ABSTRACT
In decision making, idea generation is an important activity. A number of brainstorming methods have been proposed to generate large numbers of ideas. Ideation benefits from the participation of multiple actors, who provide ideas from multiple viewpoints and build on each other’s suggestions to generate more creative input. However, these usually result in disorganized sets of ideas that frequently contain overlapping or duplicate ideas, which need to be organized before decisions can be made. In this paper, we describe a model and an implementation of a system to move past ideation to alternative generation. We define an alternative to be a refinement of one or more ideas, obtained through the combination of ideas, forming coherent units. Alternatives should be complete enough that they can be discussed and evaluated in a following phase of the decision making process. Decisions can then be made about which proposal to adopt.

Categories and Subject Descriptors
H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces

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Management, Design, Human Factors

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Decision support, idea generation, proposal organization

1. INTRODUCTION
Decision making is an important process for both large companies and ordinary people. Strategic decisions may well decide the future of the organization, which means poor choices could lead to material losses, layoffs or even the closure of the company. At an individual level, personal choices may shape a person’s life for a long time to come. Decision making is therefore of paramount importance in several levels [1].

Systems have been developed to assist the decision making process, and a large body of literature exists both on Decision Support Systems (DSS), which usually assist a decision maker in the evaluation and weighing of alternatives, and so called Group Support Systems (GSS), which usually refers to meeting support as a whole. GDSS, or Group Decision Support Systems are a blend of the two, emphasizing decision making meetings [3]. GDSS were developed to support idea generation, definition of proposals, documentation and final decision making. In these systems, the process of generating ideas, refining proposals and making decisions may be executed by a group working together on a given issue.

Models have also been created to represent decisions in meetings, which help externalize and document choices, their reasoning and available alternatives. One of the best known argumentation models, IBIS [7][15] has provided a base for a few meeting support systems, focused on capturing the rationale of the meeting (eg: gIBIS, Quest Map, Compendium) [12][13][15].

The idea generation phase usually applies brainstorming techniques that encourage creativity without criticism, focusing on expanding the set of ideas. Electronic brainstorming allows greater control of the idea flow and makes it feasible to hold asynchronous and distributed brainstorming. At the end of this phase, the organization and combination of the most useful ideas is usually carried out by the group. After that, alternatives can be discussed in more depth, refined and decided about. However, when a large number of ideas are generated, this process can become quite lengthy.

Our proposal is to treat alternatives as combinations of the “raw” ideas generated during brainstorming. A proposal would then be constructed through the establishment of links that define relations between ideas, creating a certain amount of structure and organization between them. We implemented a first system to test our ideas. Through this system, participants can conduct brainstorming sessions, then move on to generating alternatives and finally decide on one.

It has also been noted by several authors that diversity is beneficial to ideation, and that large groups have the potential to perform as well as individual experts [14]. Thus, enabling large scale participation, not only during the idea generation stage, but also during the alternative generation phase would be desirable.

This paper is organized as follows: Section 2 presents the theoretical background, Section 3 reviews existing systems, Section 4 discusses the approach and technology adopted, Section 5 presents a brief evaluation and Section 6 finishes the paper, with a brief discussion and future work.

2. THEORETICAL BACKGROUND
The mESA model for collective decision making [9] presents a three-step decision making process, composed of the following steps:
• Expansion: phase in which new requests, ideas or possible solutions are generated, and the solution space is further explored.
• Synthesis: where a reduction of ideas happens, through merging or combination of similar ideas. Alternatively, responses to demands or requests may be generated in this phase.
• Analysis: involves evaluation and selection of the preferred option(s).

This is a cyclic process, which repeats itself over and over again during decision making, as ideas and alternatives are explored and refined. The process is shown in Figure 1.

![Figure 1: mESA Collective Decision Making Model](image)

With this project, we focus on the Synthesis stage, where the ideas generated during the expansion phase need to be manipulated and combined to generate alternatives that can then be analyzed during the next phase.

The IBIS model was created to provide structure to discussions by capturing and organizing argumentation elements. It has been effectively used as a basis for rationale capture for quite a while [15]. The IBIS model is based on the assumption that the design process is a conversation between stakeholders [7][12]. The model defines Issues, Positions and Arguments as the fundamental building blocks for a decision process. As the meeting progresses, a coordinator records the discussions in a graphical tool. Alternatively, participants may enter their ideas and positions individually, forming a collectively built graph. This record constitutes a valuable resource for later use, as it captures designers’ rationale and enables an easy visualization of the reasoning behind decisions.

MacLean [10] introduces an alternative approach to handle design rationale. They propose a style of analysis called Design Space Analysis which aims to explain why a certain artifact was built. This approach elicits why the artifact is the way it is, i.e., what the designers were thinking and reasoning when they made decisions about the artifact. MacLean et al. propose a semi-formal notation for representing key elements of this analysis called Questions, Options and Criteria (QOC). Questions ask some important identified design issues used for organizing the needs. Options provide alternative solutions to these questions and Criteria present arguments that may be linked as favorable or against the options.

MacLean et al. state that although Questions, Options and Criteria may be similar to the IBIS’ Issues, Positions and Arguments (respectively), they are not. The QOC representation is less general, so it may be seen as a compilation of the IBIS most relevant elements for logical argumentation. In other words, QOC is more focused on the description of specific design options and the design space structure rather than the more general issues. Additionally, they state that both IBIS and QOC perform complementary roles.

In [11], McKerlie and MacLean describe their experiments using the QOC representation. For instance, they decomposed a fax message sent by a project team member in issue, solution and evaluation components. They then inferred 15 Questions and identified the respective Options and Criteria following the methods presented in [10]. Simultaneously, other members searched for problems independently. They merged both scenarios in a reduced set of ideas, which was better for discussion and comparison. They state the technique helped them with structuring, criticizing and augmenting the design space as well as combining alternatives. It also supported communication among the team, revisiting of decisions and summarization. Nevertheless, they state that additional notes and other documentations are desirable to provide more details. Finally, they identify the need for further practical experiences to define costs and benefits of the approach.

3. RELATED WORK

Weatherall states that creativity is important in collaboration and describes creativity techniques that can energize the participants and improve the effectiveness of meetings [2]. The author analyzes the difficulty of being creative in conventional meetings and considers two environments for creative problem solving: conventional and electronic, suggesting that some features of the electronic meetings naturally enhance creativity. The paper also presents a work process for creative problem solving in an electronic meeting. We were inspired by this process and by their analysis of creativity in solutions and electronic meetings when creating our proposed brainstorming module system.

Munkvold and Anson [3] note that the obvious benefits for team collaboration achieved through the use of Electronic Meeting Systems (EMS), are not so obvious in an organizational scale. Even after several years, there are relatively few published reports on the adoption and diffusion of this technology. The broader class of technologies such as Group Support System (GSS), which include products that have experienced great success, such as Lotus Notes and NetMeeting, fared substantially better, according to an empirical in depth study of an organizational application of EMS in Statoil, a major Norwegian oil company. The paper compares the adoption trajectory of Lotus Notes, GroupSystems and NetMeeting in parallel until these technologies become integrated, showing a level of commitment and dissemination in the organization. This paper inspired us to work on tools that integrate the various stages of decision making.

In turn, Yakemovic and Conklin recognize that certain kinds of vital information related to why certain actions are taken, usually informal and unstructured, are frequently lost in large projects [4]. They speculate that this type of information, while important, is too unstructured to be readily captured and retrieved. They also report on a field study in which the IBIS method for structuring information was used for a prolonged period of time to record and enable a significant amount of this kind of information to be captured, using simple technologies such as hypertext and groupware.

Romano proposes a project centered on the user to extend GSWeb, a Group Support System (GSS) based on the World Wide Web [5]. This paper focuses the need for virtual workspaces and the various obstacles involved in their implementation.
(complexity, configuration and usability of the interface, consistency of tools and options for the facilitator, etc.) Being a relatively old paper, the major problem at the time was the difficulty of distributed collaborative activities.

Although there have been many meeting support systems, few have focused on the convergence method, and structuring ideas into proposals to be selected at a later stage. Furthermore, they tend to focus on small groups, while we would like our system to cater to larger audiences.

4. THE mIPS SYSTEM
In this section, we present our proposal for group deliberation, the mIPS model (multiparty ideas, proposals, selections). Our main goal was to create a web-based system to enable large groups to:

1. Generate ideas
2. Compose proposals structuring these ideas
3. Decide on which proposal should be selected

Given that many alternatives already exist for idea generation and voting, we decided to focus on the second stage, proposal generation. The proposal generation step is a convergence stage, where the many ideas are analyzed and refined into proposals.

An important step in the convergence stage is organizing ideas, and tying them together into a coherent whole. Therefore, we consider that the initial phase should involve creating links that bind ideas together through meaningful relationships.

4.1 Proposal Generation Model
Based on the IBIS model, our model enables the creation of different types of links between ideas, structuring information and starting to define proposals that can then be discussed. It supports the decision process shown in Figure 2, where a user suggests a problem/question, and invites others to discuss it.

**Figure 2: Decision Making Process**

The original IBIS model, discussed in [7] leveraged concepts of topics and issues (an issue in view of the system) which lead to discussion. Positions are constructed based on the development of this debate and arguments (comments for and against each position in the system) are derived from the personal view of each user involved in the process. The mIPS model can be seen in Figure 2. To the IBIS model, we added the concept of ideas, which are atomic units that can serve as a foundation for the creation of proposals.
Issue creation screen is shown in Figure 4. When creating a new question, the user can set the duration of each stage of the process (in days): ideation, proposal creation and voting on the proposals. This is necessary because in asynchronous environments, individuals may have to manifest themselves at different moments. The system is flexible enough to adapt to the needs of users and allows each steps to be controlled manually. This leaves it to the creator of the question to decide whether all stages need to be implemented and whether these have yielded good results, if enough proposals have been generated and the verification that all have voted. Only after that, should one be able to disable their participation and proceed with the decision process.

During the brainstorming step, shown in Figure 5, the issue is openly discussed, and several ideas are created by participants. An idea is an atomic concept that can be refined to form other ideas. This process of refinement takes place through the creation of relationships between ideas, which can be of the following types:

- equivalent, when two ideas are similar in essence;
- complementary, when a complete idea can be considered an extension or improvement of a previous one(s);
- antagonistic, when ideas differ enough to make them opposite to each other; and
- dependent, when one idea is dependent on other(s) to be implemented and only makes sense when viewed together, within the context of the issue under discussion.

These relationships were initially identified by the authors as being the most relevant ones, but the system can be configured to include other types of relationships according to user needs. After the creation of relationship between ideas, proposals can be generated based on a set of related ideas.

The proposal step can be seen in Figure 6, and aims to organize the ideas and consolidate them into proposals that solve the issue presented. In this step, participants may include pros and cons of each proposal, and create overarching relations of proposals with ideas, thereby establishing connection between the proposal and the ideas that led to it. One can also relate proposals with each other, using the same types of relationships mentioned before.
After generating proposals, the voting phase can be initiated. A sample result graph is shown in Figure 7. Voting was the decision making process adopted for the selection by the group of the proposal that best fits the problem under discussion. All participants may vote on only one proposal per issue and may change their vote until the end of the voting period. After the voting period, the system prepares an ordered ranking of proposals, and the user who created the issue can select one or more as preferred solutions to the problem, taking into consideration the ranking of proposals.

To enrich the user experience, a graphic display of ideas and their relations can be seen during each one of the steps, showing the state of the general discussion. It is possible to view a graph of ideas, proposals, or a combined graph showing both. The correlation of ideas is illustrated in Figure 8. The graph provides a dynamic view to explore ideas and proposals put into the system. A radial graph display was used [8]. By selecting the plus sign on a node, further information about the idea or proposal can be seen.

The system also includes a statistical module to help the creator of the issue manage the discussion. It is possible to view the ratio between number of ideas and proposals for an issue and the levels of participation of users who are creating ideas and proposals in the discussion. These indicators can help the discussion coordinator moderate the discussion, encouraging further discussion or participation from certain members.

It is also possible to view a chart that compares proposals and their respective pros and cons, and the statistics of the most voted proposals. Both serve to help the decision of which proposal is the most appropriate for the given issue.

The system was implemented in Java using MySQL as a backing database and adopts a Model-View-Controller (MVC) architecture. Java Server Faces (JSF) and the RichFaces library were used for the user interface. For graph drawing, the JavaScript InfoVis Toolkit (JIT) [6], an open source library for displaying data on the web was used.

5. PRELIMINARY ANALYSIS

We conducted a preliminary experiment using the mIPS platform using as issue the transportation problem that afflicts the city of Rio de Janeiro, which will become worse by the time of the FIFA World Cup in 2014. The evaluation lasted 2 days and involved 9 people from 2 computer related graduate courses and also a couple of volunteers with no relation to the area. The ideation stage was concentrated on the first day and proposal generation on the second. During the first stage, 21 ideas were generated, which were refined into 4 proposals in the second day. During the first stage, participants also established relations between the ideas. Finally, 8 of them voted during the voting stage. At the end of the process, a questionnaire was given for the participants to elicit their impressions and guide changes to the system.
relationships between ideas and proposals.

that the graph visualization helped understand the ideas and its relationships. However, some points were raised, regarding the interface, including access to certain features, which were not easy to find; difficulties in assimilating the difference between the concepts of ideas and proposals; and need for additional features to facilitate the understanding of ideas as a whole for the composition of the proposals.

New types of relationship between ideas and proposals may be needed. At the moment, ideas and proposals can only be mapped as being equivalent (same goal), complementary (or further increase), antagonistic (opposition) or dependent, which was considered too small a set.

The platform is ready for expansion and will soon receive new features such as user groups, to facilitate communication and interaction between subsets of participants (which may be important when larger groups are involved); support for the different roles played by each user within a particular discussion (facilitator, coordinator, participant, observer, etc.) This platform allows interaction among the users during the process of creative solution to a problem only through comments, and new functionalities are desirable. Anonymity is also desirable, and we plan to create two different modes of discussion: identified and anonymous. Currently, all discussions are held in identified mode.

Management of relationships between ideas and proposals also needs some additional work. One possibility is the creation of algorithms to identify contradictions or paradoxes in relationships between ideas or proposals. For instance, given ideas X, Y and Z, if X and Y are equivalent and Y and Z are equivalent, it is not possible for X and Z to be antagonistic. This relationship would close an inconsistent cycle and therefore should not be allowed by the system.

In addition, tools were embedded in the system to measure the participation of users in each stage of decision making process, but these could be extended to directly encourage users to participate in the discussion of issues and generation of options.

Finally, further tests with more participants are also necessary. The initial evaluation is encouraging but already points to a number of improvements. With larger groups, it would be possible to observe how people interact and collaborate and how ideas develop with large numbers of people authoring them. The proposal stage also needs to be strengthened and issues such as disagreement on relationships between ideas and/or proposals also need to be handled.

We believe this is a worthwhile avenue of exploration and plan to continue working on this problem, focusing in particular on the generation of alternatives. Now that an initial prototype is available, improvements and expansions can be more easily made and tested.

6. DISCUSSION AND FUTURE WORK

This paper presented a new system to support the decision making process, from the initial generation of ideas and their relationships (brainstorming), through aggregation of ideas into proposals, on to the voting phase of one or more proposals to the question proposed. The system is flexible regarding the execution of steps, i.e., it is possible to select which steps will be executed during the decision making process. The system also provides a way of viewing relationships through graphs, so that the user can view the current status of an issue as a whole, accessing the relationships between ideas and proposals.

Open questions with a group of users served as the basis for assessment of new needs for the system. Participants liked the notion of collaborative idea generation, and found that the graph visualization helped understand the ideas and its relationships. However, some points were raised, regarding the interface, including access to certain features, which were not easy to find; difficulties in assimilating the difference between the concepts of ideas and proposals; and need for additional features to facilitate the understanding of ideas as a whole for the composition of the proposals.

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7. REFERENCES


