Cognoter,

Theory and Practice of a Colab–orative Tool

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ABSTRACT

Cognoter is a program helps a cooperating group of people to organizing their thoughts for a presentation, e.g., a paper or talk. It is designed for use in the Colab, an experimental laboratory created at Xerox PARC to study computer support of cooperative real–time group problem–solving. Cognoter provides a multi–user interface and a structured meeting process. An annotated graph of ideas is built up by the group in three stages: *brainstorming* for idea generation, *ordering* for idea organization, and *evaluation* for choosing what will be finally be presented. Interesting aspects of Cognoter include direct spatial manipulation of ideas and their order relationships, support of parallel activity, and incremental progress toward a total ordering of ideas.

Introduction

Cognoter is a computer program for preparing presentations — talks, papers, memos, anything in which ideas must be organized so that they can be understood. It is an example of what we call a *meeting tool*: software intended to support a meeting process and to provide a powerful *multi–user* interface to participants. At the end of a successful meeting using Cognoter, the participants will have an annotated outline of ordered ideas and associated text. Cognoter has been used to prepare outlines for several talks and papers, including this one.

In an environment where there is little cost associated with trying things out, things tend to get tried out. Meeting tools, such as Cognoter make it easy to re–arrange items, and to alter their relationships to each other. They encourage a breadth of approach. Such flexibility is useful over a range of applications.

The underlying philosophy behind Cognoter is two–fold. On one hand a tool should not be too prescriptive. People in a group should be able to jot down ideas as they think of them, without regard to order or relevance, and then play around with the ideas and their relationships until they are satisfied with the overall content and organization. On the other hand, some active assistance, a supportive environment that guides consensus and funnels progress toward a coherent organization, is also

desirable. Cognoter combines these two points of view.

Comparison to Idea Processors. Cognoter is similar in some ways to currently available "idea processors". These include commercially available personal computer programs like ThinkTank™[4], and research projects like the NoteCards system[2] developed at Xerox PARC. All of these share the goal of organizing ideas. All express an organizational model and display ideas graphically.

The most obvious difference between Cognoter and most other idea processing tools is that Cognoter is designed for simultaneous use by multiple participants (though the organization process it embodies is also useful for a single user). It is also designed to manage the complexity of organizing ideas in more direct ways than existing idea processors. Cognoter divides the organization process into smaller and different kinds of steps. In Cognoter, independent decisions can be made independently, ideas can be generated and simply "put on the table" without concern about their position in relation to other ideas. The steps for organizing ideas are incremental and efficient. Cognoter separates the concerns of idea generation, ordering, and evaluation.

In ThinkTank, ideas are always organized in an outline — there is no place else to put them. When a new idea is added the user must also decide, at creation time, where it comes in the scheme of things. In most idea processors it is a simple matter to change an item's position, but it is not readily apparent when an item is only provisionally placed. Items appearing in nonsense order in an outline look no different than carefully ordered items.

ThinkTank and NoteCards support well-known metaphors for organization (outlines and file cards, respectively). Whereas Cognoter can display organized ideas in an outline format, a goal of its design was to find more powerful ways to display, consider, and manipulate ideas. Cognoter does more than supply an active reflection of a known model (such as an outline), as shown in the next section it also assists the organization process.

Cognoter's Problem-solving Process

The organizational techniques embodied by Cognoter are similar to techniques that have long been used without computer support. Participants come to the session with a general goal in mind, something like: "Let's use this tool to plan a paper about the stuff we've been talking about recently". But a typical group will not have a clear notion of the best framework to present their ideas. They may not even know what the key ideas are.

How does a group get past the blank page? Diving into a depth-first approach is almost certainly wrong: "What's I?" "Now, what's I.A?" Similarly misguided is a breadth-first approach: "What's I?" "What's II?" A more flexible approach, including bottom-up, top-down, and middle-out techniques, is needed.

A group planning a presentation needs to do several things. First, relevant ideas must be accumulated. The participants need to decide which ideas are related and how the ideas go together. They need to determine the presentation dependencies between ideas: which ideas should come before which other ideas. Finally, they need to decide which ideas or groups of ideas are at the wrong level of detail or are irrelevant to the presentation.

Stages. Cognoter organizes a meeting into three stages: *brainstorming*, *ordering*, and *evaluation*. Each stage emphasizes different kinds of activities. As the group advances through the stages, the set of possible actions is expanded; for instance, brainstorming, emphasized in the first stage, is still possible in the last stage. Groups that find the rigid enforcement of stages too confining can skip immediately to the last stage where all operations are possible.

One of the goals of work with Colab is to experiment with various structures and techniques for group problem solving — the particular three stages mentioned above are only our current best guess, based on successful traditional techniques and the expected strengths of computer-based tools. These three stages will not be useful for all kinds of problem-solving. Others have described similar stages for problem-solving[3,5,6].

Brainstorming Stage. The goal of the brainstorming stage is to get many ideas "on the table" for possible inclusion in the presentation. Too many ideas are better than too few — it is easier to prune than to generate. Since the goal is quantity, participation by all members of the group must be encouraged and any actions that would inhibit the flow of ideas should be discouraged. Ideas are represented in Cognoter by short descriptive *items* that are displayed in a public window. Items are not evaluated or deleted in this stage and, at first, little attention is paid to details of organization.

This theory of brainstorming is reflected in Cognoter's software and in its "rules of the game". Participants can act simultaneously, adding new items as they think of them to a Cognoter window (see Figure 1). In the brainstorming stage there is only one window for all items (in later stages any number of subwindows are permitted).

Participants may attach *supporting text* to any item by selecting the item and using a private editor. Supporting text is used to clarify or amplify an item appearing in a Cognoter window. Once text is attached to an item it can be displayed publicly or further edited by any participant (see Figure 2). Items with text attached to them are displayed in a bold font.

Items cannot be deleted in this stage, and it is against the rules of the game to verbally criticize ideas. They can be moved freely, but there is little other organization during this stage. It is time to move on to the Ordering stage when the main window is too full, a jumble of ideas begging for organization.

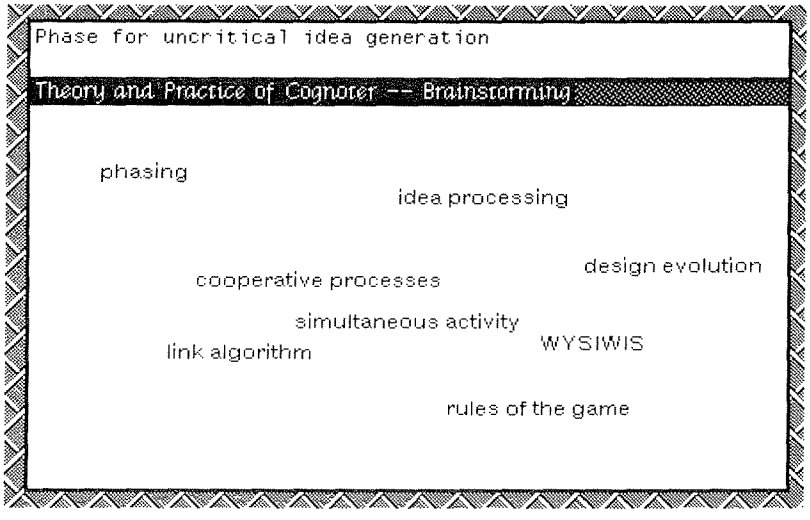

Figure 1. *Cognoter in Action: Brainstorming.* This figure shows the main Cognoter window early in a session. The goal of this stage is to generate as many ideas as possible. Collaborators simultaneously add items with little regard for their relative positioning. New items are added by buttoning the mouse over the background of the window and entering a short title or phrase that stands for the idea. As items are entered they appear on the screens of all participants.

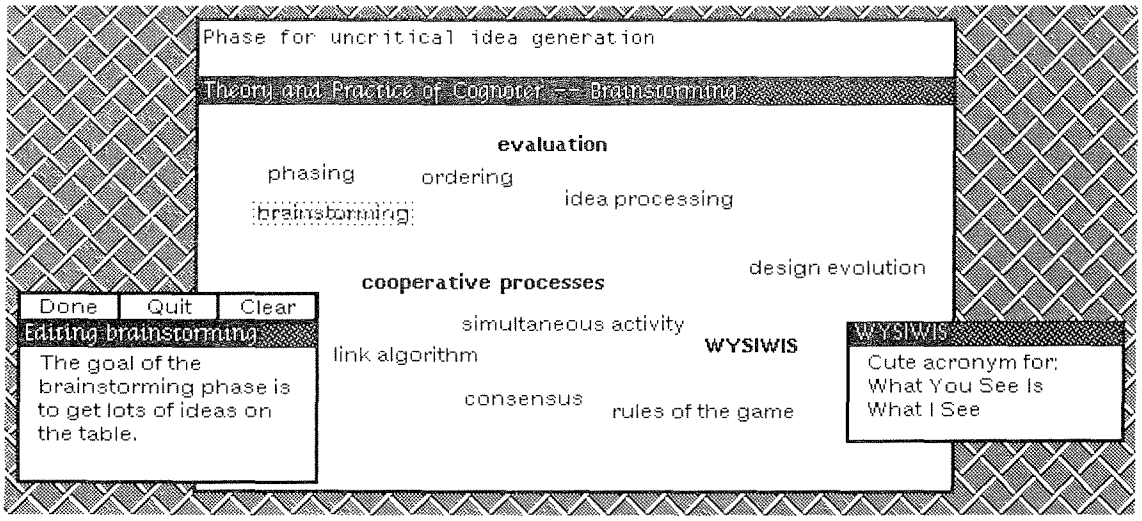

Figure 2. *Text Annotations and Busy Signals.* In addition to adding new items, participants can also amplify items by attaching supporting text. Supporting text explaining the ideas in more detail can be entered by selecting the item with a mouse and then using a text editor in a separate window. Above is a private editor active on item *brainstorming*. Notice the greying-out of the item: this "busy signal" appears on all displays and indicates that the item is undergoing alteration. Supporting text of the item *WYSIWIS* is being publicly displayed. Items with text attached to them are displayed in a bold font.

Ordering Stage. Once meeting participants have a window full of items, they are ready to put them into order. There are two basic operations added in this stage: asserting that one idea should be presented before another and asserting that several ideas belong together. Both of the ordering operations, *linking* and *grouping*, support incremental decision-making. An aggregate of small ordering decisions about what comes before what and what goes with what can yield a total order of the ideas being considered. A visual representation of ambiguities in the current ordering constraints can serve as a guide to participants that more ordering constraints are needed.

Participants indicate precedence by linking items: a link is a suggestion that the item at the link tail should be presented before the item at the link head. This may be accompanied by verbal discussion: "I'm putting *cooperative processes* before *rules of the game* since we'll need to motivate *rules of the game* before we claim that it helps." Linking is represented visually by directed arrows between items as shown in Figure 3.

Cognoter provides operations that allow items to be ordered incrementally. The link-forming operation organizes the ordering task so that a partial ordering of items is refined stepwise towards a complete ordering. Transitivity and grouping operations make it possible to organize the ideas efficiently with a small number of links. Optionally the places where the ordering is over- or under-constrained can be indicated. The groups and links are used collectively in the final stage to determine a complete order of idea presentation. Circular or contradictory linkings can be carried along and resolved when desired.

The item moving operation makes it possible to discuss grouping operations before actually doing them by moving items near each other before clustering. Thus, spatial clustering provides a suggestive intermediate indicator of organization before formal divisions are agreed upon.

Items can also be clustered into groups as shown in Figure 4. When items are grouped, they are replaced in the Cognoter window by a single new

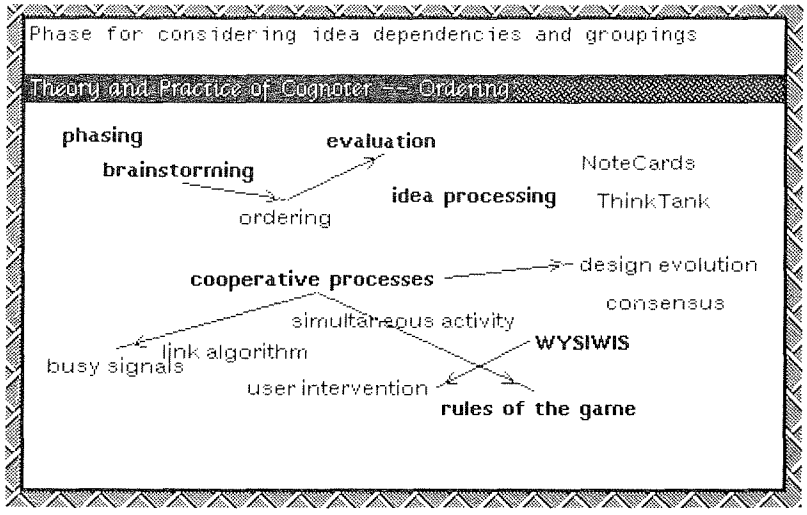

Figure 3. *Links show the sequential order of ideas.* The order of ideas is established incrementally by linking items. The semantics of a link are that the item at the tail should be presented before the item at the head. Links can be added or removed through item operations. Items will usually have one or more links to other items. In the early stage of ordering represented by the figure, *cooperative processes* comes before *busy signals* and *design evolution*. The order of *busy signals* and *design evolution* has yet to be specified.

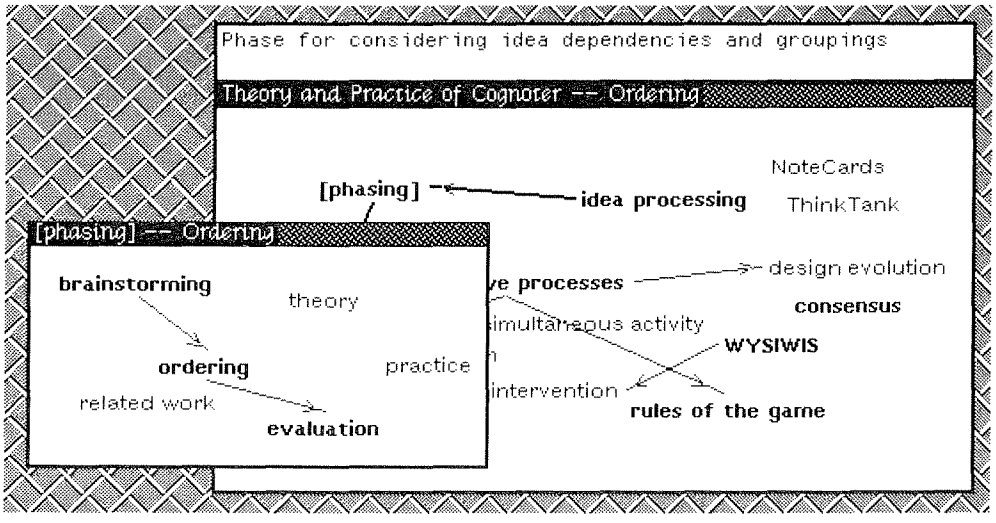

Figure 4. *Groups describe the hierarchy of ideas.* Items that should be taken together can be grouped. The items are replaced with a new item with brackets surrounding it to indicate that it is a complex item. Each group item has an associated window for displaying the items it contains. In the figure, *phasing* has been converted into a group item, *[phasing]*, and opened to show the partially ordered items it contains.

group item (surrounded by brackets). The items that were grouped can be displayed and manipulated by *opening* the group item. An opened item displays the contained sub-graph of items in a separate window. A link to or from a group item is treated like a link to or from the whole contained sub-graph. Items can be moved into across group window boundaries with links and display being adjusted accordingly.

Evaluation Stage. In the evaluation stage the final form of the presentation is determined. In this stage the participants prepare the complete organization of the paper or talk. Participants should review the overall structure, reorganizing the ideas as needed, filling in missing details, and putting aside peripheral and irrelevant ideas. Critical analysis, deletion, and outline generation are best considered after brainstorming and ordering are mainly complete.

There are several reasons to delay deletion until this stage. One reason to delay deletion is for the liberating effect on group idea generation. Criticism or deletion in the brainstorming stage tends to inhibit participation, since most people don't like to be criticized and will feel that they must generate arguments to defend their ideas henceforth. Another, related, reason is that arguing against (or for) ideas too soon will slow the generation process down. In the evaluation stage, however, arguing that an idea is tangential or insubstantial is likely to be productive since the Cognoter graph of ideas maintains focus on the session goal and most of the ideas are visible.

The evaluation stage is also a good time to consider re-organizations of various kinds because there is a more tangible basis for discussion. For instance, an argument than an item is in the wrong place is more compelling when other places for it are visible. An argument to delete an item because it is irrelevant is much more compelling when it is obviously not linked to the rest of the presentation. A claim that an item is too trivial is more convincing when competing items are right there displaying their virtues. A complaint that there are too many items is more convincing when all the items can be displayed. Most of the ordering operations are made based on local information. This stage, with the items essentially ordered, is a good time to consider the more global elements of the presentation: Is there the right amount of material in the introduction? Have key terms been defined? Is a glossary or appendix needed?

Cognoter provides a facility for systematically generating an outline (see Figure 5). Outline generation is delayed until this stage since it is not useful until the item ordering is largely complete. Items with no incoming links are potential starting points for the presentation. Cognoter can assist in the ordering process by focusing attention on ambiguously ordered (or unordered) items. The presentation graph can be displayed in outline format, with or without the attached text, by successively displaying and removing *beginning* items, items with no in-links Items with no outgoing links are potential endpoints for the presentation. Items with no links at all are probably irrelevant to the presentation.

Multi-user Interfaces

To make the shared database simultaneously accessible to all the members of a group, Cognoter provides a multi-user interface. The observations in this section and the next are drawn from several Cognoter sessions in the Colab meeting room at Xerox PARC, and a small set of controlled experiments done at Berkeley[1].

WYSIWIS Interfaces. Strict WYSIWIS (What You See Is What I See) demands that all screen images are exactly the same: all views are sized and placed identically and the images of all cursors are visible. The WYSIWIS ideal for multi-user interfaces must be addressed in a system, like Cognoter, that supports a multi-user interface.

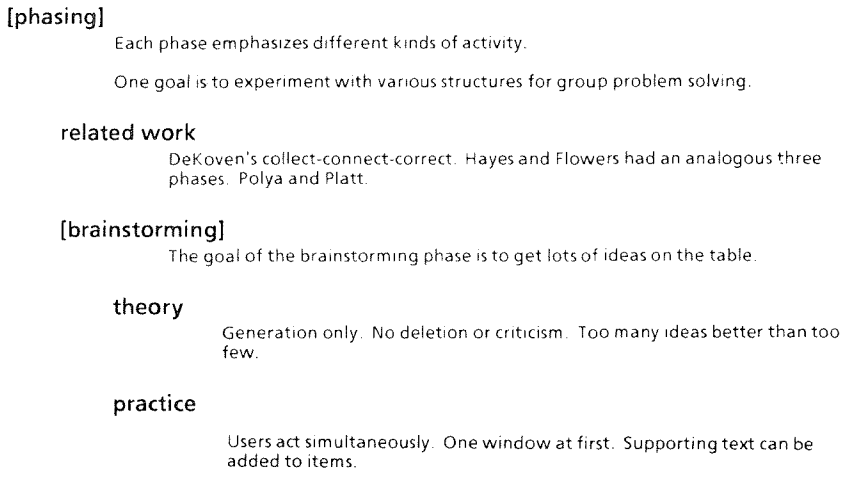

Figure 5. *A portion of a Cognoter Outline.* When desired, Cognoter will display an outline. The outline can be displayed for the whole presentation graph, without or without attached text, or for any subgraph. The figure shows a small part of an outline based on a slightly later version of the graph.

Elsewhere we address the general issue of WYSIWIS[7] and the need for relaxations in the next generation of meeting tools. Here we consider some of the simple ways that WYSIWIS is treated in the current version of Cognoter. Cognoter relaxes strict WYSIWIS because it provides both private and public display space. The Cognoter windows, those windows where the links and items are displayed, are public, but the outline display and item editing windows are private. Visual cues indicate whether a Cognoter window is public or private.

Even in a multi-user interface, it is important that users have a high degree of control of their displays. Cognoter provides private placement of public windows. This freedom of screen use comes at a WYSIWIS cost: users will not necessarily have the same views of the shared models. Participants can not refer to screen objects by absolute position.

Busy signals and Social Conventions. When more than one user is able to interact with shared objects, conflicts can occur. This is a key problem in the overall design of Colab, but largely avoided in Cognoter through the use of *busy signals.* Cognoter helps participants avoid conflict by signaling potential conflict (see Figure 2 above). Busy items are greyed-out in all views when being edited or moved or grouped. These busy signals do not make conflict impossible, but do make it largely avoidable, by relying on the participants to notice that an item is being changed.

In a face-to-face meeting social conventions come into play. While using Cognoter people can verbally gain exclusive access to a shared object, "I'm going to knock the introduction into shape", or suggest non-interfering subtasks: "Why don't you work on the conclusion." Cognoter is intended to support these kinds of behaviors (indeed, it depends on them in the current implementation of conflict avoidance). Another convention is semi-reserving the left side of the displays for private activity. This partially avoids the problem of remote competition for screen space.

Meeting Processes

As a meeting tool, Cognoter inevitably reflects a philosophy and model of meeting processes. By making some things explicit and ignoring others, meeting processes are inadvertently (or deliberately)

biased. For example, Cognoter users must take the stages into account: they can either follow the urged path or consciously react against it. On the other hand, Cognoter (for better or worse) is not involved in policing the technical level of the presentation — this must be worked out by the participants.

Parallelism and Equal Access. Cognoter users at personal workstations have the potential to simultaneously handle different parts of a task. For example, during the brainstorming stage, participants often add items simultaneously to the shared database (and all displays). In the ordering stage, participants frequently partition items into sets order the sets in parallel. In all stages, it is usual for participants add attached text to different items simultaneously.

In Cognoter sessions a characteristic pattern of activity occurs, especially in the ordering stage. Users interact verbally for a few minutes, discussing things and making short plans of action. This is followed by a period of intense individual interaction with the system. Gradually, over the course of minutes, the group tends to lose track of what the others were doing and the session returns to verbal interchange for summarization and focusing.

Incremental actions. The ability of a tool to support incremental progress is very important. It is key to the rapid and synergetic interactions. The parallel actions that we see in Cognoter are not at the grainsize of hours — they are the interactions that make up the give and take of participants in a rapid problem–solving context. Interactions range from a few seconds to a few minutes, and the shorter ones must happen quickly or they will slow down the meeting. Many small contributions and local decisions about idea ordering taken in sum constrain large scale organizational decisions. Large scale organizational decisions may turn out to be sufficiently constrained that they simply do not have to be made at all.

Consensus. Cognoter serves as a focus of attention and, since it supports only a single version of the idea organization it, perforce, maintains consensus. Consensus maintenance will not be the correct approach for all applications. Other applications may wish to delay consensus. For instance, *Argnoter*[8], a Colab tool under development for considering competing proposals, seeks to delay consensus to highlight the differences between several competing proposals.

The "Rules of the Game". People who agree to cooperatively solve a problem are likely to implicitly agree to the "rules of the game" — especially if they think that playing the game will help them work more effectively. Cognoter establishes a working framework both in the software and in the implicit or explicit rules of the game. In effect, it both carries and presupposes certain attitudes about the way that meetings are done. When tools like Cognoter become widely used, they may have an important effect on large organizations as carriers of problem–solving "culture".

Limitations of Cognoter. Some important parts of the group problem–solving process are not captured in Cognoter. For example, Cognoter has no representation of the goal for the presentation other than a title. On the flexibility side this is good, but it also allows the group to wander off the point. Cognoter does not handle a specification of the audience for the presentation. When using Cognoter participants get little help at keeping the technical or verbal level of the presentation at the appropriate level. The current version of the tool does not provide the ability to attach supporting arguments to links or deletions. We leave experimentation with these to future work.

Summary

Cognoter is a meeting tool that supports a group of people who are organizing ideas for presentation. It is the first computer-based meeting tool to be regularly used in the Colab. Experience with

Cognoter has helped us to better understand the design of multi-user tools and computer-supported meeting processes.

A key motivation for computer-supported meetings is the possibility of parallel activity by participants. To support this, Cognoter provides a multi-user interface which gives all participants equal and immediate access to the shared database of the meeting. Cognoter's interface is based on the WYSIWIS abstraction, which ideally enables all users to see the same written information and where other participants are pointing.

Computers, as an active medium, allow us to capture some aspects of the meeting process in the tools and to experiment with them. Cognoter has three stages that guide a presentation–planning meeting from the generation and articulation of ideas through an annotated outline of the presentation. At each stage of the meeting, progress towards the goal is achieved through small, incremental actions that ultimately lead to a complete ordering of the ideas to be presented.

The first generation of Cognoter is now finished and we have done some informal studies of its use. We are currently re-examining some of our assumptions in the design of the tool, its process, and its multi-user interface[7]. During the next part of our work, we will complete a set of facilities for meeting observation and analysis that will enable us to carry out more formal studies of Cognoter and other meeting tools.

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A GROUP DECISION SUPPORT SYSTEM FOR IDEA GENERATION AND ISSUE ANALYSIS IN ORGANIZATION PLANNING

by

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ABSTRACT

The increasing reliance on group decision-making in today's complex business environments and advances in microcomputer, telecommunications and graphic presentation technology have combined to create a growing interest in the design of group decision support systems (GDSS). Planning is an important group decision-making activity within organizations. Effective planning depends on the generation and analysis of innovative ideas. For this reason, the idea generation and management process has been chosen as the domain for the study of the design and implementation of a GDSS to support complex, unstructured group decision processes within organizations.

The MIS Planning and Decision Laboratory has been constructed to provide a research facility for the study of the planning and decision process while top executives from a variety of organizations use the laboratory to conduct actual planning sessions for their organization. This paper presents the design of a system to support the idea generation and analysis process in organization planning. Results of research conducted in the MIS Planning and Decision Laboratory on the use of the Electronic Brainstorming system with over 100 planners from a variety of organizations are presented and discussed.

The findings of the research indicate that computer brainstorming stimulates task oriented behavior, decreases group interactions and