

Visualizing the Decision-Making Process in a Face-to-Face Meeting

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Abstract

The decision making process is usually one of the most critical elements of any face-to-face meeting. Participants in a group meeting follow certain procedures and guidelines for facilitating the decision making process. These include such rules as turn taking, not interrupting the consultation, and keeping suggestions or ideas clear and concise. The ultimate objective of such meetings is to arrive at decisions in a timely manner by having a diversity of opinions from as many participants as possible. We postulate that by visualizing the group dynamics during a face-to-face meeting, administrators might be able to get a better handle on the strengths and weaknesses of the group's consultation process. The end result would be to improve the overall quality of meetings. We present a visualization tool that captures and reveals the ongoing social dynamics during the decision-making process within a face-to-face and real-time meeting. Our system captures the required data through a simple and easy-to-use interface and then visualizes the outcome of the meeting.

Keywords

Social visualization, group dynamics, turn-taking conversation, decision-making process, real time displays, computer-supported cooperative work (CSCW).

1. Introduction

Decision making is a complex social phenomenon. It is considered to be a cognitive process that helps members of a group choose an action among a set of alternatives and to ultimately arrive at a decision, typically referred to as "a final choice". Examples of making complex decisions can be apparent in many environments such as during board meetings of a corporation, a gathering of doctors before a complex surgery, and in meetings held by government officials. The complexity of the decision making process is a factor of the experience, the background and the number of participants. As the number of participants rises and as individuals differ in their opinions, making decisions can be a daunting task. They may have different viewpoints

and ideas about a common problem. For instance, imagine a scenario in which a group of board directors meet around a table to decide about hiring new employees for different departments of their company. Each member of the group would provide a different perspective from an economic, a social, or an administrative point of view. Furthermore, in a group setting it is possible that some individuals may influence others' decisions or votes while others may dominate the discussion.

Understanding the group interaction during a face-to-face meeting can enhance the quality and participant's experience during meetings. Usually, participants are unaware of their actions, even though subtle, and how these can impact the outcomes. For instance, it would be ideal if the manager or administrator of an organization were to look at reports of the collaboration, cooperation and consultation during meetings. The manager could identify such trends as "who has been the dominant character during most meetings?", "if a decision has reached, how long it has taken to make a decision?", "have participants built upon each other's suggestion, or have they mostly gone off tangent?", "how many topics were covered during the meetings?", etc. Based on such reports the administrators can introduce new policies, can educate the participants, and can facilitate more fluid interactions.

Visualization tools can support and facilitate the types of questions presented above. In a visual tool, details of the interactions among group members can be represented and captured. It can help the participants and meeting reviewers gain a better sense of the group's social milieu by portraying patterns (specially those that are unknown) that occurred during a meeting. In this paper, we present a visual representation that intends to capture all the communication and coordination incidents between group members during a decision making process in a face-to-face setting. The paper first presents literature related to online and face-to-face meetings, followed by an explanation on the two components of the system designed to capture the data necessary for the visualization as well as their data types. We describe the details of our visual depictions by means of a scenario.

2. Related Literature

A substantial body of research has been developed and devoted to the study of social communication in groups from various viewpoints such as sociology, computer-supported cooperative work (CSCW), human-computer interaction (HCI), and linguistics. The work being discussed here has been largely inspired by a number of existing social visualizations that fall under the category of online and face-to-face meetings.

2.1. Online Meetings

Online environments consist of any textual/audio/video communication or collaboration over computer networks such as chat programs, instant messaging, and email applications. Visualizing the interactions that take place in such an environment is not a trivial task both in terms of what to depict and how to depict it. However, several systems have successfully demonstrated the benefits of visualizing the dynamics of online meetings.

Coterie, *People-Garden*, and *Loom* [4] are three projects that use semantic information to visualize patterns in online conversations. These projects have different methods to visualize online users' interactions. *Coterie* visualizes an Internet Relay Chat (IRC) discussion. It provides a representation of both participants' activities and a structural analysis of their written conversation. It depicts users in a conversation as ovals with different colors where the ovals change in response to the users' dialogue. Also, it uses algorithms to support conversational unity by grouping messages by common content. *People-Garden* uses different mapping techniques to illustrate users' conversations. It uses flowers and petals to show participation activities on a message board. For instance, the height of the stem indicates user's involvement and number of the petals reflect the number of posting comments. *Loom* makes use of two visualization techniques to illustrate discussion in Usenet newsgroups. The system visualizes both newsgroup participants into groups based on their involvement in a topic and their conversational threads.

Threaded Text Chat [12] is another visualization that addresses some limitations of text chats by modeling the basic turn-taking structure of face-to-face conversations. The issues include scarcity of links between people and what they say, lack of listening-in-progress, lack of turns-in-progress, no control over turn positioning, and lack of useful recordings and social context. Threaded Chat presents all chat turns in the form of a tree similar to the way Microsoft Windows Explorer shows the file system on a hard disk. Moreover, it organizes turns into turn-and-response structures called threads that can be extended to any size. Results have shown that users quickly adapt to Threaded Chat in spite of giving lower preference rankings to it compared to standard chat systems. Furthermore, user

performance with Threaded Chat was as equally effective as standard chat.

Several studies have focused on designing an interface for very large-scale online conversations such as in email and Usenet newsgroups. *Conversation Map* [11] is an interface to browse and display both social and semantic networks of very large-scale online conversations. The *Conversation Thumbnail* [14] is an interface that employs a focus+context technique and a quick automatic search mechanism to explore very large-scale discussions. Initial studies have shown that it is faster than a standard web interface to navigate very large-scale conversations. *Conversation Space (ConverSpace)* [9] is a spatial representation of computer-mediated conversation that supports multithreaded discourse structure and improves oral conversations as well as oral traits of asynchronous text-based discourse. In *ConverSpace*, the authors [13] presented a set of visualizations to depict different patterns of activity and the structure of discussion threads in social cyberspaces such as Usenet newsgroups.

Babble [6] and subsequently *Loops* [5] were two other studies that were conducted to provide a historical visualization of text-based group conversation. These systems show users' presence and their activities, conversation topics, and conversation contexts in a categorical fashion. Although the systems present more information about group activities, they lack information abstraction.

2.2. Face-to-face Meetings

Face-to-face meetings require participants to meet in the same physical place. They differ from online meetings in that many non-verbal cues can be easily captured in such settings.

DiMicco, et al. [3] showed that presenting real-time displays of social information within a group influences the behavior of the group during a collaboration task so that over-talkative participants are encouraged to speak less and under-talkative participants to speak more. As result, it was found that the group can make more effective and higher-quality decisions. The interface in [3] is limited to some extent by primarily showing how much participants spoke during a meeting. Furthermore, it requires users to wear a microphone which may lead to unnatural tendencies during the meeting process. The conversation chain model [7] is a visualization system designed to show how students acquire an understanding of a particular subject. It achieves this goal by visualizing the classroom progress and the interactions between students and the teacher. The visualization illustrates the students' questions, responses, and interpretation as well as the quality of the discussion. Chen [1] also developed a multiparty videoconferencing system to visualize the interaction dynamics of a remote classroom. It automatically provides feedback if students are speaking, making gestures, or moving in their seats. Second Messenger [2] is a visualization system that

provides an automated method for reviewing the turn-taking patterns in a face-to-face meeting so that even non-participants can gain insight into the group interaction dynamics. The system provides four different depictions for ongoing participation levels, turn-taking patterns, overlapped speech, and floor control by collecting spoken timestamps. The results showed that users were able to recognize people's side and their extreme behavioral differences based only on the speaking patterns exhibited in a debate.

None of the above mentioned studies investigated the ability to visualize coherent group patterns in online and face-to-face meetings. We address this issue by presenting a visualization technique that uses several visual mappings to see and facilitate post-meeting analyses.

3. The Elements of a Face-to-face Meeting

We first present aspects of a face-to-face meeting that we felt were important to capture. Before a meeting begins, participants identify a chairperson (or chair). The chair is responsible for ensuring that the meeting proceeds fluidly and ensures that people talk in turn and stay on the topic. The chair is also responsible for ensuring that items on the meeting agenda are attended to. Moreover, every meeting has a secretary to keep the records of the meeting including the meeting's agenda(s), the people who were present or absent, and the content of their consultation and input. Usually the secretary of the meeting records decisions and actions that need to be carried out as a result of the meeting. After starting the meeting, with the permission from the chairman, participants express their ideas about the desired agenda as well as their positions. They consult by showing agreement, disagreement or naturalness to a topic. During the consultation period members can maintain their positions or can express new ideas based on what is learned from others. At the end of the consultation period for a particular agenda item, a group decision is made by a vote. However, in some circumstances, a definite decision can not be made and it can be deferred to the next meeting.

4. Visual Mapping Strategy

To come up with a visual representation we based our design on Mackinlay's [8] perceptual ranking matrix. This assisted us in the design of the system and mappings explained in Section 4. Mackinlay categorizes the visual mapping matrix based on the underlying type of the data - quantitative, ordinal or nominal. Figure 1 summarizes the ranking of perceptual tasks for each type of data.

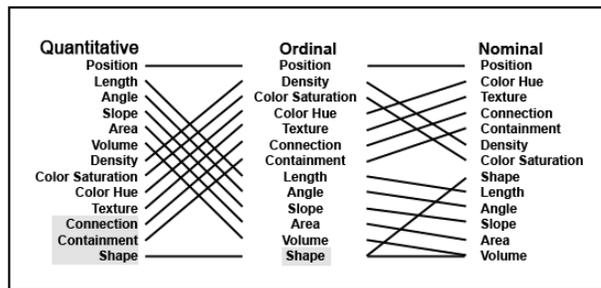


Figure 1: The rank of perceptual tasks. (adopted from [8]).

We selected eleven variables to visualize in our system; we categorize these variables based on the effectiveness ranking chart of Mackinlay [8]. These variables are described as follows and their mappings to visual attributes are provided in Table 1.

- *Individual attendance*: did an individual attend the meeting?
- *Individual activities*: was the individual speaking, listening, or interrupting?
- *Individual decision*: did the individual agree, disagree or abstain.
- *Group decision*: did the group agree, disagree or defer the topic.
- *Agenda*: a specific topic to be discussed.
- *Number of participants*: number of people present or absent.
- *Chairperson*: the person selected to coordinate the meeting.
- *Duration of topic consultation*: how long it took a participant to discuss the issue.

Variable name	Variable type			Variable map
	Q	O	N	
Individual Attendance		√		Color
Individual activities			√	Color
Individual decision		√		Color
Group decision		√		Color + texture
Agenda		√		Position + texture
Participants	√			Position
Chairperson	√			Color
Duration	√			Position

Table 1: The category of variables we used in both components based on the Mackinlay's approach [8]

5. Capturing Required Data

In order to capture data with our system, we designed two components. The first interface is used for creating the particulars of the meeting. The second interface is used for

capturing the specifics encountered during the meeting. The system's user, in this case is the secretary who is required to capture the data required for these two interfaces. The first interface contains three data sets which are the meeting information, the meeting agenda item(s), and meeting participants. Meeting information includes general data about the meeting such as the name, date, and location of the meeting. The second data set contains the meeting agenda item(s) that need to be discussed. The third set of data is the meeting participants. This data set has a checkbox for each participant (in this example there are ten participants, so ten checkboxes), who attends the meeting and a combo box to choose a chairperson for the meeting who ensures that the meeting is moving smoothly. In addition, there is a list provided for any external participants that can join the meeting on an ad-hoc basis. Figure 2 shows our first interface with its data sets that must be completed before going to the next interface.

The second interface is filled out from the moment the meeting starts to its end. It contains the information captured under the following sets:

- *Meeting trend:* the system enables the user (in our case the secretary) to identify all the meeting activities within a series of time slots. For instance, “who is talking now?”, “who is waiting?” and so on. If a person is talking the button listed under “Speak” beside the participant is pressed. This captures in the system the time the person is talking. If another person speaks instead their respective button is pressed and the system captures the data from that point onward.
- *Meeting agenda:* the buttons for the meeting agenda allow the user to navigate and select one of the items listed for the meeting agendas, as entered initially in the first interface.
- *Participants' attendance:* check boxes allow updating the attendance of a participant. If any of the participants who have attended the discussion of the topic leaves before the meeting has ended, the user can record that through the interface. Subsequently, if they re-enter the meeting the secretary recording the data can reselect the check box.
- *Individual decision for each agenda item:* by pressing on the “Vote” button, the systems opens a new panel (Figure 4) that can facilitate entering the decision of each individual.
- *Group decision for each agenda item:* by pressing on one of three buttons in the section labeled “Group Decision”, the system can record whether the group agreed, disagreed or deferred the topic of discussion.
- *Timeline scale:* the system gives the ability to change the time slots for the meeting in each item agenda to present more details.

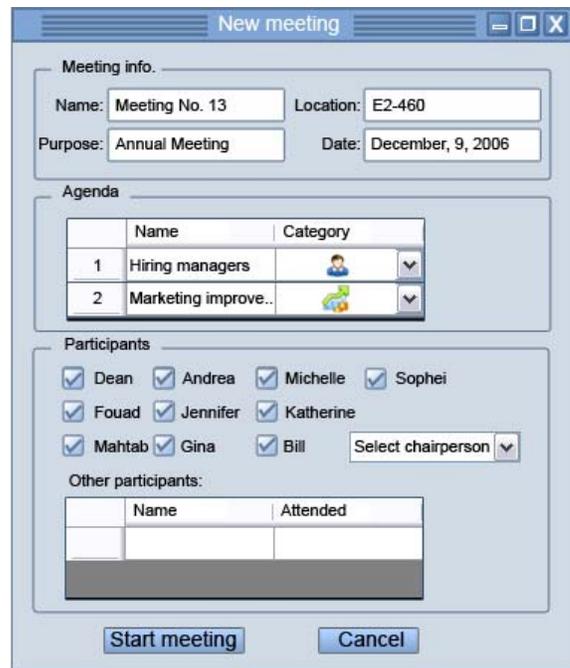


Figure 2: The first interface to capture the data before the start of a meeting.

Figure 3 demonstrates our second interface in order to record the activities done during a meeting.



Figure 3: The second interface designed to record the data during a meeting. After clicking the Vote button the interface will change to capture individuals' decisions as shown in Figure 4.

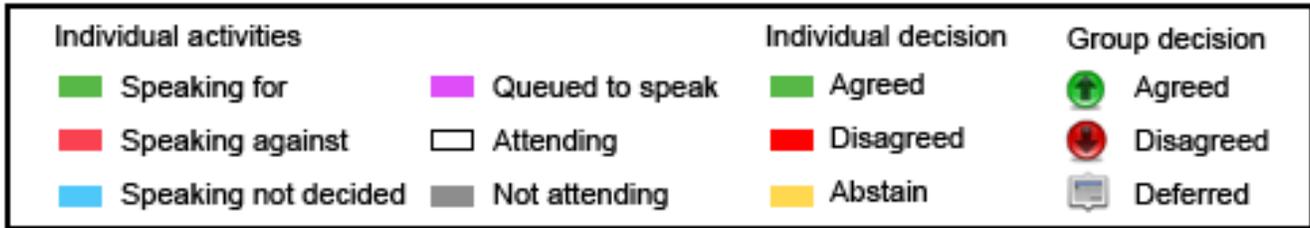


Figure 5: Our designed mapping technique for the visualization group decision making.



Figure 4: User, secretary, select individuals' decisions by choose their positions in regarding to each agenda.

- The group decision for each agenda item. This is the overall result of the vote on each agenda item: agree, disagree, or deferred.
- Hidden activities such as collaboration among some participants in changing the final decision.

In the visualization graph, we have different data values including numerical and categorical data such as the topics on the meeting agenda, the names and number of participants in attendance, the time taken for each agenda item, the total meeting time, the designated chairperson, and individual activities of the participants.

We use three visual marks: position, shape, and color. Position is used for showing the time on an axis. The agenda items are shown using a glyph or shape. Color is used for showing the type of participant activity (attending/not attending, speaking for/against/not decided, waiting to speak) and the outcome of individual decisions (Agreed, Disagreed, Abstain). Figure 5 presents these mappings for our visualization.

6. Visualizing the Decision Making Process

After inserting data through the data recording component, the system finally provides a visualization interface of the group decision making process. It uses a three dimensional graph to present the following data:

- The overall meeting time.
- The time taken to complete each agenda item.
- A description of the different meeting agenda items.
- The meeting participants.
- The participants who missed the meeting.
- The chairperson for the meeting.
- Individual activities:
 1. Who was speaking about the topic with an opinion for, against or undecided about it.
 2. Who was waiting to speak.
 3. Who spoke the most time during the discussion.
 4. Who was active in the discussion.
 5. The trend of the decision making process (i.e. whether participants built on each other's suggestion, or they mostly went off tangent).
- The individual decision of each participant who voted.
- The total number of participants who agreed, disagreed, or abstained from the vote.

7. Scenario

We demonstrate the visualization of a group decision making process using a scenario. Acme Co. is a company with a board of directors who are meeting to make a number of decisions regarding the company. Sometimes other directors from a third party affiliation attend Acme's meetings. On one particular meeting, the topics for discussion on the meeting agenda are:

- Hiring managers for new departments
- Issuing additional common shares for the company
- Improving marketing efforts
- The production process for Widget products
- The establishment of a new corporation
- Approval of new policies recently proposed

There are ten board directors who are expected to attend the meeting and no individuals from third parties. The attendees are Dean (designated as the Chairperson), Fouad, Mahtab, Andrea, Jennifer, Gina, Michelle, Katherine, Bill and Sophei. A secretary is responsible for monitoring and observing the meeting's activities. The activities are recorded on a Tablet PC operated by a stylus using an application that executes our proposed meeting recording component. Before starting the meeting, the secretary

creates a new meeting profile in the system by filling out the following meeting information (shown in Figure 2):

Name: Meeting No. 13
Date: December, 9, 2006
Location: E2-460
Purpose: Annual Meeting

Six meeting agenda items are entered. An identifying symbol is chosen for each agenda item. The symbol is used to help maximize the space available for summarizing and presenting visual information about the meeting after it is completed. The names for all expected participants are selected and Dean is chosen as the chair. When the meeting starts, the secretary clicks on the *Start Meeting* button. This sets in motion the capturing of the dynamics of the meeting in the Discussion recording system interface (shown in Figure 3).

As the meeting is taking place, the secretary uses the column of check boxes and buttons on the left hand side of the Discussion recording system interface (see Figure 3) to keep track of who is attending, who is speaking and who is waiting to speak. On the right hand side, the interface scrolls horizontally through the seconds of the meeting, recording the current status of the meeting using colored blocks.

By default, the Discussion recording system records a white block for each second each participant attends the meeting. When a participant leaves, the secretary removes their checkmark from the Attend column. The Discussion recording system records a grey box (indicating "Not attending") for each second the participant is not present for the meeting.

When a participant speaks (whether or not they were permitted to at that time) the secretary presses their Speak button and by default the Discussion recording system records a light blue color indicating an initial status of "Not decided" for the opinion of the speaker. The secretary listens as the speaker continues and determines if they are expressing an opinion for, against or not decided about the topic being discussed. The *Speaking* box (shown on the right hand side of Figure 3) overlaid on the scrolling view of the meeting status permits the secretary to select an appropriate color (green, red or light blue) for the colored block that characterizes the opinion (for, against, or not decided, respectively) the speaker is presenting. When a participant indicates a desire to speak (either by raising their hand or through some other gesture), the secretary chooses their Wait button. The Discussion recording system records a purple block each second for the duration of the period the participant waits before being given the opportunity to speak.

At a certain point in the discussion of an agenda item the chair typically determines that it is time to vote on the matter. At this time, the secretary presses the *Vote* button on the Discussion recording system. The timing stops and a set of buttons for recording the individual decisions for each meeting participant opens on the right hand side of the Discussion recording system screen as shown in

Figure 4. As each participant indicates their individual decision related to the agenda item being voted on, the secretary records it by pressing their corresponding *Agreed*, *Disagreed* or *Abstain* button. The secretary presses the corresponding *Agreed*, *Disagreed* or *Deferred* button to record the group decision resulting from the vote after all participant responses have been tallied. The secretary continues to the next item in the meeting agenda by pressing the Next button and a new iteration of recording the discussion is started again.

The discussion recording/voting process continues until all the items on the agenda have been discussed and voted on. At the end of the meeting, the secretary presses the *View Result* button to see a detailed visualization of the meeting discussion and vote results as shown in Figure 6. Many different characteristics of the discussion can be observed from the results shown:

The Widget production process agenda item elicited discussion from many participants. Sophie was the first person to speak, followed by Bill and Michelle. During the discussion, Katherine waited to talk after Gina, but ended up getting interrupted by Bill and Michelle (who spoke out of turn) before she had an opportunity to speak. Although the discussion was short (only about 600 seconds or 10 minutes), there was much discussion. Some of the discussion was not decided, while a few participants were decidedly speaking for or against the topic. In the vote at the end of the discussion seven participants disagreed, two were undecided, and one agreed. The overall group decision for this agenda item was disagreed as shown by the down pointing arrow in the red circle. The New policies and Marketing improvements agenda items also yielded disagreed vote outcomes. The New corporation establishment and Hiring managers agenda items were agreed. The Share issue agenda item was deferred to a later date.

In each of the six agenda items, the secretary checked the presence of the participants. For example, Katherine was absent during the discussion related to the Hiring managers agenda item. She was present during the discussion of the other items on the agenda.

Some additional overall characteristics of the meeting discussion can be observed in Figure 6:

- The longest discussions were for Marketing improvements and Hiring managers (each lasting 1080 seconds or 18 minutes long), followed by New policies then New corporation establishment. The least time consuming topics were Share issue and Widget production process (both 10 minutes each).
- In each agenda item, we can observe who took up most of the discussion time. For example, the dominant character who contributed most on the Marketing improvement agenda item was Fouad, followed by Dean. This is shown in Figure 7.
- Waiting queues and their sizes can be easily recognized through the graph at any given point in

time. For instance, the biggest waiting queue belonged to the agenda item Marketing improvements. Here three participants waited to speak. The longest wait was for Katherine who waited over half of the duration of the entire meeting to speak.

- We can also infer certain patterns of collaboration. For instance we observe that by looking at the two agenda items of improving marketing efforts and issuing more shares, one can recognize that there is collaboration between four people (Bill, Katherine, and Michelle, and Gina) who lean on the same side of the decision.
- Additionally one can observe that for certain agenda items, several back-and-forth discussions were taking place. For instance, the topic of widget production generated a lot of discussion from participants. This also happens to be one of the shorter agenda items, and one can possibly watch for the repetition of such a pattern and induce that as a lot of discussion gets generated participants are able to arrive at decisions more rapidly.

8. Conclusions and Future Research

Showing all the details that occur in the decision making process of a face-to-face meeting can be helpful in reviewing the structure of a meeting and potentially improving its quality. In this paper, we presented a visualization system that addresses the issue by displaying information that assists the group in reflecting upon its current and past interactions. The system provides two major components; to capture data from the user before a meeting starts and then to visualize the process while the meeting goes on or after the meeting has ended. We also used a sample scenario to illustrate how our system operates. Due to the exploratory nature of the proposed system, a full evaluation with respect to factors like applicability in real group settings or usability has not been conducted. Nonetheless, the practicality and value of the approach can be demonstrated by looking at the results one could capture with prearranged scenarios. This work makes a contribution towards information visualization by developing a system that has the potential of improving the group decision making process.

In the near future, we are developing a fully functional system and will evaluate it in actual face-to-face meetings. Moreover, we intend on looking at other areas of application such as displaying communication processes in parallel computing and/or telephone networks.

It is our intention to move towards supporting visualization in the context of more formal meeting procedures. This will involve a more detailed analysis of meeting dynamics, especially as they relate to formal meeting such as those outlined in [10].

Acknowledgements

<omitted for review>

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Meeting name: Meeting No.13, Date: December, 9th, 2006, Location: E2-460, Purpose: Annual meeting

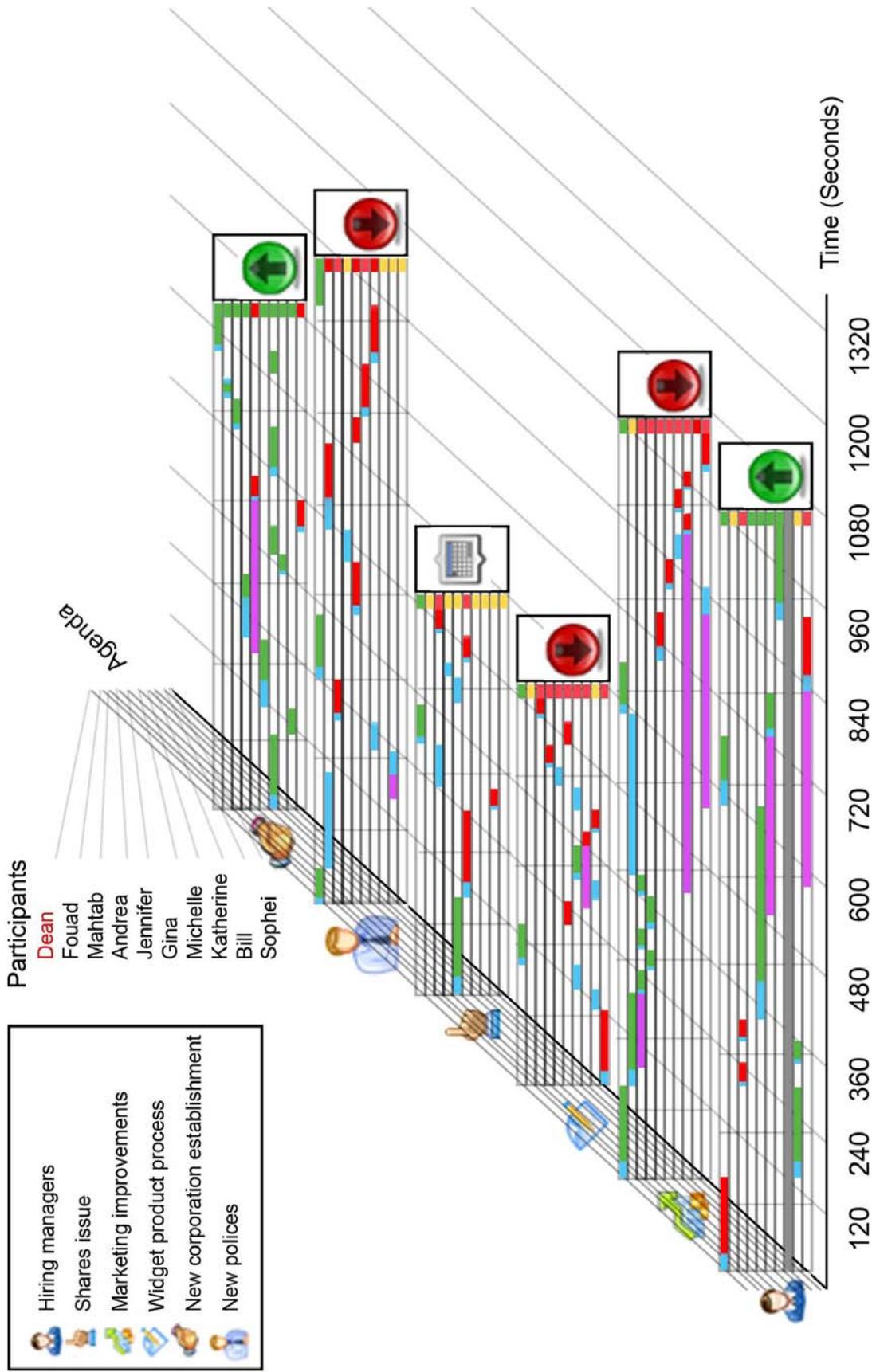


Figure 6: The visualization interface for the sample scenario.

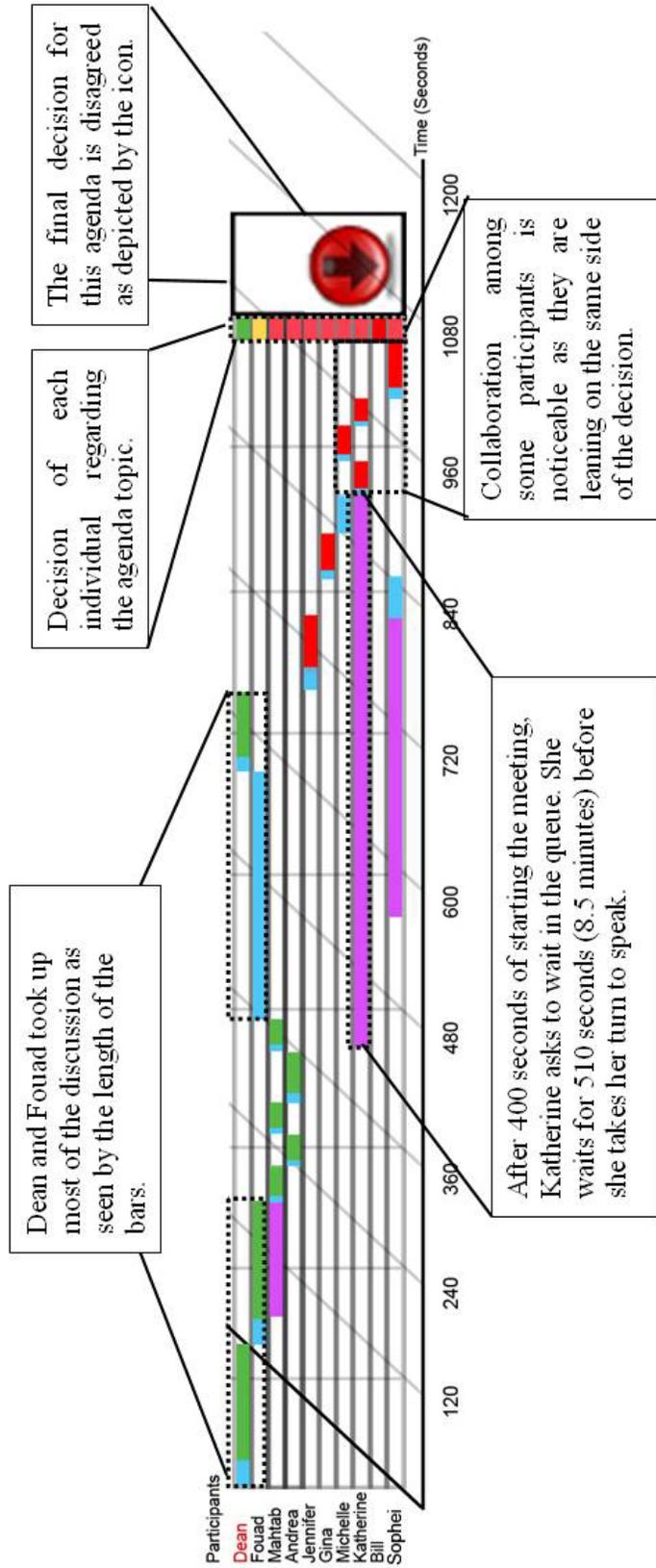


Figure 7: Zoomed segment for one of the meeting agendas from the visualization interface. Information and patterns can be obtained from the graph as explained.