Structuring Elements for Group Interaction

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Abstract

This paper describes a computer-based synchronous tool that implements the Nominal Group Technique, a structured behavioral science technique for group generation of ideas and consensus forming. The generic problem addressed is the mapping between the processes and objects defined by a decision technique and their counterpart in the computer support. The structuring elements of the tool are a set of objects named teleassistants, which are based on an extension of the notion of telepointers that guide users in managing group information, interaction and coordination.

1 Introduction

The use of computer-based tools for improving the effectiveness of organizational activities presents a large spectrum of intervention ranging from the automation of administrative processes to communication, decision and negotiation. With the purpose of providing integrated computer support for organizational processes, be they formal or informal, our domain of interest falls under the category of group decision support systems [19], as a class of tools that implement behavioral science techniques in a computer platform [2].

From the design's viewpoint, while some approaches to group decision support systems focus more on asynchronous operations, others have addressed the problem of synchronous operation [26]. Of the later, some systems are oriented to the high bandwidth range of applications, basing their functionality on the use of continuous media like audio- or teleconferencing systems. We are particularly interested in the support for synchronous operation over large scale networks. This environment stresses the relevance of compact and synthetic textual and graphical communication.

The generic problem addressed in this paper is the mapping between the processes and objects defined by a particular decision technique and their counterpart in the computer application that supports the technique. This mapping has to satisfy two categories of requirements: the first is to adequately express the objects and behaviors perceived by participants in natural (non-computer supported) settings; the second is to effectively embed the meta-processes like concurrency control, sharing or visibility.

The paper describes the design and implementation of a technique called Nominal Group Technique, which has a clearly defined structure. The design is centered around the notion of teleassistants, interactive objects that implement the above mapping.

The remainder of this introduction presents the Nominal Group Technique. The next section lists constraints and requirements that have to be met by a computer implementation of such a technique. The tool itself, NGTool is described in the following section, including the basic functionality, interface decisions, role of the teleassistants as structuring elements, and the group processes that are involved. A comparison with a natural meeting is then presented, and highlights some of the open issues. A reference is also made to the underlying support of the tool. Finally, conclusions are presented.

1.1 The Nominal Group Technique

The NGT is a special-purpose behavioral science technique that is adequate to situations where individual ideas and judgments need to be tapped but where a group consensus is the desired outcome [34]. Other characteristics include: single problem, structured approach, limited argumentation, limited conflicts [16]. The technique per se does not involve any computer support. The NGT meetings have the following steps:

- Introduction of the meeting (by the moderator).

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- Individual and silent generation of written ideas.
- Round-robin feedback of ideas, which means going around the table asking for one idea from one member at a time, and writing it on a flip chart.
- Group clarification of each recorded idea.
- Individual voting on ideas.
- Discussion of results.

2 Constraints and requirements

2.1 Social and organizational issues

Group processes involve many organizational and social variables which condition the success of any supporting technology. Group structure, size, roles, goals, individual conflicts and motivations are examples of such variables [27].

We assume several premises concerning group nature and stimulus. The members must have a common concern, be committed to work and willing to cooperate. We also restrict the technique to a small number of participants (4 or 5). The intention is to avoid dealing with the complexity of providing technology for insidious people, conflict resolution and bargaining processes [23, 38, 1, 3].

The problems posed by the oversimplification of social and organizational aspects can be mitigated either through a moderator/facilitator [7, 13, 25, 37] or with specific techniques, some of them used by the NGT: allow members to disagree without argumentation, democratic access to the medium or avoid verbal exchanges.

2.2 Technological issues

The role of technology in group processes presents many positive aspects. For example, technology can bring more individual knowledge to the group discussions by supporting knowledge sharing, representation and visualization tools [22, 33, 30]; levels of participation are enhanced with contributions from members located in different sites of the organization; and organizational memory can be augmented with more relevant data: issues, comments, votes, decisions [8].

However, current technologies face important problems to support distributed cooperations. The cultural familiarities of face-to-face meetings should be kept to remote members [18] but are challenged by the low throughput and long feedback delays of current networks [30]. The articulation of cooperative work and sharing of information space also poses important user-interface issues [4].

As pointed out in [25], the effects introduced by the media in the group processes are not only related with the problems posed by the reduced bandwidth compared with the possibilities of a face-to-face environment but do also reflect different modes of communication promoted exactly by the limitations of the media. Our purposes are positioned in this track. More specifically, the intention is to search for computer-based techniques that improve users' awareness of cooperative tasks.

3 The NGTool

The functionality of the non-computerized NGT has been briefly described. We then presented a set of general constraints and requirements that must be considered when designing computer support for this and other techniques. This section describes the NGTool, its basic implementation decisions and the developed cooperative techniques.

We discriminate two different types of users, the participants in the decision/negotiation meeting and the moderator of the meeting. From the design and implementation standpoint, the moderator is only a privileged user of the NGTool that, nevertheless, interacts with the tool in the same way as the participants.

The NGT requires the support to both shared and private spaces [32, 35, 36]. For instance, the generation of ideas is a private task while the round-robin proposal is a public task. We adopted a very simple solution to this problem based on dividing the whole surface of the tool in a small private space on the left and a shared space on the right.

Figure 1: The items manipulated by the NGTool.

We have also identified the objects that must be manipulated by the tool. According to our view of the NGT, the participants generate *Ideas*, *Comments* and *Votes* during the group process. The moderator attaches *Clarifications* and *Scores* to Ideas. The Clarifi-

cations and Scores are assembled from Comments and Votes, respectively. All these objects will be named *items* and are depicted in figure 1.

The reader will find similarities between the NGTool and some graph editing tools [5]. The approach is intentional and derives from our observation that graph editing tools:

- Offer a way to structure information
- Provide simple techniques for the generation of associations between data elements
- Allow direct manipulation
- Data elements can have a variety of graphical and textual representations
- It is possible to introduce multiuser input consistency at the representation level rather than at the lower graphical level

Any item is organized on the tool with hyperlinks and represented by an icon and a data element. The icons are kept visually consistent in the shared space (strict WYSIWIS [35, 14]) but the data elements may be freely and privately opened and closed by any participant without interfering with the other participants (relaxed WYSIWIS [12, 6]). The strategy is to maintain only a minimum consistency and preserve shared space. Users see the same items in the same locations of the shared space but they manipulate individually these items.

The items are located in the shared and private spaces according to their context. Comments and Votes are private while Clarifications and Scores appear in the shared space. Ideas may appear in both private or shared spaces but the later result from the round-robin proposal of ideas.

Additionally to items, the other objects present in the NGTool are the teleassistants, which will be described next.

3.1 The teleassistants

The semantics of the NGTool is structured with a set of objects designated as *teleassistants*. The teleassistants break down group interaction and coordination into light composite processes and simplify and guide the creation and manipulation of items.

The teleassistants are based on an extension of the notion of telepointer [11, 28]. The telepointer allows to point at information under discussion on a shared space and develop meta-discussions [11]. The

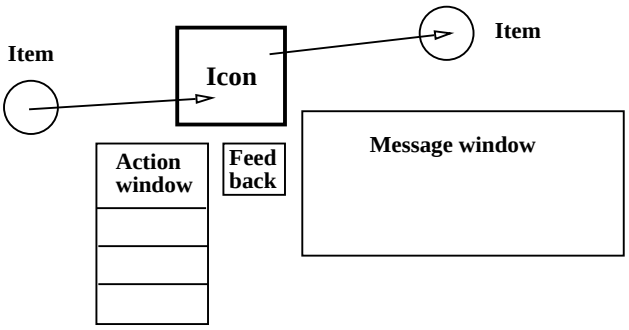

Figure 2: The teleassistant.

basic characteristic of the telepointer is that its positions and movements are equally seen by all the users (WYSIWIS). In several systems there is only one telepointer available. This is intended to avoid the annoying effect of seeing too many pointers moving simultaneously on the shared space [24]. The access to the telepointer is moderated by a concurrency control mechanism.

A teleassistant draws from the above functionalities of the telepointer and extends its functionality in several ways. See figure 2 and explanation below.

Teleassistants have types Each teleassistant has a specific type which is identified by a particular icon. Several operations can be requested to the teleassistants using associated popup action windows.

Teleassistants can be public or private Public teleassistants manage the interactions with the group. They also handle concurrency control and manipulate public items. On the contrary, private teleassistants manage interactions with one single user, manipulate private items and do not have a concurrency control

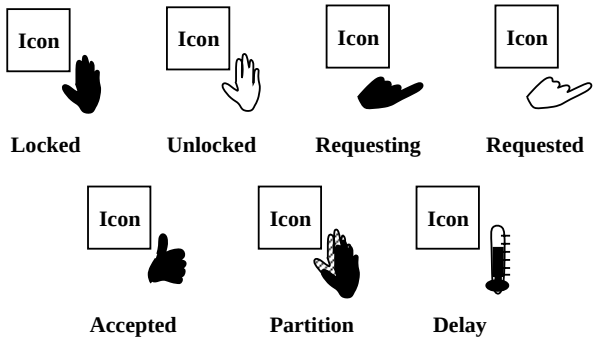

Figure 3: Expanded feedback provided by teleassistants.

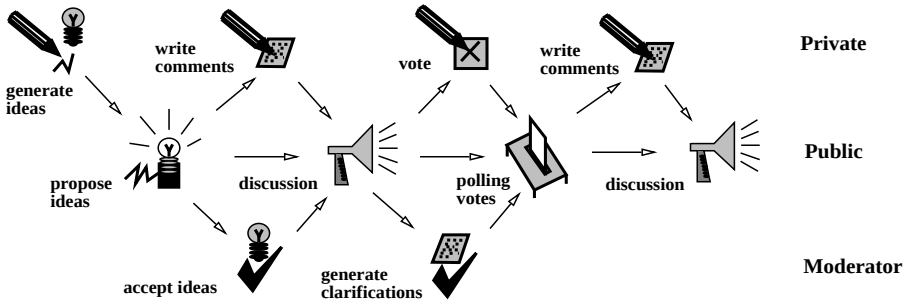

Figure 4: Group process.

mechanism.

Teleassistants allow more complex interactions with the user Besides positioning, movement and concurrency control, which are handled by telepointers, the teleassistants also allow item creation, acquisition and display. This type of interaction is performed by linking the teleassistant to an empty space (creation) or linking one item to the teleassistant (acquisition and display).

Teleassistants have associated popup message windows These windows are used for communication with the group, if the teleassistant is in the shared space, or with the user if in the private space. The public teleassistants manage window popups and popdowns and maintain a consistent view among the several users.

Usually, the message displayed in the window is acquired from an item in the way previously described. While the message window allows for user editing, we currently do not use this functionality in most of public teleassistants, since during extended editing the teleassistant remains locked by an user. It is better to do any user inputs into a private item, using a private teleassistant, and only afterwards request to lock the public teleassistant which is then used for displaying only.

Teleassistants provide expanded feedback to users The public teleassistants do not only provide information from users but also information about users' activities. More specifically, teleassistants provide feedback on concurrency control operations, making users aware of locks, unlocks, lock requests and acceptances [9]. They also provide feedback about unreachable users (due to network partitions [29]) and temporary inconsistencies of the shared space due to communications delays. The feedback information appears just under the item's icon, as shown in figure 2. An example of how this information is presented in the NGTool is shown in figure 3.

3.2 Group process

The group process is structured by the coordination of public and private teleassistants according to the rules of the NGT.

We identify several sub-processes in the technique. Four of them develop in public: round-robin proposal of ideas, discussion for clarification, polling of votes and final discussion. There are other four sub-processes which are private to each participant: silent generation of ideas, comment writing, voting, and final comment writing [1]. Finally, two other sub-processes are run privately by the moderator: acceptance of ideas and generation of clarifications [2].

For each sub-process, the teleassistants will assume a particular identity. The sequencing of sub-processes is illustrated in figure 4.

We will now describe the use and coordination of teleassistants in the NGTool.

Idea generation Each participant will see a teleassistant in the private space for generating ideas (pencil and lamp shown in figure 5). As described previously, an Idea is created by a link movement out of the teleassistant into the private space. After creating the item (small lamp), the participant can describe the idea by writing down some few lines of text in the associated

[1] Comment writing is inherent to our computer version of the NGT and not to the technique itself.

[2] During the NGT session the moderator needs to address sporadic comments to the group, at the introduction, when announcing new public sub-processes, helping or guiding the group. To execute these tasks, the moderator uses a public teleassistant and its corresponding message window. This functionality was not included in the tool description.

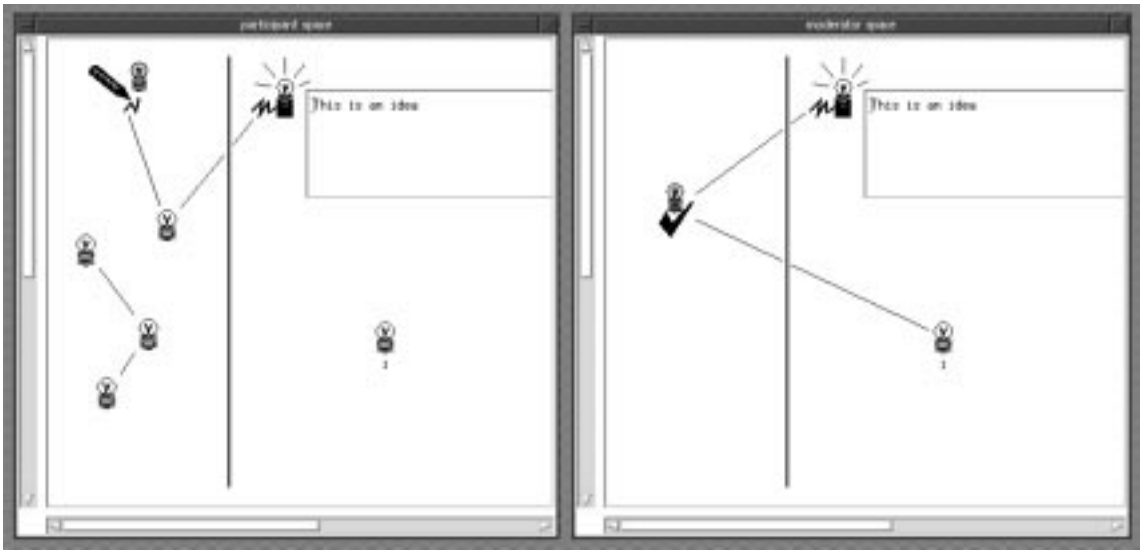

Figure 5: Idea generation (participant on the left and moderator on the right).

Figure 6: Concurrency control (request on the left and accept on the right).

data element. As in a graph editor, the participant can link and move the items freely within the private space.

According to the NGT, participants have approximately 15 minutes for private creation of ideas. Afterwards, the moderator announces the beginning of round-robin idea proposals and one public teleassistant appears on the shared space for accepting idea proposals (lamp switched on). The participants can then select some of their private ideas to be exposed to the group. A participant links one Idea from the private space to the public teleassistant. If the teleassistant is locked by other participant, a "requesting" symbol is fed back to the requester (see Figures 3 and 6). The locker will see a "requested" symbol. When the requesting participant gains the lock, the linked Idea is acquired and displayed to the group in the teleassistant's message window. The lock is automatically released by the system after a time sufficient for reception and reading by all users.

Notice that the idea is only made public to the group. It is a task of the moderator to pick the idea, re-phrase it if needed, and place it on the shared space, as in the natural setting. The ideas are automatically numbered by order of proposal.

The spatial and hierarchical organization of ideas in the shared space is a role of the moderator (although the participants can make comments about this issue).

Discussing ideas After finishing the round-robin proposal of ideas, the moderator switches to discussion of ideas and clarification.

The private creation of Comments and the act of turning them public are handled similarly to the operations described previously. In order to allow to associate a comment to an idea, it is also possible to create a comment by linking a public Idea to the private assistant. When the comment is made public, it will be displayed linked to the idea (see figure 7).

If the moderator gives relevance to the comment, he/she will acquire the text into a clarification. There

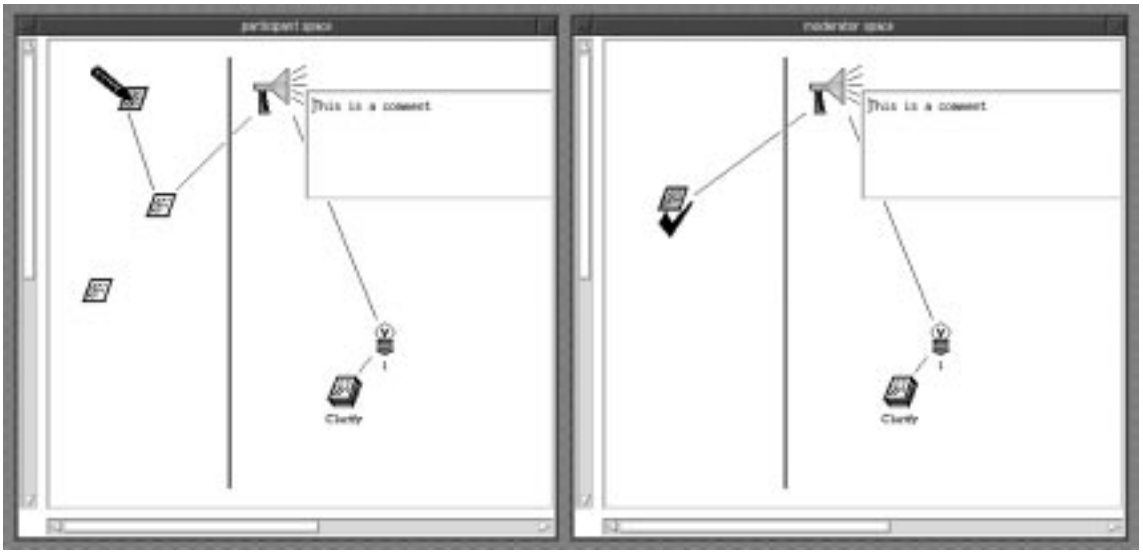

Figure 7: Discussing ideas (participant on the left and moderator on the right).

is only one Clarification item per Idea. However, this item collects information from several comments.

Voting on ideas The next step to discussion is voting on ideas. Therefore, voting teleassistants are shown in the participants' private spaces and one public polling teleassistant appears in the shared space. As expected, votes are associated to ideas. Therefore, they are created by linking an Idea from the shared space to the voting teleassistant which is available in the private space. Then, the private teleassistant generates a Vote item. The participant must fill-in the item's data element (figure 8).

The polling teleassistant is dedicated to deliver votes. The teleassistant must identify the ideas being voted and organize them in the corresponding Score item. This task is automated by the tool.

Final discussion The final discussion is, in terms of functionality, analogous to the discussion of ideas which has been previously described. In this stage the moderator may need to modify the structure of ideas in the shared space, such that the group's view on their importance is reflected.

4 Comparison with the non-computerized meeting

We identify two major areas of concern when comparing the NGTool with the non computerized version:

Communication The NGTool does not provide face-to-face interactions neither video or audio counterparts. One question that is relevant is whether these characteristics are fundamental to the success of the NGT. From our point of view, the technique does not allow for extensive interactions. As said in [16], the term "nominal" means silent and independent. Ideas are created silently and limited to some few words, round-robin idea proposals are not discussed, only clarifications and final discussion require more interaction. Even then, the avoidance of conflicts and a strong control from the moderator are of major concern. The result is that the technique is not affected by the limited communication facilities offered by the tool but better writing abilities are required from the participants.

The teleassistants play a most important role as technological interfaces for users' communications. From our point of view, there is a perceptive gain in associating the written messages with positions, movements, concurrency control and feedback on communications delays such that improved awareness, both from users and from the system about users' activities, is provided to users.

We expect to find the effects of depersonalization on the group development [25]. However, the limited opportunities for conflict plus the reduced number of participants contribute to reduce its effects. The depersonalization can also be avoided in the near future by improving the teleassistants. For instance, public teleassistants can be personalized in order to identify their users. Other relevant issues, like anonymity

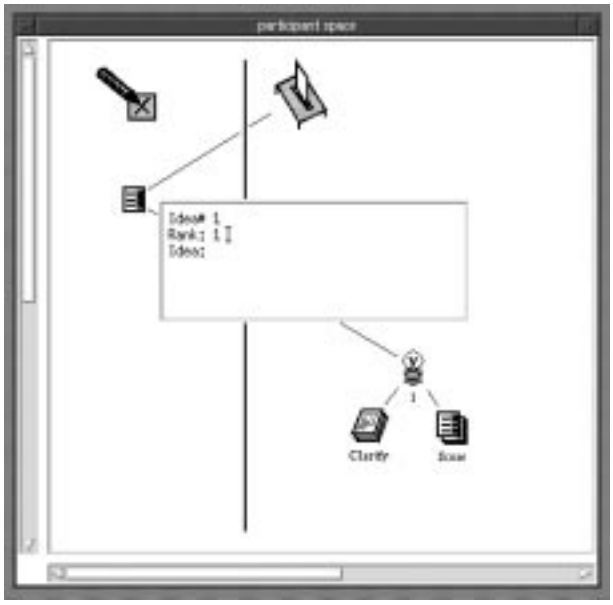

Figure 8: Voting ideas (participant's window).

[21], seamless collaboration [17] or spontaneous interactions [20] will be studied in the future.

Structure The NGTool does not follow the flip chart of the NGT as described by [34]. The ideas are organized in a way that is more adapted to computer displays. The moderator has more flexibility for organizing ideas. The participants can profit from a more rational and compact structure.

The way participants work is changed. The usage of teleassistants is more demanding than the paper and pencil version. As [15] indicates, it is necessary to avoid disparity in work and benefit for this kind of tools to succeed. We believe that by using teleassistants, which provide better feedback and automate some cooperative tasks, we are giving benefits to users.

The group process in the NGTool is less open to initiatives that fall out of the guidelines. For instance, it is not clear how the tool may support development of plans in the final discussion. One possible solution, which will be tested in practice, is to release control from the moderator in the final discussion and allow participants to directly create and manipulate Comments on the shared space.

5 Underlying support

The NGTool is a replicated application based on a group management platform which provides wide area group communication protocols and replication management [9, 10, 31]. This platform has been extended in several directions, in a joint effort that uses the NGTool as a basis to essay and demonstrate innovative solutions for synchronous cooperations over wide area networks.

Due to the limitations in current networks (long delays, limited bandwidth, failures) synchronous cooperations require extensive awareness of network conditions. The platform is able to detect and report network partitions and makes local measurements over communication delays. The user interface is designed to adapt constantly the users expectations to the performance of the system.

6 Conclusion

We have described a computational synchronous tool that implements the Nominal Group Technique, a structured behavioral science technique for group generation of ideas and consensus forming.

The tool is based on a shared space and a set of teleassistants. The teleassistants, which are a generalization of telepointers, help and guide users in managing group information creation, management, control and communication. The teleassistants also provide useful feedback on communications and network conditions.

The group process is based on the coordination of public and private teleassistants and results in three

simple tracks for idea generation, discussing ideas and voting ideas.

We believe that the functionalities provided by the tool are adequate for synchronous cooperation over wide area networks under the unavailability of audio or video communication.

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