physical proximity* facilitates face-to-face communication by affording informal awareness, and by providing convenient access to potential collaborators and an easy channel for frequent, impromptu and brief communications. Studies have shown that people who are spatially closer are more likely to interact than those who are separated by distance, even if the distances are small (Hagstrom, 1965; Kraut et al., 1988). Proximity is vital to work collaborations because it brings people together by providing the opportunity for partners to meet, identify problems, plan for the projects and supervise subordinates (Kraut et al., 1988). Indeed, Kraut et al. (1988) showed that interactions drop exponentially as the distance of separation increases.

While proximity is important to casual interaction, we are now seeing distance-separated groups becoming more prevalent. For example, many organizations are so large and space is so tight that co-locating a large team is often impractical. Telecommuting has become commonplace. Businesses are globalizing in modern society and require teams to work together from different organizational locations. If these teams are to work together effectively, it is imperative to find solutions to overcome their difficulty of casual interaction.

## 2.2 Technologies for Casual Interaction

The fact that people who are physically close in proximity are more likely to communicate frequently and casually suggests that we should design technology that artificially brings distance-separated people into something resembling close virtual proximity (Kraut et al., 1988; Fish et al., 1990; Whittaker et al., 1994). Consequently, there has been mounting interests in recent years to develop real-time communication tools to promote casual interaction amongst distributed workers. Popular technologies include instant messaging systems and media spaces, which will be discussed next.

### 2.2.1 Instant Messaging

*Instant Messaging* (IM) offers impromptu, brief and context-rich interactions in near-real time. Almost all IM systems are one-person initiated where a person can start a directed conversation with another person. Some IM systems, e.g., AOL Instant Messenger and MSN Messenger, support multiparty chat by allowing people to invite others to join in the conversation.

AOL Messenger System, MSN Messenger, Yahoo! Messenger and ICQ are commercial examples of IM. All offer minimal real time awareness information, usually by indicating presence as estimated by keyboard or mouse activity. Figure 2.1 shows the user interfaces for MSN Messenger. The interface on the far left shows 6 friends on the list are logged on (as shown under 'Online'); among these 6 online buddies, 3 are estimated as being 'away' because they have not touched their mouse/keyboard for several minutes (icons with a clock). Others (i.e., 19) are not logged on (as shown under 'Not Online'). Clicking an online buddy's name on the list creates a text-chat box (middle interface) where a person can chat with his/her 'buddy'. From this chat box, one can invite other online buddies into the conversation. The chat box shown involves a three-party conversation between Charlotte, Carman and Nelson. In addition to the text chat, files and images may be transferred (as shown near the bottom of the leftmost

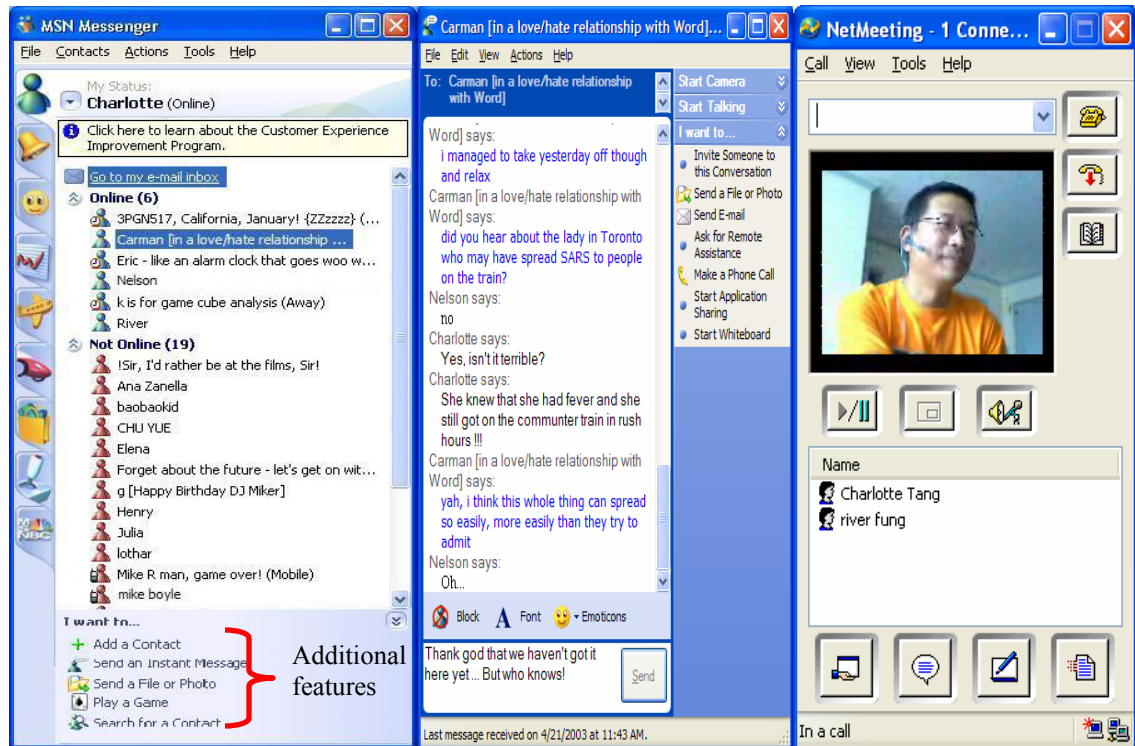


Figure 2.1: MSN Messenger interfaces: the left interface shows availability status of buddies; the middle interface shows a 3-party chat between Charlotte, Carman and Nelson; the right interface displays a video stream of River as seen on Charlotte's monitor, although River is not a participant in the chat dialog.

interface) or a video channel (right-most interface) may be opened. These multimedia features are fairly recent additions, usually as poorly integrated add-ons.

Studies by Nardi et al. (2000) showed that most people use IM as a tool to ask short questions, to make simple clarifications, to arrange and schedule social or work-related meetings, and to build social relations. Given its spontaneous nature, IM is often used as the primary means to find out if a person is available by consulting the buddy list or by prompting with a short presence query like “Free to talk?” This provides a quick way to locate an intended collaborator while minimizing the interruption rendered by a phone call or an office visit; thus the online presence indicator of others is important.

IM allows for *plausible deniability* about a recipient's presence if he or she does not respond to an instant message (Nardi et al., 2000). This is because IM states are often inaccurate indicators of presence, since they estimate it by measuring keyboard/mouse

inactivity. Therefore, the person who initiates a conversation is generally uncertain if the intended recipient is actually there or not. As a result, the intended recipient's failure to respond is not necessarily interpreted as rudeness. On the other hand, responding to an instant message is extremely lightweight relative to the effort required to retrieve and respond to a voicemail message or phone someone for a conversation at just the right moment. In comparison, only about 40% of workplace phone calls reach intended recipients. As well, IM keeps a short term record of the conversation: as long as the point-to-point link is on, instant messages are persistent and retrievable so that the ongoing conversational context can be maintained (Nardi et al., 2000).

### 2.2.2 Media Spaces

At the other extreme of current technology for casual interaction, a *media space* provides a rich multimedia communications environment to connect collaborators, offering them rich awareness and easy communication through always-on video and audio links (Mantei et al., 1991). The activity and availability of a person is easily determined by glancing at the video link. A person can initiate a conversation through means similar to face-to-face situations, e.g., glancing or gesturing. Such actions can result in full-scale audio/video conversations if the recipient accepts the initiation. However, with video there is no chance for *plausible deniability* of presence (Nardi et al., 2000) as social obligation compels people to acknowledge their presence when they are visible through the video link (Fish et al., 1990). Much effort has been put in designing media spaces to enhance effective communication.

*Xerox PARC Link* was the first known media space system put to use in a real setting between two research offices. It provided a round-the-clock open link of full video and audio between the commons areas of two geographically separated sites in Portland, Oregon and Palo Alto, California. When analyzing conversations over the link, Olson and Bly (1991) found that 70% of the link conversations were brief, informal 'drop in' interactions which were unlikely to occur without the link. The remaining 30% were formal scheduled meetings which would have taken place anyways. This pioneering

system played an important role in demonstrating that distributed awareness and, thereby, casual interactions can be supported by media spaces (Goodman and Abel, 1986).

The full-video used by Xerox PARC link required substantial bandwidth. This is not desirable for connecting a large number of distributed groups. Therefore, *Portholes* presents an ‘overview’ of a community by broadcasting a set of regularly-updated digitized video images from many distributed locations including personal offices and common areas (Dourish and Bly, 1992). Essentially, Portholes displayed a grid of small images, where each image was a video snapshot of a remote location taken, say every minute or so. Portholes proved to be a lightweight tool to find out if a colleague was available and to offer quick and brief information exchange. It also had an integrated email system that allowed directed messages to be sent between collaborators. In essence, Portholes created a multipoint shared community where people could meet and know more about remote colleagues.

*Cruiser* (Root, 1988; Fish et al, 1993) was a desktop video/audio conferencing system that supported informal communication through an ‘offices-along-hallway’ metaphor. In the real world, people will meet while walking along a hallway or they will glance into an open office to see if a person is available. These encounters often lead to interactions. Cruiser imitates these real world activities by offering three ways to encourage spontaneous conversation. First, a person can directly ‘call’ a named party; a video conversation will take place if the called party accepts the call. Second, a person may wander a virtual corridor; video links are opened to random offices, simulating serendipitous hallway encounters. Third, one can glance into people’s offices to check for their availability; if they are there, the person can then make a directed call to the available individual. To address privacy concerns, Cruiser imposed a reciprocity rule on all calls so that, for example, if John sees Mary, Mary sees John too. It also provided a ‘do not disturb’ mode to block others from glancing at an inappropriate time. Studies showed that people used Cruiser mainly for greeting others and scheduling appointments. Problem solving and decision making was accomplished by switching to another medium such as face-to-face meetings. This is likely because Cruiser users were co-located in the

same building (making face-to-face meetings possible), and because Cruiser did not offer necessary tools and artefacts like shared whiteboards and editors for people to move into actual work (Fish et al, 1993).

*Montage* (Tang and Rua, 1994; Tang et al., 1994), which also used the hallway model, differed from Cruiser mainly in that it provided richer communication media: a shared whiteboard for drawing and writing during interaction and textual notes for messages. It also allowed people to look up another's online calendar to estimate their availability.

This evolution of media space systems illustrate that designers have moved from two-point to multi-point connectivity, and that they supply ever richer media that include more task-supportive features. Consequently, newer systems not only provide distributed awareness crucial for casual encounter, but also allow people to easily move into purposeful interaction.

## 2.3 Meeting Capture

Current computer-based systems for supporting real-time casual interactions focus only on the present: the information communicated is typically ephemeral. This means that group members cannot review past conversations or view missed ones. It also means that researchers cannot analyze these conversational activities unless they instrument the systems.

Yet we have already explained how casual interaction is the backbone of everyday collaboration. Casual interactions contain a wealth of valuable production- and socially-oriented information (Kraut et al, 1988; Root, 1988; Whittaker et al, 1994). Some of this information is vital to group goals and processes, and should not be lost. Nevertheless, this area is unfortunately under-researched (Minneman et al., 1995). To my knowledge, no system currently logs computer-based *multimedia casual interactions*. What does exist are capture systems for formal meetings, e.g., Classroom 2000 (Abowd et al., 1998) and ToMaTe (Arapis, 1999); few of them also capture informal collaborative activities during

the scheduled meetings, e.g., Coral (Minneman et al., 1995). I will identify several design principles from these systems to aid designers of similar systems for capturing computer-based multimedia casual interactions. This section discusses each of these design principles and how the principle helps subsequent information access and retrieval, which is the ultimate goal of capturing these interactions. These principles will be used to guide the design of the conversation capturing tool described in the next chapter.

### **2.3.1 Time-stamp Events**

In cognitive psychology, two types of memories are defined. Semantic memory refers to the memory that involves mapping meaning to events and episodic memory is the memory of life experiences that enables people to reconstruct sequences of events that have occurred in the past (Geyer et al., 2001).

People are often able to adopt idiosyncratic temporal markers to recall incidences happened in the past. For example, one may recall that an event happened around the time a visitor dropped into the laboratory, or shortly after a meeting. Therefore, to retrieve from a history of casual interaction, episodic memory is more relevant. This is so because all casual interactions have one thing in common: the dimension of time. Therefore, time-stamping interaction events as they occur is important for later browsing and retrieval of information (Minneman et al., 1995; Arapis, 1999; Geyer et al., 2001). It also lets one re-construct the meeting in time order.

### **2.3.2 Allow Indexing of Captured Materials**

If a captured record does not provide indices for people to access a particular point in the record upon demand, people will have to tediously browse the entire record to locate the point of interest (Arapis, 1999). The captured record in this case is then a mere static transcription of what has happened in the past. This is not a satisfactory solution for information retrieval. One solution is to index the captured material with meaningful (or at least heuristically useful) pointers. Users can browse these indices, and if they find

them of interest, they can randomly access the records (Minneman et al., 1995). For example, indexing a person's first appearance and departure allows users to directly access the indexed event.

Indices can also be created manually when people intentionally flag or annotate particular time points or segments of activity during interaction, or when annotations are added to records after the interactions (Minneman et al., 1995).

There are advantages and disadvantages for using these indices. Automatic flagging does not hinder the natural communicative and interactive activities of a meeting, but if time is the only criterion used for indices then nothing about the event or interaction will be revealed. Thus, semantic annotations, which describe the interaction in a more meaningful way, can be deliberately created by people as indices during interaction. This however often obstructs the natural progress of the interaction and even distorts the normal practice of participants as they have to attend to note-taking while interacting. To avoid the drawback of real-time annotation, one can then annotate afterwards, yet post-record annotation unfortunately consumes an extensive amount of time and is rarely done.

### **2.3.3 Allow Query**

If a person wants to find specific information from a captured record of interactions, a query mechanism will let them efficiently retrieve parts of a record of interest (Arapis, 1999). Therefore, capture tools should ensure that users can query the interaction record so that segments of interest can be retrieved for review. To facilitate queries, systems commonly store records of past events in a database. When query capabilities are combined with the indexing facility, this database of interaction events will enable direct and random retrieval of desired segments of the captured interactions.



### **2.3.4 Provide for Different Media Types**

New communication genres often involve multiple media types: text, image, audio, video and animation. Each media type has its own inherent characteristics that affect how it should be stored and retrieved. For example, text chat data, usually comprising a timestamp, a participant's name, and the message, can be stored directly in a text-based database. Other media types may require special techniques, e.g., encoding and compression mechanisms, in order to store and retrieve the data efficiently and properly. This is especially true for large binary data, such as video streams. In general, capturing tools and also its underlying database should be extendible to the data types and formats that the communication tool handles (Arapis, 1999).

### **2.3.5 Be Unobtrusive**

Capturing tools must not inhibit or distort the natural interactions of casual encounters (Neal and Simons, 1983; Minneman et al., 1995). If the capturing tool gets in the way of the interactions, or if it compromises performance, participants may change their interaction patterns. For example, people may feel 'spied' upon if they find the capture tool obtrusive, and then may resort to using another communication channel. On the other hand, if participants have to make an extra effort to have their interactions captured for later use, e.g., to monitor a complicated capture interface, they may give up using the capturing tool. Therefore, Rubin (1994) believes that fully-automated logging process is most desirable.

## **2.4 Visualization Techniques**

As explained in Chapter 1, lengthy recorded logs of casual interactions do not offer much benefit if people cannot browse or view them efficiently. This implies that the record must be visualized. While there is no known visualization tools developed specifically for multimedia casual interaction histories, there are a few other general techniques for visualizing large information spaces of temporal data. In this section, I will discuss

techniques used in previous work to visualize temporal data, and that suggest how we can visualize casual interaction histories.

### 2.4.1 Timelines

A linear timeline is intrinsically a prime candidate for displaying temporal data. Timelines provide an efficient mapping between events and their chronological ordering of occurrences, which in turn helps preserve the context of events. In contrast, a non-linear representation of time often distorts the temporal relationships between events and so confuses their context (Richter et al., 1999).

Smith et al.'s (2000) 'piano-roll' representation of document annotation presents a data-rich example of a timeline (Figure 2.2). Every row is a document and every column is a day. Documents are sorted in order of the day on which they were first annotated. Each point represents a day on which a document was annotated at least once. By looking at the top-most points, people can get a sense for the rate at which new documents were being annotated. With the two light grey lines near the top marking

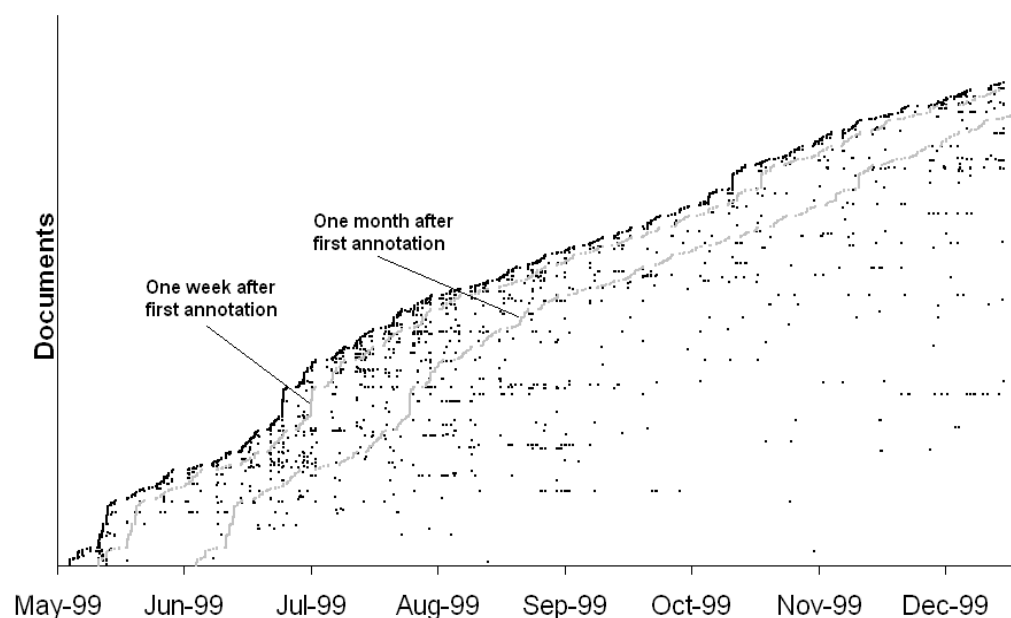


Figure 2.2: A 'piano-roll' representation of document annotations made over time. (Source: Smith et al., 2000)

week and month time difference, people can get a sense for the time period over which documents were annotated. The scattered data points generally show that a good amount of documents are annotated over a very long period of time (more than 6 months in some cases). As with many excellent graphs, this one shows both global patterns while still allowing a person to explore data in detail (Tufte, 1990).

Another example is *Lifelines* (Plaisant et al., 1998), which uses multiple timelines to display the medical history of a patient. As seen in Figure 2.3, the horizontal timelines are scaled into years as shown near the top of the display. Each timeline represents the duration of a disease. At a glance, we can find out the onset of a disease and how long it has lasted. In the particular case shown in the figure, the patient has had the coronary artery disease since early 1990 and the congestive heart failure started in early 1993. The overlapping of the two timelines indicates that the patient has had these two diseases concurrently during that time period.

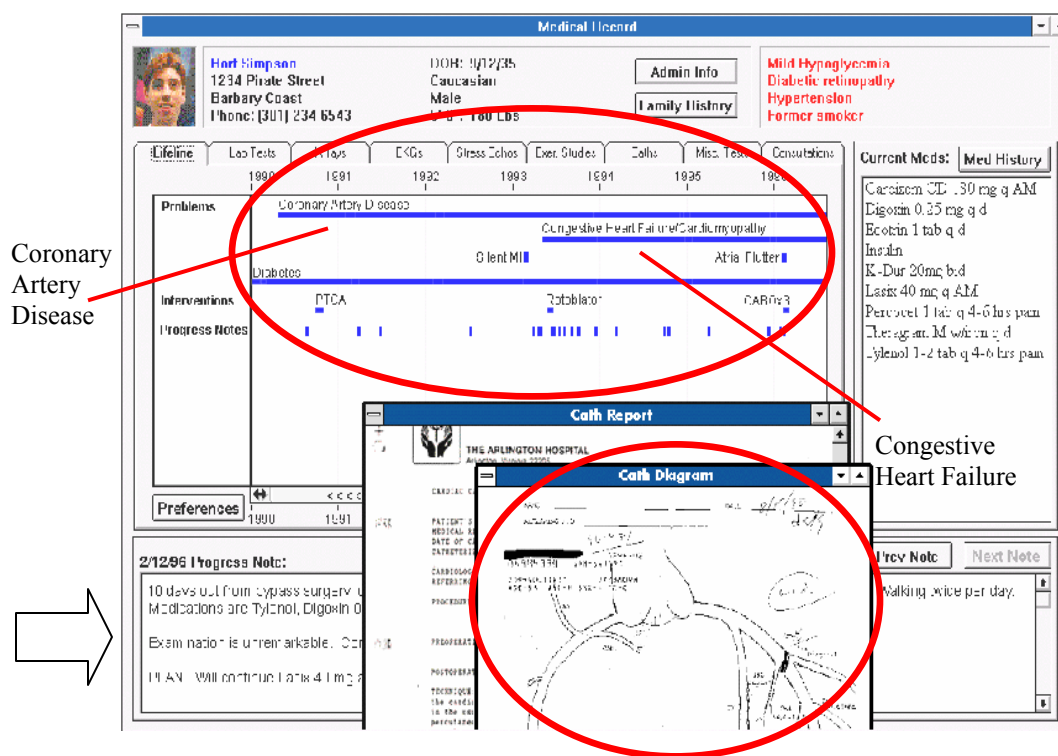


Figure 2.3: Lifelines for visualizing patient records—horizontal timelines are used for duration of diseases (top circle) and details of the disease is shown as inset (bottom circle) (Source: Plaisant et al., 1998).

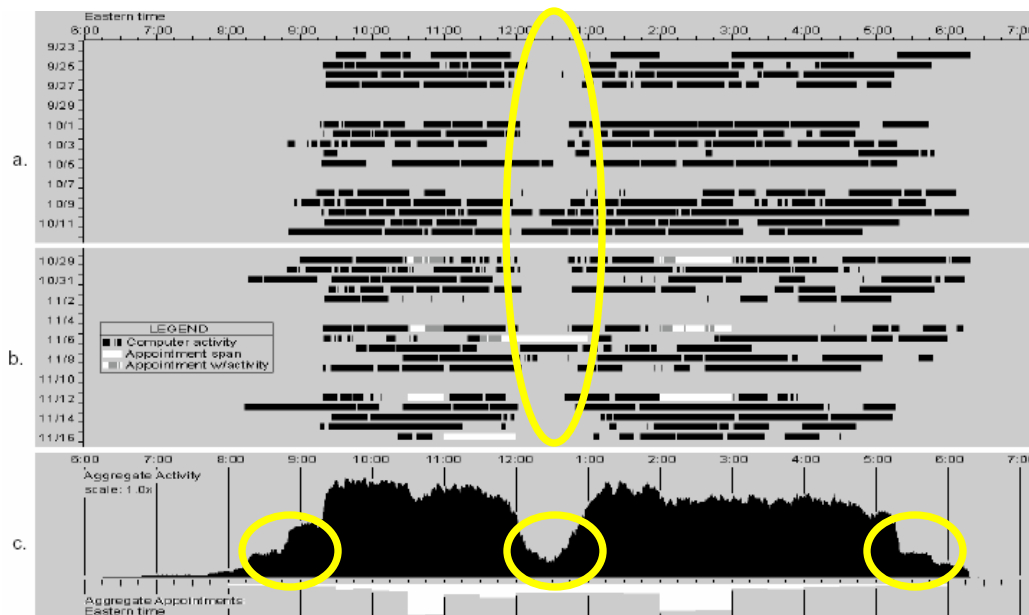


Figure 2.4: Work Rhythms—Visualization of a user's computer activity. (Source: Begole et al., 2002)

In other research, Begole et al. (2002) combine *timelines* and *histograms* to analyze the history of a person's online activity patterns in order to identify convenient times to contact a distributed collaborator who is not only spatially separated but also time-shifted due to different time zones. The arrangements shown in Figure 2.4a and 2.4b are called actograms. Each row represents daily activities and the column represents multiple days at that time instance. A person's computer activity periods are indicated as black lines while his/her inactivity is shown as gaps along the timelines in both figures. In addition, Figure 2.4b displays this person's online appointment times (shown as white lines) and computer activity during appointments (shown as grey lines). Both figures show general daily patterns in the person's activity like typical arrival, lunch and departure times (e.g., the large oval signifies typical lunch breaks for this person). Figure 2.4c shows an aggregate histogram in which the height of the graph is the sum of the days over the entire study period that the user was active at each time interval (one minute in this case). The lunch hour is clearly visible (small oval in the middle). The graph also reveals other trends, e.g., it is likely that this individual arrives at work around 8:40 a.m., and rarely before 8:00 a.m. (small oval on the left). Similarly, he/she leaves around 5:15

p.m., and rarely stays later than 6:00 p.m. (small oval on the right). This technique can be applied to investigate trends and patterns of casual interactions in a work group.

### 2.4.2 Details on Demand

The previous visualization shows an overview of data so that one can examine trends and spot patterns for exploration. They do this at the cost of hiding detail. One common way to show detail is through details on demand, where people can selectively examine data presented in an overview. For example, *Lifelines* gives viewers direct access to details on demand of particular medical records as shown in Figure 2.3 (Plaisant et al., 1998). Upon clicking one of the icons along the ‘Progress Notes’ (big arrow on the left of Figure 2.3), a front inset window is raised (circled at the bottom) which shows a sketch of the patient’s heart. This is accompanied with the doctor’s notes regarding the patient’s condition. *Lifelines* allows comparison of different details (perhaps a disease’s progress in different time periods) by letting users demand and display multiple windows of detail

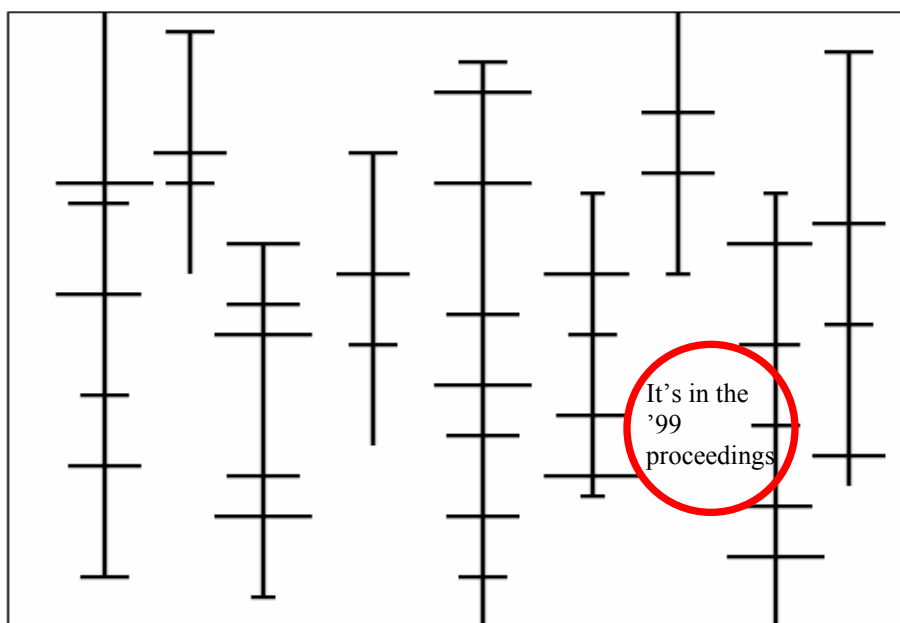


Figure 2.5: Conversation Landscape (Donath et al., 1999). Each vertical line represents a login session of one participant, the horizontal lines are conversations, their lengths represent the conversation duration. (Re-created for better image quality)

information (not shown).

*Conversation Landscape* (Donath et al., 1999) also integrates timelines with detail-on-demand to visualize textual chats. As shown in Figure 2.5, participants of a chat community are arrayed along the x-axis and time is linearly represented by the y-axis starting from the bottom. Each vertical line represents a login session of a participant and each intercepting horizontal line represents a textual contribution made by that person, where its length reflects the length of the message. Details of the textual message can be displayed by clicking on the horizontal segment, where the message is popped up next to its data point (circled item). This interface, however, is limited to showing only one message in detail at any one time. It only deals with text chats, without considering other media types.

### 2.4.3 Focus and Context

While details-on-demand helps, it suffers in that details are often shown out of context, e.g., a fragment in a separate window or pop-up. Focus-and-context visualization technique solves this problem. It provides detailed view of specific parts of an

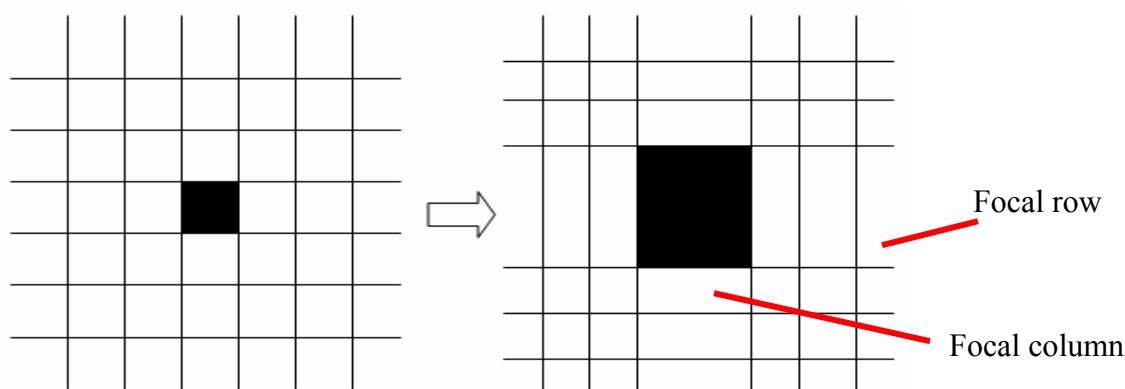
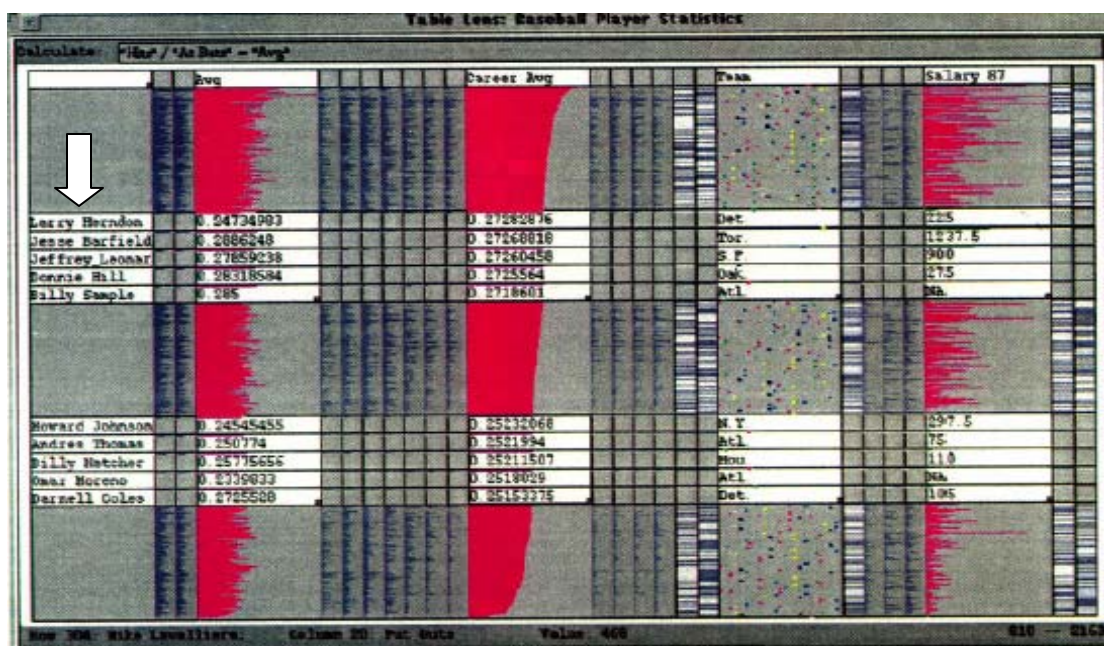


Figure 2.6: The concept of focus-and-context technique used in Table Lens (Rao and Card, 1994; figure created for illustration)



	Bvg	Career Avg	Team	Salary 87
Larry Herndon	0.24734993	0.27285876	Det.	225
Jesse Barfield	0.2886248	0.27268818	Tor.	1237.5
Jeffrey Leonard	0.27859038	0.27260458	S.F.	900
George Hall	0.26318584	0.2725564	Oak.	275
Billy Sample	0.285	0.2716601	Atl.	365
Howard Johnson	0.24545455	0.25112668	N.Y.	1297.5
Andres Thomas	0.250774	0.2521994	Atl.	75
Billy Hatcher	0.25775656	0.25211507	Phi.	110
Omar Moreno	0.2739833	0.2518029	Atl.	365
Bernell Giles	0.2725588	0.25152275	Det.	105

Figure 2.7: A Table Lens showing baseball statistics. The selected rows are expanded to reveal detail information; each expanded row shows the player name, batting average in the season, career average, team name and salary in 1987. (Source: Rao and Card, 1994)

information set while maintaining the global structure of the set.

The interchange between focus and context is valuable for history review as it (in principle) supports searching for patterns while examining details seamlessly.

Furnas' *Fisheye* techniques (Furnas, 1986), the *Perspective Wall* (Mackinlay et al., 1991) and the *Document Lens* (Robertson and Mackinlay, 1993) are all examples of this technique. Rao and Card's (1994) *Table Lens* (Figure 2.7) illustrates the basic concept of the focus-and-context technique applied to a table. The idea is that one or more cells are enlarged to show detailed information at the expense of other cells, while still preserving the coherence of rows and columns and their labels despite these distortions. For example, Figure 2.6 shows a specific cell in solid black on the left. The focus-and-context technique zooms in on this cell and simultaneously stretches out the entire focal row and focal column as shown on the right. With the focal row and column expanded, more information can then be displayed. However, other rows and columns are smaller. Figure 2.7 shows how Table Lens is used on real data, where the example

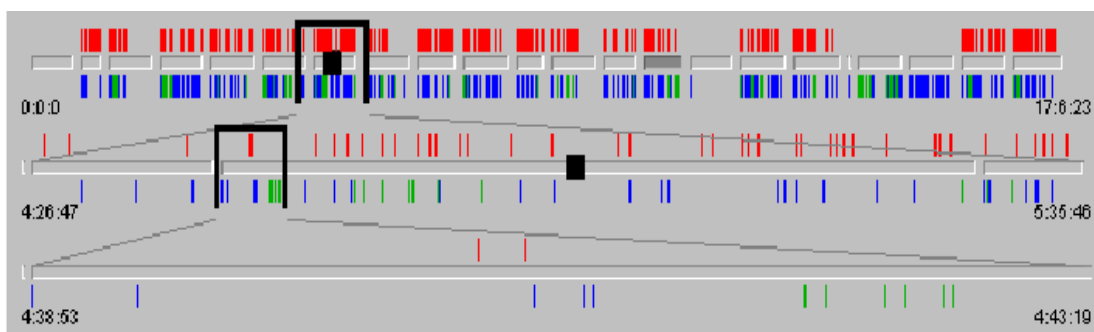


Figure 2.8: A multi-scale timeline slider—the focus area (shown covered by an inverted bucket) on an upper timeline determines display range on the lower timeline, events that are clustered in the upper timeline are more spread out in the lower sliders. (Source: Richter et al., 1999)

displays baseball statistics. The non-focal rows remain as ‘short’ as a line and do not reveal detailed information. The focal rows display detailed information, which would otherwise be hidden in the table structure. For example, the first expanded row (indicated by a downward arrow) shows the information of Larry Herndon who is a player with the Detroit team. His batting average over the season was 0.24734983, career average is 0.27282876 and salary was 225 (unit is not shown) in 1987. Similar details are displayed for other players whose rows are zoomed in. Un-zoomed rows show the same information as a graphics.

Richter et al. (1999) applied focus-and-context technique with timelines in their *multi-scale timeline slider* for browsing large amounts of event data where individual events cannot be distinguished. As shown in Figure 2.8, three individual timelines are used with a focus-and-context technique. The first timeline displays the ordered streams covered by the entire time period. The second timeline represents the focused region (i.e., the region covered by the inverted bucket) of the first timeline. Similarly, the third timeline shows the focused region of the second timeline. Hence, individual streams and events get spread out and are easier to distinguish as focus increases along successive timelines. While this example does not show the content of each event, it should, in principle, be easy to show the actual data once enough room opens up for it.



### 2.4.4 Dynamic Filtering

Even with focus-and-context techniques, exploring large information can be challenging. In practice, not all information is relevant, and the display of this unimportant information may obscure how people search, browse and understand the information of interest.

Dynamic filtering solves this problem by supporting “browsing, rapid filtering to reduce result sets, progressive refinement of search parameters and visual scanning to identify results” (Ahlberg and Shneiderman, 1994). People filter the data by specifying the query parameters using interface components such as sliders, buttons and maps. The key is that the visual display is updated dynamically to display the filtered results. In a well-designed system, the query components can constrain people from making erroneous actions, reduce the likelihood of null results and allow people to see the impact of each selection while forming a query.

*FilmFinder* (Ahlberg and Shneiderman, 1994) is an example system integrating dynamic filtering to help a person search for movies. The system initially displays an overview of all the movies available in the video store as shown in Figure 2.9a. The scattered display shows that there are more recent movies than old ones (year is shown along the x-axis). The movie categories are displayed at the bottom of the interface for selection. Unfortunately, there are too many movies to view comfortably. This is where dynamic query helps. If a user wants to see movies starring Sean Connery and prefers the movie duration between 59 and 276 minutes, he can adjust the sliders on the right to narrow the view. The results are displayed as the controls are adjusted (Figure 2.9b). The number of movies in the display has been cut down from about 2000 to 25. He now decides to look further at ‘The Murder on the Orient Express’ (circled in Figure 2.9b). He selects it using the *Detail on Demand* (Section 2.4.2) and the detailed description of this movie is displayed (Figure 2.9c). This example illustrates how the dynamic filtering technique can be used to progressively reduce data sets in order to locate and retrieve desired information, and how it can be combined with details on demand.

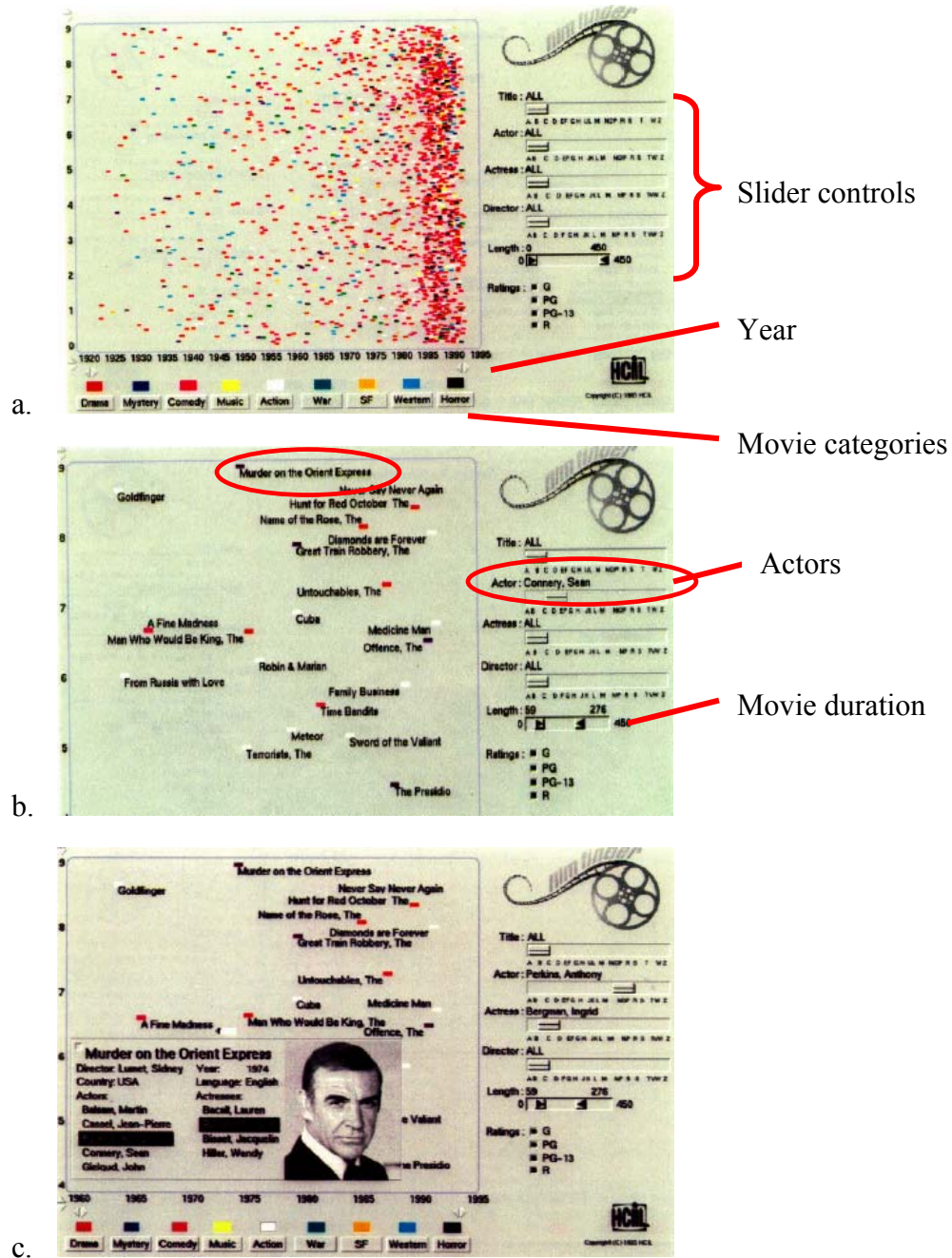


Figure 2.9: The FilmFinder. (a) an initial overview display (b) a reduced result set after adjusting the query components (i.e., sliders) on the right (c) detailed description of a movie.

### 2.4.5 Animated Presentation

Movies offer a vivid and compelling way of presenting captured events and information exchange (Harrison and Baecker, 1992). Not only do they present the content and context, but they also augment subtle temporal aspects of the interaction dynamics. This replay technique is widely used to capture and analyse how people use computers, i.e., where people's everyday experiences are recorded for later use (Abowd et al., 1998). In HCI, for example, video-logging is commonplace in user studies, where the study session is recorded so that the investigators can review and analyse them afterwards. We can then extrapolate that replaying casual interactions as a movie can breathe life into the captured history, and it may reveal subtleties that are otherwise overlooked.

## 2.5 Summary

In this chapter, I have described the importance of casual interaction to collaboration. I then discussed how technology can help create artificial proximity to bring collaborators together in the virtual environment. I described how two popular computer-mediated genres—instant messaging and media spaces—offer lightweight means for promoting casual interactions.

From the literature on capturing formal meetings, I have identified several design principles as a starting point to design a conversation capturing tool for multimedia casual interactions. These design principles are:

- ***Time-stamp casual interactions*** in order of their occurrences so that sequences of events can be reconstructed temporally to reflect what has happened in the past.
- ***Allow indexing of the captured materials***, which serves as some kind of highlighted marker amongst the large information space with the goal of easy identification and hence retrieval.
- ***Allow query on the captured materials*** such that unwanted data can be filtered out while focusing on the narrowed result set.

- ***Provide for different media types*** to capture all possible media transmitted through the communication tool.
- ***Be unobtrusive*** to prevent the capturing tool from hindering the natural progress of interaction and the normal practice of conversers.

As histories of multimedia casual interaction are usually temporally dependent, therefore, I looked into five techniques that we could explore to visualize temporal conversational data.

- ***Timelines*** enable users to easily map events with time of occurrence; other applications of timelines provide powerful visualizations such as Begole et al.'s work (2002) of incorporating histograms with timelines to exhibit important trends and pattern information.
- ***Details on demand*** enables people to selectively examine data presented in an overview.
- ***Focus-and-context*** techniques allow people to examine details without disrupting the global context; this is particular useful for investigating the relationship of a particular subset and the entire data set.
- ***Dynamic filtering*** supports searching and browsing by letting people rapidly filter out unwanted data, progressively refine the search parameters, and visually scan and identify desired data.
- ***Animated presentation*** brings the static interaction transcription back to life so that the interaction dynamics are revealed.

This chapter lays the foundation for later chapters. Chapter 3 first describes the Notification Collage in detail and how people converse over it. It then presents the design of the tool that captures NC conversations using design principles identified in Section 2.3. Chapter 4 describes the visualization tool named VisStreams where the visualization techniques discussed in this chapter served as guidelines for its design.

## Chapter 3. Conversation Capture

---

I argued in Chapter 1 that a retrievable record of casual interactions would benefit both group members and researchers and that a visualization of interaction history would help for reviewing and analysing past conversations. Thus, my research aims to fulfil two major functions: *conversation capture* and *conversation visualization*.

This chapter discusses conversation capture. I begin by describing in detail the primary interaction tool used in my research, the Notification Collage (Greenberg and Rounding, 2001). This section provides the background information for understanding the difficulties of capturing multimedia conversations from the Notification Collage. Next, I discuss issues that I have identified and that make it challenging to design and implement a conversation capturing tool for the Notification Collage. Finally, I present the design of a conversation capturing tool using the design principles for formal meeting capture outlined in Chapter 2. I also highlight my solutions to the issues identified in this chapter.

### 3.1 Notification Collage

As introduced in Chapter 1, the Notification Collage (NC), pictured in Figure 3.1, is a groupware system where distributed colleagues can post media items onto a collage displayed in real-time on workstations or public displays (Rounding and Greenberg, 2000; Greenberg and Rounding, 2001). The NC is a technology that integrates and extends features of instant messaging and media spaces to support casual interactions and informal awareness. Because my research uses the NC as a case study in multimedia capture, it is discussed here in detail. I first describe the user interface and the media

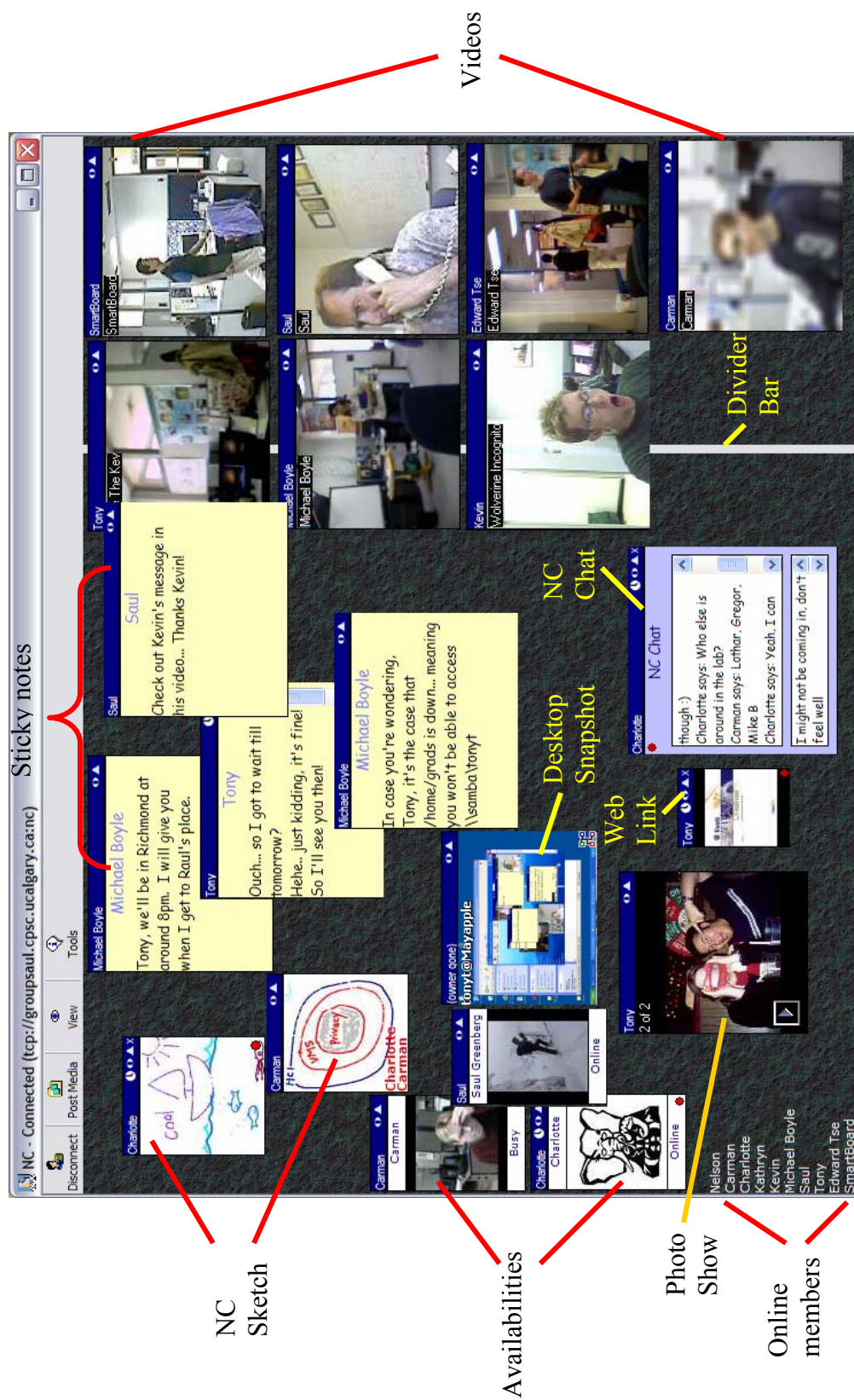


Figure 3.1: The Notification Collage (Greenberg and Rounding, 2001) showing various media items for communication: Videos, Sticky Notes, NC Sketches, Availabilities, Desktop Snapshot, Photo Show, Web Link, and NC Chat (starting from the rightmost).



items currently available to users. Next, I present the aspects of the underlying architecture that influence the design of the conversation capturing tool.

### 3.1.1 Interface

The NC uses a public bulletin board metaphor, becoming a shared virtual place for people to post multimedia items for both synchronous and asynchronous casual interaction (Figure 3.1). Incoming items are randomly placed on the left side of the vertical divider bar and may possibly overlap other visual items as a collage. A person may move items to the right side of the divider bar so that they will not be overlapped by newly posted items. People can post assorted media items according to their needs. Available media items currently include the ones listed below; however, new media items can easily be created with modest programming effort.

- **Sticky Note** follows the metaphor of a real sticky note (i.e., a PostIt™ note). People may type or edit textual messages on the sticky notes while others see the character by character changes in real time. This is the most widely used media item for conveying text messages, particularly in exchanging brief greetings and rapid conversations. Users also use the notes to post short questions and answers, or broadcast announcements.
- **Video** is captured from a desktop PC camera. People may adjust the refresh rate at which their image is captured and displayed in a mode ranging from ‘near-live video’ (e.g., 1 frame/second) to ‘intermittent snapshots’ (e.g., 1 frame/minute). People can also manually take a snapshot at anytime by clicking the current image; or pause video recording so that the last captured image is persistent. It also offers a degree of privacy preservation while still providing collaborators with awareness information (Neustaedter and Greenberg, 2003). People can adjust the video fidelity by choosing a level of *blur filtration*: a technique that naturally blends regions of an image to produce a blurred effect so that the image fidelity is reduced accordingly (Boyle and Greenberg, 2000). An example of a blurred scene is visible in the bottom right of Figure 3.1.

- ***Photo Show*** provides a venue where people can post one or more photos to share with others in the online community. Viewers may choose to cycle through the photos or pause at a particular snapshot. Alternatively, viewers may choose to view the full-sized photos in a separate window or to save the images.
- ***Desktop Snapshot*** cyclically displays periodically-taken snapshots of a participant's computer screen as a thumbnail. For privacy reasons, people must explicitly opt in if they wish to display their own desktop.
- ***Web Link*** portrays a webpage as a thumbnail. Interested people may access the site by clicking the web link, which raises a browser with that web page loaded.
- ***NC Chat*** is like the textual dialog window of most instant messaging services, except that no invitation is required and any person can join the conversation by simply typing in their message.
- ***NC Sketch*** allows people to move from awareness to collaborative multi-party free-form drawing. A person starts a sketch pad and the sketch pad will appear as a thumbnail on the NC of other users. Other people can join in by expanding the thumbnail into a large drawing canvas where they can interactively post and draw over their desktop snapshot, a snapshot of a specified window, or an imported image.
- ***Availability*** allows people to publicize their activity status by displaying an icon with an appropriate message like 'online,' 'busy,' 'be right back,' or 'away'; people may import images to personalize the icons. It also allows a person to alert an online member by using a built-in 'buzzer'. It is usually used to replace the video item when the connecting person does not have a camera.

Rounding and Greenberg (2000) claim these media items offer rich awareness and multimedia information to support casual interaction. When people notice interesting conversations, postings, and/or relevant artefacts on the display, they act upon them. The Notification Collage has been used as a daily communication tool in the Interaction Laboratory at the University of Calgary for the past two years. Therefore, it is much



more than just an academic exercise; people use it as a useful real-life tool for casual communication between co-located and distributed group members.

### 3.1.2 Implementation

To give a better understanding of how the NC works and how it affects the design of a conversation capturing tool (discussed later), I will briefly explain the underlying architecture of the NC.

The NC architecture is developed using the *Collabrary Shared Dictionary* (Boyle and Greenberg, 2002; Boyle, 2003) for transmitting and receiving multimedia information. Superficially, the Collabrary Shared Dictionary resembles a typical dictionary data structure that stores a list of <key, value> pairs. However, it differs in two significant ways. First, keys are hierarchical, where the string comprising a key's name resembles a hierarchical path, e.g., /level\_1/level\_2/level\_3. These keys are pattern matched so that a sub-tree containing many <key, value> pairs can be treated as a single logical construct. For example, if the dictionary contains /users/1/name, users/2/name, ..., users/10/name, then the programmer can iterate through a list of all 10 users by referring to 'users/\*/name'. Second, the dictionary is a distributed shared data structure: any client process can get and set values from the dictionary, and receive notification when keys are added, deleted, or changed by themselves or any other connecting client. Thus, the Shared Dictionary allows the sharing of its contents among the connecting clients. Data may be passed on either end of the connection, at any time, via a persistent, full-duplex TCP/IP connection. The Shared Dictionary is a type of Notification Server (Patterson et al., 1996) that informs all connected clients of data additions, deletions and changes. It differs from most notification servers by using hierarchical keys, centralised data storage, and its ability to handle multimedia data.

The NC exploits this Shared Dictionary. First, the NC architecture follows a 'star' (a.k.a., client-server) topology, where multiple NC clients can connect to the Shared Dictionary, which in turn acts as the server. Figure 3.2 shows two clients, Tony and Carman (bottom), connected to the NC Server (top). The NC interfaces shown have been

modified to display only the media items created by the clients for illustrative purposes. Second, the NC defines a standard interface between NC clients, specifically defining which keys are to be used and what types of values to expect for particular media items and to identify connected users. For example, in Figure 3.2 line f, the key `‘/media/{261}/caption’` specifies the value to be a string `‘Tony’`. New `<key, value>` pairs can be added to the NC server.

A new client when logging on to the NC server will be automatically assigned a unique key preceded by `‘/users/’` to distinguish it from media item key, followed by a GUID which is a 32-digit long string uniquely generated by the Collabrary Shared Dictionary (i.e., the NC Server). For brevity, the GUIDs have been replaced with a 3-digit number in the example shown below. Its value will be a record containing information about this client such as name, phone number, and email address (e.g., Figure 3.2, lines a+c). Similarly, a new media item (e.g., *Sticky Note*, *Video*, etc.) will be assigned a unique key preceded by `‘/media/’` when created, followed by a unique 32-digit long GUID (also replaced with a 3-digit number in the example) and its value will be a record containing metadata about the media item such as the name of the media item (e.g., sticky note, video), the data type the media item contains (e.g., text or jpeg image), where that data can be found (relative to the metadata) and who posted it (as a corresponding client ID) (e.g., Figure 3.2i).

Every user key and every media key has a sub-key `‘/users/*.transient’` and `‘/media/*.transient’` respectively. The value of these sub-keys is the client’s GUID. In this way, the NC creates an ‘ownership’ association between a client and all the media items the client has created. When a client disconnects from the NC server, this information is used to find and remove all of the client’s `<key, value>` pairs, including media items it created.

To illustrate, Figure 3.2 shows how the NC server is updated when clients are connected to it and when media items are used for communication. We use only the *Sticky Notes* and *Video* media items to illustrate the notification property of the NC

## NC Server

- Contains hierarchical key/value pairs
- Notifies subscribers of changes

Key	Value
a) /users/{112}	name: Tony, email: tonyt@cpssc.ucalgary.ca, homepage:, phone: {112}
b) /users/{112}/.transient	{112}
c) /users/{999}	name: Carman, email: carman@cpssc.ucalgary.ca, homepage:, phone: {999}
d) /users/{999}/.transient	{999}
e) /media/{261}/.transient	{112}
f) /media/{261}/caption	Tony
g) /media/{261}/message	Howdy!
h) /media/{261}/colour	12648447
i) /media/{261}	progid:NCItems.StickyNote, mimetype:text/ascii, ... rootpath:/media/{261}
j) /media/{467}/.transient	{999}
k) /media/{467}/caption	Carman
l) /media/{467}/message	How's it going?
m) /media/{467}/colour	12563459
n) /media/{467}	progid:NCItems.StickyNote...owner:{999}, rootpath:/media/{999}
o) /media/{788}	progid:NCItems.VideoSnapshot, mimetype:image/jpeg...rootpath:/media/{888}
p) /media/{788}/.transient	{999}
q) /media/{788}/snapshot	<Binary data>

## NC Clients

- Manage user information and listen to notifications from the NC Server

NC Client: Tony



NC Client: Carman

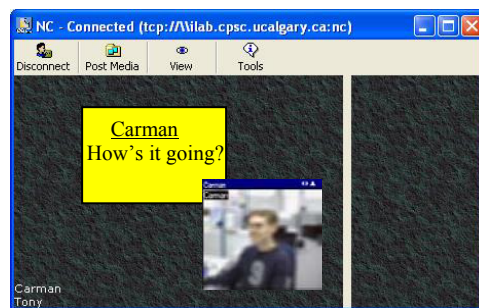


Figure 3.2: System architecture of the Notification Collage—changes on the Notification Collage (NC Client) are passed to the NC Server (Collabrary Shared Dictionary) where the corresponding <key, value> pairs get updated and notification of the changes will be passed to other clients.

although similar operations will take place for other media items. The set of sub-keys for each media item, however, may vary. For example, *Sticky Notes* are associated with sub-keys ‘/media/\*/caption’, ‘/media/\*/message’ and ‘/media/\*/colour’ while *Videos* are associated with the ‘/media/\*/snapshot’ sub-key.

When Tony first logs on, he is assigned the unique user key ‘/users/{112}’, the value is the metadata containing his information—name: Tony, email: tonyt@cpsc.ucalgary.ca, etc. (Figure 3.2, line a). The same happens to Carman when he first logs on; his unique user key is ‘/users/{999}’ and its value is the metadata of Carman’s information (Figure 3.2, line c).

Then, when Tony creates a *Sticky Note* media item, the NC Server assigns to this media item a unique media key ‘/media/{261}’ with a metadata value containing this media item’s information—progid:NCItems.StickyNote, mimetype:text/ascii, ... rootpath:/media/{261} (Figure 3.2, line i). When Tony types ‘Howdy!’ in the sticky note as shown in the bottom left of Figure 3.2, the NC server updates the value for the sub-key ‘/media/{261}/message’ to ‘Howdy!’ (Figure 3.2, line g). It then sends out notification to all other connected clients to update that <key, value> pair so that all clients see the same value, ‘Howdy!’ For clarity, only the media items created by the NC client are shown in the respective client interface (bottom of Figure 3.2) although every client can indeed see all the media items posted. Similarly, when Carman creates a sticky note to reply ‘How’s it going?’ (bottom right of Figure 3.2), the NC first assigns a unique media key to the sticky note ‘/media/{467}’; the value contains information about this media item (Figure 3.2, line n). The NC server then updates the value for the sub-key ‘/media/{467}/message’ to ‘How’s it going?’ (Figure 3.2, line l) and all other clients are notified to update the same. Later when Carman uses a *Video* media item to broadcast his image to other NC clients, the NC Server assigns a key ‘/media/{788}’ to this media item and the value is metadata representing this media item’s information (Figure 3.2, line o). The sub-key ‘/media/{788}/snapshot’ then stores the image captured by this media item in binary format (Figure 3.2, line q). Each time the *Video* media item

updates, it will notify the NC Server which will in turn notify all other NC clients to also update.

The NC architecture is an example of a model-view-controller design (Krasner and Pope, 1988) where the NC's data is completely uncoupled from how a user enters it and from how it is displayed. Because the model is persistent, new clients that arrive after some activity has already occurred are automatically updated with the current states of the dictionary and can immediately update their display as necessary. The model-view-controller also means that we can write software to tap into the model as the NC is running without affecting other clients. This is how the conversation capturing tool is implemented, discussed shortly in Section 3.3.

## 3.2 Issues in Capturing NC Information

In this section, I describe two issues I have identified while designing and implementing the conversation capturing tool. These issues make my research in conversation capture function challenging.

### 3.2.1 How to Deal with Multimedia Data?

The NC offers rich multimedia channels for people to communicate using a wide range of media items. Current media items allow people to communicate using text (e.g., *Sticky Note* and *NC chat*) and images (e.g., *Video*, *Photo Show*, *NC Sketch*, and *Desktop Snapshot*). Text-based data is in ASCII format, which can be stored and retrieved without processing. Hence, text data is generally efficient to retrieve. In contrast, image data may come in different formats, e.g., jpeg, png or bmp images, which may also be encoded or compressed. It is imperative to know the exact representation of the binary data for proper capture and retrieval. For the known data types of current media items, a conversation capturing tool can be easily programmed to capture all the necessary data. However, we should ensure that such a tool also allows for capturing future media items of unknown data types so that all multimedia data can be captured and retrieved properly.

### 3.2.2 What are the Implications of the NC Notification Feature?

The NC is a synchronous real-time communication system. Any change to the contents held by media items will be noted and updated by the NC server which will in turn notify each client immediately. Such fine-grained notification raises a question that must be considered when designing a conversation capturing tool—at what granularity do we capture and store the evolving text and the similar/identical images? Two examples will illustrate the problem.

<u>Key</u>	<u>Change in Value</u>
/media/{261}/message	H
	Ho
	How
	Howd
	Howdy
	Howdy!
/media/{467}/message	H
	Ho
	How
	How'
	How's
	How's
	How's i
	How's it
	How's it
	How's it g
	How's it go
	How's it goi
	How's it goin
	How's it going
	How's it going?

Figure 3.3: Notification of changes made to all connecting clients when Tony types “Howdy!” and Carman replies “How’s it going?”

**Evolving text.** As a person types in a sticky note, the NC server treats each character change as an individual event, notifying all the clients each time a character is typed. For illustrative purposes, the two sticky note text exchanges made by Tony and Carman in Figure 3.2 will be used (‘/media/{261}’ and ‘/media/{467}’ are the keys for the sticky notes created by Tony and Carman respectively). Figure 3.3 shows the series of notifications propagated from the NC Server as Tony types ‘Howdy!’ on a sticky note (as shown in the bottom left of Figure 3.2) and similar notifications as Carman replies with ‘How’s it going?’ When designing the conversation capturing tool, we must decide what

should be captured and stored in the database, e.g., all the evolving text (as shown in Figure 3.3) or only a selected portion of the evolving text, e.g., the final complete message. It is however very difficult to decide if a message is complete without semantically examining the message. Other situations that make this even more difficult may occur. For example, a user may erase a message before completing it, such as when a suitable reply is received before a question has been asked fully or when network connectivity unexpectedly disconnects the client as the user types a message.

**Similar/identical images.** Several of the current media items allow people to post images for communication, e.g., *Video*, *Photo Show*, *NC Sketch* and *Desktop Snapshot*. Even if these images are stored in a compressed format, e.g., jpeg format, the file size can still be large. Although computer storage is relatively inexpensive nowadays, it is still a problem when the number of images becomes excessively large. It is also important to consider how the images are stored so that they can be retrieved in an efficient manner.

Specifically, I am concerned with how repeating frames should be handled without hampering the context of the activity if successive images are identical or almost identical. This can be illustrated with a situation where a group member of an online NC community sets a high refresh rate, for example once per second, for their *Video* media item. This means that the image taken by this person's PC camera will update every second. This means identical scenes, such as head shots shown in Figure 3.4, or an empty office if a worker is not around, will be captured every second by the conversation capturing tool—a very inefficient use of resources! Therefore, a conversation capturing tool must decide if every frame, even if it is (almost) identical to the previous or referenced frame, should be stored.



Figure 3.4: 10 similar head-shots of a NC user captured from his video item in 10 seconds.

### **3.3 The Conversation Capturing Tool**

I now describe the multimedia conversation capturing tool I have designed for the NC. While describing the tool's design, I consider the issues described previously in this chapter and the design principles that I outlined in Chapter 2. I will also highlight how my solution addresses the aforementioned issues and utilizes the design principles.

#### **3.3.1 The Conversation Capturing Tool as an NC Client**

The conversation capturing tool is implemented as a client to the NC server. It listens to the server for all event changes, which include entry and departure of clients, as well as changes to media items posted on the NC. With the model-view-controller design of the NC, the capturing tool taps into the NC Collabrary Shared Dictionary component where it listens for event changes. Except for a slight extra load on the server (the cost of transmitting the notifications), resource use is minimal. Thus it only modestly affects the natural interaction between the server and the clients—satisfying the design principle of being unobtrusive to users (Section 2.3.5).

Although I purposely ignore privacy in my research context, I do provide other NC clients with visual cues that the transactions are being recorded. For example, the conversation capturing tool's name 'VisStreams' will appear in bold and red within the NC's list of users (Figure 3.1, bottom left, not shown) when the tool is turned on. The community is then informed that the communication is being logged.

#### **3.3.2 Conversation Information is Stored in a Database**

The tool captures and stores multimedia conversations occurring on the NC in a SQL database that allows full SQL query (design principle 2.3.3). Using the local time, the tool first time-stamps each event in the order of its occurrence (design principle 2.3.1) before storing it in a database. To this, we add an incrementing value as a unique key



which means that events can be retrieved in their true temporal order, e.g., to avoid problems of items with identical time stamps. We also design the database to allow post-capturing indexing by means of adding annotations to a pre-defined field (design principle 2.3.2). Because the database allows query, users (through the visualization system to be discussed in Chapter 4) may then use one or more query parameters to retrieve specific data. The time-stamp and the index described are two examples of the query parameters for extracting desired record sets from the database.

### 3.3.3 Filtering Evolving Texts

Due to the fine-grained notifications from the NC, I faced the challenge of capturing messages typed in a sticky note without cluttering the database with the evolving texts. I have taken two different approaches to examine this issue—the interval approach and the differential filtering.

**Interval approach.** I experimented with using a timer in the NC server (in collaboration with Michael Rounding, the NC inventor) so that it would only notify the conversation capturing tool of changes made to sticky notes at predetermined time intervals.

I tried two timer intervals to test how timed notification affects the completeness of captured data. For illustrative purposes, longer textual messages are used. ‘How are you? This is such a beautiful day!’ is typed first; it is then replaced by ‘I finished my paper.’ Figure 3.5 and 3.6 show the entries captured using a timer interval of 5 seconds and 20 seconds respectively. It is also assumed that the timer last fired off at 10:12:00AM.

<u>Time</u>	<u>Event change captured every 5 seconds</u>
10:12:05 AM	How are
10:12:10 AM	How are you? This is such a beautiful da
10:12:15 AM	I
10:12:20 AM	I finished my pa
10:12:25 am	

Figure 3.5: Entries captured using a timer interval of 5 seconds.

<u>Time</u>	<u>Event changes captured every 20 seconds</u>
10:12:20 AM	I finished my pa
10:12:40 am	

Figure 3.6: Entries captured using a timer interval of 20 seconds.

The timer interval of 20 seconds has obviously removed significant portions of the messages (Figure 3.6), making it virtually impossible to understand what has actually been communicated; thus, this 20 second timer interval is definitely not viable. With some guessing effort, a user may be able to re-construct the actual communicated messages from Figure 3.5 which is captured every 5 seconds. It appears that this timer interval may be useful especially when the person reviewing the logged data has additional context knowledge that can be used to determine the actual communication. However, it is impractical to rely on guesses when reviewing conversational histories. Therefore, I conclude from these informal experiments that enforcing a timer to capture communication is not advisable.

**Differential filtering.** The goal of capturing text communication is to obtain a complete transcript of the conversation. If all evolving texts are captured such that each character change represents an entry in the database, the reviewer will have difficulty to locate the intended message. With the unsatisfactory results obtained from enforcing a capture timer, we decided to experiment with techniques to filter out redundant evolving texts, which may be performed either in real-time or during post-capture processing. The approach I use is to filter in real-time during logging.

The algorithm I have devised to filter out redundant evolving texts in sticky note conversations is called 'substring assessment'. A cache of the previous state of the sticky note message text is maintained. As a change to the value in the shared dictionary is notified, the algorithm compares the new value to the previous one. If the change exceeds a two second time threshold, the previous cached value is considered significant and is stored in the database. The two second timeout is important because distinct utterances in the conversation are often merely appended to an existing sticky note or

replace existing sticky note contents. When a change occurs within the two second threshold, substring comparisons are used to determine if the previous cached value is considered redundant. If the new value is a substring of the previous one or if the previous value is a substring of the new one, the previous value is classified as redundant. Otherwise, the previous value is classified as significant and is stored in the database. In either case, the new value is cached for future substring assessments. The first check (to determine if the previous value is a substring of the new value) is obviously needed: an evolving text implies that that new words in an utterance are appended to the existing phrase under construction. The second check (to determine if the new value is a substring of the previous) is motivated by the observation that people routinely use the backspace key to edit typographical errors in their messages as they are being composed. Informal trials of the substring assessment algorithm and the two second time threshold showed that the combination is reasonably good at classifying redundant changes to evolving message texts based on the current NC implementation and its usage.

### 3.3.4 Filtering Repeating Images

I am concerned with two issues regarding image data. First, I investigate how images should be stored so that they can be retrieved efficiently. Second, I look at how storage of repeated images can be minimized.

To investigate the first issue, I conducted an informal experiment to decide how images should be stored. In the experiment, I used a Microsoft Access<sup>1</sup> database to test the time difference taken to retrieve images in two settings. The number of images used in both settings was the same and in the tens of thousands. In the first setting, I stored the binary data for each image directly in a database. When retrieving images under this setting, I used several methods provided in the Collabrary toolkit for multimedia

---

<sup>1</sup> Other SQL database was also considered. An expert in databases advised that there is no significant performance difference in retrieving images from the stored binary data when there are tens of thousands of stored images.

groupware (Boyle and Greenberg, 2002) to convert stored binary data to picture images. In the second setting, I stored the images in a folder (directory) on the local file system and only file names were stored in the database. Images could be retrieved simply by accessing the stored file using the filename. The results of my experiment showed that storing binary data directly in the database was problematic. There were two reasons for this. First, it took a considerably longer time, in orders of magnitude, to retrieve and display images from binary data entries than retrieving the filename and then opening the file. Second, the binary data for large images often exceeded the maximum data field size available in the database. While this is specific to the Microsoft Access database, I suspect this generally applies to most other databases as well.

To solve the second issue of heavily redundant images such as those media captured by a video media item, I examine if the images differ enough to warrant storage. I use a method for computing a coefficient representing the difference between two images. A video snapshot is only stored in the database when the coefficient value is below a hard-coded threshold (indicating sufficient change). For instance, if a person leaves a *Video* media item running after he leaves his workstation (assuming no other people use his workstation), only one image of the idle workstation will be captured until he returns, regardless of the refresh rate he has set. This greatly reduces the number of images captured. To achieve this, I considered examining the difference between successive images and assessing the difference of an image from a key frame.

Comparing successive images will likely abandon most subtle changes between images as each difference may be so small that none of the changes will warrant storage. To illustrate, imagine a *Video* media item is capturing a scene of an online member with his back against a window that reveals the time of the day, e.g., bright sunlight in the afternoon and pitch dark at night. If the person works very intensely, thinking hard with rare body movement for a long time, say from afternoon till dark, changes between successive images of the scene will likely be so gradual that nothing will be stored. However, if the images are compared against a key frame, say the first image captured when the *Video* media item is turned on in the afternoon, the image reflecting later hours

through the darker background (say, at 7pm) will be stored even the person did not stir. This kind of information may be useful. Therefore, I decided to compare images with a key frame and when an image is found that is different enough from the key frame, the image is stored and becomes the new key frame for comparison with successive images.

```

a)      keyFrame.Subtract capturedImage
b)      If keyFrame.PSNR < -25 Then
c)          SavePicture capturedImage, imagefile
d)          DatabaseControl.AddToDB imagefile
e)          keyFrame = capturedImage
f)      End If

```

Figure 3.7: A code fragment using the methods in the Collabrary toolkit to estimate the difference between a pair of images (Boyle and Greenberg, 2002).

Figure 3.7 shows an example code fragment to illustrate how this is done. I use methods provided by the Collabrary Photo object to find absolute differences in the pixel values between a pair of images (i.e., between the key frame and the latest image captured in this case), as shown in line a of Figure 3.7 (Boyle and Greenberg, 2002). The result is an image where black regions indicate no difference; and where there is a difference, pixel intensity indicates the magnitude of the difference at that position. I then use Collabrary methods to obtain a peak signal-to-noise ratio (PSNR) coefficient for the entire image (Figure 3.7, line b). The PSNR coefficient is a floating point value that normally ranges between -80 and 0, where higher values indicate image similarity. This example uses -25 as the threshold PSNR value, but other values may be used depending on the desired degree of difference between images. When the key frame is found sufficiently different from an image, the image is then saved as a file and the file name is stored in the database (Figure 3.7, lines c+d). This image then becomes the new key frame (Figure 3.7, line e). Figure 3.8 shows an example where 42 images are captured unfiltered (top) and when these images are filtered by the key frame comparison (using a threshold PSNR value -25), only 11 of them are saved (bottom).

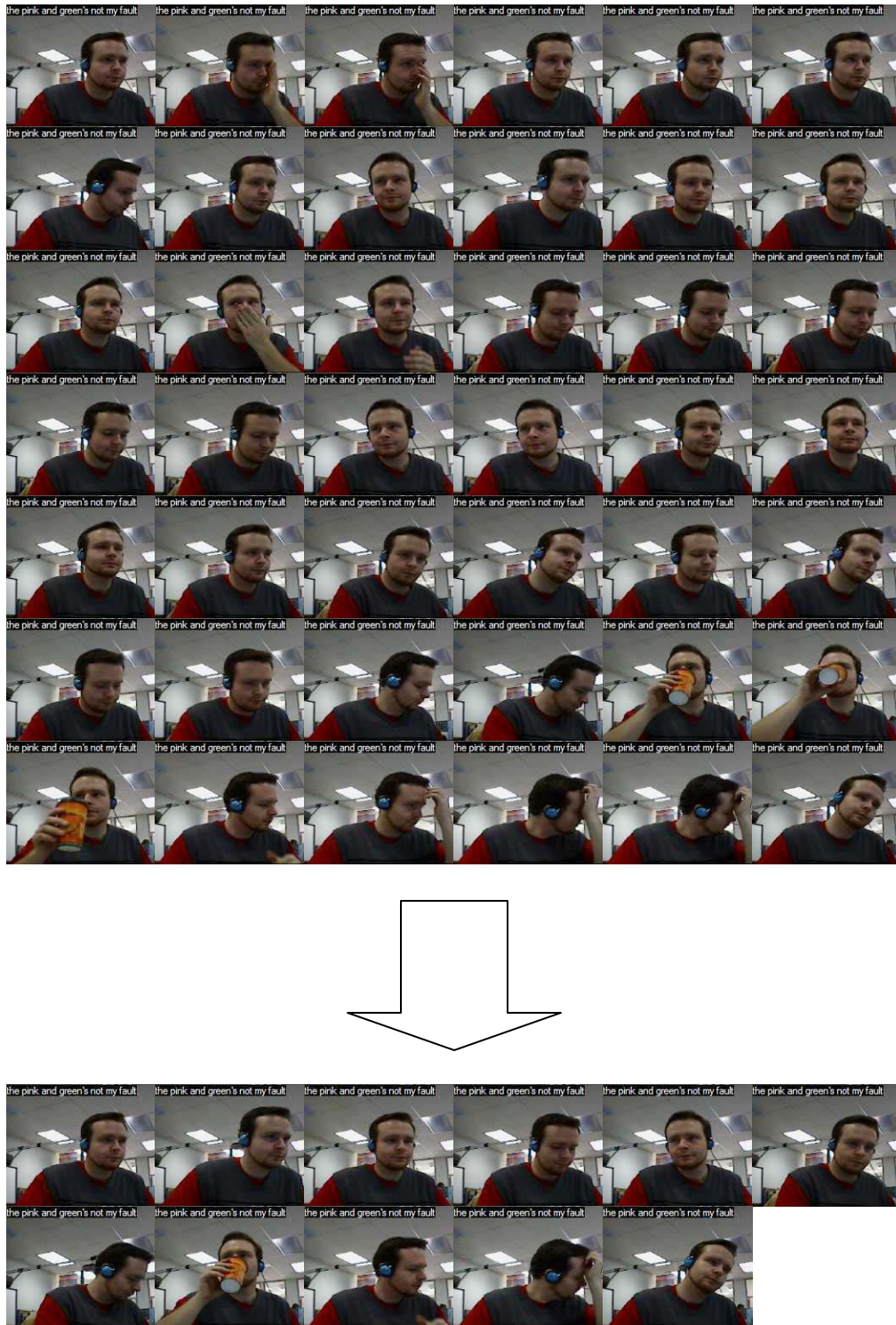


Figure 3.8: Only 11 snapshots out of 42 are captured and stored when images are filtered by key frame comparison (threshold PSNR value = -25).

### 3.3.5 Capturing other Multimedia Data

In addition to being a customized logging tool (with filtering features) for current media items, the conversation capturing tool also simultaneously captures, without filtering, all multimedia data including unknown types contained in future media items (design principle 2.3.4). Therefore, all evolving texts and all (redundant) images are captured and stored in a separate database in Base-64 format using a method provided in the Collabrary (Boyle and Greenberg, 2002). Post-capture processing of the data may then be performed to retrieve elements in the proper data format. This is important as media items can be created with modest effort and so new ones are often added.

- a)      Dim dataStructure As New Collabrary.Struct
- b)      Dim Buffer as New Collabrary.Buffer
- c)      Dim B64 as String
- d)      Buffer.Paste val, Value                      ‘ val is the value of the key for the event change
- e)      B64 = Buffer.Copy(Base64)
- f)      DatabaseControl.AddToDB B64

Figure 3.9: A code fragment for storing the values for all the event changes in Base-64 format in the database.

Figure 3.9 shows a simple code fragment to store the values for all event changes in Base-64 format. The value is first stored into a buffer (Figure 3.9, line d), then the content of the buffer is converted to a string of Base-64 format (Figure 3.9, line e). Finally, the string is stored in the database (Figure 3.9, line f).

## 3.4 Discussion

The conversation capturing tool described above has been developed iteratively during my research. Each iteration included additional features and improvements. Most improvements to the capture tool were in response to changes made to the NC as it was being actively developed and modified by student researcher Michael Rounding in the same laboratory (i.e., the Interaction Laboratory of University of Calgary). For example,



the initial tool first captured only the texts posted on *Sticky Notes* and images on *Video* items without any filtering. Successive iterations of the tool included filtering out redundant repeating messages (by imposing a timer and subsequently by using the substring comparison algorithm), modifying the tool to capture communication contents contained in the newly created media items like the *NC Chat*, *NC Sketch*, *Web Link*, *Desktop Snapshot* and *Availability*, and adapting the tool to capture all future unknown data types in its current version.

As described in Section 3.3.3, substring comparison filtering is used to remove evolving texts on the *Sticky Notes*. This is based on how people generally compose a text message (by appending characters to the end or backspacing from the end of an existing message). However, when people add or remove characters within the message, the substring algorithm will not work properly. An example is shown in Figure 3.10 which shows a portion of some real data captured from the Notification Collage when Saul edits the message he composes. Each time he adds or deletes a character inside the message,

Date	Time	Name	Value
9/24/2003	2:41:09 AM	Saul Greenberg	All by myself in France, guess its late at night in Calgary.
9/24/2003	2:41:09 AM	Saul Greenberg	All by myself in France, nguess its late at night in Calgary.
9/24/2003	2:41:09 AM	Saul Greenberg	All by myself in France, noguess its late at night in Calgary.
9/24/2003	2:41:09 AM	Saul Greenberg	All by myself in France, no guess its late at night in Calgary.
9/24/2003	2:41:10 AM	Saul Greenberg	All by myself in France, no Gguess its late at night in Calgary.
9/24/2003	2:41:10 AM	Saul Greenberg	All by myself in France, no Grguess its late at night in Calgary.
9/24/2003	2:41:10 AM	Saul Greenberg	All by myself in France, no Groguess its late at night in Calgary.
9/24/2003	2:41:10 AM	Saul Greenberg	All by myself in France, no Grouguess its late at night in Calgary.
9/24/2003	2:41:10 AM	Saul Greenberg	All by myself in France, no Groupguess its late at night in Calgary.
9/24/2003	2:41:11 AM	Saul Greenberg	All by myself in France, no Grouplguess its late at night in Calgary.
9/24/2003	2:41:11 AM	Saul Greenberg	All by myself in France, no Grouplaguess its late at night in Calgary.
9/24/2003	2:41:11 AM	Saul Greenberg	All by myself in France, no Grouplabguess its late at night in Calgary.
9/24/2003	2:41:11 AM	Saul Greenberg	All by myself in France, no Grouplabbguess its late at night in Calgary.
9/24/2003	2:41:11 AM	Saul Greenberg	All by myself in France, no Grouplabbguess its late at night in Calgary.
9/24/2003	2:41:12 AM	Saul Greenberg	All by myself in France, no Grouplabberguess its late at night in Calgary.
9/24/2003	2:41:12 AM	Saul Greenberg	All by myself in France, no Grouplabberguess its late at night in Calgary.
9/24/2003	2:41:12 AM	Saul Greenberg	All by myself in France, no Grouplabbguess its late at night in Calgary.
9/24/2003	2:41:13 AM	Saul Greenberg	All by myself in France, no Grouplabbguess its late at night in Calgary.
9/24/2003	2:41:13 AM	Saul Greenberg	All by myself in France, no Grouplaguess its late at night in Calgary.
9/24/2003	2:41:14 AM	Saul Greenberg	All by myself in France, no Grouplguess its late at night in Calgary.
9/24/2003	2:41:14 AM	Saul Greenberg	All by myself in France, no Groupguess its late at night in Calgary.
9/24/2003	2:41:14 AM	Saul Greenberg	All by myself in France, no Grouguess its late at night in Calgary.
9/24/2003	2:41:14 AM	Saul Greenberg	All by myself in France, no Groguess its late at night in Calgary.
9/24/2003	2:41:14 AM	Saul Greenberg	All by myself in France, no Grguess its late at night in Calgary.
9/24/2003	2:41:15 AM	Saul Greenberg	All by myself in France, no Gguess its late at night in Calgary.
9/24/2003	2:41:15 AM	Saul Greenberg	All by myself in France, no guess its late at night in Calgary.
9/24/2003	2:41:15 AM	Saul Greenberg	All by myself in France, no lguess its late at night in Calgary.
9/24/2003	2:41:15 AM	Saul Greenberg	All by myself in France, no llguess its late at night in Calgary.
9/24/2003	2:41:16 AM	Saul Greenberg	All by myself in France, no llaguess its late at night in Calgary.

Figure 3.10: Real data collected from the Notification Collage—showing that adding or removing characters inside a message on Sticky Notes beats the substring assessment algorithm.



the conversation capturing tool considers it a new message as the substring criteria is not satisfied. Therefore, this is an issue that needs to be addressed in future iterations of the tool.

While filtering can undoubtedly help reduce the number of entries captured in the database, it also comes with some trade-offs. Unlike semantic filtering, automated filtering is often based on some prescribed criteria. Therefore, the resulting dataset may not truly reveal the interactions that have taken place. For example, when Tony types “How about a movie, we ”, Carman immediately responds “yes”. Tony continues with “can go see Terminator which I heard.” while Carman continues “Saw that, Matrix instead?” in the same sentence as Tony types. And Tony responds with “Sure.” While the sentences are not grammatically correct, they reflect how people converse. Yet, with the filtering algorithm described in Section 3.3.3, only two entries would likely be captured: Carman’s “yes Saw that, Matrix instead?” and Tony’s “How about a movie, we can go see Terminator which I heard. Sure.” This means the subtle interaction embedded within their questions and replies would be missing. Similarly, using the image redundancy detection algorithm by imposing a hard-coded threshold value (Section 3.3.3) may remove important information offered in a snapshot sequence. Figure 3.8 shows that the filtering technique captured only 11 snapshots from a sequence of 42 images. The number of images captured is obviously reduced; however, closer examination reveals that many subtle changes like hand movements are filtered out. This may be a problem for people who are interested in studying micro-changes within interactions.

Therefore, the conversation capturing tool not only allows for capturing filtered conversations communicated through current media items, but it also captures all media types including future unknown ones as an unfiltered resource for people who need fine interaction details.

## 3.5 Summary

This chapter describes the underlying rationale and the design of a conversation capturing tool, instrumented to capture conversations that occur on the Notification Collage. Using the conversation capturing tool, one can collect multimedia conversational data that has taken place on the NC. The capturing tool is implemented as a client of the NC server. It captures NC activities by monitoring changes in values to keys stored in the Collabrary Shared Dictionary. These changes are then stored in a database.

When designing the conversation capturing tool, I considered issues concerning multimedia data, e.g., how they should be stored and retrieved properly, and the influence of the NC architecture upon data capture, specifically, how its notification property influences the capture of multimedia data.

To deal with the issues described, trial experiments were performed at different stages of the research. The conversation capturing tool can therefore be described as follows:

- It is implemented as a client of the NC server.
- All event changes are time-stamped and stored as a temporal history in a database with an incrementing unique key.
- It parses (using substring assessment algorithm) the textual messages conveyed through the *Sticky Notes* to filter out the evolving texts before saving them in the database.
- It filters out repeating images by comparing new images to a key frame and only saving an image when it is sufficiently different from the key frame.
- It captures all multimedia conversations taking place on the NC, including media of unknown types that may be contained in future media items.

The next chapter describes the primary part of my research—conversation visualization. I will describe VisStreams: a conversation visualization tool that I have

designed and built for visualizing histories of multimedia conversation captured by the conversation capturing tool described in this chapter

## Chapter 4. Conversation Visualization

---

In this chapter, I present the design of a prototype conversation visualization tool called VisStreams, which enables users to interactively explore and analyze histories of conversation and interaction. VisStreams presents a history of multimedia interactions using the data collected with the conversation capturing tool described in Chapter 3. I present a scenario to illustrate the functionality of VisStreams and how VisStreams can be used to help explore and examine conversational histories. Next, I discuss two issues that are pertinent to VisStreams' implementation and that influence how a person uses the tool to navigate and review past conversations. I then briefly outline a pilot usability study conducted on a previous version of VisStreams (v.1.0). For clarity, VisStreams v.1.1, which is the visualization prototype illustrated in the scenario, is fundamentally similar to the previous version except that it runs faster and offers more features to explore and navigate the communication data.

### 4.1 Functionality of VisStreams

VisStreams embraces several filtering, playback and visualization techniques that allow users to navigate and selectively examine past conversational data. In particular, the functionality of VisStreams can be categorized by the visualizations it offers: *timeline overview*, *timeline detailed view*, *episode replay*, *timeline filtered conversation*, and *dynamic zooming*. I begin by describing each of these in turn, followed by several other auxiliary features.

The following scenario is used to demonstrate how Jane, a new member of an NC community, uses VisStreams to perform tasks to help her understand the dynamics of this online community. Jane is a researcher in human-computer interaction and an

experienced computer user. The data used in this section is based on actual conversation data recorded using the capturing tool presented in Chapter 3 taken from the Interaction Laboratory Notification Collage community (with permission of the community members), modified as needed to increase anonymity and illustrative power.

### 4.1.1 Timeline Overview

When Jane starts VisStreams, she first sees an overview (top region of Figure 4.1) of a portion of the interaction data that was captured between 7/15/2002 and 7/31/2002 (shown as a range in the bar between Figure 4.1a+b). She sees the media items grouped into rows, where each row collects all items created by a named person, e.g., the first row of media items are posted by Charlotte and the second row by ‘Mike R@Home’. If a person has different ‘names’, then the items are collected in temporal order on separate rows, e.g., Saul@home and Saul@ilab are shown as separate rows (Figure 4.1c). It

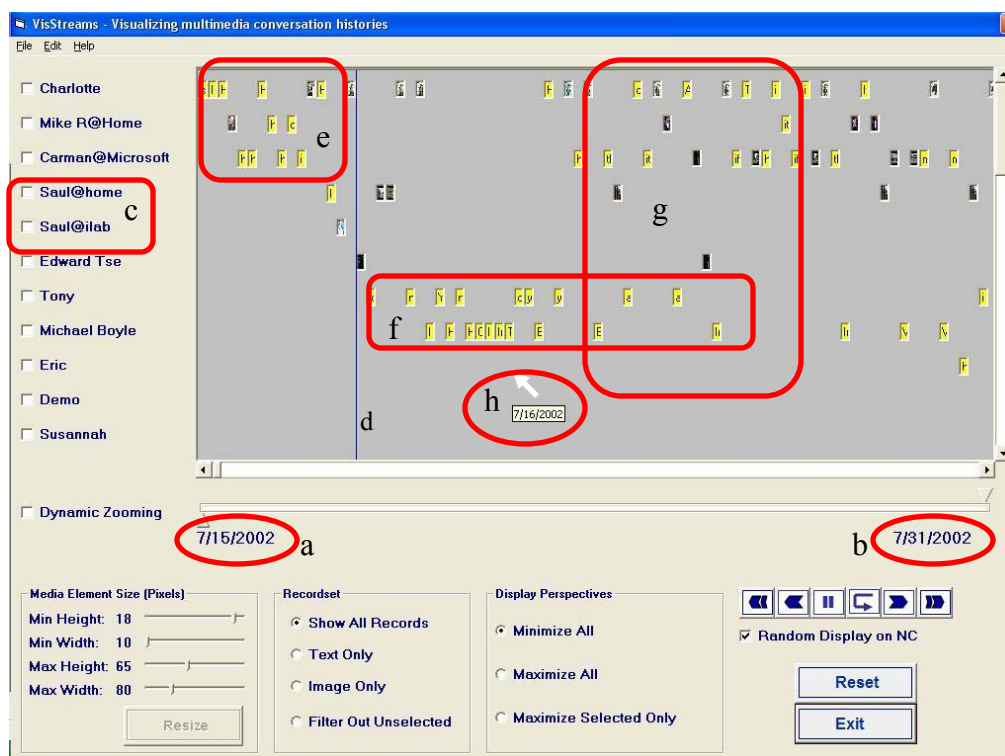


Figure 4.1: Start-up Timeline Overview of VisStreams

should also be pointed out that although the capturing tool presented in Chapter 3 and VisStreams presented here are unable to make strong associations between Saul@home and Saul@ilab, Jane is able to interpret the meaning of these NC user names within VisStreams to easily establish such associations.

Within this particular overview, all media items are minimized as small rectangular ‘icons’, e.g., Figure 4.1f+g. Each ‘icon’ represents an event of a particular type (e.g., a sticky note is a yellow icon with the first character of the message, while a video is a scaled version of the image snapshot). In this minimized view, Jane sees many yellow sticky note icons and image-based media icons. All events are displayed in their relative temporal order of occurrences from left to right. Day boundaries are marked by fine vertical lines (Figure 4.1d).

With the fine vertical lines separating the dates (e.g., Figure 4.1d), she can easily get a high-level view of the activity volume for a particular day. The calendar date is displayed in a tooltip (Figure 4.1h) as she moves the mouse. To illustrate how such overview supports reviewing past conversations, Figure 4.1e shows that the conversation that occurred on the first day of the specified period (i.e., left of the fine vertical line) is dominated by the first three participants; this is why there is a large empty space beneath Figure 4.1e. The second day begins with an intense exchange of utterances between Tony and Michael Boyle (Figure 4.1f), their conversation is later interleaved with the conversation made by Charlotte (1<sup>st</sup> row) and Carman@Microsoft (3<sup>rd</sup> row) as shown in Figure 4.1g. This overview, however, does not inform if the latter two joined in the conversation Tony and Michael started or if they started a new topic. The rows of media items also allow Jane to get a coarse idea of how active each person was.

In summary, timeline overview allows users to acquire a general overview of the conversational activities which have occurred in a given online community as well as an approximate involvement of each participant in the communication.

### 4.1.2 Timeline Detailed View

After scrolling around the overview display in Figure 4.1, Jane finds a particular day showing a set of activities that appear interesting. She would like more details of this interaction. She first scrolls to find the interested region (the tooltip shows that it is 7/16/2002, Figure 4.1h) and double-clicks an empty spot in that region. This expands all of that day's events such that the textual messages are readable and the images are recognizable (Figure 4.2). Media items for all other dates remain as small icons (not visible here) and the calendar slider markers coincide to show 7/16/2002 (Figure 4.2a). She moves both horizontal and vertical scroll bars to examine the conversational details. However, she sees that some *Sticky Notes* are too small to show the entire message

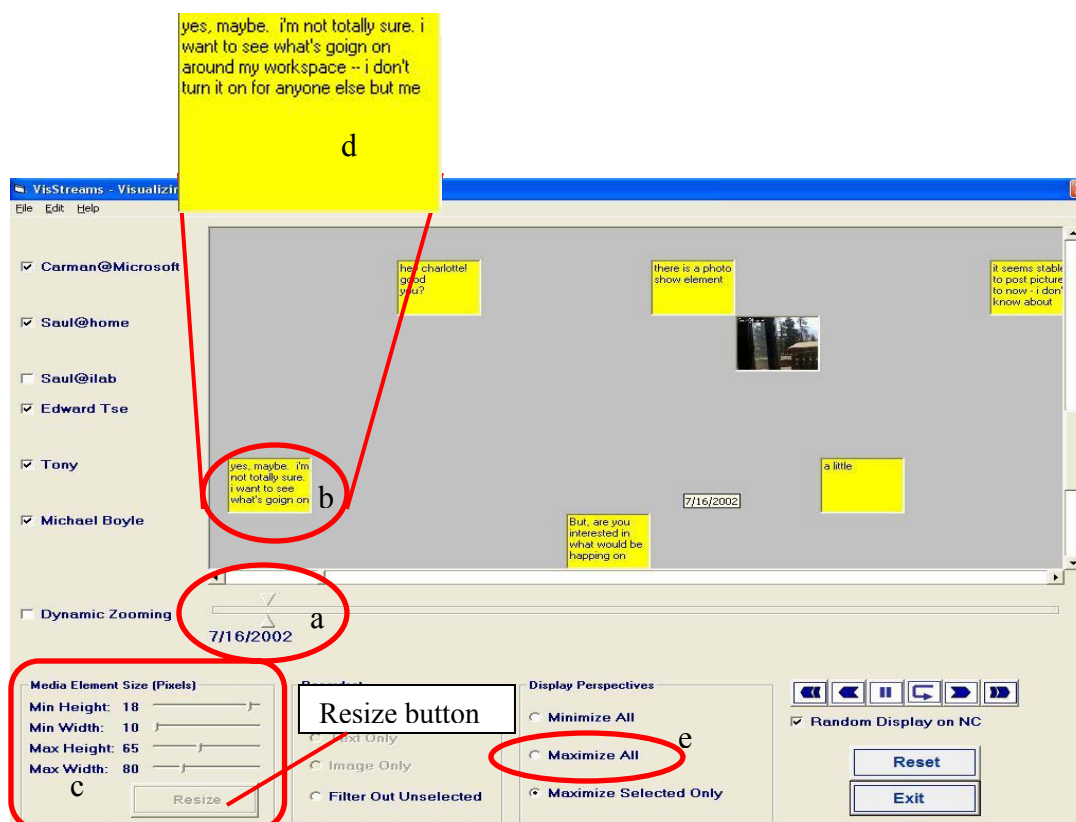


Figure 4.2: All media items that are posted on 7/16/2002 are expanded (only a portion is visible here)—images are recognizable and texts are readable.

(Figure 4.2b). Jane decides to increase the height and width of the media items by adjusting the ‘Max Height’ and ‘Max Width’ slider values (Figure 4.2c) and then clicks the ‘Resize’ button (shown disabled, but will be enabled when a slider is changed). All expanded media items are then resized accordingly (Figure 4.2d shows an example of what the resized *Sticky Note* would look like).

Since Jane is a new member to this workgroup, she really wants to get acquainted with the activities that have taken place between community members in the past. She finds it very helpful to understand this community by reading the textual notes and viewing various images (e.g., video snapshots, photos). She therefore clicks the option button ‘Maximize All’ (Figure 4.2e) and sees that all media items are now expanded to show either readable text or recognizable image (not shown, but the display is similar to Figure 4.2). Jane then scrolls through the display to find episodes of interaction that interest her and examines these media items in detail.

In brief, the timeline detailed view offers users a close-up examination of the activity details that have occurred within a given online community.

### 4.1.3 Episode Replay

While the expanded media items allow Jane to read and see the communicated texts and images, she finds that it does not give her a good sense of how the entire conversational story unfolds over time without excessive scrolling. For example, conversational threads are often heavily interleaved (described in Section 1.1.4) and therefore media items may easily become spatially far apart on the display as they are not only grouped into rows specified by the named participants, but are also placed in temporal order horizontally. To illustrate, while Tony (5<sup>th</sup> row) and Michael (6<sup>th</sup> row) discuss about an interesting project as shown in Figure 4.2, Carman@Microsoft (1<sup>st</sup> row) and Charlotte (not visible here) are also exchanging greetings. As these two ‘conversations’ occur concurrently, the media items posted during that time period are then placed along their own row in their relative time of occurrence. Therefore, Figure 4.2 shows that the conversation made between Tony and Michael spreads across the display window because of the interleaving



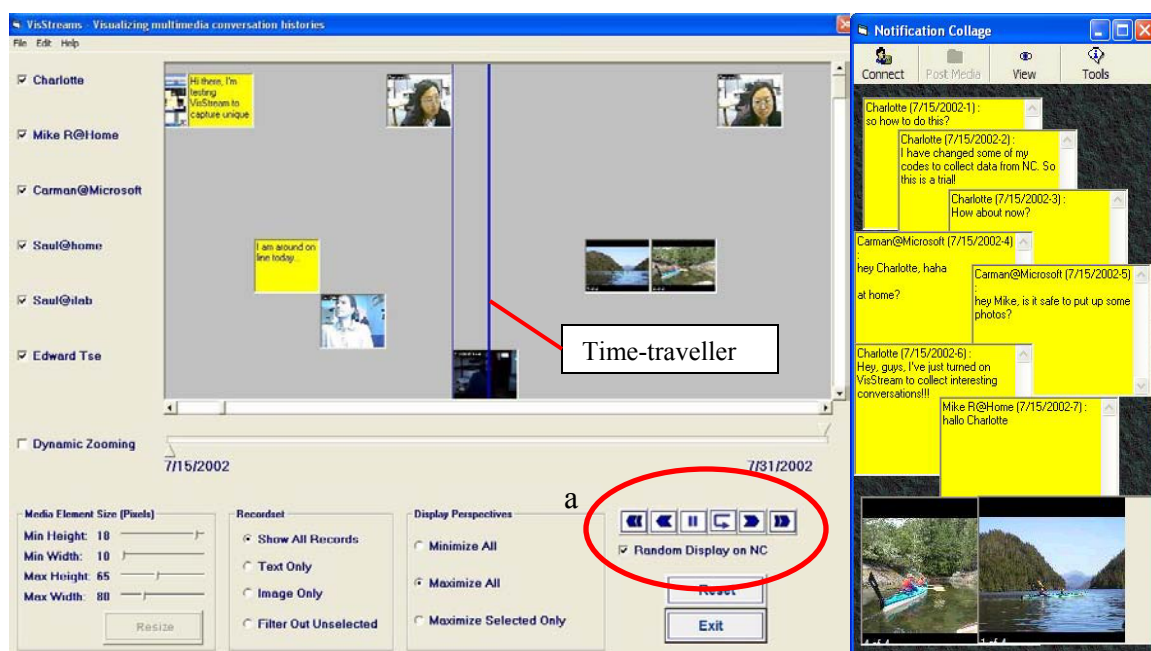


Figure 4.3: All the media items are expanded (left); past interactions are played back and media items are rearranged on the 'playback' NC (right) while the time-traveller travels from left to right. (The time-traveller here has been re-positioned for illustration.)

greetings made between Charlotte and Carman. This spatial separation becomes worse when more participants are involved in the conversations or when more concurrent conversations take place.

Jane wants to get a good sense of the interaction episodes without facing these problems, so she decides to use the CD-player style buttons (Figure 4.3a) located near the bottom right of the VisStreams interface to replay a period of interaction. She clicks the 'play' button (Figure 4.3a, right arrow button), she then sees a thick vertical bar (the time-traveller shown in Figure 4.3; its thickness distinguishes it from the date boundary lines), travelling from left to right, and a special 'playback' version of the Notification Collage appears on a second monitor. When the time-traveller passes over an expanded media item, a full-sized copy of that media item is then randomly placed on the playback-NC, unless she deselects the 'random' option (Figure 4.3a, bottom). Therefore, this episode replay does not truly play back what has actually happened on the Notification Collage: it does not reveal how the contents of individual media items that were posted on the Notification Collage changed over time; it also does not reveal how long a media

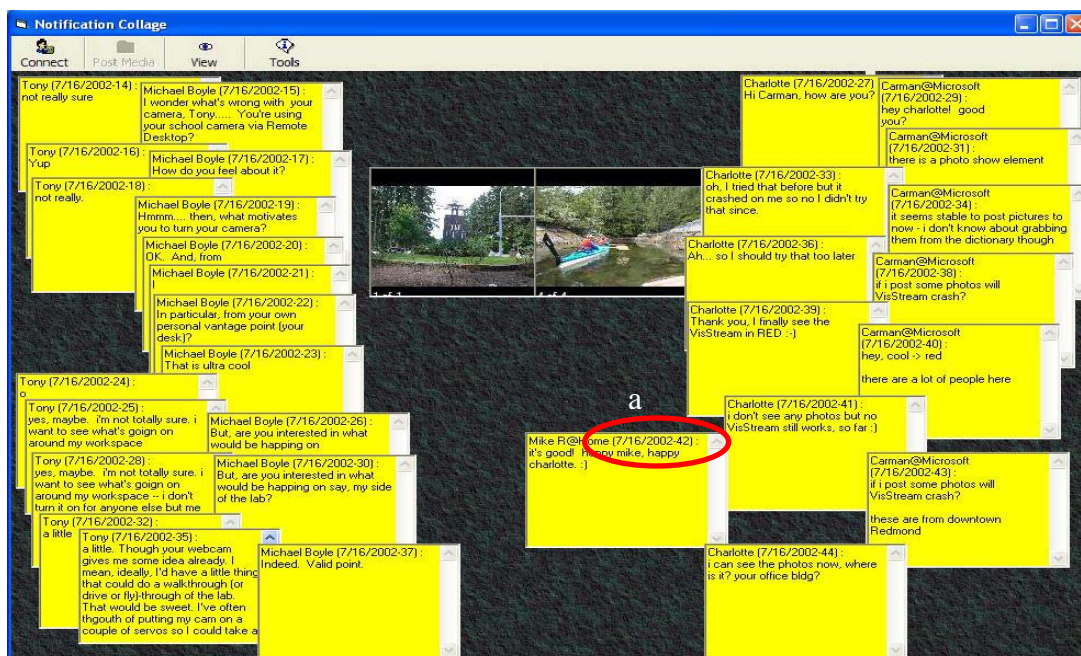


Figure 4.4: A full-size play-back Notification Collage showing an example arrangement of media items.

item stays on the NC. We chose this ‘virtual’ episode replay because we believe that it is useful for users to be able to manipulate the database entries as individual media items so that they can arrange them in the way they want on the playback-NC. For example, they can group, order, and overlap them spatially to help them review the past conversations.

Jane uses the mouse to move and rearrange the media items on the playback-NC to re-build the past interaction (a narrow version is shown in the right of Figure 4.3). She begins to get a good grasp of the interaction history, yet as more and more media items appear on the playback-NC, she finds it too overwhelming to see so many items at once. Jane decides to remove some media items from her playback-NC. She clicks the ‘erase’ button (Figure 4.3a, button with an arrow pointing left) and the time-traveller begins moving in the opposite direction (i.e., back in time). Items it passes over are removed from the playback-NC. Next, Jane clicks the pause button (Figure 4.3a, button with two vertical bars), and no more media items appear on the NC. She can now take her time to re-arrange the visible media items and examine the past conversations.

Jane sees that the complete interaction history contains a vast number of media items, but she now wants to focus on just one particular segment of interaction. In particular, she is interested in the conversation on 7/16/2002 shown in Figure 4.1f+g. First, Jane locates the starting point where she wants to replay the interaction. Next, Jane right-clicks on the display to bring the time-traveller to that position; this action also clears the playback-NC. She then clicks the ‘play’ button to start playing the selected portion of the interaction history and clicks ‘pause’ when the time-traveller reaches the end of the episode. In this way, she is able to skip uninteresting regions of activity and selectively play back interesting episodes. Figure 4.4 shows an example arrangement of the media items on the full-size play-back Notification Collage. Within it, Jane has identified two concurrent conversational threads, where she placed them on the two sides of the Collage (the left one made by Tony and Michael; the right one made by Charlotte, Carman@Microsoft and Mike R@Home on 7/16/2002). She roughly places these *Sticky Notes* in temporal order from top (oldest) to bottom (most current). This can be done easily as the *Sticky Notes* are all dated and numbered (Figure 4.4a). She also places two photos Saul posts to share with the group in the middle while removing other uninteresting media items by right clicking them. With this visualization, Jane is able to group the apparently interleaved conversation shown in the timeline overview (Section 4.1.1) into two separate conversations.

In brief, the episode replay lets users bring the conversation history to life by ‘replaying’ either the entire history or a selected portion of it on a special ‘playback’ Notification Collage board. Users can re-arrange the media items on this NC to group them into meaningful clusters. They can also examine the items’ details for analysis purposes.

#### **4.1.4 Timeline Filtered View**

Jane feels that she has acquired a good grasp of the activities that have occurred in this group. Since she finds the conversation between Tony and Michael made on 7/16/2002 really interesting, she decides to explore this particular conversation with another

visualization. She wants to filter out all irrelevant media items in the timeline display. There are several ways to do this.

She chooses to first reset the display (by clicking the Reset button, Figure 4.5a) so that the *timeline overview*, where all check-boxes are unselected, appears (Figure 4.1). She then selects Tony and Michael (Figure 4.5b). As she checks each of them, the respective row of media items becomes expanded leaving the unselected ones minimized (Figure 4.5).

As she wants to focus on one particular day, she moves the left calendar slider marker (Figure 4.5c) to the point indicated as 7/16/2002. Since neither Tony nor Michael posts anything on the previous day (as shown by the large empty space beneath Figure 4.1e), the display remains the same. She then adjusts the right calendar slider marker to coincide with the lower one (Figure 4.6a) to select a single day which causes all the media items posted by Tony and Michael on other days to become minimized as ‘icons’ (not shown). To remove all the uninteresting media items (i.e. the minimized ‘icons’),

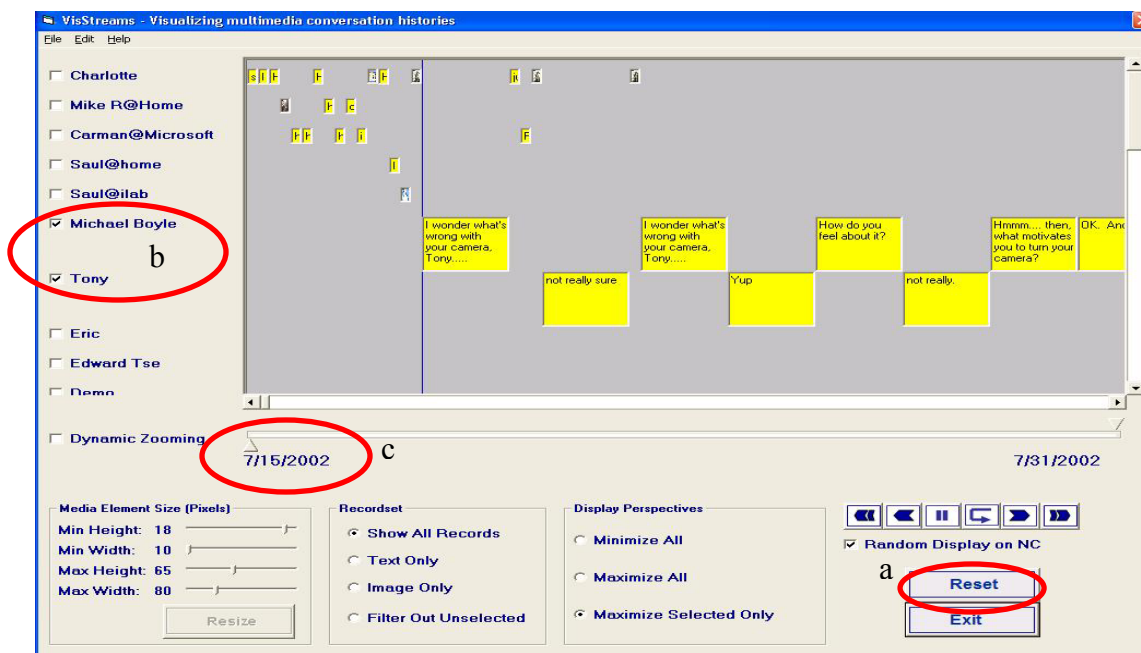


Figure 4.5: VisStreams showing a Timeline Filtered View with two focal rows embedded among rows of minimized icons.

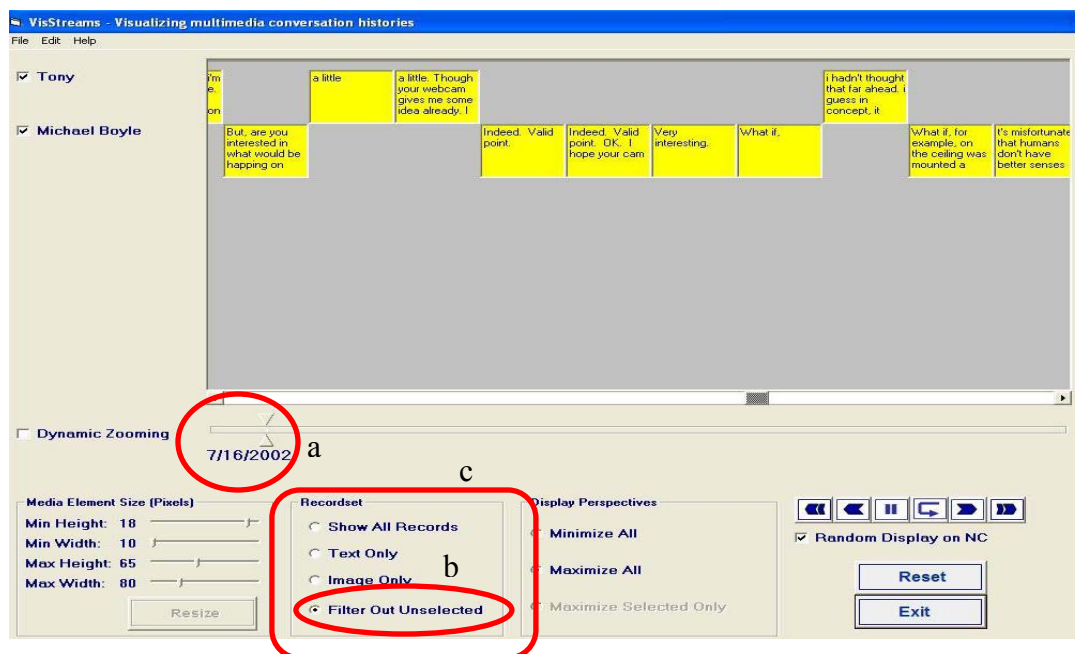


Figure 4.6: A Timeline Filtered View showing a portion of the conversation made between Tony and Michael on 7/16/2002.

she selects the 'Filter Out Unselected' option button (Figure 4.6b). Only two rows of media items which are posted by Tony and Michael remain, still in temporal order (Figure 4.6, top). She also knows that there are other filtering options she could use. For example, she could filter out textual media items to display only media items containing an image if there are image media types in the display (see options in Figure 4.6c).

In summary, the filtered conversation view lets people concentrate on interesting portions of an interaction history for review and analysis. Users can filter history segments by named people (by selecting the check boxes on the left), dates (by adjusting the calendar slider markers), and media types (by selecting options shown in Figure 4.6c).

### 4.1.5 Dynamic Zooming

While Jane finds it useful to examine the details by maximizing all the media items, the increased element size reduces the number of items that can be displayed (as constrained by the screen real estate). So she decides to explore the dynamic zooming feature. She



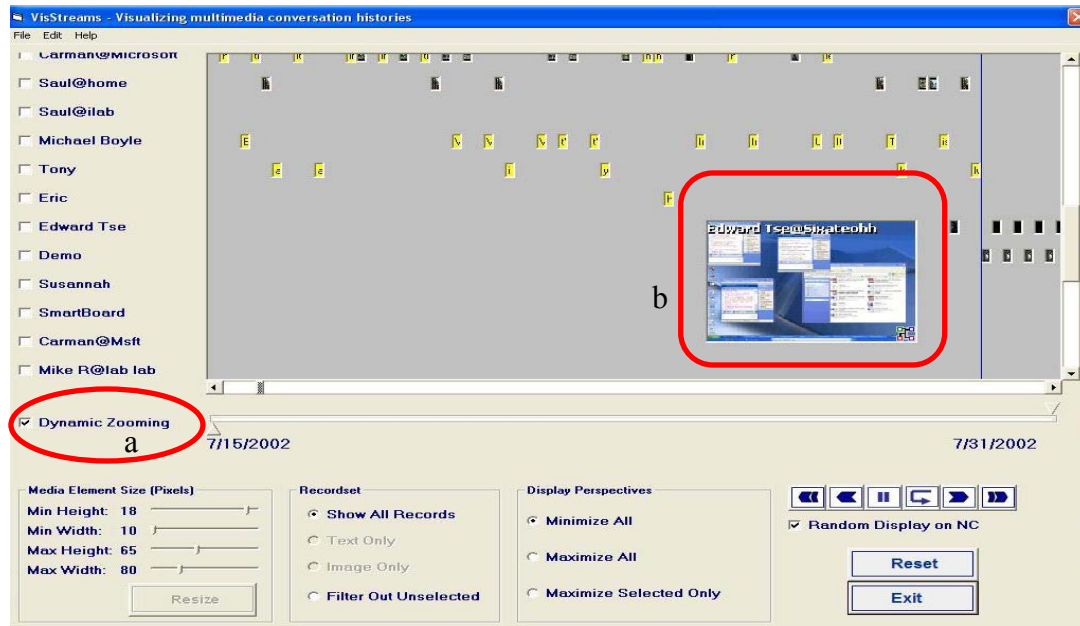


Figure 4.7: Dynamic zooming enables viewers to casually examine the details of each media item.

resets the display to show the timeline overview displaying more media items on the screen. She selects ‘Dynamic Zooming’ (Figure 4.7a). As she moves the mouse over a minimized ‘icon’, it is expanded to reveal details of the media item content (Figure 4.7b). As she moves the mouse away, it resumes its original size. This visualization technique expands one media item at a time for detailed inspection of the element. In fact, this feature is somewhat similar to the ‘scrubbing’ feature that many video-editing tools offer, e.g. the *Adobe Premiere*. The difference is that the user only needs to move the mouse in one direction (usually horizontally) in those tools while in VisStreams, the user has to follow the way media items are placed on the display. To sum up, the dynamic zooming feature allows users to casually go through details of the interaction data to locate interesting episodes.

#### 4.1.6 Auxiliary Features

**Key word search.** Jane knows that she can search for media items by keyword. She uses either a menu or a hot key (control-f) to raise the search window (Figure 4.8a) and types ‘VisStream’ into the pop-up dialog. She clicks the ‘Find Next’ button; the first

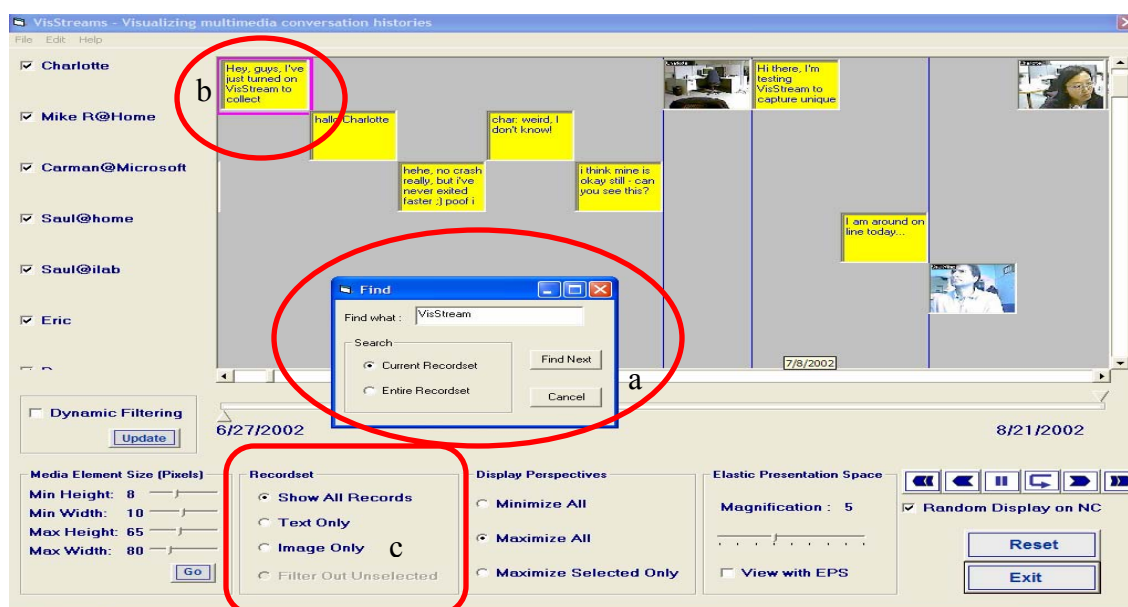


Figure 4.8: Search results are highlighted and brought to the leftmost of the display as indicated by the small circle.

media item containing the key word is highlighted with a coloured rectangle around it and placed at the leftmost side of the visible display (Figure 4.8b). Every time she clicks the 'Find Next' button again, the next media item containing the key word will be displayed similarly until the active record set has been searched. Users can specify through the search dialog whether to search only the current record set (i.e., the displayed dataset) or the entire record set. In the latter case, the display will first be refreshed to show the entire set of media items.

**Rename identities.** One of the NC users, Carman, worked at Microsoft for a period of three months. During that time he used two different identities when logging in to the NC: 'Carman@Microsoft' and 'Carman@Msft'. But Jane decides to integrate the two name rows into one. Jane clicks 'Edit' on the menu bar and chooses 'rename'. A 'rename' window appears (Figure 4.9) and Jane replaces 'Carman@Msft' with the preferred 'Carman@Microsoft' (Figure 4.9a+b). Jane now sees that the updated display has integrated two rows into one, labelled as 'Carman@Microsoft' (not shown).

The scenario described above illustrates the functionality of VisStreams and how VisStreams can be used to help explore and examine conversational histories. The next

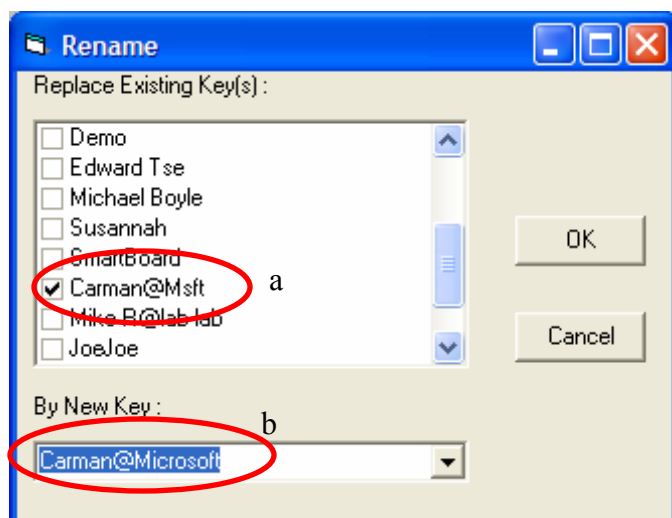


Figure 4.9: VisStreams allows renaming names as a way to manage the dataset

section describes two issues that are pertinent to the VisStreams' implementation and that influence its use for navigating and reviewing past conversations.

## 4.2 Implementation Issues

While VisStreams offers several visualizations to let people navigate and review past conversations, two implementation issues that influence the effectiveness of VisStreams should be dealt with in the future prototypes. First, VisStreams runs relatively slowly for an interactive application. For example, running on an Intel Xeon 1.40 GHz processor with 512 MB of RAM, it takes about 5 seconds to load approximately 1000 media items (60-70% of which are image items). It takes between 2 to 5 seconds for each interaction (e.g., to maximize all the media items takes about 5 seconds and to show only textual items takes about 2 seconds). Nevertheless, the current VisStreams version has been improved from the previous version, VisStreams v.1.0, which required over a minute and sometimes as long as 3 minutes for each interaction. This interaction latency was unacceptable. While both versions are implemented in Microsoft Visual Basic 6 (VB 6), the dramatic difference in transition time lies in the higher cost to load images. Previous versions used only image controls to display all media items; meaning that textual messages were also displayed as images. This method was chosen because it allowed



textual media items to be completely viewable, which was particularly useful for long messages.

The extreme interaction latency prompted me to use more efficient user interface controls in the current prototype, e.g., text box controls are used for media items containing only text. This has significantly improved interaction time compared to the previous version. However other, though comparatively minor, trade-offs emerge. For instance, only partial text for longer messages may be visible in the default maximized element size. To deal with this, a resizing option (located at the bottom left corner of the VisStreams interface, Figure 4.2) is available to expand the media items. As well, the minimum width allowed for textboxes in VB 6 (3 pixels) is more space-intensive than that for image controls (1 pixel) so media items are more spatially distributed in the *timeline overview* and the maximum displayable number of ‘icons’ is thereby reduced.

Second, the software (VB 6) used to implement VisStreams restricts the display dimension. To illustrate this, imagine that media items are placed on a large canvas in the same way as shown in the *timeline detailed view* (Section 4.1.2). The media items can only be seen through a small rectangular viewing glass. Therefore, one has to move the viewing glass around to examine the media items that are scattered around the canvas. Since the canvas has a limited maximum size, it constrains the number of items that can be placed on it especially because media items are placed along the horizontal timeline in temporal order. Thus, for a large number of media items, some will not be placed on the canvas when the maximum display width is exceeded. For example, when the media items are displayed in the width of 80 pixels (the maximize width pre-set in VisStreams), only about 200 media items can be displayed (because they are temporally placed across the canvas). To see the rest of the media items, adjustments need to be made to the filtering options, e.g., to narrow the time period, so that the desired media items can be placed on the display canvas for viewing.

To deal with these two issues, future work may include implementing VisStreams with another programming language that can handle images more efficiently and that

supports extended display dimensions. The next section describes a pilot user study performed on VisStreams v.1.0.

## 4.3 Usability of VisStreams v.1.0

I developed VisStreams v.1.0 (Tang and Greenberg, 2002) to capture and visualize multimedia conversations in what I thought would be an effective manner. Its interface is not shown here but it is very similar to the current prototype (i.e., VisStreams v.1.1). The main difference is that VisStreams v.1.0 is an integrated conversation capture and visualization tool, and it supports only a subset of functionality that is available in the current prototype. Specifically, VisStreams v.1.0 did not allow dynamic zooming (Section 4.1.5) and resizing of media items (Figure 4.2c) while it always displayed a combination of texts and images as opposed to the choice of texts, images or a combination in the current prototype (Figure 4.8c). This old version is also slower than the current prototype.

This section outlines a pilot study that focuses on the conversation visualization function of VisStreams v.1.0 to evaluate its usability in exploring and navigating a large dataset of multimedia conversational history.

### 4.3.1 Methodology

**Study data.** We used a mimicked conversation set consisting of episodes of communication that occurred in an imaginary trading and vessel-chartering company. Any unfamiliar terminology was explained to participants prior to the commencement of the study.

**Participants.** Study participants were 8 experts and 2 novices, classified by their general experience in using computer.

**Materials.** VisStreams v.1.0 was the integrated conversation capture and visualization tool under investigation. This system required two side-by-side displays to view the VisStreams system and the ‘play-back’ Notification Collage. A set of 12 tasks

(Appendix A.5) were used in the test, each of which asked the user to examine the data set in order to answer a particular question. Other study materials can be found in Appendix 1-4.

**Procedure.** Each study session (about an hour long) involved a single participant. Participants were asked to think aloud during the study.

First, participants were asked to express their conceptual model of the user interface. They described what they felt was the function of each interface component and how it operated without actually operating on it. They were also encouraged to predict changes in the system after performing probable operations with each interface control.

They then performed the prescribed tasks (Appendix A.5), one at a time. There was no explicit time limit imposed for each task. However, if it became obvious that a participant was stuck on a task, the investigator asked the participant to proceed to the next task. The study session ended when the one hour limit had expired even if there were unfinished tasks.

### 4.3.2 Results

The experts basically shared similar views which, for the most part, reflected the true operation of the components while the novices' predictions were quite different from the true operations of the system.

For the 12 tasks, seven participants (all experts) completed all the tasks. The remaining expert finished 11 while the two novices finished 8 and 9 tasks.

The post-test questionnaire (Appendix A.4) generally showed a positive response to the VisStreams system, with the exception that people felt the system ran too slowly. The participants expressed that the long latency between screen transitions (while filtering) undermined the interactivity. Yet, most participants thought that the system was easy to use and they were able to find what they were asked to. They also suggested a few features that were missing in VisStreams v.1.0, such as the keyword search.

### 4.3.3 Discussion

VisStreams is the first known tool to navigate and review multimedia histories of casual interaction. Therefore, the primary purpose of this pilot study was to find out if this prototype can help people explore and review the communication data and to look for insights to guide the next stage of the research. The results show that this tool is promising, and raised several enhancements for a future system redesign. Many participants showed great interest in this prototype as they believed that this research would be useful to review past conversations. Indeed, many of them suggested that this research should extend to cover other popular communication tools such as emails, MSN Messenger and ICQ.

Therefore, in the few months following the study, I focused on improving VisStreams' user interface and functionality as recommended by the participants. I developed a new prototype, VisStreams v.1.1 (described in Sections 4.1), which offers a broader range of functionality for exploring the historical data. As well, I altered the implementation to improve its efficiency.

I also stepped back to create low-fidelity prototypes of tool interfaces embracing different sets of functionality. They all appeared to fulfil the intended task of exploring and analyzing the conversational histories. However, the more I worked on VisStreams, the more I realized that the list of possible features was potentially boundless. I was not confident if these proposed interface components would actually help users perform their intended tasks, or if the visualizations presented the history in ways that would make sense to them. Many questions emerged while developing the prototypes. To list a few, what granularity of visualization would a person be interested in, say, the entire period, a month, a day or an hour, and what are the determining factors? If a person wants to locate some particular communication contents, what visualization would that person prefer? Will there be other tasks that one wants to perform other than reviewing the communication contents? Will the person want to examine interaction patterns such as communication rhythms and trends (Begole et al., 2002)?

It became clear to me that a missing piece in my research was understanding tasks. Since there were no known prior studies on how people would use such historical information of multimedia conversations and their visualizations, I decided to take a more grounded user-centered approach to find out what tasks users would perform on multimedia conversation histories and how they would visualize them. My approach and its results are discussed in the next chapter.

## 4.4 Summary

In this chapter, I presented a scenario describing how VisStreams could be used to explore and visualize multimedia conversation histories. It demonstrated how VisStreams' functionality is categorized according to the visualizations it offers.

- ***Timeline overview*** reveals activity levels and a crude picture of communication rhythms.
- ***Timeline detailed view*** presents clearly readable and recognizable communication contents on a horizontal timeline; thus, users are able to follow and trace the progress of communications.
- ***Episode replay*** allows past conversations to be played back and re-assembled on the Notification Collage.
- ***Timeline filtered conversation*** allows users to concentrate on the data they are interested in by removing irrelevant information or maintaining a detail-in-context visualization by de-emphasizing media items of less interest.
- ***Dynamic zooming*** lets users to zoom in on interesting media items.
- ***Auxiliary functionality*** includes keyword search and renaming. These features help users locate desired media items and manage the conversational history log.

I then discussed two issues pertinent to the implementation of the VisStreams system. A usability study conducted for VisStreams v.1.0 proved promising, and I revised it to include features recommended by users and by speeding it up. It then

appeared that I could halt the research at this stage. However, emerged uncertainties caused me to revisit the basics of my research that VisStreams might fail to address. Instead of looking into incremental improvements of the tool, I decided to redirect my research to examine the user-centered task requirements for a conversation visualization tool, discussed in the next chapter.

## Chapter 5. Exploring Multimedia Histories of Casual Interactions

---

My research goal has been to explore the issues involved in presenting and analyzing histories of multimedia-based casual interactions. This is a challenging task and not one that has been addressed before.

Using data collected from the Notification Collage, the VisStreams prototype was a first attempt at a solution for the problem. However, initial prototyping experiences demonstrated a need for a more grounded approach to the design.

As discussed in Chapter 4, while the VisStreams prototype showed good potential, I realized over time that I needed a more grounded user-centered approach to help me understand users' actual requirements. The problem was that as I continued to work on VisStreams, I realized that the range of possible features that could be included within it was endless. Besides, a lot of uncertainties emerged while developing the prototypes.

I believe that the *multimedia histories of casual interactions* are important for both *group members* to find and reflect on their past interactions, and for *researchers* to investigate the nuances of online communities. Yet because I had little knowledge of what people would actually do with these histories and how they would like them visualized in order to fulfil the intended tasks, designing a truly effective history review system proved difficult. Hence, I decided that I needed a more grounded approach to help uncover user-centered requirements for a visualization tool displaying multimedia histories of casual interactions.

To do this, I conducted an exploratory study with the help of a graduate student Gregor McEwan who did this as a graduate course project<sup>2</sup>. This chapter describes the user study Gregor and I conducted. The goal of this study was to answer two questions that correspond to Goal 2 of my research.

- 1) What questions would people ask about a history of multimedia data of casual interactions?
- 2) If the raw data were made available to them, how would people arrange it to answer these questions?

We gathered sophisticated NC users as study participants, and had them analyze paper-based records of real data captured from the Notification collage. The study roughly fell into two phases matching the above questions: a brainstorming phase where we elicited tasks that they would do over these records, and a data re-organization activity centered on how they would visualize these records to help them perform their tasks.

In the following sections, I first describe the methodology employed in this study, followed by the findings in each stage. I then recommend several task-centered visualization views for the interaction history tool. Finally I summarize the findings from the study.

## 5.1 Methodology

This user study is primarily exploratory in nature. It roughly fell into two phases matching the abovementioned questions: a brainstorming phase where we elicited tasks that the participants would do over these records, and a data organization activity centered on how they would visualize these records to help them perform their tasks.

---

<sup>2</sup> Much of the material presented in this chapter was published in: C. Tang, G. McEwan and S. Greenberg, A Taxonomy of Tasks and Visualizations for Casual Interaction of Multimedia Histories, in Proceedings of Graphics Interface 2003, pp.225-236.



### **5.1.1 Study Data**

We chose to capture data from researchers at the Interaction Laboratory of the University of Calgary, as they relied heavily on the Notification Collage as a way to casually interact with one another and to discuss research-related topics. We used the conversation capturing tool described in Chapter 3 to capture five days of activities. These were then presented as raw paper-based log data for the study. Each event was printed on a detachable PostIt™ Note. They were then arranged in time order in a booklet (a page from this booklet is shown in Figure 5.1).

### **5.1.2 Participants**

Study participants were 13 computer science students: 10 graduate, 1 undergraduate and 2 interns from Germany who have been with the Interaction Laboratory for several months. All were doing research in either Human Computer Interaction or Information Visualization. All participants had personal experiences using the Notification Collage, and were members of the NC community whose data we had captured.

This selection was deliberate, as we wanted ‘expert’ participants who could respond from both group member’s and researcher’s perspective. As a member of the community, the participant revealed how one would personally use a visualization tool to review interactions of one’s own community. As a researcher in human computer interaction, the participant revealed how one would use this tool as a scientist trying to understand these interactions. Because all the participants were members of the NC community whose data we had captured, we expected and also found them highly motivated. They wanted to discover things about their community as they analyzed the data.

Because the participants had used the Notification Collage for real purposes, they were all familiar with its basic concepts. Due to the brainstorming nature of the tasks, the study would work best with participants familiar with the basic concepts.

### 5.1.3 Methods and Materials

Each study session lasts about 1 to 1.5 hours involving a single participant working through four stages. Both investigators were present in each study session. Gregor was the primary prompter during the study after considering the possibility that I, being the sole designer and developer of VisStreams, might be inclined to ask leading questions. The study materials can be found in Appendix B.1-5.

**Stage 1. Pre-test questionnaire.** Participants completed a questionnaire asking about their familiarity with the Notification Collage, VisStreams, CSCW and groupware, and data analysis techniques (Appendix B.4). These questions were measured with a Likert scale. It also asked for their specific research areas. We wanted to evaluate the influences these factors may have on the tasks and visualizations brainstormed by the participants.

**Stage 2. Brainstorming tasks.** To answer question 1: What questions would people ask about a history of multimedia data of casual interactions? We asked the participants to brainstorm tasks they would perform with a tool that let them review multimedia histories of casual interactions. It was made clear that this was a brainstorming activity and there was no criticism of any idea. As they brainstormed ideas, we gave only positive feedback to encourage idea generation. All ideas were noted and used to guide the third stage.

**Stage 3. Data manipulation and visualization.** Participants were provided with a booklet containing five days of raw log data captured from the NC (a page from this booklet is shown in Figure 5.1). Raw events were presented as time-ordered rows annotated by the time and date of the event. The event itself was printed on a detachable PostIt™ Note ~3.5cm x 5cm in size.

Raw events appearing on these PostIts included: a person's connection/disconnection on the NC, a media item's appearance/disappearance, and the detailed contents of media items as they changed e.g., text posted to *Sticky Notes*, pictures posted to *Photo Shows*, and video frames appearing in *Video* snapshots. As is visible in

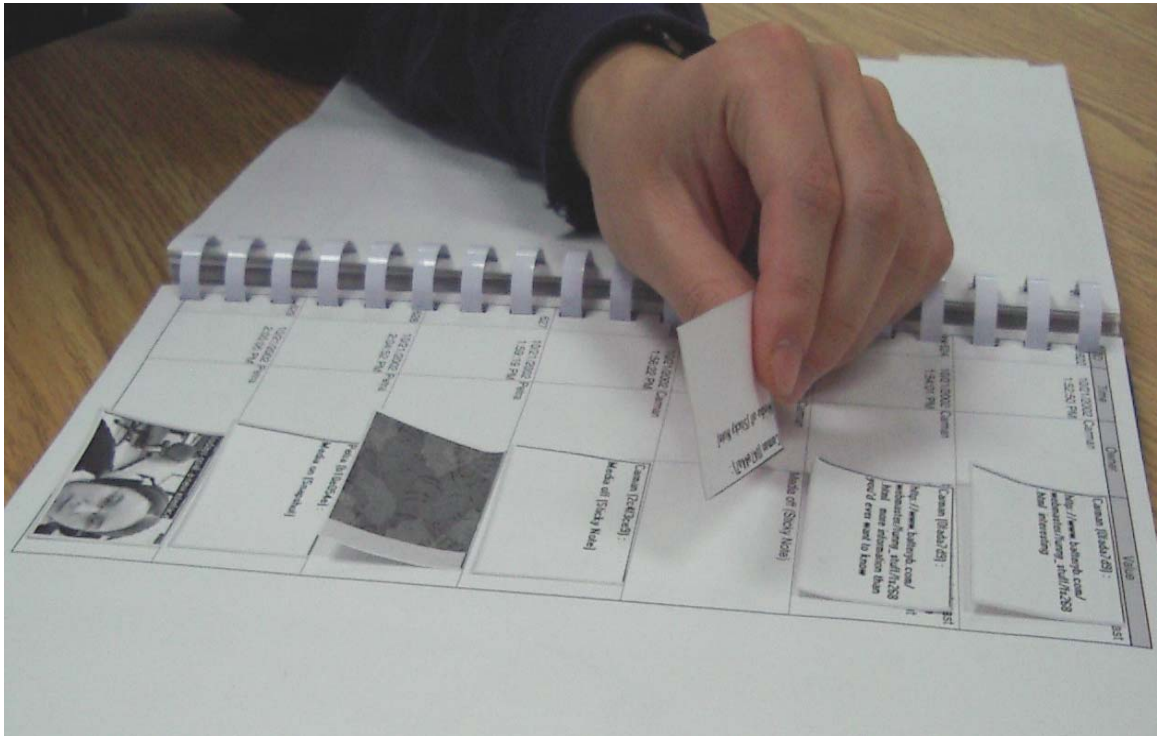


Figure 5.1: A participant manipulating the history log (reconstructed for better picture quality)

Figure 5.1, raw events displayed the data in human-readable form i.e., image data were presented as images (the 5<sup>th</sup> and 7<sup>th</sup> row), sticky notes as its current text contents (1<sup>st</sup> and 2<sup>nd</sup> row) and other events as explanations such as “Log on”, “Log off”, “Media on” and “Media off”.

As seen in Figure 5.2a, we also provided participants with large tables, several whiteboards, whiteboard markers, blank PostIt<sup>TM</sup> notes, pens and masking tape.

To answer question 2: If the raw data were made available to them, how would people arrange it to answer these questions? We asked participants to perform the tasks they had brainstormed in Stage 2. In particular, we asked them to create visualizations by restructuring these raw materials in any way that made sense to them. Because events were on detachable PostIts<sup>TM</sup>, participants could move them around freely on the whiteboard, and annotate them as needed (Figure 5.2b gives an example of what they did, reconstructed for better picture quality). While we also had a list of tasks prepared *a*

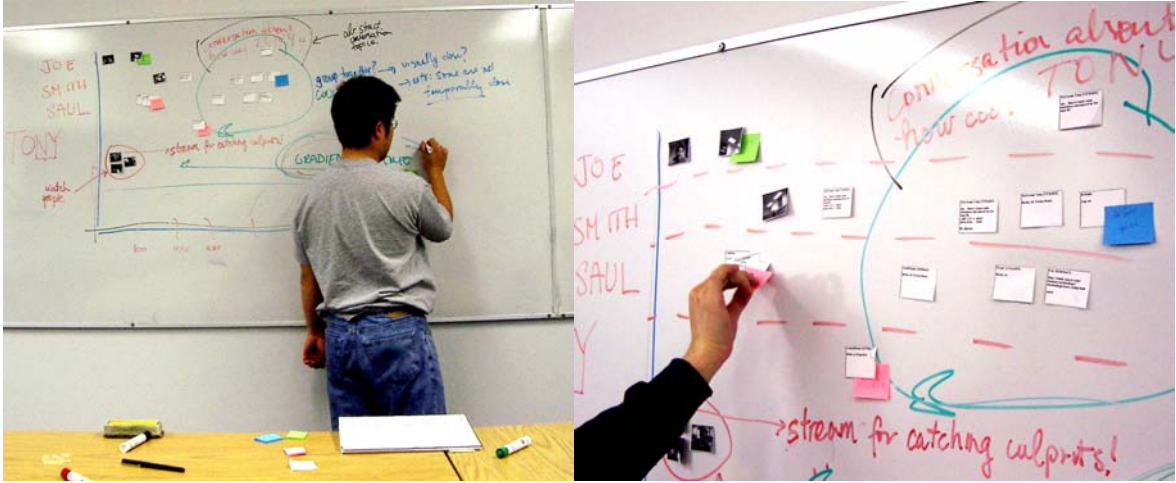


Figure 5.2: (a) A participant restructuring the data, and (b) a close-up of the visualization he is creating

*priori* to offer participants if they were stuck, we avoided using these tasks as much as possible to circumvent influencing the participants. In practice, we only had to give participants these tasks twice overall. These data visualizations were recorded in detail by both investigators as well as a video tape.

**Stage 4. Post-test questionnaire.** A short questionnaire gave participants opportunity to comment on the limitations of both the data representation and provided materials (Appendix B.5). The participants were able to express where the materials prevented or hindered them in their representations.

## 5.2 Results

This section details the results from each of the stages of the trials.

### Stage 1: Pre-test Questionnaire

The questionnaire confirmed that our participants fit the demographics we wanted. That is, they were very familiar with the Notification Collage, and they frequently used other groupware, typically an Instant Messaging system. The majority had some experience with data analysis, although this expertise varied considerably across both depth and

domain. While all had some prior exposure to our VisStreams prototypes; none had extensive experience with it or had used it for real purposes.

## Stage 2: Brainstormed Tasks

Participants generated a large list of potential tasks that they would perform over a history of multimedia casual interactions. We augmented this list with other tasks we saw people perform in Stage 3, i.e., tasks that emerged as people worked with their visualizations. We analyzed these lists by categorizing them and looking for patterns.

All tasks fell naturally into five categories, as shown in Tables 5.1 and 5.2, and as detailed below. We will explain how these tasks serve the perspective of a group member interested in personal exploration and of a researcher interested in patterns and social networks.

Task categories				
Interaction primitives	Conversations	Rhythms and trends	Descriptive statistics	Community and social networks

*of group member*      *Perspective*      *of researcher*

Table 5.1: Task categories and perspectives

**Interaction primitives.** Many participants had tasks centered on the explicit interaction held by the contents of a media item e.g., the events that occurred, the conversational utterance, the actual media that appeared. All of these tasks are characterized by the fact that they involve no processing of the raw events. Almost all tasks involving interaction primitives concern *finding* specific media items or login data. As listed in Table 5.2a, these include finding past comments about what someone said, who was present at a moment in time, locating particular information (such as a URL held in a sticky note), locating a picture in a photo show or a video snapshot of a person. Participants formed these tasks mostly from their perspective as a group member i.e., they wanted to know about things that happened that were personally relevant to their membership in the NC community.

Table 5.2: Task categories and specific questions

<b>a) Tasks centered on interaction primitives</b> <ul style="list-style-type: none"> <li>• see group member presence at a particular time</li> <li>• find answers to common questions</li> <li>• find past comments</li> <li>• find URLs</li> <li>• find slideshow pictures</li> <li>• find past video snapshots</li> </ul>
<b>b) Tasks centered on conversations</b> <ul style="list-style-type: none"> <li>• identify and reconstruct conversations</li> <li>• find past conversations</li> <li>• discover participants of conversations</li> <li>• compare and relate conversations</li> </ul>
<b>c) Rhythms and trend Tasks</b> <ul style="list-style-type: none"> <li>• what times do conversations occur?</li> <li>• what different purposes are sticky notes used for?</li> <li>• when are the people usually present?</li> <li>• which people tend to be lurkers vs interactors?</li> <li>• what are the patterns of numbers of people logged in?</li> <li>• how long do people usually stay logged on?</li> <li>• are there patterns in the number of media items posted?</li> <li>• are there patterns of posting different types of media items?</li> <li>• how many and how long are the breaks in daily activity?</li> <li>• how stable is the NC software?</li> <li>• how often do media items change?</li> <li>• what types of posts do I mostly make?</li> <li>• what is usually the busiest time period?</li> <li>• what are the patterns of activity for an individual?</li> <li>• what topics does an individual discuss?</li> <li>• what content are communicated on different media item types?</li> </ul>
<b>d) Descriptive statistics tasks</b> <ul style="list-style-type: none"> <li>• who participates in discussions the most?</li> <li>• what is the maximum number of people that participate in a single conversation?</li> <li>• how many items do individuals post?</li> <li>• how many times did an individual log on in a time period?</li> <li>• who posts most often?</li> <li>• who responds to posts most often?</li> <li>• how often is the "clear" function used on sticky notes?</li> </ul>
<b>e) Community and social structure tasks</b> <ul style="list-style-type: none"> <li>• can we identify social networks by analyzing which people are around at the same time and how they interact?</li> <li>• can we discover credibility and reputation?</li> <li>• who supplies good answers?</li> <li>• how is reputation gained in the community?</li> <li>• what are the social norms of the community?</li> <li>• what form does 'social policing' take?</li> <li>• what makes people decide to use the NC, IM, or email at different times?</li> <li>• can we evaluate the role of NC in collaboration?</li> </ul>

- how does co-located *vs* distributed use of the NC compare?
- what are the synchronous *vs* asynchronous behaviors on the NC?
- how does NC interaction differ from that on a bulletin board?

**Conversations.** Another set of tasks are characterized by grouping media items together into blocks that roughly define a ‘conversation’. All tasks involve identifying conversations and conversational properties. As Table 5.2b illustrates, example tasks include identifying and reconstructing past conversations, locating past conversations based on topic, identifying participants in the conversation, and relating conversations over time. These tasks predominantly help group members recall past conversations and details about it. However, some tasks are also useful to the research perspective, e.g., what defines conversations and their memberships.

**Rhythms and trends.** Some tasks ask questions about rhythms and trends i.e., summaries of the history that uncover patterns. These questions are typically phrased as ‘when does this usually happen’, ‘how long does it happen for’, ‘what is usually...’ and ‘how often does it happen’. Table 5.2c lists the specific questions, such as when do conversations occur, when are people usually present, how often do media items change, what topics a person usually talks about, etc. While these tasks appear more research oriented, they maintain a strong element of personal usefulness. For example, Begole et al. (2002) describe how visualizations of work rhythms can enhance a group’s awareness of one another.

**Descriptive statistics.** Other tasks are questions that can be answered through descriptive statistics derived from analyzing the history of all media items. As listed in Table 5.2d, these tend to ask ‘who’ and ‘how many’ questions about individuals, such as who participates the most, how many times does one post, and so on. These tasks tend to be more research oriented.

**Community and social network.** The final set of tasks concern questions about community and social structure. These questions typically focused on discovering social norms and relationship networks. Table 5.2e includes examples of how people try to reconstruct the social networks in the user group, such as who has strong social ties to

whom, questions about reputation and social norms and so on. It also asks questions that compare communal use of the NC as a collaborative resource e.g., how people use it for co-located vs. distributed communication. The questions in this category are complex and at a high level of abstraction, and are almost entirely research oriented.

To summarize, the analysis revealed many questions that we grouped into five categories. We believe these categories can be organized linearly into a continuum that reflects data granularity and it fits to particular user perspectives (Table 5.1). Categories on the left side tend towards details about particular interactions, and are of most interest to group members involved in the community. Categories on the right side tend to gather abstractions about the interaction history, which are likely most relevant to a researcher.

### **Stage 3: Data Manipulation and Visualization**

We gave participants the raw data presented in human-readable form (Figure 5.1), and asked them to answer the questions they had posed in stage 2 by restructuring and manipulating this data in any way that helped them make sense of it (as one person did in the example illustrated in Figure 5.2b). We then observed and recorded how they manipulated and visualized this data.

From these collective observations, we saw that most people created visualizations generally including one or more of these five organizational parameters (Table 5.3):

- time scale,
- conversational granularity,
- level of detail,
- media item streams, and
- data perspective.

Each parameter is further layered into factors that describe the visualizations in finer detail. The parameters and how they interact with one another are discussed below.



Table 5.3: Parameters of visualizations

Time Scale
<ul style="list-style-type: none"> <li>• Entire logging period</li> <li>• Months to a year</li> <li>• Weeks</li> <li>• 1 to 7 days</li> <li>• hours</li> <li>• not important</li> </ul>
Conversational granularity
<ul style="list-style-type: none"> <li>• single conversation</li> <li>• multiple conversations</li> <li>• not important</li> </ul>
Level of detail
<ul style="list-style-type: none"> <li>• Statistical summary</li> <li>• conversation</li> <li>• individual items</li> <li>• individual details</li> </ul>
Media item streams
<ul style="list-style-type: none"> <li>• collaborator appearance / disappearance</li> <li>• lifespan</li> <li>• single stream</li> <li>• interacting multiple streams</li> </ul>
Data perspective
<ul style="list-style-type: none"> <li>• details</li> <li>• overviews</li> </ul>

**Time scale.** Time played heavily as an organizing principle in many visualizations, where people considered interactions over varying time scales. For instance, visualizations might extend over an hour, over days, over months, the entire logging period, and so on. However, a few visualizations did not use time at all, e.g., one showed a social network portraying frequent interactions with no indication of time.

**Conversational granularity.** Most participants expressed the need to group related media items into conversational units. Our study showed that *Sticky Note* was the only media item that interested participants for re-constructing conversations. Consequently many visualizations were organized around conversations. Some displayed only single conversations, which visualized a single conversation stream between a subgroup of participants. Others displayed multiple conversations containing several conversations; these included concurrent, overlapping, and temporally separate conversations. Of

course, many other views did not discriminate by conversations and just showed events by some other organizational principle.

When participants focused on conversation(s) rather than individual media space events, exact time scales seemed unimportant to them although relative order and sequencing was still highly relevant. They worked with conversation blocks regardless of the time interval between them. The only relevant time information was the sequencing of media item events within each conversation.

**Level of detail.** Different visualizations revealed different levels of detail about the data. These ranged from abstract overviews to raw data streams which fall into statistical summaries, conversational threads, crude yet identifiable individual media items, or media items in full detail.

When examining conversations, most participants visualized the full details of all media items constituting a conversation. One person, however, considered each conversation as a building block without revealing any underlying details, where these blocks were used to show relations with other blocks.

**Media item streams.** Another way participants organized their data was to look at events that happened within one or more media item streams. Some participants concentrated on the appearance or disappearance of collaborators within the video snapshot stream. Others were interested only in the lifespan of streams i.e., how long a stream persisted on the NC. Some focused on changes within a single stream, such as the evolving text in a sticky note. Others would look at the interaction between streams such as the relationship between multiple sticky notes and photo items. In most of these cases, people were interested in which streams and events were visible (and thus of interest) to other collaborators.

Of all the streams, participants tended to be most interested in the sticky notes because these held the actual conversations. Photo shows were second in popularity. Participants generally used video snapshots to discover the presence of NC group

members; most compacted this video stream into a representative snapshot that served as an icon, where they could expand it later or play it as a movie.

**Data perspective.** Likely because we gave participants raw primitive data, all participants' initial visualizations were detail-oriented. What was surprising was that detailed visualizations persisted over time. Even when we gave people gentle hints to try overview visualizations containing larger time-scales, some participants remained uninterested, while others created short-lived overviews as a way to locate details they wanted. However, a few participants (2 out of 13) shifted on their own accord to create overviews; they then persisted in using high-level overviews. These were also people more interested in conceptual explorations, such as understanding the community and its social structure.

In general, when people created visualizations looking at a very short period of time, they typically displayed full details and all media streams i.e., they wanted to see exactly what was going on during that interval. When their visualizations considered longer time periods, they tended towards much more abstract overviews e.g., conversational units *vs* detail; stream relations *vs* stream details.

#### **Stage 4: Post-test Questionnaire**

Overall, people were satisfied with the raw materials we gave them to create their visualizations. Participants felt they could express their ideas well through the combination of sticky notes for the media events, the whiteboard, and the annotation tools. They thought the whiteboard useful because they could place items on them and draw/erase graphics and notes. Still, a few participants felt constrained by the physical nature of their materials e.g., that they were unable to overlay data or to show animations effectively.

Participant's reaction to the raw data we gave them in the booklet was generally good. The majority were extremely positive about working from real data, and praised the richness of the data since it was complete. However, a few people complained that

the booklet contained much irrelevant data; for the most part these were the events signalling media item appearance and disappearance.

## 5.3 Discussion

The main goal of this particular study was to motivate requirements for a visualization tool for multimedia histories of casual interactions. Our results provide the tasks that become our user-centered requirements, and the visualization parameters imply directions for interface solutions.

From these results, we recommend several task-centered views that the visualization tool should provide, centered around the primary questions that motivate users of such a tool. We also discuss the auxiliary features for the visualization tool that were either suggested by participants or emerged during the study.

### 5.3.1 Task-centered Views

**Detailed views of short time segments.** Many tasks and visualizations concern people asking ‘*What, in detail, is happening around this moment of time?*’ To answer this question, the history visualization system should provide a detailed view that displays all activities in full detail over a short time segment (minutes to an hour or two). This could perhaps take the form of an animated playback tool (e.g., showing a replay of NC activities), or a tool based around a timeline.

**Conversation view.** Other tasks and visualizations are centered around ‘*What conversations are occurring and how do they relate to one another?*’ This implies that a person must be able to group relevant streams of media items, such as sticky notes and related conversational artefacts, into conversational units, and that they should be able to view these units as conversational threads. These threads should somehow summarize or hint at their content, with details on demand. While the visualization needs to obey time ordering of conversations, it does not need to reflect real time i.e., time gaps could be compressed. These visualizations also need to show who is actually present, as people

may be interested in knowing who can overhear the conversation even though they are not participating in it directly.

**Rhythms and trends view.** Another common question that is reflected in both the tasks and the visualizations of our participants is ‘*What rhythms and trends occur on the NC over time and who communicates most often?*’ To answer this, the history visualization system should portray abstract views of patterns and trends over long time periods, e.g., ‘work rhythm’ as done by Begole et al. (2002). Although the rhythms and trend tasks (Table 5.2c) and the descriptive statistics tasks (Table 5.2d) are listed as separate task categories, we actually believe that the latter represents a special class of the former. Therefore, these questions can be answered, in general, through statistical summaries or graphs of one or more variables of interest, such as the daily rhythm of people’s presence and activities, active people vs lurkers, and so on. While time is usually important in detecting rhythms, it may be of lesser importance for uncovering other trends. An interface could perhaps list and have the user select from the factors suggested in Table 5.2c+d, which would generate a view displaying the relationships between these factors.

**Community and Social Structures View.** The final question asked is ‘*What is the social structure of the community and what are the relationships between community members?*’ This visualization would be highly abstract. Time is of little concern, and the challenge would be to either manually or automatically distil the raw data into a form that answers a specific question e.g., a socio-grid showing the patterns of communication between particular members and the evolving of conversations.

### 5.3.2 Supportive Features

Our study results, including participant comments, also suggest other features that, while not central to a particular visualization parameter, are listed because they help people provide important supportive tasks.

**Search tool.** Many people asked for a search tool to help them find particular information e.g., conversational fragments, particular collaborators, etc.

**Presence markers.** Most participants would like to use the history to seek presence information of a particular collaborator. Because some group members always remain logged on, simple presence on the system does not suffice. Yet manually analyzing the video stream or other personal activity is too much work. The system needs to supply an automated way to determine presence and place it in the visualization as markers.

**Time-axis.** Time plays a strong role in several views, and thus we expect one axis would represent time (most visualizations used the horizontal axis). Because people are interested in different time scales, this axis should be scrollable and/or zoomable. A side effect of zooming into this axis could be to increase resolution of the data visible within it.

**Grouping tools.** Some views suggest the ability to group and collapse data. Conversations are the main example, where people need to indicate regions within one or more streams that reflect a conversation.

**Filtering tool.** Because there is an overwhelming amount of data, people wanted the ability to filter their views to remove extraneous materials. Techniques such as dynamic queries can help here (Ahlberg and Shneiderman, 1994; Goldstein and Roth, 1994).

We realize that these are just hints for what the visualization tool should include, and that many details need to be worked out. For example, instead of providing discrete views, perhaps the system could ‘morph’ one view into another, thus revealing information about the history that answers questions from different perspectives. We will leave this for future work.

## 5.4 Summary

This chapter presented an exploratory user study to determine firstly the tasks that were required for the tool, and secondly how the data should be presented to perform the tasks.

From the study we obtained a clear categorization of the types of tasks to be supported and characterizations of the most useful styles of visualizations.

The tasks can be categorized into five groups which can be organized linearly into a continuum that reflects data granularity and its fit to particular user perspectives: starting with pure group member's perspective to entirely researcher's perspective as follows.

- ***Interaction primitives***: find actual conversation communicated through the media items or to find login information only.
- ***Conversations***: identify and group media items into conversational blocks.
- ***Rhythms and trends***: uncover patterns from history summaries.
- ***Descriptive statistics***: derive statistical answers from analyzing the history.
- ***Community and social networks***: discover social norms and relationship networks.

These task categories form a coherent taxonomy to serve the perspective of a group member interested in personal exploration and of a researcher interested in patterns and social networks.

The visualizations collectively observed generally include one or more of the following organizational parameters:

- ***Time scale***: visualize interactions over varying time scales, e.g. over an hour, over days, over the entire logging period and so on, or do not use time reference at all.
- ***Conversational granularity***: identify and group related media items into conversational units, either a single conversation or multiple conversations containing concurrent, overlapping and temporally separate conversations.
- ***Level of detail***: range from abstract overviews to raw data streams—statistical summaries, conversational threads, crude yet identifiable individual media items, or media items in full detail.
- ***Media item streams***: focus at events that happened within one or more media item streams, e.g., appearance/disappearance of collaborators, lifespan of streams, changes within a single stream and interaction between multiple streams.

- ***Data perspective***: being more inclined towards either detail or overview visualizations.

In general, when visualizations are created on a very short period of time, full details and all media streams are usually displayed. On the other hand, visualizations that consider longer time periods tend to be much more oriented towards abstract overviews.

From these categorizations, we recommended several task-centered views that a visualization tool for multimedia histories of casual interaction should provide:

- ***Detailed views of short time segments***: detailed display of all activities over a short time segment (minutes to at most two hours).
- ***Conversation view***: conversational threads as units which should reveal detail upon demand and in proper time sequence (real time is not required).
- ***Rhythms and trends view***: abstract views displaying patterns and trends over long time periods by means of statistical summaries or graphs of one or more variables of interest.
- ***Community and social structures view***: highly abstract views emphasized on social issues within a community, with little concern of time.

The taxonomy of tasks and visualizations for multimedia histories of casual interaction acquired from the study provide some clear directions for future prototyping of VisStreams. We expect that they also provide some insight for other designers of similar tools.

In the next chapter, I will critique VisStreams (described in Chapter 4) based on the findings from this exploratory study.



## Chapter 6. An Evaluation of VisStreams

---

In Chapter 5, I identified a taxonomy of tasks and visualizations that should be supported by a visualization tool for multimedia histories of casual interactions. I also recommended four task-centered views to visualize these histories within an online community. Specifically, these are: Detailed Views of Short Time Segments; Conversation Views; Rhythms and Trends Views; and, Community and Social Structure Views.

In this chapter, I re-evaluate VisStreams based on these recommended task-centered views. I discuss if and how each of these views is supported by VisStreams and where and why VisStreams fails to address them. This critique of the VisStreams prototype will also direct the next design iteration and identify open research areas.

### 6.1 Detailed Views of Short Time Segments

*Detailed Views* serve to answer questions like ‘*What, in detail, is happening around this moment of time?*’ To answer this question, VisStreams provides the *timeline detailed view* (Section 4.1.2), which presents clearly readable and recognizable communication contents on a horizontal timeline. Thus, users can follow and trace in detail the progress of communication that took place during the logged period.

VisStreams also supports Detailed Views with the *timeline filtered view* (Section 4.1.4). This is similar to the *timeline detailed view* with the exception that the filtered view presents communication contents of only those media items of interest after filtering by date, participants, or media types. In both views, the shortest time segment allowable in the current prototype is a single day. It requires minimal programming effort to extend

the prototype to display communication over shorter time segments, e.g., a few minutes to an hour or two.

The *episode replay* (Section 4.1.3) in the VisStreams prototype allows past conversations to be replayed and re-assembled on a ‘play-back’ version of the Notification Collage. Users can choose to replay any time segment of the past conversation. They can also *dynamically zoom* in a particular media item to examine the details (Section 4.1.5).

Despite VisStream’s support of Detailed Views by several rich visualizations, it does not visualize the life span of objects such as the login/logoff of participants and the appearance/disappearance of media items. We learnt from the exploratory study in Chapter 5 that this information is useful, e.g., to find out when a person is usually present and who are present when a conversation takes place. Visualizing temporal data has been an actively researched area, e.g., Smith et al.’s (2000) piano roll visualization, Begole et al.’s work rhythms (2002) and Rao and Card’s (1994) Table Lens. To visualize an

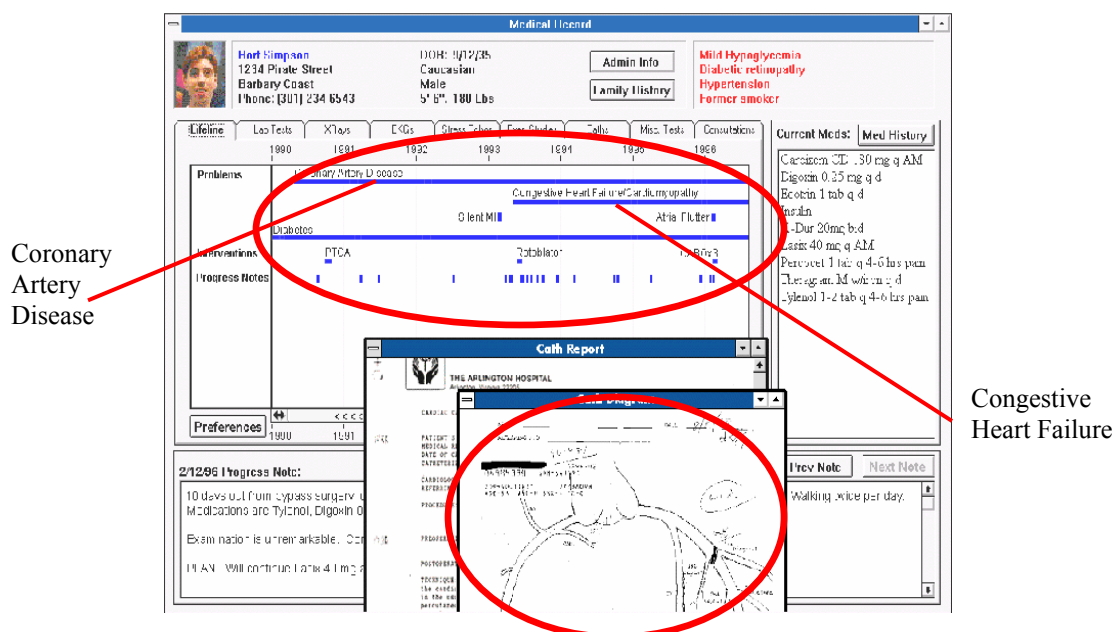


Figure 6.1: Lifelines for visualizing patient records—horizontal timelines are used for duration of diseases (top circle) and details of the disease is shown as inset (bottom circle) (Source: Plaisant et al., 1998).

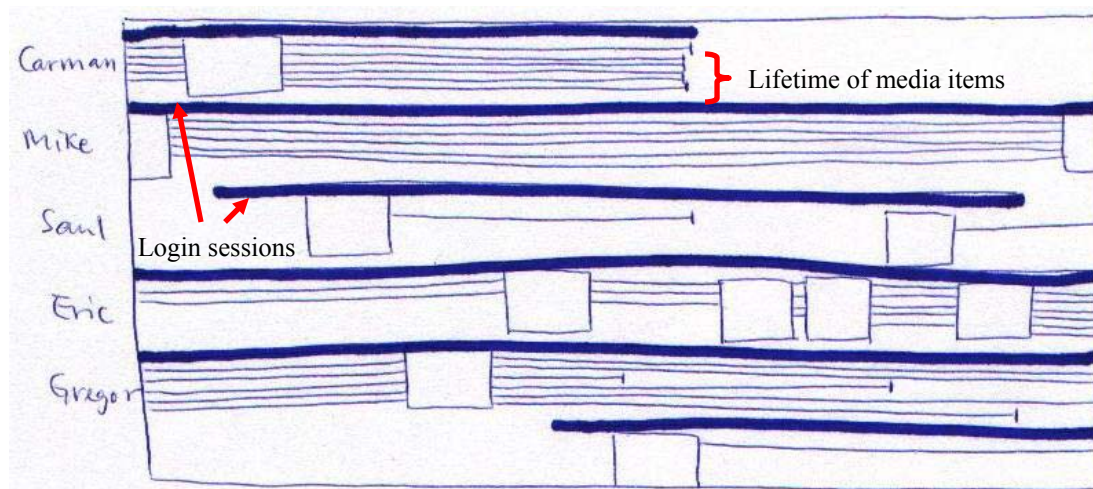


Figure 6.2: A timeline detailed view showing logon sessions and life spans of media items.

object's lifetime, which is also temporally dependent, is not an easy task. Extending lines are often used along time axis to show continuity (e.g., an object's lifetime) in the visualization. It is easier to visualize continuity on an overview level, e.g., Lifeline (Plaisant et al., 1998) uses horizontal lines to show the duration of a disease in the health overview (Figure 6.1, top circle). The continuity, however, is often interrupted (and even abandoned) when details are desired. For example, detailed information is shown in a separate window in Figure 6.1 (bottom circle). I suspect this is due to a screen real estate limitation. To illustrate this, when there are many large objects on the display, the screen will easily become cluttered making visualization and hence information retrieval difficult. This problem gets worse when lines are extended from these objects to show their life span.

Figure 6.2 shows an example detailed view exhibiting the login/logoff history of participants and the life spans of media items (i.e. from the time the media item is created to the time it is removed). The login sessions can be visualized without much difficulty by using thicker lines as shown. However, the lines representing life spans of the media items create a rather chaotic visualization. It gets worse when large number of media items 'live' for long time. It is unknown if such representation (with or without color-

coded lines) will benefit users who are evaluating the communication data. Yet, I do not intend to solve this problem here; I only highlight some of the issues that may lead to further investigation in this area.

In summary, VisStreams offers several Detailed Views for users to find and analyze details in the communication contents. However, further work is needed to address the lifetime visualization issue.

## 6.2 Conversation Views

Conversation is essential in our everyday life. Through conversation, we create, develop, question, clarify and share knowledge and experience (Erickson et al., 2002). For these reasons and more to be explained, a Conversation View is vital for visualizations of interaction histories.

### 6.2.1 The Difficulty of Identifying Conversational Threads

The tasks and visualizations for a Conversation View often center on questions like *‘What conversations are occurring?’* and *‘How do they relate to one another?’* Thus, a Conversation View is distinguished from other views by its visualization focus on conversational units (e.g., a discussion of groupware toolkit) rather than individual events (e.g., a single message or an image). This implies that relevant streams of media items, such as sticky notes and related conversational artefacts, must first be grouped into conversational units for visualizations.

The current VisStreams prototype, however, does not visualize histories of casual interactions as conversational units. To create a Conversation View for the data collected from the Notification Collage, we must first deal with the difficulty of identifying how people and media items are related to a conversational thread. This is no easy task, however, without altering the primary usage of the NC or incurring costly manpower to semantically examine the communication contents of large amounts of data.

Much work has been done to investigate how conversation threads can be identified from text-based communications such as IM conversations (Smith et al., 2000) and email exchanges (Venolia and Neustaedter, 2003). Popular techniques include grouping messages by subject lines, e.g., conversations via emails can be conveniently grouped by the same subject lines (though the topic often branches off to other topics), and by sequential conversation exchanges (i.e., initial message and all subsequent replies) as are common in newsgroup and bulletin board discussions. These techniques rely on some kind of ‘marker’ or structure within the conversation, such as shared subject headings and linked conversations.

However, most conversations over the Notification Collage do not possess any of these explicit structures to make them identifiable for conversation threads. Instead, media items rely on the implicit context of surrounding items, the temporal events that lead up to an element’s appearance, and the meaning of an item’s contents as interpreted by its viewers. For example, the appearance of a set of ski photos in a *Photo Show* and a *Sticky Note* saying “Check out my ski photos” creates an implicit link between these two items, even though no spatial or explicit link is present. Similarly, two independent conversations can occur when, say, one person responds to postings in other media items within their single *Sticky Note*. Alternatively, a “thumbs up” in the *Video* can acknowledge a request in a *Sticky Note*.

Nonetheless, a few media items do have a conversational structure within them so that conversations made through these media items can be linked as a thread. There is, however, no explicit structure that exists between media items for the same linking purpose. For example, *NC Chat* (described in Section 3.1.1) is similar to other chat tool dialogs that can be used to link conversation exchanges made within them into a thread. However, conversations made on two or more *NC Chat* items cannot be linked even if they carry discussions on the same topic. Similarly, the popular *Sticky Notes* and most other media items do not possess within- or between- structures for thread identification. While people predominately use *Sticky Notes* for all text messages, these notes do not provide any subject lines or other structures to link conversations.

One apparent solution to thread identification would have people explicitly group relevant media items into conversational threads. Users can (perhaps) assign a subject heading to media items so that elements that are relevant to a particular topic are grouped with other elements about the same topic. Users could also use interface components to select which elements a new element should be linked to. This, however, interferes with the primary use of the Notification Collage for lightweight awareness and casual communication within a group of intimate collaborators. Inserting a subject heading makes the communication more formal, more structured, and heavy-weight.

Alternatively, evaluators could identify threads after the fact, where they could carefully examine the communication data and identify conversational units. However, the evaluator's workload to process such potentially large amounts of data collected would be costly. It could also be error-prone as it would rely on the evaluator's own interpretation of data for grouping conversations. Still, this is better than nothing. I recommend that the visualization tool should not only visualize the communication information but also allow evaluators to manipulate the media items into conversational groups.

In spite of the fact that current technology is not quite ready yet to perform such semantic evaluation on multimedia conversations, future advances may let this happen. At present, information retrieval methods using advanced analysis such as n-gram based content analysis (Miller et al., 2000) have been performed on the content of text-based conversations to group relevant events into threads, albeit with different degrees of success. Therefore, I expect that the semantic evaluation of multimedia information will entail extensive research efforts in this area.

In brief, jeopardizing the light-weight use of the Notification Collage for casual interaction by mandating its users to insert subject lines or to specify how it links to other messages does not appear to be a good solution. Future technologies for automatically analyzing this unstructured data are not yet ready. Consequently, I recommend manual evaluation of logged conversations for threads. Although this is to be left for future

work, I will propose how manual grouping of conversations can be performed in the low-fidelity prototype to be described next.

## 6.2.2 Conversation View Prototype

For completeness, I will present a low-fidelity prototype that shows how media items can be grouped into conversations, and what a potential Conversation View would look like.

Figure 6.3 shows an interface where media items can be extracted from a detailed view to form conversation threads on the fly. The *timeline detailed view*, shown on the left, visualizes only the communication contents of media items, i.e. it does not visualize the lifespan of any objects. Evaluators first create a circular container for a new conversation thread on the right of the interface. They then drag relevant media items from the detailed view on the left and drop them into the desired thread container on the right. This information can of course be saved to a database for future use. Other enhancements can also be made. For example, the conversation threads grouped on the right can be queried interactively such that when a thread is selected, all the relevant media items in the detailed view are highlighted or, alternatively, all of the irrelevant ones greyed-out or hidden. In this way, evaluators can not only dynamically group

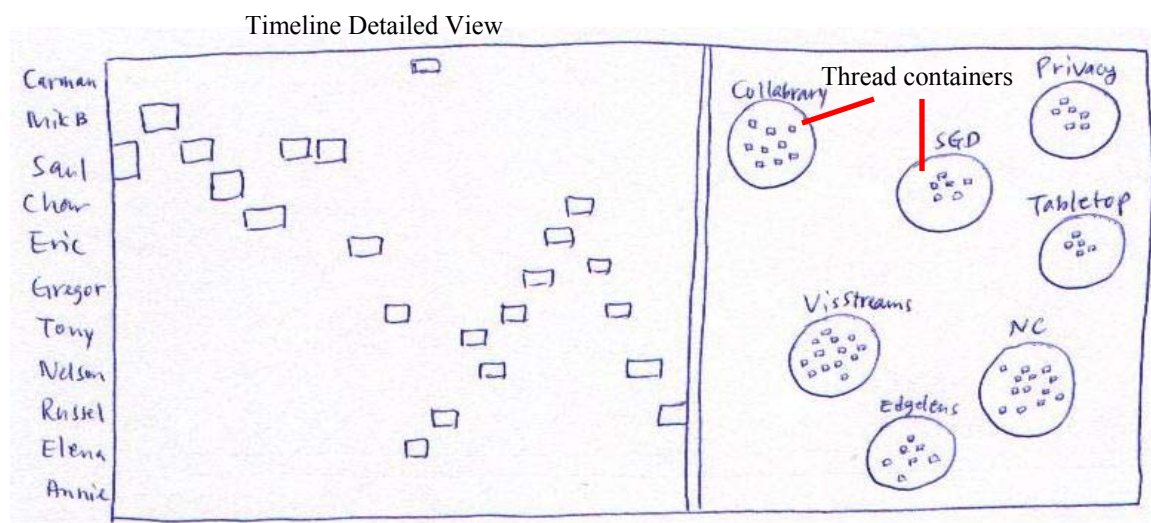


Figure 6.3: An interface that supports grouping media items into conversation threads

conversations while exploring the communication data, but can also review the threads they have grouped for accuracy before they are visualized in the Conversation Views.

To visualize conversations, I propose an example low-fidelity prototype as shown in Figure 6.4. This prototype visualizes each conversational thread as a row of media items displaying detailed contents in time-ordered sequence on the left (*detailed conversation view*) and simultaneously as a row of narrow bars in proper time-positioning (the dates are shown at the top) on the corresponding right (*conversation overview*). Conversation topics are displayed along the vertical axis (far left) while all the media items grouped for each conversational thread are placed temporally from left to right in both views. The size of the display windows can be adjusted by moving the bar between the two windows so that when the evaluators desire to focus on the overview display on the right, they can move the bar to widen the *conversation overview* display.

In the *detailed conversation view* (left), all the media items including all utterances and their supporting images for each conversation thread are displayed in detail horizontally. Rows may be collapsed so that evaluators can focus on the expanded rows. When a row in the detailed conversation view is collapsed, the corresponding row in the *conversation overview* (Figure 6.4, right) will also be collapsed to maintain the alignment (e.g., 4<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> rows, Figure 6.4a+b).

The *conversation overview* (right) visualizes each media item as a vertical bar, color-coded for the participant who posts it, shown in its proper positioning in time. This overview reveals the approximate discussion volume for each conversation thread by the total number of vertical bars, intensity of discussion in different time periods by the density of the bars along the horizontal timeline, life span of the conversation threads as indicated by the first and last bar, and relative involvement of participants in the discussions by the relative amount of color-coded bars. This gives an at-a-glance view of the discussion topics that have evolved in this online community over time, what concurrent conversations have taken place, and who the active participants in the discussions are. Media items in the *detailed conversation view* may also be highlighted by selecting a group of bars in this overview.



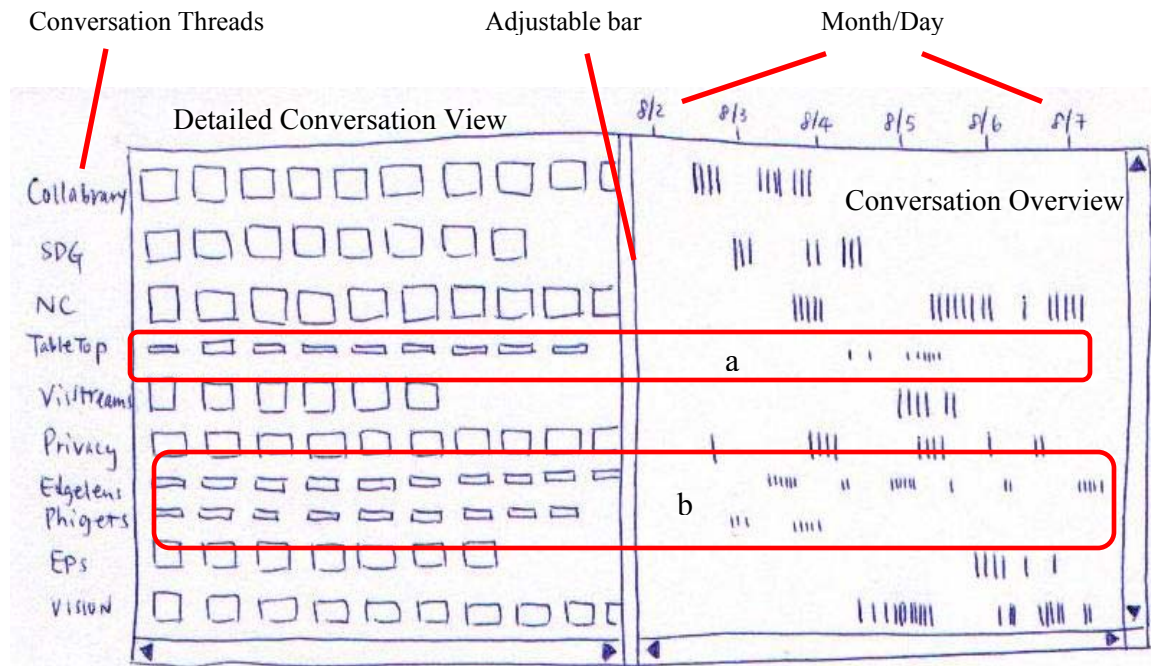


Figure 6.4: A prototype conversation view—conversation detail view (left) and conversation overview (right).

In summary, this prototype supports grouping media items into conversation threads. As well, the interface for grouping conversation threads can also be applied to performing other groupings, such as classifying media items into message types (Section 6.1.3) and making conversations directional (Section 6.1.4). Moreover, the Conversation View prototype allows evaluators to acquire an abstract view of conversational activities and participant involvement in a community, and to browse past conversations by discussion topics for knowledge and experience shared by the group members of the community. The prototype does not however support visualization of the life span of media items for threads, and it is difficult to visualize how conversations are related or how they have evolved in this Conversation View. For example, the VisStreams project may be evolved from the NC discussions, but this visualization does not reveal this relationship. Nevertheless, the prototype described in this section aims at giving directions for future work rather than providing a final solution to the problem.

## 6.3 Rhythms and Trends Views

Much of our everyday life exhibits a certain degree of temporal pattern. For example, a person may habitually arrive at work around 9 am, return phone calls around 10 am, go for lunch at noon, attend meetings at 3 pm and leave work around 6 pm. Begole et al. (2002) have shown that visualizations of these temporal patterns may provide useful cues for collaborators' activity and availability (or interruptibility). This is particularly beneficial in a society where telecommuting is prevalent and work teams are often geographically distributed.

A history of past conversations has the potential to answer questions pertinent to the rhythms and trends within a community, e.g., '*When do people usually communicate during the day?*' VisStreams *timeline overview* visualization presents an abstract overview of daily communication volume and personal participation at a glance (Section 4.1.1). However, this single view does not suffice to show the rich rhythms and trends over time.

Depending on the questions to address, there can be other rhythms and trends visualizations created from the past conversations. For example, a daily *timeline overview* may stack up to show the general rhythms of activity, like the busiest time period and breaks in a day; this could be similar to the daily activity shown in Figure 6.5

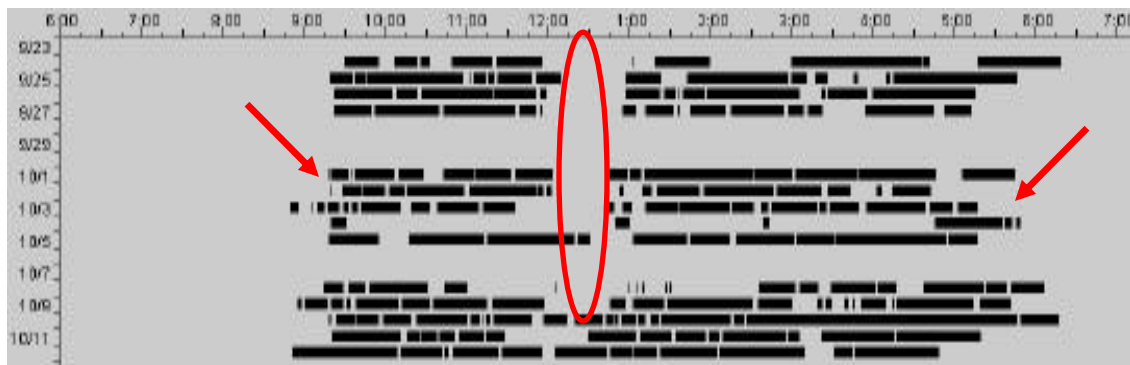


Figure 6.5: An example of visualization to reveal daily temporal patterns (Source: Begole et al., 2002)

(Begole et al., 2002). These visualizations can reveal temporal patterns like the usual lunch break (circled), and the time that people usually arrive and leave work (indicated by the arrows).

Alternatively, past conversations may first be classified into different message types and then presented graphically to show the rhythms and trends. For example, Handel and Herbsleb (2002) examined the log files of text-based computer-mediated conversations of several work groups. Based on this, they developed a set of conversation categories: availability, greetings, work, non-work, and humor. They then classified the logged conversations accordingly and visualized the daily percentage of each message type graphically (Figure 6.6). From their visualization, they can easily identify the percentage of time that the communication tool is used for each purpose, when these work groups use the communication tool and for what purpose (Figure 6.6). For instance, the graph on the left of Figure 6.6 shows the availability and interaction of people throughout a typical day. People log on to the tool between 6 and 9 am and start to exchange greetings. They then leave for lunch as implied by the reduced availability at noon. Finally, they log off between 4 and 6 pm. Meanwhile, the visualization on the right of Figure 6.6 shows the different uses of the tool—work-related, non-work, and humor. It shows that non-work and humor conversations play an important role in this

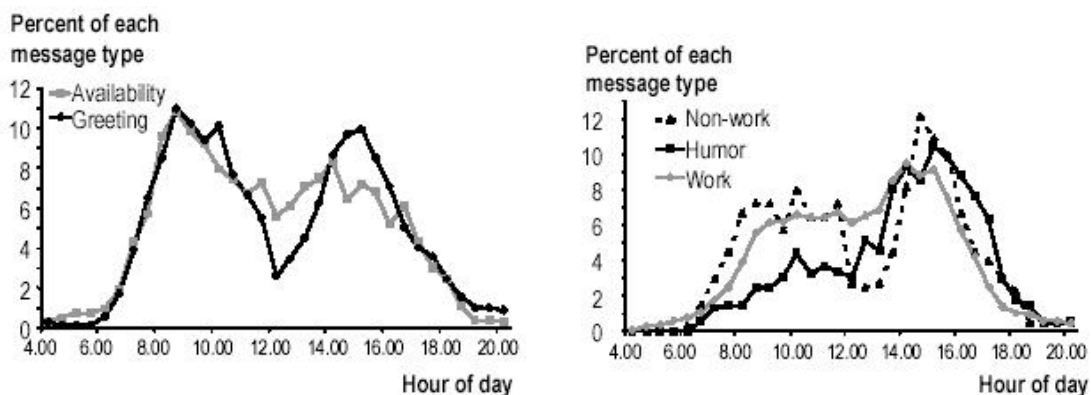


Figure 6.6: Visualizing communication by categories—availability and greeting (left), and non-work, humor, and work (right) (Source: Handel and Herbsleb, 2002)

work group. This may indicate that this is a group of intimate collaborators who not only discuss work-related topics, but frequently communicate socially, seasoned with humor.

To visualize similar message types in VisStreams, an interface akin to Figure 6.3 may be used to classify the conversations. Instead of creating conversation threads on the right, we can drag and drop media items from the detailed view to appropriate message type ‘containers’.

As discussed in Section 5.3.1, the descriptive statistics tasks can be regarded as part of the rhythms and trend tasks category. The visualizations revealing rhythms and trends, as well as alternative trend views displaying particular statistical information, should therefore suffice to help an evaluator (e.g., a social behavioural researcher) understand the community. Such visualization may also help inform how the communication tool can be improved.

## 6.4 Community and Social Structure Views

A social network is a set of people, organizations, or other social entities connected by socially meaningful relationships (Wellman, 1996). These relationships are characterized by content, direction and strength. The content of a relation refers to the resource that is exchanged, e.g., knowledge or emotional support. A relation can be either directed (i.e., to a target participant) or undirected (i.e., to the entire network), and can differ in strength. There can also be multiple kinds of relationships between pairs of people, e.g., personal and work relationships.

Thus, a Community and Social Structure View on a history of casual interactions should portray these attributes—contents, direction, strength, and relationship type. The current VisStreams prototype cannot provide such social network views as a result of the primary architecture of the Notification Collage.

### 6.4.1 The Difficulty of Visualizing NC Social Structure

As described in Section 3.1.2, the Notification Collage is analogous to an electronic public bulletin board where group members can post media items for sharing and act upon those that interest them. As far as the central server of the NC is concerned, all communications are directed to the public at large, i.e., not directed at any particular person. This un-directedness of the NC makes it very difficult to answer questions like *‘What is the social structure of the community?’* or *‘What are the relationships between community members?’*

### 6.4.2 Visualizing Social Networks

Social networks are often visualized as diagrams in which nodes represent social entities and directed lines designate the direction of relation. Social networks are commonly visualized with an ego-centric view or an entire network view (Garton et al., 1999). The ego-centered approach considers the relations reported by a focal individual. Relations are shown as directed from this focal person to other members of the network. An example is shown in Figure 6.7a, which displays the set of contacts made by the person in the center. On the other hand, the whole network approach considers the occurrence and non-occurrence of relations among all members of a population. An entire network view describes the ties that each member of the network maintains with all other members in that group (e.g., Figure 6.7b). These social network diagrams not only present a snapshot of the social interaction within the network, but may also portray the relationship changes that take place over time. Intuitively, this offers invaluable information for social analysts to study community dynamics and culture shift. For both approaches, more details can be revealed by visualizing the relations according to the relationship type and strength using, say, different colors for relationship types and line thickness for relation strength.

However, to use these approaches, the direction of information flow must be known, as opposed to the non-directedness of NC conversations. In spite of this, I

[illegible]

The graph shows the following nodes and their colors: Susan (yellow), Kathy (yellow), Donna (red), Harold (green), Carol (green), Charles (red), Wynn (green), Stuart (red), Sharon (green), Bob (green), Fred (green), Tanya (yellow), and Nancy (yellow). The edges represent directed relationships between these individuals.

(b) An entire-network view  
(Source: Brandes et al., 2001)

in the entire-network view. As this ‘public’ node is the most popular audience, as seen from the frequency table in Table 6.1, this means that an extra line will be extended from each other node to this ‘public’ node. This problem gets worse when the size of the NC community is large. The entire-network view will become cluttered and with many lines intercepting each other, thus undermining the effectiveness of visualizing social structures with this view.

I still believe that there can be other visualizations that can more effectively present the social structure of an undirected communication. However, I will not try to solve this problem in this thesis, rather, I will leave this as future work as this is an open research area that warrants more in-depth investigation.

	Carman	Nelson	MikeB	Saul	MikeR	Char	Public
Carman	0	2	1	3	0	8	28
Nelson	1	0	4	9	5	6	14
MikeB	23	6	0	4	6	5	71
Saul	20	10	6	0	11	17	59
MikeR	5	8	12	31	0	8	48
Char	5	30	14	15	16	0	26
Public	0	0	0	0	0	0	0

Table 6.1: A matrix display of a social network (the numbers showing the frequency of messages directed from the participants named in the column to those in the row).

## 6.5 Summary

This chapter critiques VisStreams based on the four visualizations recommended in Chapter 5: the Detailed Views of Short Time Segment; Conversation Views; Rhythms and Trends Views; and, Community and Social Structure Views.

VisStreams supports the Detailed Views with its *timeline detailed view*, *timeline filtered view*, and *episode replay*; all can be enhanced by *dynamic zooming*. While it is easy to extend the current prototype to visualize shorter time segments, it is difficult to also visualize the life span of media items in the same detailed view.

VisStreams fails to offer Conversation Views due to the difficulty in identifying conversation threads from the communication occurring on the Notification Collage. I suggested that evaluators can first manually group media items into conversation threads, which can then be visualized in *conversation overview* and *detailed conversation view*. The proposed Conversation View presents an overview of conversational units revealing the temporal shift of discussion topics and the relative involvement of participants. It also provides topic-based communication details for closer examination.

As for the Rhythms and Trends Views, VisStreams' *timeline overview* provides an abstract view of daily communication volume and participant's daily involvement in the conversations. Other rhythms and trends views are also suggested to answer different questions, e.g., daily timeline overviews can be stacked to review temporal patterns like arrivals, lunch breaks and busiest periods. The communication data can also be first classified to present visualizations like daily frequencies of message types such as work-related, non-work, humor, availability, and greetings.

VisStreams is currently unable to address the social network visualization primarily due to the un-directedness of communication through the Notification Collage such that the direction of resource flow between participants is not available. To get around this difficulty, evaluators can first 'directionalize' the communications so that the target audience, which includes the 'public', can be specified for the communicated messages and artefacts. I also suggested that existing visualization approaches can view the social structure containing the 'public' node. Still, while they appear to be effective in ego-centric views, its value is questionable in entire-network views expected in large NC communities. Future work should look at visualizing community and social structures for undirected communications.

This chapter lays a solid foundation for future researchers to develop tools to visualize histories of computer-mediated multimedia conversations. The open research areas identified are also valuable for both human-computer interaction and information visualization fields.



## Chapter 7. Conclusion

---

This chapter concludes this thesis and discusses its research contributions. First, I revisit the research motivation and problems set out in Chapter 1 and summarize how these problems were solved. Second, I summarize the contributions that this research has made to Human Computer Interaction and Information Visualization research. Third, I describe directions for future work based on the research presented.

### 7.1 Research Problems and Summary

This thesis has explored the capture of multimedia casual interaction and visualization of its conversational histories. The research was motivated by the general lack of research efforts in investigating how technology can help people navigate and review past interactions. Specifically, the motivations of this research were:

- both group members and researchers can benefit from a system that lets one review histories of casual interactions conducted over computer-mediated communication tools
- an examination of the tasks people do with these histories can provide insight into a principled design of the visualization tool to fulfil their respective purposes.

This research focused on capturing multimedia conversations and designing a visualization tool for the conversational history. Chapter 1 outlined three research problems in the paradigm of multimedia casual interaction.

1. **We do not know how to effectively capture the information communicated through a multimedia conversation tool.** Multimedia communication data require special techniques to capture and retrieve, unlike the text-based

communications. We do not know what issues are involved and how they should be dealt with in order to effectively capture the multimedia conversations.

2. **We do not know what people want to use these interaction histories for and how they want to go about these tasks.** There has not been known research to investigate what tasks people want to perform on a multimedia casual conversational history and what visualizations help them navigate and examine such history.
3. **There is no visualization tool that helps people review and analyse histories of multimedia casual interactions.** With the belief that both group members of an online community and researchers can benefit from a system that lets one review histories of casual interactions conducted over computer-mediated communication tools, I would design and implement a visualization tool for multimedia casual interaction, VisStreams.

I solved the first research problem by instrumenting the Notification Collage to collect multimedia conversations for my research. I identified the difficulties of capturing multimedia conversations that occurred on the NC and performed experiments to solve the identified issues while developing my own conversation capturing tool (Chapter 3). I solved the second problem by performing an exploratory study to identify the tasks and visualizations required for multimedia histories of casual interactions from the perspectives of both group members and researchers. I also recommended several task-centered visualization views for designing tools similar to VisStreams (Chapter 5). I partially solved the third problem by designing and building an interaction history visualization tool, VisStreams. While a usability study (Chapter 4) suggested it is useful and promising, I realized over time that I needed a more grounded approach to help me uncover user-centered requirements for a visualization tool displaying multimedia histories of casual interactions (Chapter 5). I then evaluated VisStreams against the recommended visualizations from the exploratory study described in Chapter 5 and identified several research possibilities for future work (Chapter 6).

## 7.2 Contributions

This thesis contains two significant research contributions. First, I contribute a taxonomy of tasks and visualizations of multimedia history of casual interactions to human-computer interaction and information visualization research (Chapter 5). The taxonomy includes a spectrum of categories of tasks that people would perform on an interaction history along with a list of visualization design guidelines to help design tools for visualizing such a history. I also recommended four views to visualize multimedia histories of casual interactions. These will serve as a useful roadmap for designers and practitioners who are developing similar tools for conversation and interaction analysis on data collected from other computer-mediated communication tools.

Second, I contribute the design and critique of a visualization tool, VisStreams, to visualize multimedia histories of casual interactions (Chapter 4 and 6). The visualization tool enables group members to interactively review past conversations. As well, it is a valuable tool for researchers to study the new genre of multimedia communications as well as researchers in other disciplines, for instance, the organizational behavioural and the social psychological researchers, to learn more about the dynamics and communications within workgroups. Moreover, VisStreams, along with the tasks and visualization taxonomy (Chapter 5), provides a solid foundation for the development of future prototypes of the tool (Chapter 6).

A third lesser contribution is the design of a conversation capturing tool along with a set of design issues and solutions for building such tools (Chapter 3). Moreover, I have shown that these solutions are generalizable to capturing conversations communicated through other computer-mediated casual interaction tools. The design issues I present may also provide insights to fine-tune various communication tools, including the Notification Collage used in my research.

## **7.3 Future Work**

This research raises new questions for the area of multimedia conversations. I describe several areas below that show promise for further research based on what I have done: extending the research to other NC communities, prototyping visualization tools for conversational histories, performing a field study on the future VisStreams prototype, further investigating tasks and visualizations on interaction history, further exploring visualization techniques, and investigating the relationship of interaction history and privacy.

### **7.3.1 Extending Beyond In-house Research**

Much of the design and evaluation of VisStreams and of NC use is from the experience and responses of our in-house NC community. In spite of this, we believe that the work is externally valid as our NC community consists of real users representing both group members and researchers and our task-centered visualizations are also generated from these real users. Yet, since this is only a small community of real users who have varying degrees of stake in the technology, they may not truly represent other potential users of the visualization tool. Therefore, for future work, I suggest to deploy the tool to other NC communities to gather experiences of these NC users by means of, say, field studies, interviews or questionnaires. I also recommend to investigate the use of such visualization tool by other research groups interested in studying interactions and languages, e.g., sociologists, linguists, protocol analysts and other CSCW researchers.

### **7.3.2 Prototyping Visualization Tools**

The taxonomy of tasks and visualizations for multimedia histories of casual interaction presented in Chapter 5 serves as a general guideline for designers to develop visualization tools for conversation histories. Specifically, future work using these guidelines is expected to improve the current VisStreams prototype: starting points as suggested in Chapter 6. Research areas that warrant investigation include formulation of conversation

threads, and visualization of social networks for undirected communication. Therefore, these guidelines and recommendations should entail future work to develop similar visualization tools for data collected from other communication tools.

### **7.3.3 Field Study of VisStreams**

In the beginning of my research, my plan included building VisStreams and deploying it to a small group of research collaborators for evaluation. I found, however, that the design and implementation of VisStreams was far more complex than I had originally thought because of many issues that emerged (Chapter 3, 4 and 5). For this reason, VisStreams has not been used in practice other than the pilot user study on the previous version. This proved to be beneficial, however, as the detour from developing an improved prototype of VisStreams allowed me to identify a tasks and visualization taxonomy (Chapter 5) that can guide designers to develop similar visualization tools. This taxonomy is a necessary and important research step because, along with the recommended prototypes (Chapter 6), it provides a roadmap for the next design iteration of VisStreams and, more importantly, provides a framework to guide the design of future conversation visualizations in general. Future research in this area can then focus on the design of conversation visualization tools along with deployment and field evaluations aimed at investigating how people use this tool to help them navigate and review past conversations and what limitations people encounter that may constrain them from performing their intended tasks.

### **7.3.4 Further Investigation of Tasks and Visualizations**

In Chapter 5, we developed our tasks and visualization taxonomy through a small group of subjects with very specific backgrounds and experiences as members of the NC community and as CSCW researchers. While useful, these tasks may not truly generalize to other potential user groups.

Two research directions are possible. First, the tasks and visualization study can be repeated using two different groups of participants—one with group members only

and the other with researchers only. The resulting lists of tasks and visualizations should be compared for similarities and differences. Second, using a visualization tool developed based on the taxonomy identified in Chapter 5 (i.e., a tool designed to be used by people who are both group members and researchers themselves), a study can be carried out with different groups of participants—one with group members only and the other with researchers only. This allows us to examine if and how the tools constrain each group of users to find out what they want to know from the interaction history. In this way, we will know how the tool should be altered to suit the needs of each group of users.

### **7.3.5 Visualization Techniques**

In Chapter 1, I identified the characteristics of multimedia casual interactions as opposed to other interactions like formal meetings. These characteristics make it challenging to visualize multimedia casual interactions. Timelines is by far the most intuitive visualization for temporal data. While other visualization techniques, e.g., detail-in-context, fisheye views and episode play-back, have been employed in my research, most of them are based on the timeline concept. Thus, research is warranted to explore other visualization techniques that specifically address the characteristics of casual interactions in a multimedia paradigm, which may in turn be used to visualize temporal data in other disciplines.

### **7.3.6 Interaction and Privacy**

In this thesis, I have ignored the impact of interaction history on the interaction pattern and context. There is ongoing research to investigate the privacy issues for using groupware communication systems both at work (Boyle and Greenberg, 2003) and in home settings (Neustaedter, 2003), but these are for real-time conversations. When communication history is retrievable, there is clearly potential to threaten privacy. This issue gets amplified when social patterns can be analysed from the communication

history. Therefore, future research should look at how privacy issues influence the way people communicate through these groupware systems.

## **7.4 Conclusion**

Computer-mediated communication has become indispensable in our everyday life, whether at work or at play. Technology to capture and visualize these communication data would be useful for later review and analysis of these conversation. The research described in this thesis has grounded the work in capturing and visualizing multimedia casual interaction from the perspectives of a group member and a researcher. It has also motivated several areas for future work.

## References

---

- Abowd, G., Atkeson, C., Brotherton, J., Enqvist, T., Gulley, P. and LeMon, J. (1998), **Investigating the Capture, integration and Access Problem of Ubiquitous Computing in an Educational Setting**, *Proceedings of the ACM Conference on Human actors in Computing Systems (CHI 1998)*, LA, 1998, ACM Press, pp. 440-447.
- Ahlberg, C. and Shneiderman, B. (1994), **Visual Information Seeking: Tight Coupling of Dynamic Query Filters with Starfield Displays**, *Proceedings of the ACM Conference on Human actors in Computing Systems (CHI 1994)*, ACM Press, pp.313-317.
- Arapis, C. (1999), **Archiving Telemeetings**, *Proceedings of the Eighth International Conference on Information and Knowledge Management*, Kansas City, Missouri, United States, 1999, ACM Press, pp.545-552.
- Begole, J.B., Tang, J.C., Smith, R.B. and Yankelovich, N. (2002), **Work Rhythms: Analyzing Visualizations of Awareness Histories of Distributed Groups**, *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW 2002)*, ACM Press, pp.334-343.
- Bellotti, V. and Sellen, A. (1993), **Design for Privacy in Ubiquitous Computing Environments**, *Proceedings of the Third European Conference on Computer Supported Cooperative Work (ECSCW 1993)*, Milan, Kluwer Academic Publishers, pp. 77-92.
- Bly, S., Harrison, S. and Irwin S. (1993), **Media Spaces: Bringing People Together in a Video, Audio, and Computing Environment**, *Communications of the ACM*, Vol. 36, Issue 1, 1993, ACM Press, pp. 28-46.
- Boyle, M., Edwards, C. and Greenberg, S. (2000), **The Effects of Filtered Video on Awareness and Privacy**, *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW 2000)*, ACM Press, pp. 1-10.
- Boyle, M. and Greenberg, S. (2002), **Grouplab Collabratory: A Toolkit for Multimedia Groupware**, J. Patterson (Ed.): *ACM CSCW 2002 Workshop on Network Services for Groupware*, November.



- Boyle, M. (2003), **Collabrary Shared Dictionary v1.0.17: Programming Paradigm and Wire Protocol**, Report 2003-731-34, Department of Computer Science, University of Calgary, Calgary, Alberta, Canada.
- Boyle, M. and Greenberg, S. (2003), **A Lexicon for Privacy in Video Media Spaces**, Report 2003-724-27, Department of Computer Science, University of Calgary, Calgary, Alberta, Canada, May.
- Brandes U., Raab, J. and Wagner, D. (2001), **Exploratory Network Visualization: Simultaneous Display of Actor Status and Connections**, *Journal of Social Structure*, 2(4), October 19, 2001, available at <http://zeeb.library.cmu.edu:7850/JoSS/brandes/index.html>.
- Chin, G., Myers, J. and Hoyt, D. (2002), **Social Networks in the Virtual Science Laboratory**, *Communications of the ACM*, August 2002, Vol. 45, No. 8, ACM Press, pp. 87-92.
- Donath, J. (2002), **A Semantic Approach to Visualizing Online Conversations**, *Communications of the ACM*, April 2002, Vol. 45, No.4, ACM Press, pp. 45-49.
- Donath, J., Karahalio, K. and Viegas, F. (1999), **Visualizing Conversation**, *Proceedings of 32nd Hawaii International Conference on System Sciences*, 1999.
- Dourish, P., Bly, S. (1992), **Portholes: Supporting Awareness in a Distributed Work Group**, *Proceedings of the ACM Conference on Human Factors in Computer Systems (CHI 1992)*, 1992, ACM Press, pp.541-547.
- Erickson, T., Herring, S. and Sack, W. (2002), **Discourse Architectures: Designing and Visualizing Computer Mediated Conversation**, *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2002)*, April 20-25, Minneapolis, Minnesota, USA, ACM Press, pp. 936-937.
- Finn, K., Sellen, A. and Wilbur, S. (1997), (Eds.) **Video-Mediated Communication**, LEA Press, 1997.
- Fish, R., Kraut, R. and Chalfonte, B. (1990), **The VideoWindow System in Informal Communications**, *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW 1990)*, ACM Press, pp.1-11.
- Fish, R., Draut, R., Root, R. and Rice, R. (1992), **Evaluating Video as a Technology for Informal Communication**, *Proceedings of the ACM Conference on Human actors in Computing Systems (CHI 1992)*, pp.37-48.
- Fish, R., Kraut, R., Root, R. and Rice, R. (1993), **Video as a Technology for Informal Communication**, *Communications of the ACM*, Volume 36, Issue 1, January 1993, pp. 48-61.

- Furnas, G. (1986), **Generalized Fisheye Views**, *Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems (SIGCHI 1986)*, ACM Press, April 1986, pp. 16-23.
- Garton, L., Haythornthwaite, C. and Wellman, B. (1999), **Studying Online Social Networks**, *Doing Internet Research*, S. Jones, Ed. Sage, Thousand Oaks, CA, 1999, pp. 75-105, also available at <http://jcmc.huji.ac.il/vol3/issue1/garton.html>.
- Geyer, W., Richter, H., Fuchs, L., Fraunhofer, T., Daijavad, S. and Poltrock, S. (2001), **A Team Collaboration Space Supporting Capture and Access of Virtual Meetings**, *Proceedings of the 2001 International ACM SIGGROUP Conference on Supporting Group Work*, Vol. 2001, September 2001, ACM Press, pp. 188-196.
- Goldstein, J. and Roth, S.F. (1994), **Using Aggregation and Dynamic Queries for Exploring Large Data Sets**, *Proceedings of the ACM Conference on Human actors in Computing Systems (CHI 1998)*, v.1, ACM Press, pp. 23-29.
- Goodman, G. and Abel, M., (1986), **Collaboration Research in SCL**, *Proceedings of the First Conference on Computer Supported Cooperative Work (CSCW 1986)*, Austin, TX, December 1986, pp. 246-251.
- Greenberg, S. (1996), **Peepholes: Low Cost Awareness of One's Community**, *ACM SIGCHI'96 Conference on Human Factors in Computing System*, Companion Proceedings, pp. 206-207.
- Greenberg, S. and Rounding, M. (2001), **Notification Collage: Posting Information to Public and Personal Displays**, *Proceedings of the ACM Conference on Human actors in Computing Systems (CHI 2001)*, [CHI Letters 3(1)], ACM Press, pp.515-521.
- Hagstrom, W.O. (1965), **The Scientific Community**, Carbondale, Ill: Southern Illinois University Press, 1965.
- Handel, M. and Herbsleb, J. (2002), **What is Chat Doing in the Workplace**, *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW 2002)*, ACM Press, pp.1-10.
- Harrison, B.L. and Baecker, R.M. (1992), **Designing Video Annotation and Analysis Systems**, *Graphics Interface 1992*, May, pp. 157-166.
- Krasner, G.E. and Pope, S.T., **A Cookbook for Using the Model-View-controller User Interface Paradigm in smalltalk-80**, *Journal of Object-Oriented Programming*, August/September 1988, pp. 27-49.

- Kraut, R., Egido, C. and Galegher, J. (1988), **Patterns of Contact and Communication in Scientific Research Collaboration**, *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW 1988)*, ACM Press, pp.1-12.
- Mackay, W. and Davenport, G. (1989), **Virtual Video Editing in Interactive Multimedia Applications**, *Communications of the ACM*, July 1989 Volume 32 Number 7, pp. 802-807.
- Mackinlay, J.D., Robertson, G.G., and Card, S.K. (1991), **The Perspective Wall: Detail and Context smoothly integrated**, *Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems*, ACM Press, April 1991, pp.173-179.
- Mantei, M., Baecker, R., Sellen, A., Buxton, W., Milligan, T. and Wellman, B. (1991), **Experiences in the use of a media space**, *Proceedings of the ACM Conference on Human Factors in Computer Systems (CHI '91)*, New York, ACM Press, pp.203-209.
- Miller, E., Shen, D., Liu, J. and Nicholas, C. (2000), **Performance and Scalability of a Large-Scale N-gram Based Informatin Retrieval System**, *Journal of Digital Information*, Jan 2000.
- Minneman, S., Harrison, S., Janssen, B., Kurtenbach, G., Moran, T., Smith, I. and Melle, B. (1995), **A Confederation of Tools for Capturing and Accessing Collaborative Activity**, *Proceedings of the Third ACM International Conference on Multimedia*, San Francisco, CA, 1995, pp.523-534.
- Nardi, B., Whittaker, S. and Bradner, E. (2000), **Interaction and Outeraction: Instant Messaging in Action**, *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW 2000)*, ACM Press, pp.79-88.
- Neal, A. and Simons, R. (1983), **Playback: A Method for Evaluating the Usability of Software and its Documentation**, *Proceedings of the SIGCHI Conference on Human Factors in Computer Systems 1983*, pp.78-82.
- Neustaedter, C. (2003), **Balancing Privacy and Awareness in a Home Media Space**, *MSc Thesis*, Department of Computer Science, University of Calgary, Calgary, Alberta, Canada, June.
- Neustaedter, C., and Greenberg, S. (2003), **The Design of a Context-Aware Home Media Space for Balancing Privacy and Awareness**, *Proceedings of the Fifth International Conference on Ubiquitous Computing (Ubicomp 2003)*, ACM Press, pp. 297-314.
- Olson, M.H. and Bly, S.A. (1991), **The Portland Experience: a report on a distributed research group**, *Computer-supported Cooperative Work and Groupware*, edited by Saul Greenberg, Academic Press, 1991, pp. 81-98.

- Owen, R.N., Baecker, R.M. and Harrison, B. (1994), **Timelines, a tool for the gathering, coding and analysis of usability data**, *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 1994)*, v.1, ACM Press, pp.7-8.
- Patterson, J., Day, M. and Kucan, J. (1996), **Notification Servers for Synchronous Groupware**, *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW 1996)*, ACM Press, pp. 136-143.
- Plaisant, C., Heller, D., Li, J., Shneiderman, B., Mushlin, R. and Karat, J. (1998), **Visualizing medical records with LifeLines**, *Proceedings of the Conference on Human Factors in Computing Systems (CHI 98 summary)*, 1998.
- Rao, R. and Card, S.K. (1994), **The Table Lens: Merging Graphical and Symbolic Representations in an Interactive Focus+Context Visualization for Tabular Information**, *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 1994)*, v.1 p.180-185.
- Richter, H., Brotherton, J., Abowd, G. and Truong, K. (1999), **A Multi-Scale Timeline Slider for Stream Visualization and Control**, *Technical Report GIT-GVU-99-30*, GVU Center, Georgia Institute of Technology, June 1999.
- Robertson, G. and Mackinlay, J. (1993), **The Document Lens**, *Proceedings of the ACM Symposium on User Interface Software and Technology*, ACM Press, Nov 1993.
- Root, R. (1988), **Design of a multi-media system for social browsing**, *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW 1988)*, ACM Press, Portland, OR, pp.25-38.
- Rounding, M. and Greenberg, S. (2000), **Using the Notification Collage for Casual Interaction**, *ACM CSCW 2000: Workshop on Shared Environments to Support Face-to-Face Collaboration*. Philadelphia, Pennsylvania, USA, December.
- Rubin J. (1994), **Handbook of Usability Testing**, Wiley Technical Communication Library, 1994, pp. 156-169.
- Smith, M., Cadiz, J. and Burkhalter, B. (2000), **Conversion Trees and Threaded Chats**, *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW 2000)*, ACM Press, pp 97-105.
- Smith, M. and Fiore, A. (2001), **Visualization components for persistent conversations**, *Proceedings of the SIGCHI conference on Human factors in computing systems (SIGCHI 2001)*, pp. 136-143.
- Tang, C. and Greenberg, S. (2002), **VisStream: Visualizing Temporal Multimedia Conversations**, *Poster Proceedings of Graphics Interface 2002*.

- Tang, C., McEwan, G. and Greenberg, S. (2003), **A Taxonomy of Tasks and Visualizations for Multimedia Histories of Casual Interaction**, *Proceedings of Graphics Interface 2003*, Halifax, June, pp.225-236.
- Tang, J., Isaacs, E.A., Rua, M. (1994), **Supporting Distributed Groups with a Montage of Lightweight Interactions**, *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW 1994)*, ACM Press, pp.23-34.
- Tang, J. and Rua, M. (1994), **Montage: Providing Teleproximity for Distributed Groups**, *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 1994)*, v.1 pp. 37-43.
- Tufte, E.R. (1990), **The Visual Display of Quantitative Information**, Graphics Press, Cheshire, Connecticut.
- Venolia, G. and Neustaedter, C. (2003), **Understanding Sequence and Reply Relationships within Email Conversations: A Mixed-Model Visualization**, *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2003)*, ACM Press, pp. 361-368.
- Want, R., Hopper, A., Falcao, V. and Gibbons, J. (1992), **The Active Badge Location System**, *ACM Transactions on Information Systems*, Vol. 10, No. 1, January 1992, pp.91-102.
- Wellman, B. (1996), **For a Social Network Analysis of Computer Networks: A Sociological Perspective on Collaborative Work and Virtual Community**, *Proceedings of the ACM Conferences of SIGCPR/SIGMIS*, 1996, Denver Colorado, USA, pp. 1-11.
- Wexelblat A. and Maes, P. (1999), **Footprints: History-Rich Tools for Information Foraging**, *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 1999)*, pp. 270-277.
- Whittaker, S., Frohlich, D. and Daly-Jones, O. (1994), **Informal Workplace Communication: What is it like and how might we support it?** *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 1994)*, v.1 pp. 131-137.

## Appendix A. Pilot Study

---

### A.1 Protocol for the Experiment

*Before you begin, you should have a pre-test questionnaire ready for the participant and the software up and running. No other windows should be visible.*

*Introduce yourself.*

- My name is \_\_\_\_\_, and I will be giving you instructions on what to do and will answer your questions.
- I've developed a prototype computer system that can help people navigate histories of past conversations which may consist of textual messages and images. I'm now doing a study to see how this tool can help people explore these conversational data. You're helping us by trying out this product in its early stage. We're looking for places where the product may be difficult to use.

*Tell them about the experiment.*

- The system we are testing will be displayed on the two monitors. You will be given a set of tasks, one at a time, to perform, and you may use either or both the mouse and the keyboard to carry out these tasks.
- We found that we get a great deal of information from these informal tests if we ask people to think aloud as they work through the exercises. It may be a bit awkward at first, but it's really very easy once you get used to it. All you do is speak your thoughts as your work. If you forget to think aloud, I'll remind you to keep talking.

*Tell the participant that it's OK to quit at any time.*

- Although I don't know of any reason for this to happen, if you should become uncomfortable or find this test objectionable in any way, you are free to quit any time.
- Do you have any questions at this point?

*Give them the consent form to sign. If it is not signed, do not proceed.*

*Record the subject ID. Hand the participant a pre-test questionnaire.*

- Before we begin the study, I would like you to answer a few questions found on this form. They will give us some background information about your computer experience.

*Participant should answer the pre-test questionnaire.*

- We will now begin the study. I will ask you to perform the tasks.
- I will be sitting here and may be recording various observations during the study on paper. Besides, the study will also be videotaped for later review.

*Participant should perform the tasks, one at a time.*

*Participant should answer the post-test questionnaire.*

## A.2 Consent Form

**Research Project Title:** Usability testing of a visualization tool for reviewing past conversations

**Investigator:** Charlotte Tang and Saul Greenberg

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

### **Description of Research Project:**

This study is investigating the use of a visualization tool to retrieve past conversations which are either in textual format or as snapshots of images. There will be a list of about 10 specified tasks for you to perform during the study. You are going to be asked to find from the visual display a particular piece or a series of information either by its content, converser(s), or date. We would like to ask you to “think aloud” while performing the tasks. This means that you speak out your thought aloud while you perform your tasks. The study is going to be videotaped for later review and analysis. This study requires approximately 1 hour of your time.

Participation in this study will not put you at any risk or harm and is strictly voluntary. All information regarding your personal information and those that could identify how you personally performed is confidential: only the researchers involved will have access to it.

After the test, a post-session questionnaire will be given to you in order to collect information about your experience during the test.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

At the conclusion of the study and its analysis, we will post any resulting papers that we have written about it. You can view these by asking the investigator.



If you have further questions concerning matters related to this research, please contact:

Charlotte Tang, Department of Computer Science, University of Calgary  
Phone: (403) 220-3532, [tangsh@cpsc.ucalgary.ca](mailto:tangsh@cpsc.ucalgary.ca)

If you have any questions or issues concerning this project that are not related to the specifics of the research, you may also contact the Research Services Office at 220-3782 and ask for Mrs. Patricia Evans.

---

Participants Signature

Date

---

Investigator and/or Delegate's Signature

Date

---

Witness' Signature

Date

A copy of this consent form will be given to you to keep for your records and reference if you request it. This research has the ethical approval of the University of Calgary.

### A.3 Pre-Test Questionnaire<sup>3</sup>

A. Check the item that best describes your use of desktop computers

- [ ] Never use computers
  - [ ] Use them very occasionally (once several months)
  - [ ] Use them at least several times a month
  - [2] Use them several times a week
  - [8] Use them almost every day
- Anything else you want to add about your computer expertise?
- 

B. Check the item that best describes your use of a mouse

- [ ] I never used a mouse before
  - [ ] I have used a mouse, but do not feel comfortable or proficient with it
  - [ ] I have used a mouse, and feel comfortable in using the left button only
  - [10] I have used a mouse, and feel comfortable in using both the left and right button only
- Anything else you want to add about your use of a mouse?
- 

C. Check the item that best indicates your familiarity with the use of visualization tools for navigation

- [5] I never used visualization tools for navigation before
  - [3] I have used visualization tools for navigation, but do not feel comfortable or proficient with them
  - [2] I have used visualization tools for navigation, and feel comfortable and proficient with them
- Anything else you want to add about your use of visualization tools?
- 

---

<sup>3</sup> In the pre- and post-questionnaires, the number in *italic* inside [ ] indicates the frequency of responses and the text comments are shown in *italic*.

D. Check one of the following that best describes your familiarity with checkboxes

- ☐ I never used with checkboxes before
  - ☐ I have used with checkboxes, but I do not feel comfortable with them
  - ☐ I have used with checkboxes and feel comfortable with them
- Anything else you want to add about your familiarity with checkboxes?
- 

E. Check one of the following that best describe your familiarity with radial buttons

- ☐ I never used with radial buttons before
  - ☐ I have used with radial buttons, but I do not feel comfortable with them
  - ☐ I have used with radial buttons and feel comfortable with them
- Anything else you want to add about your familiarity with radial buttons?
- 

F. Check one of the following that best describe your familiarity with calendar controls

- ☐ I never used with calendar controls before
  - ☐ I have used with calendar controls, but I do not feel comfortable with them
  - ☐ I have used with calendar controls and feel comfortable with them
- Anything else you want to add about your familiarity with calendar controls?
- 

G. Check one of the following that best describe your familiarity with pull-down menus

- ☐ I never used with pull-down menus
  - ☐ I have used pull-down menus, but I do not feel comfortable with them
  - ☐ I have used pull-down menus and feel comfortable with them
- Anything else you want to add about your use of pull-down menus?
-

## A.4 Post-Test Questionnaire

- A. Do you find the tool easy to use?  
 Hard to use 1 2 3 4 5 Easy to use  
 [2] [2] [6]
- B. Do you find the labels on the display easy to understand?  
 Hard to understand 1 2 3 4 5 Easy to understand  
 [1] [1] [4] [3] [1]
- C. Do you find the overview display (i.e., the small-box scatter graph) useful?  
 Not Useful 1 2 3 4 5 useful  
 [2] [2] [3] [3]
- D. Do you find the enlarged messages useful to locate information?  
 Not Useful 1 2 3 4 5 useful  
 [3] [1] [3] [3]
- E. Do you find an easy mapping between people's names and their respective messages displayed?  
 Hard 1 2 3 4 5 Easy  
 [2] [2] [1] [4] [1]
- F. What do you think about the RANDOM display of messages/images on the simulated Notification Collage board?  
 Bad 1 2 3 4 5 Good  
 [2] [3] [1]
- G. Do you find the simulated Notification Collage board useful for reviewing?  
 Not Useful 1 2 3 4 5 useful  
 [3] [3] [1] [3]
- H. Do you find the calendar control (i.e. the double slider) easy to use?  
 Hard to use 1 2 3 4 5 Easy to use  
 [1] [1] [4] [4]
- I. Do you find the set of video buttons easy to use?  
 Hard to use 1 2 3 4 5 Easy to use  
 [1] [1] [1] [3] [2]
- J. Which task do you find most difficult to perform?
- *finding the broken plant conversation* [6]
  - *specific search for information* [3]
  - *find the cell phone number* [1]
  - *find pictures of peanuts* [1]

- K. How do find the transition taken place on the screen?
- *fine, a bit slow* [6]
  - *too slow* [4]
- L. What additional features in the tool would you like to have for navigating past conversations?
- *keyword search* [4]
  - *different color backgrounds for different people's postits* [3]
  - *search by time, date, time range, name, file type* [2]
  - *show poster names on the media items* [2]
  - *allow scrubbing the timeline* [1]
  - *change play button to pause when pushed* [1]
  - *set begin and end of conversation* [1]
  - *vertical guide* [1]
  - *better indication of time/date in overview* [1]
  - *multi-line tooltip instead of single line* [1]
  - *option to change font size* [1]
  - *have actual date on each of the media item* [1]
- M. Do you have any comments or ideas about the tool that you would like to add?
- *everything works different than my initial mental model, but as soon as I start to use things, I start to feel like I understand how things work* [1]
  - *don't like the CD-style player buttons* [1]
  - *helpful to display conversation sequentially* [1]
  - *the yellow bar seemed to disappear and the checkboxes were confusing* [1]
  - *faster to find items than I originally expected* [1]

## A.5 Task List

- 1) If you want to see the complete set of conversation in more detail, how would you do that?
- 2) Connie did not finish the L/C (Letter of Credit) application for the Korean tender. Why?
- 3) If you just want to see the conversations fallen between Oct 25 and Nov 13 in more detail, how do you do that?
- 4) If you only want to see the conversation made on Nov 29, 2001. What would you do?
- 5) What was the conversation made on Nov 29 about?
- 6) There were some pictures of peanuts shown during the conversations, peanut in shell, peanut kernels and blanched peanuts. Can you show me those pictures in such a way that I can compare them?
- 7) Joyce said in the first half of December that she has got a new cell phone number. Can you please tell me what that new number is?
- 8) Frederick has shown us two pictures of the packaging for peanut butter jars. Can you show them to me?
- 9) I had no idea when this was made but I know that the company has chartered a vessel for a customer called Granadex. Joyce got the deal from a ship-broker. What was the cost and what price did they intend to offer to Granadex? Can you please find it?
- 10) Someone mentioned that the blanching tank in Tianjin plant was broken around end of 2001 and beginning of 2002. You would like to see a reproduction of the conversation taken place about the Tianjin plant with regard to the broken blanching tank. Can you show me please?
- 11) From the conversation episodes you have seen and please feel free to browse the conversation again, can you tell me the kinds of product this company deals with?
- 12) Again you may refer back to the conversation set on the display, can you guess what duties the staff have in the company and their relative ranks?

## Appendix B. Exploratory Study

---

This appendix contains the experiment materials used in the exploratory study to investigate the tasks and visualizations required to navigate and review multimedia histories of past conversations.

### B.1 Protocol for the Study

*Before you begin, you should have a pre-test questionnaire and all the materials, including the booklet containing re-stickable communication data, white board markers, Post-it notes, and masking tape, ready for the participant*

*Introduce yourself.*

- My name is \_\_\_\_\_ and my co-investigator is \_\_\_\_\_. We will be giving you instructions on what to do and will answer your questions.
- The purpose of this research is to understand how people analyze conversations from a log that contains a large set of temporal multimedia data and to translate the knowledge into requirements for a tool for analyzing histories of multimedia conversations.

*Tell them about the experiment.*

There will be two specific tasks for you to perform:

- 1) You are going to be asked to brainstorm the task features that you deem appropriate in the tool.
- 2) You will be given a booklet of pre-processed data with every piece of textual as well as image data in post-it note format arranged in time order. A variety of stationary including blank post-it notes and marker pens in different colors will also be provided. You will be asked to construct the data set on a large white

board and/or over a table in the way you desire.

We would like to ask you to “think aloud” while performing the tasks, meaning that you should speak out your thoughts while performing the tasks. The study is going to be videotaped for later review and analysis.

*Tell the participant that it's OK to quit at any time.*

- Although I don't know of any reason for this to happen, if you should become uncomfortable or find this test objectionable in any way, you are free to quit any time.
- Do you have any questions at this point?

*Give them the consent form to sign. If it is not signed, do not proceed.  
Record the subject ID. Hand the participant a pre-test questionnaire.*

- Before we begin the study, I would like you to answer a few questions found on this form. They will give us some background information such as demographics, your familiarity with groupware and data analysis.

*Participant should answer the pre-test questionnaire.*

- We will now begin the study. I will ask you to perform the tasks.
- We will be sitting here and may be recording various observations during the study on paper. Besides, the study will also be videotaped for later review.

*Participant should answer the post-test questionnaire.*



## B.2 Consent Form for Use of Conversation Data

**Research Project:** Exploratory study on visualizing and analyzing histories of multimedia conversations

**Investigators:** Charlotte Tang, Gregor McEwan and Saul Greenberg

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

### Description of Research Project:

The focus of this research is to understand how people analyze conversations from a log that contains a large set of temporal multimedia data and to translate the knowledge into requirements for a tool for analyzing histories of multimedia conversations.

The conversations will be real-life conversations captured through a computer-aided casual conversation system, the Notification Collage [Greenberg and Rounding, 2000]. Image snapshots of yourself and conversations made by you through the Notification Collage will be logged in a database and used as part of the dataset for the subjects of this study to navigate in order to perform the designated tasks in the study. The subjects are going to analyze the data to construct a visual display for navigation. Hence, your name, image and conversations may be revealed to the subjects during the course of the study. You will have a week to review the logged data where you can request that any data collected involving you directly be erased and excluded from the study.

Your involvement in this study will not put you at any risk or harm and is strictly voluntary. At the conclusion of the study and its analysis, we will post any resulting papers that we have written about it. Your identity, image snapshots and conversations may appear as snapshots taken from the system in the paper.

Your signature on this form indicates that you have understood to your satisfaction the information regarding having your identity, image snapshots and conversations exposed in the research project and agree to have your identity, image snapshots and conversations included in the dataset for the study and as snapshots in the paper. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to review the data about you used in the study at any time. Your continued involvement should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout the study.

At the conclusion of the study and its analysis, we will post any resulting papers that we have written about it. You can view these by asking the investigator or by accessing the website: <http://www.cpsc.ucalgary.ca/grouplab/papers/>.

If you have further questions concerning matters related to this research, please contact:

Charlotte Tang or Gregor McEwan of the Department of Computer Science, University of Calgary by phone: (403) 210-9507, or by email: [tangsh@mcewan@cpsc.ucalgary.ca](mailto:tangsh@mcewan@cpsc.ucalgary.ca)

If you have any questions or issues concerning this project that are not related to the specifics of the research, you may also contact the Research Services Office at 220-3782 and ask for Mrs. Patricia Evans.

---

Participants Signature

Date

---

Investigator(s) and/or Delegate's Signature

Date

---

Witness' Signature

Date

A copy of this consent form will be given to you to keep for your records and reference if you request it. This research has the ethical approval of the University of Calgary.

## B.3 Consent Form for Study Participants

**Research Project:** Exploratory study on Visualizing and analyzing histories of multimedia conversations

**Investigators:** Charlotte Tang, Gregor McEwan and Saul Greenberg

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

### Description of Research Project:

This study is to explore the task- and interface-specific user requirements for a visualizing and analyzing tool for a large set of temporal multimedia conversations communicated over a computer-mediate communication tool. The data include plain texts, video image snapshots and possibly others.

There will be tasks for you to perform during the study.

- You will be asked to brainstorm the task features that you deem appropriate in the tool.
- You will be given a pile of pre-processed data with every piece of textual as well as image data in post-it note format arranged in time order. A variety of stationary including blank post-it notes and marker pens in different colors will also be provided. You will be asked to construct the data set on a large white board and/or over a table in the way you desire.

We would like to ask you to “think aloud” while performing the tasks, meaning that you should speak out your thoughts while performing the tasks. The study is going to be videotaped for later review and analysis. This study requires 1 to 1.5 hour of your time.

Participation in this study will not put you at any risk or harm and is strictly voluntary. All information regarding your personal information and those that could identify how you personally performed is confidential: only the researchers involved will have access to it.

After the test, a post-session questionnaire will be given to you in order to collect information about your experience during the test.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

At the conclusion of the study and its analysis, we will post any resulting papers that we have written about it. You can view these by asking the investigator or by accessing the website: <http://www.cpsc.ucalgary.ca/grouplab/papers/>.

If you have further questions concerning matters related to this research, please contact:

Charlotte Tang or Gregor McEwan of Department of Computer Science, University of Calgary, Phone: (403) 210-9501, [tangsh@mcewan@cpsc.ucalgary.ca](mailto:tangsh@mcewan@cpsc.ucalgary.ca)

If you have any questions or issues concerning this project that are not related to the specifics of the research, you may also contact the Research Services Office at 220-3782 and ask for Mrs. Patricia Evans.

---

Participants Signature

Date

---

Investigator(s) and/or Delegate's Signature

Date

---

Witness' Signature

Date

A copy of this consent form will be given to you to keep for your records and reference if you request it. This research has the ethical approval of the University of Calgary.

## B.4 Pre-Test Questionnaire<sup>4</sup>

Gender: \_\_\_\_\_

Occupation: \_\_\_\_\_

Research Areas / Specialties : \_\_\_\_\_

A. How familiar are you with the Notification Collage application?				
1	2	3 [4]	4 [1]	5 [7]
Never seen it	Seen it before	See it frequently and logged in at least once	Use regularly at least 3 times/week	Use daily

B. How familiar are you with VisStream, the research prototype being developed by Charlotte Tang?				
1 [1]	2 [3]	3 [3]	4 [3]	5 [2]
Never seen it	Caught a glimpse	Have a general idea of the research	Seen demonstrations and presentations	Know concepts/ appearance well

C. How often do you use Groupware applications?				
1	2	3 [1]	4 [4]	5 [7]
Never used	Used once	Used 2-5 times	Used many times	Use daily

D. How familiar are you with Computer Supported Cooperative Work (CSCW) or Groupware?				
1	2 [4]	3 [3]	4 [1]	5 [4]
Never heard of it	Heard the term before	Know some of the principles	Done some work in the field	It's my primary research area

<sup>4</sup> In the pre- and post-questionnaires, the number in italic inside [ ] indicates the frequency of responses and the text comments are shown in italic.

E. How familiar are you with data analysis techniques?

1 [3]	2 [4]	3 [2]	4 [3]	5
Not familiar	Analyzed 1 or 2 data sets previously	Occasionally analyze some data	Frequently analyze different types of data	Very familiar with lots of techniques

If you have some familiarity with data analysis, please list the kinds of data that you have analyzed.

---

## B.5 Post-Test Questionnaire

- 1) Please comment on what you liked or disliked about using the materials, including the data sets, supplied.

Likes:

- *the flexibility of whiteboard/pens so that I can draw out my ideas, gesture over them and draw to respond to questions* [7]
- *like that the events are re-stickable* [4]
- *rich data set* [2]
- *real data* [1]
- *like to use the table to show visualizations* [1]

Dislikes:

- *too many irrelevant data, e.g., logon/logoff items* [3]
- *nothing that I don't like* [3]
- *don't like working with upright whiteboard* [2]
- *don't like brainstorming* [2]
- *couldn't locate picture or web items to show how I would deal with those differently* [1]
- *boring content in media items* [1]
- *not good at drawing, sometimes find it hard to show ideas by drawing* [1]
- *couldn't write on the sticky notes, like to add content, e.g. timestamp* [1]
- *need more color of felt pens* [1]
- *incomplete information on the PostIts, needs time-stamp and id* [1]

- 2) Was there anything that you wanted to do that you couldn't because of the limitations of the materials? Please comment on what and how.

- *no, feel free to do anything I wanted* [10]
- *animations, couldn't show things moving* [2]
- *can't do composite overlays e.g., alpha blending* [1]

3) Is there any kind of information that you wanted to see that was not available in the supplied materials? Please comment.

- *the information is rich enough [9]*
- *the re-stickable interaction data arranged in a different way [1]*
- *missing data from technical problems [1]*
- *want more interesting data [1]*

4) Other comments?

- *really interesting [4]*
- *somewhat intimidating to have investigators on both sides [1]*
- *both investigators did a good job of conducting the session, feel that the session had a flavour of a design session, so it might be helpful to involve experienced designers in the session [1]*
- *may involve social psychologists to help inform design [1]*



## Appendix C. Ethics Approval



UNIVERSITY OF  
CALGARY

### CERTIFICATION OF INSTITUTIONAL ETHICS REVIEW

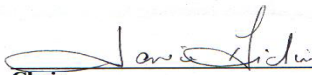
This is to certify that the Conjoint Faculties Research Ethics Board at the University of Calgary has examined the following research proposal and found the proposed research involving human subjects to be in accordance with University of Calgary Guidelines and the Tri-Council Policy Statement on *Ethical Conduct in Research Using Human Subjects*:

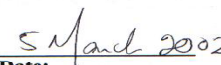
**Applicant(s):** Charlotte S.C. Tang  
**Department/Faculty:** Department of Computer Science, Faculty of Science  
**Project Title:** Usability Testing of a Visualization Tool for Reviewing Past Conversations  
**Sponsor (if applicable):**

**Restrictions:**

This Certification is subject to the following conditions:

1. Approval is granted only for the project and purposes described in the application.
2. Any modifications to the authorized protocol must be submitted to the Chair, Conjoint Faculties Research Ethics Board for approval
3. A progress report must be submitted 12 months from the date of this Certification, and should provide the expected completion date for the project.
4. Written notification must be sent to the Board when the project is complete or terminated

  
 Chair  
 Conjoint Faculties Research Ethics Board

  
 Date:

**Distribution:** (1) Applicant, (2) Supervisor (if applicable), (3) Chair, Department/Faculty Research Ethics Committee, (4) Sponsor, (5) Conjoint Faculties Research Ethics Board (6) Research Services

09/00



UNIVERSITY OF  
CALGARY

### CERTIFICATION OF INSTITUTIONAL ETHICS REVIEW

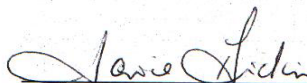
This is to certify that the Conjoint Faculties Research Ethics Board at the University of Calgary has examined the following research proposal and found the proposed research involving human subjects to be in accordance with University of Calgary Guidelines and the Tri-Council Policy Statement on *Ethical Conduct in Research Using Human Subjects*. This form and accompanying letter constitute the Certification of Institutional Ethics Review.

**Applicant(s):** Charlotte SC Tang / Gregor McEwan  
**Department/Faculty:** Department of Computer Science, Faculty of Science  
**Project Title:** Exploratory Study on the Visualization and Analysis of Histories of Past Conversations  
**Sponsor (if applicable):**

**Restrictions:**

**This Certification is subject to the following conditions:**

1. Approval is granted only for the project and purposes described in the application.
2. Any modifications to the authorized protocol must be submitted to the Chair, Conjoint Faculties Research Ethics Board for approval.
3. A progress report must be submitted 12 months from the date of this Certification, and should provide the expected completion date for the project.
4. Written notification must be sent to the Board when the project is complete or terminated.

  
**Chair**  
**Conjoint Faculties Research Ethics Board**

  
**Date:**

**Distribution:** (1) Applicant, (2) Supervisor (if applicable), (3) Chair, Department/Faculty Research Ethics Committee, (4) Sponsor, (5) Conjoint Faculties Research Ethics Board (6) Research Services

09/00

## Appendix D. Co-Author Permission

---



UNIVERSITY OF  
CALGARY

Department of Computer Science  
University of Calgary  
2500 University Drive  
Calgary, AB, CANADA T2N 1N4

November 3, 2003

I, Saul Greenberg, give Shui Chun Charlotte Tang permission to use co-authored work from our papers, "A Taxonomy of Tasks and Visualizations for Casual Interaction of Multimedia Histories" and "VisStreams: Visualizing Temporal Multimedia Conversations", for Chapters 4, 5 and 6 of her thesis and to have this work microfilmed.

Sincerely,

A handwritten signature in blue ink, appearing to be 'S. Greenberg'.

Saul Greenberg

A handwritten signature in blue ink, appearing to be 'Shui Chun Charlotte Tang'.





UNIVERSITY OF  
CALGARY

Department of Computer Science  
University of Calgary  
2500 University Drive  
Calgary, AB, CANADA T2N 1N4

November 3, 2003

I, Gregor McEwan, give Shui Chun Charlotte Tang permission to use co-authored work from our paper, "A Taxonomy of Tasks and Visualizations for Casual Interaction of Multimedia Histories", for Chapters 5 and 6 of her thesis and to have this work microfilmed.

Sincerely,

A handwritten signature in blue ink, appearing to read 'G. McEwan'.

Gregor McEwan