

COLLABORATING IN THE CAPTURE LAB: Computer Support for Group Writing

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How can computer technology be used to support collaborative writing in the workplace? What new computer tools are needed? The emerging field of computer-supported cooperative work (Grief, 1988) is exploring these questions through research on collaboration in the workplace. The development of innovative computer tools known as groupware (e.g., Stefik, et al., 1987; Ellis, Gibbs, & Rein, 1988) provides opportunities for group collaboration. This paper describes one experimental tool, a computer-supported conference room for business teams. The conference room, designated "The Capture Lab," enables meeting participants to "capture" their thought processes, plans, and decisions on-line. From our observations of many different groups using the lab, we find it to be a particularly effective and promising tool for collaborative writing.

In the first two sections, we describe the features and design principles of this computer-supported conference room. In the third section, we discuss how groups have used this environment for collaborative writing. In the final sections, we share our observations of how users respond to the technology and how they learn to use the room.

THE CAPTURE LAB

The Capture Lab is an ergonomically designed meeting room that provides computer support for groups of up to eight people (see Figure 1). Here, as participants capture their discussions on-line, staff researchers can capture the meetings on videotape and on specially designed logging software while viewing the participants through a one-way mirror. Analysis of this videodata allows researchers to study the effects of the technology on the meeting process.

Originally, the designers of the Capture Lab were strongly influenced by Colab, an early groupware facility at the Palo Alto Research Center of Xerox Corporation (Xerox PARC). Colab was designed to support up to six participants focused on problem-solving activities via highly specialized, custom-built software (Stefik, et al., 1987). Its design appeared to support its technically sophisticated users very well. However, to best serve our user population of business teams, we needed an environ-

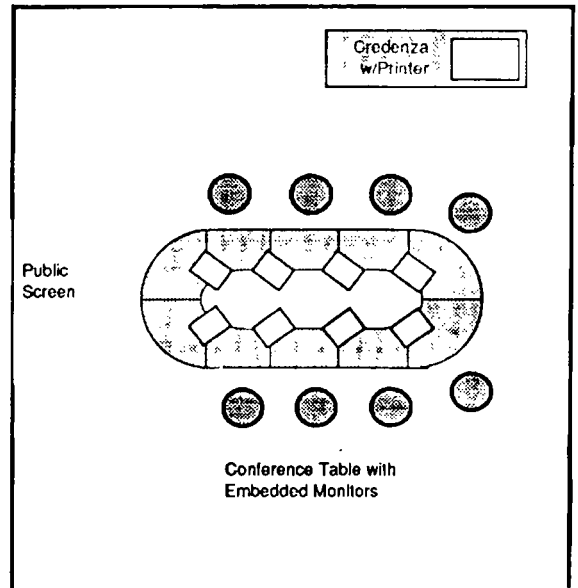


Figure 1. Diagram of Capture Lab

ment that offered an easy-to-use interface and off-the-shelf software. Thus, the lab designers selected Macintosh computers because of their friendly interface. Capture Lab users may select any Macintosh software needed for their specific task, such as word processors, spreadsheets, databases, outliners, and graphics tools. Any Macintosh application program can be used in the conference room without modification.

The lab's conference table has eight keyboards, mice, and monitors for individual participants' use. The monitors are recessed into the table to support visual contact among participants. In the front of the room, a large public video display screen shows the output of a ninth Macintosh that serves as the group's "public computer." This computer is linked via a local area network to the eight individual computers. (All nine computers are stored remotely, because users seldom need to access them.)

Initially each user's keyboard controls his or her own machine. A user can transfer control from the personal computer to the public computer by pressing a special access key on the keyboard. (There is no keyboard or mouse for the public machine.) The access key on each

personal computer is a toggle switch. When pressed the first time, it transfers a user's control to the public machine; when it is pressed again, the user's keyboard is reconnected to his or her private machine. One participant can "bump" someone from controlling the public machine by simply pressing the access key. The first user is then automatically reconnected to his or her personal computer, and the second user gains control of the public computer.

Since one of the design goals of the conference room was to support the natural meeting process as much as possible, the physical protocol for turn-taking on the public computer parallels the social practice of one speaker interrupting another. We refer to this physical protocol imposed by the computer system as the "preemptive protocol."

Users can move data (text or graphics) between their individual machines and the public machine with an enhanced clipboard transfer function. When a user moves between an individual computer and the public computer, information on the clipboard moves as well. A user can copy or cut data to or from the clipboard, where it is held in a buffer, until transferring control to or from the public machine. When the user switches control from one machine to another, he or she selects the desired place in the document for the text or graphics and then places it with the paste function. (Transferring control alone will not change the display; it remains unchanged until the clipboard contents are positioned and pasted.)

When a user transfers control from a personal computer to the public screen, the display and content of the personal monitor are frozen while the mouse and keyboard control the cursor on the public machine's display. Thus, individuals can prepare information on their personal computers before transferring it to the public computer for presentation. Alternatively, a user may transfer information from the public computer onto his or her individual machine, for example, to rework material privately.

It's important to note that the presence of the computer equipment in the meeting room does not appear to detract from the normal verbal and visual communication of conventional meetings. People spend periods of time discussing issues, pausing to record information on the public machine and to take notes on their private machines or on paper. Some meetings also include periods when participants work in parallel on their private machines, later merging their work into a document on the public machine for group discussion and review.

INTERFACE DESIGN FOR COLLABORATIVE WRITING

The Capture Lab was designed to support business people (often novice computer users) meeting together without the technology interfering with the flow of the meeting. In this section we briefly discuss three of the interface requirements for computer-supported meeting rooms that are most relevant to collaborative writing: (1) transitions between private and public work, (2) consistency in viewing shared information, and (3) ease of use with minimal training. (See Mantei, 1988; Elwart-Keys Halonen, Horton, Kass, & Scott, 1990, for further discussion of design requirements.)

Transitions Between Private and Public Work

Meetings are typically steps of much larger tasks. In a business environment, several people may work on a project for a period of time, often alone, sometimes in subgroups, and sometimes as a whole group. People need to be able to shift easily between working on a task privately on a personal computer and working on it collectively in a computer-supported meeting. Two types of transition need to be supported: (1) shifting between private work in participants' offices and collective work in the meeting, and (2) shifting between phases of private work within a meeting and collective work occurring in a meeting.

Because this computer-supported meeting room uses commercially available software, it is possible for persons to use the same software in their offices as they do when they work together in the lab and to transfer work easily between the two environments. The individual computers also enable members of a team to work independently during portions of a meeting, to draft or edit a section of a report, for example, and then to copy their work to the public machine for review by the other members. In this way, several people can contribute to the document creation, without the tedious cycle of distributing and redistributing paper copies for comments.

Viewing Shared Information

The distinction between public and private information must be explicit to avoid communication breakdowns. In the Capture Lab, information placed on the public computer is shared information, while users' work on individual machines is private unless explicitly transferred to the public machine. Some users may request that the contents of the public screen be displayed on their

personal monitors for ease of viewing and scrolling at their own pace. However, all participants need to have the same view of the shared information, that is WYSIWIS, What You See Is What I See (Stefik, et al., 1987). Foster (in comments made during the Groupware Technology Workshop, Xerox Palo Alto Research Center, Palo Alto, Ca, August 24-25, 1989) has noted that the ability for individual users to customize their views of shared information can cause reference difficulties in conversations. People often use spatial descriptions to refer to items others can see, such as "the second point from the top." If meeting participants can tailor the arrangement of shared items on their personal displays, such referencing methods can cause misunderstandings. Consequently, the shared information presented by the computer system is displayed in the same way for each user.

Ease of Use with Minimal Training

Users need to learn how to use the computer-supported meeting environment effectively with minimal training. This need is particularly important for middle- and senior-level managers lacking the incentive or time to learn a complex system. The simple interface of our particular environment, involving the press of one key to switch users between their private machines and the public machine, minimizes the training required for new users, thus allowing them to focus on tasks rather than on manipulating the computer system. The ability to use the same software in one's office and in the meeting room also contributes to this simplicity.

HOW THE LAB FACILITATES COLLABORATIVE WRITING

As recent surveys of collaborative business writing have found (Allen, Atkinson, Morgan, Moore, & Snow, 1987; Couture & Rymer, 1989; Ede & Lunsford, 1986), the nature of collaboration is quite varied. Collaborative efforts range from an author discussing ideas for a report with colleagues prior to or during the writing process, to a more fully collaborative effort where a team plans and coauthors a document. Consistent findings have emerged from these studies about when in the writing process writers collaborate. Typically, group members choose to brainstorm and plan as a group and to revise their documents as a group. They rarely draft as a group. (Participants in the Allen, et al. survey reported they found drafting as a group frustrating, and Ede and Lunsford's survey respondents felt drafting and editing are best done individually.) More commonly, group members divide the drafting of different sections among them-

selves, or one member of the group generates the draft individually. Once drafted, the document is circulated for comments, and the group reconvenes to discuss and revise it.

The typical pattern of collaboration reported from these surveys requires groups to hold a series of meetings to review and integrate the writing delegated to individual members to complete on their own time. Computer-supported conference rooms such as the Capture Lab allow a much more efficient pattern, where group members can accomplish their tasks — including drafting — during their meetings. This group drafting enables all the meeting participants to contribute directly to the product, and to avoid or minimize additional meetings. This reduces some of the costs of coordinating collaborative work. (See Malone, 1988, for further discussion of how new information technologies can reduce coordination costs.)

Over the past two years we have observed a wide range of users, including our own staff, executives, and managers from the automotive and data processing industries, and faculty and student groups from universities. From these observations, we are discovering new and interesting ways in which groups use the technology for collaborative writing. We find this computer-supported conference room effectively supports many different aspects of document creation, including brainstorming, planning, drafting, and revising, as well as the group process itself.

Brainstorming and Planning

Groups can brainstorm and do more structured planning using specific software packages tailored for these tasks, or they can simply use a word processing application for capturing and displaying people's ideas. In the lab some users may generate ideas on their personal computers and share them with the group after an initial period of individual brainstorming, or others may choose to work from the outset collectively, entering ideas on the public screen for group discussion. By creating a group outline on the public machine, participants can share their perspectives, address conflicts, and potentially increase and expedite consensus on a project, all prior to one or several group members generating a more lengthy document for review.

In addition to explicit brainstorming and planning, groups often use the public screen as their collective scratchpad. For example, a group of three, working as a design task force over several months, held almost all of their meetings in the room. They used the public screen to pose questions to investigate, list alternatives, and document final recommendations.

Drafting

This computer-supported conference room makes drafting or composing as a group quite possible and the combination of the public and individual computers provides much flexibility in how groups accomplish this. We have observed several groups compose together, by generating an entire document or composing and revising new sections of a larger document. Of course, whether composing as a group is an effective or efficient strategy depends on several factors, including the particular writing task, the group dynamics, and the available time. For relatively short documents, such as business memoranda, generating the text on the public machine as a group can be quite effective. For example, group members can try out alternative phrasings verbally and enter text into their document once they reach consensus, or they can use the public screen as a group notepad to suggest and discuss possibilities. Group members may also draft individual versions of the text on their private computers and share their versions by pasting them onto the public screen and / or by circulating printed copies for review. They may then work as a group to create the final draft, merging and revising sections from the individual drafts.

For more complex or lengthy writing tasks, it can be more effective for group members to work in parallel, for example, each taking a section to draft from the group outline. While drafting their individual sections on their private machines, members can talk with each other and consult each other's work. One example of a group using the Capture Lab very effectively in this manner involved a team producing a technical paper in one day to meet a 5 p.m. deadline. They began that morning with only a very sketchy draft generated by one member. Team members worked independently on sections of the paper using their private computers for periods of time, frequently consulting one another with content and style questions. Their parallel work was interspersed with periods of focused, collective work when sections of the paper were transferred to the public machine and merged for group review and revision.

The political context of the writing also influences a group's decision to compose collectively. It is important for group members to feel they contributed significantly to the document and often just as important for all group members to sign-off. Groups frequently use the public machine to generate minutes of their meetings, getting input and approval from participants during the meeting. The design task force (mentioned earlier), working as a group for several months using the technology for brainstorming and planning, also used the room to compose and deliver a presentation of their final recommen-

dations to their customer. Whereas it may have taken less time for only one member of this team to generate a presentation, politically this approach would have been ineffective since all team members were highly invested in this project and each wanted the presentation to adequately represent his or her perspective. In this case, developing the presentation collectively was critical for consensus building and sign-off by everyone on the team.

These early observations, along with user feedback, suggest to us that provided with appropriate tools, groups can productively compose together.

Editing and Revising

The ability for all members of a group to see and edit a document makes a computer-supported environment like the Capture Lab particularly effective for final revisions, when consensus about changes can be obtained during the work session. Prior to meeting as a group, members can review printed copies of the document and bring their suggestions for changes to the meeting. Examples of groups effectively using the technology for this aspect of collaborative writing include a corporate planning group that produced a final draft of a key policy document and a university group that completed the final revisions of a collaborative grant proposal.

Improving the Group Process

The ability to produce work as a group in the same place at the same time can reduce some of the group process difficulties inherent in collaborative writing groups. Forman and Katsky (1986) argue that members of collaborative writing groups can assume either too little or too much control and ownership. Informal feedback from lab users suggests that because group members have the same access to documents on the public machine, they have a greater sense of control, responsibility, and ownership.

Users also report that the public screen depersonalizes members' contributions to the group product. Some users find it easier to challenge ideas on the screen because they are perceived as public rather than as "Joe's." Others find that depersonalization can diminish group members' opposition to the ideas, resulting in a group reaching greater consensus, in less time.

As Doheny-Farina (1986) noted in his ethnographic study of collaborative writing, collaborators need to achieve a "shared bridge of meaning." The public screen may provide just such a bridge. One compelling example of this phenomenon occurred when a high-level executive held a staff meeting in the lab to complete the final revisions on a key corporate policy document. Two of his staff members were discussing a proposal which the

executive had difficulty following. After one of them inserted the idea into the document, the executive saw their proposal visually, quickly understood it, and endorsed it.

Members of a strategic planning task force who met in the room for several sessions also reported that the display of ideas on the public screen kept their group more focused and encouraged more complete and precise development of ideas. Furthermore, one team member observed that each person in his group contributed more individually in this environment than in a regular meeting room.

HOW USERS RESPOND TO THE TECHNOLOGY

Our observations suggest that a computer-supported conference room can improve the collaborative writing process. We have also seen that group members' level of computer proficiency shapes their use of the technology and the benefits they can derive from it. In this section, we discuss how users respond to the technology and manage the sharing of the public computer.

Overcoming Technical Inhibitions

By nature, groupware is primarily focused on the collective effort of the participants to work as a unit. However, we have observed that privacy of individual work within this group forum is critical to users' acceptance of the groupware. Users with limited computer or typing skills resist working on the public computer, possibly to avoid embarrassing themselves. In some business groups, one person's status in the eyes of the group can be altered by others' perceptions of his or her computer abilities. Providing users with individual machines and the clipboard transfer mechanism reduces inhibitions, enabling them to participate in the creation of their group's documents while saving face. Other users may prefer to work first on their private computers because having the monitor physically close to them is a more familiar work style and gives them a sense of more control over the material.

A compelling example here is a corporate task force that held several meetings in the lab before the transfer function was available. In early meetings the more novice users rarely used the public computer (complaining about the computers not being user friendly), and reported that their lack of computer expertise limited their participation in the sessions. However, once the transfer function was available, they often worked on their private machines and simply pasted the resulting material into the group documents on the public screen. It allowed them to use the technology, but in a different way from their more technically proficient peers.

Scribing Patterns and Consequences

Groups adopt several different patterns for working on the public machine. As Mantei (1988) first noted, some group participants freely access the public computer when they wish, preempting the current user. Other groups appoint one individual, referred to by Mantei as the designated scribe, or take turns as a rotating scribe. Most meetings, however, are hybrids, where group members use multiple patterns over the course of the session.

Based on our observations of users who chose to work on the public computer, skilled typists and / or computer users (who find it easier to use the technology) may enhance their status in the eyes of the other meeting members. A skilled scribe can be a highly influential and controlling member of the group, who is able to manipulate the content of the document and the direction of the meeting. Combining the scribe role with that of a facilitator requires sophisticated multi-tasking. Our observation that technically skilled scribes can exert considerable influence over the meeting is consistent with Forman's (in press) recent research on the group dynamics of computer-supported student writing groups. In three quarters of these groups, the technology expert was also the writing leader.

Although this scribing function can yield power and control, we have observed that the person designated as group scribe may be no higher in function and status than a clerical person. Because the potential power of the scribe is not always obvious to new lab users, some business groups initially see scribing as a low-level task and bring a secretary to their meetings to perform this recording function. However, this kind of scribe often lacks sufficient domain knowledge to be effective and often misinterprets ideas or concepts for the group. When this occurs, meetings become bogged down as group members notice and object to problems in the group document.

Sharing the Public Computer

The simplicity of the preemptive protocol helps to maintain the regular flow of dialogue and work within meetings. Early in the development of the Capture Lab, we explored an "opportunistic" protocol, to give users access to the public machine only when no other user was controlling it. However, we discovered this more restrictive protocol was not needed to manage the sharing in our environment. Often, users seem to be reluctant to take access away from the last person to use the public machine, even when the machine is idle. Users tend to make requests or comments prior to obtaining access, such as, "I'm going to add my paragraph now," or, "Can I take the machine — I want to change that last sentence?"

Although politeness has prevailed in the varied business and university groups that have used our facility, we realize that this pattern may be very different among users in other corporate cultures.

LEARNING TO USE THE LAB

New lab users receive training on how to use the computer facilities before they work in the room. The extent and amount of training is customized based on experience with the Macintosh and the particular software applications. However, we have not attempted to give users a strategy for how to use the room. This is for three reasons: (1) we want to investigate how groups use the room without our guidance, (2) effective strategies may vary widely across tasks and groups, and (3) we are still determining what instructions to give. The questions of how to collaborate for a particular kind of work and how to use the technology effectively remain unanswered pedagogical issues.

Though users quickly master the mechanics of the room interface, time is needed to discover how to use it most effectively. A common practice is for new users to treat the public display as they would a blackboard, walking to the board to point to items, instead of accessing the public machine from their seat and pointing with the mouse. Not only does standing in front of the screen obscure others' view of the information; if someone else chooses to scroll to a different point in the document, the person standing at the screen no longer controls the information presented to the group.

Some novice Capture Lab users have difficulty coordinating different media and the transitions between group meetings and office work. Some bring paper copies (often printouts of computer-resident information), which cannot be shared or edited during the meeting. This example also illustrates that some users do not initially understand the power of the public screen as a tool for focusing the group's attention.

Over time, users become aware of the potential influence they can exert by using the public machine.

Likewise, with experience, groups discover an effective pattern of public versus private machine use for their particular group dynamics and tasks.

It is not sufficient to provide a computer-supported meeting environment and to train people how to use the technology; they also must learn effective strategies for using these resources as a group. As more computer-supported meeting environments are developed, successful strategies for utilizing these new resources should emerge. While we can inform groups about strategies, we also believe that experience working in this kind of environment is needed for a group to achieve maximum benefits, and that optimal strategies will vary across groups.

CONCLUSIONS

Some surveys of business writing (e.g., Allen, et al., 1987; Couture & Rymer, 1989) have found that groups actually write together rather infrequently, though they often collaborate in planning, discussing, and reviewing documents. In part this may be due to the lack of group writing tools that support the creative process and the coordination of individual work. We have described how the Capture Lab, a computer-supported meeting room, supports many different aspects of collaborative writing. In this environment, group work becomes more efficient. Replacing the cycle of working alone and then meeting as a group, lab groups often use the computers to draft and review, thereby accomplishing their tasks during their meetings. Another benefit may be an improved group process, yielding increased involvement and contribution among group members. The combination of individual and shared computer tools, networked together, broadens the opportunities for effective communication and collaboration among writing groups in business and in academia.

NOTE

¹ Authors are listed alphabetically

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