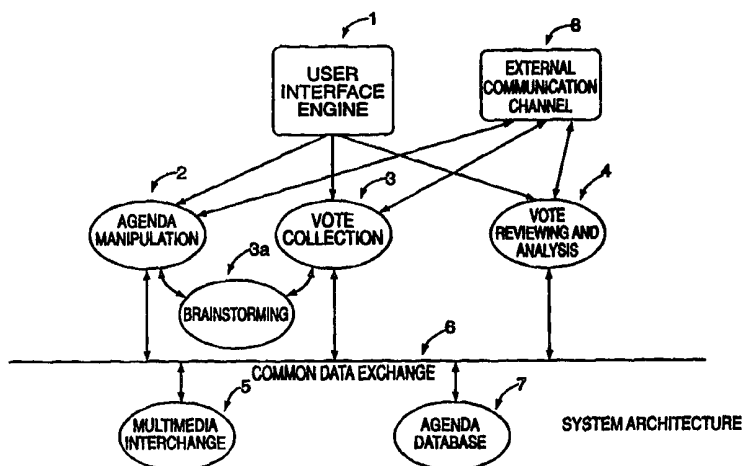




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(54) Title: METHODS AND APPARATUS FOR GAUGING GROUP CHOICES



(57) Abstract

Methods and apparatus for a choice processor that gauges group choice in a computer-mediated environment. The system uses scientific analysis of collective choice processes and outcomes produced by different voting methods to provide result data to guide an individual or group in making decisions synchronously or asynchronously. Three forms of instantaneous result data are provided. First, the system makes use of distinctive user dialogue boxes to communicate a scientific description of the initial conditions of the group choice being initiated by an individual or group. This information is processed to select the voting system or systems that facilitate the achievement of organizational or individual objectives. Second, the system employs a series of novel data processing methods to determine collective choice results throughout a collective choice process to identify differences and to communicate to initiator(s) and participants result data generated by the system to guide them in achieving one or more predetermined objectives. And third, novel rule-based artificial intelligence techniques are employed to provide quantitative and verbal analyses to user about how to weight votes and how to interpret a consensus that is not based on complete information about voter preferences or judgements.

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METHODS AND APPARATUS FOR GAUGING GROUP CHOICES

Field of the Invention

The present invention is directed to processing group choices in a computer-mediated environment.

5 Discussion of the Prior Art

Recently, computer programs have been developed to allow computer users to vote from their personal computers attached to a computer network. The price of such decision support software has dropped drastically, but existing programs simply use the computer as a super-adding machine to determine the
10 outcome for a particular voting system.

Until now, voting software has been designed to be used in "decision rooms," where personal computers or terminals are connected in either a small, separate computer system or in a network and users are guided by a facilitator in
1 reaching a group decision. Voters have no way of seeing or hearing agenda
15 choices (e.g. competing products, color schemes, or product designs) on their screens so that they can obtain information to make them more informed decision makers. When choices must be made about many agenda items, voters have no way of indicating indifferent (or tied) preferences and cannot keep track of what their preference orderings look like so that they can make sure that the
20 information that they input conforms to predetermined individual objectives and is consistent with predetermined priorities.

Even though some vendors of decision room software have expanded the types of network communications protocols that are used in networked computers, their products are still limited to the functionality found in decision room
25 software.

In such environments, voting is treated as a mechanical process where the only guidance in choosing a voting system is provided by a facilitator, who,

however well-trained, cannot keep up with the rapid interaction of comments and votes quickly enough to provide timely ("real time") guidance to individuals.

A major limitation of such environments is that no provision is made and no mechanisms provided for the institutionalization of the history of deliberation and the voting data. Once the decision room sessions are finished, the data are not made available within the voting body (e.g. agency, company, department) to allow voters and management to continue the voting dialogue, taking account of new data and new questions to be voted on. Even if printed or electronic transcripts of decision room sessions are distributed, the continuity of the dialogue is lost because there is no way of resuming group deliberations online in local or wide area networks, multivendor hardware and software environments.

Another type of group decision or voting software enables a user who has collected data about voter preference orderings or judgments to make use of voting algorithms to process the data. This decision support software is designed for decision or management specialists, not for the average user's desktop. This type of software does not provide a mechanism to support the interactive and iterative voting dialogue required by users to achieve a resolution of issues and to obtain their objectives. Such a mechanism requires a capability to choose a voting method (i.e. setting up a framework for making a decision or viewing the collection of voting information at a particular point in the voting process) and to orient the dialogue in the direction most likely to achieve resolution of the decision process and, hence, the objectives of the voting dialogue.

Voting or polling by phone is another existing type of voting software. This type of product employs keyed-in responses to polls or questionnaires to ascertain group preferences and judgments. Voting is limited to binary choices and opportunities for extracting insight are not exploited because voting is treated atheoretically as if it involved nothing more than counting single votes. Moreover, this form of voting does not make use of voice interfaces to communicate voting information (e.g. intensity of preference) that can provide insight when

participants in a conference telephone call are trying to reach consensus, but hampered by information overload and distortion.

Computer-mediated group decision making software is not only produced for human decision makers, but is also designed for computer nodes and processes that act as if they were human agents. This type of software creates protocols to solve problems in the management of computer networks such as reaching a consensus to ensure consistency and providing communications reliability in network environments. Typically, however, the solutions to these problems are limited because the voting systems employed do not take account of insights that can be derived from scientific voting analysis. This limitation leads designers to conclude that certain problems are insurmountable when they are not. The same myopia prevents the development of selfadjusting networks in which computer agents use voting systems that can be used to resolve and regulate conflicts that must be managed to provide network stability and efficiency.

SUMMARY OF THE INVENTION

The present invention is directed to methods and apparatus for interpreting and communicating computer-mediated voting. A choice processor mechanism enables users to gain sophisticated insights into a voting process derived from scientific analysis of voting inputs. The present invention includes synchronous and asynchronous modes of interaction, communication, and analysis of collective choice results.

The method and apparatus of the present and unique invention are based on five modules, a user interface module, a common data interchange module, a decision setup module, a data collection module, and a decision review/analysis module. The User Interface Module determines the media for input and output of data in the present invention.

The common data interchange module handles all of the input and output of the system including the data transactions between and among the modular

parts of the system. The common data interchange module provides a structure for communicating multipurpose information including animation, video (real-time or stored), graphics, sound, hologram, or any other representation of information. This common data interchange module provides the channel in which a user
5 inputs information and receive responses. The user can be a human being, a process or node acting as if it were a human being, or a physical object programmed to act like a human being. Commands and responses can include one or more forms of multi-purpose information.

The decision setup module provides a facility for creating an agenda and a
10 list of agenda items to be voted on. The agenda can be created by brainstorming to create a list and then evaluate it to identify items that should constitute the agenda. Or the agenda can be created by selecting a pre-existing template or model agenda for a task. Agendas created from scratch can be saved as templates and agendas set up from a template can be either edited or modified to fit a situation.

15 The decision setup module allows users to attach multi-purpose files as background information. These files, which can be copied or simply referenced (by their network address), can be either previewed, edited, or deleted within this module. This module also allows an initiator of a decision to determine the decision participants, to set their privileges in accessing information about the
20 decision process and outcome, to select a method of scoring or voting to be used by the participants, and to define the schedule and mode of interaction (synchronous or asynchronous) of the decision.

When the decision setup module is saved and closed, all participants automatically receive a multipurpose message (e.g. either voice-mail, fax, or
25 electronic mail) notifying them about the decision agenda and schedule. The data collection module collects information about voter ratings as well as their comments from the common data interchange module based on the conditions created in the setup module and communicated via the common data interchange module. The data collection module also allows voters to share either public or
30 private messages through a dialogue mediated by the common data interchange

module, which automatically archives multipurpose information in hypertext-accessible databases.

The data collected are communicated via the common data interchange module to the review/analysis module, where they are analyzed according to a
5 filter to guide users in interpreting information about the group decision making process. Representative embodiments of the present and unique invention allow users to gain insight into avoiding obstacles and making optimal choices in interpreting collective outcomes. The review/analysis module also provides insights by guiding users in setting up a decision in the setup module and in
10 monitoring trends during the data collection phase of a group decision.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 schematically illustrates elements of an environment for group 25
decision making according to the present invention.

FIG. 2 is a schematic functional diagram of a setup module utilized in the
5 present invention makes use of the elements represented in FIG. 1.

FIG. 3 schematically shows the functionality associated with a data
collection module according to controls input in FIG. 2 of the present invention.

FIG. 4 schematically illustrates a review module for analyzing data input
from FIG 3.

10 FIG. 5 schematically illustrates the process of integrating multimedia
information in the Common Data Exchange of the present invention.

FIG. 6 is a schematic representation of an Agenda setup window
integrating the features of the present invention.

FIG. 7 is a schematic illustration a Voting window that integrates features
15 of the present invention.

FIG. 8 is a schematic representation of a Review window that integrates
features of the present invention.

FIG. 9 is a schematic representation of steps used in the exemplary
processor for analyzing voting information in FIGS. 2, 3, and 4..

20 DETAILED DESCRIPTION OF THE INVENTION

This description of the present and unique invention is divided into two
sections. The first section, which focuses on features and their role in the system,
is presented from page 7 to page 74. The second section, which details how a user
or group of users would use the features in group choices, begins on page 74.
25 This mode of presentation is employed to separate the detailed explanation of

features from their actual use to make it easier to follow the logic of the invention without being overwhelmed by lengthy explanations of its parts.

A representative embodiment of the present invention can be implemented in X-Windows (a trademark of MIT), SPARC (a trademark of SPARC
5 International) or Microsoft Windows (a trademark of Microsoft), OS/2 (a trademark of IBM), or NT (New Technology, a trademark of Microsoft) environments as well as any other computer-mediated environment to provide a system which generates and communicates insights into group decisions and provides guidance to users at each stage of the process of group decisions and
10 provides guidance to users at each state of the process of group decision making.

Communication and processing of information in the present invention is structured around modules and submodules found in FIG. 1 used in either a wired or wireless computer network to set up and regulate a decision making process, collective outcomes as they are created and when they are finalized. Each module
15 processes certain input data and communicates the results inside its own environment to facilitate insight and appropriate deliberations and interpretation of collective choice result data. Each module also communicates such output in appropriate form to other modules where users can gain additional insights into the result data that enable groups to achieve their objectives. Communications
20 from one module to another is handled via a communications or common data exchange module in block 6 of FIG. 1 that, transparent to a user, provides consistent and reliable access to multipurpose, multimedia common data exchange it block 6 of FIG. 1 in the present and unique invention is the representation of complex sets of multipurpose interchange in block 5 of FIG 1 that condense
25 information that is not being used and make it accessible via rapid viewing, indexing, and iconographic techniques.

This feature is useful because it enables users to avoid information overload and see information that would otherwise be covered by current work windows. In addition, when making decisions about long lists of items, it is
30 normally impossible to gain an overview of all the items that is necessary for

making consistent decisions. But multipurpose, multimedia common data exchange in block 6 of FIG. 1 in the present and unique invention makes it possible to track one's work, organize it, and save time in dealing with complex information.

5 A representative embodiment of the present invention includes a user interface module (block 1 of FIG. 1), a decision setup module (agenda manipulation shown in block 2 of FIG. 1), a data collection module (vote reviewing and analysis in block 4 of FIG. 1), and a common data exchange module (block 6 of FIG. 1). These modules provide a structure in which
10 synchronous and asynchronous communication and interpretation of voting, textual, image, graphical, sound, animation, video (stored or live), quantitative, textual, and other information is organized to enable computer users to initiate and participate in informed group decisions from their desktops.

Each module inputs, processes, and outputs all of these types and forms of
15 data and information used in collective decision making. Processing of data and information between and among modules can take place sequentially or concurrently to guide group choices.

USER INTERFACE MODULE

A user interface module in block 1 of FIG. 1 determines the medium or
20 media that are used for data input and output in the present invention. This module includes options for using multimedia, multipurpose information, mechanical, touch-screen, and optical devices such as mice, pens, and keyboards, voice and neurological data to enter data into the modules and receive output. The user interface module uses different media suitable to the task at hand and
25 provides redundant communication when necessary.

This functionality is useful because it enables a person to use voice commands to enter data, but choose among text, graphics, and multimedia representations of data for receiving the output of the modules. This flexibility

also allows blind or deaf users to choose interface media that they are comfortable using. Such user needs are also supported by providing signing overlays for obtaining input and displaying output. For example, the needs of users from different linguistic backgrounds are supported by providing either visual or sound overlays that can be set up in the user interface module (and thereby made accessible in the other modules and submodules of the current invention). The same flexibility allows a user to receive redundant output of results for important decisions. For instance, information about the analysis of a collective decision can be disseminated in text, numbers, and graphics in a module, but also sent by voice mail to assure that the recipient receives a message as soon as possible.

DECISION SETUP MODULE AND VOTING SYSTEM GUIDANCE SUBMODULE

A setup module (agenda manipulation in block 2 of FIG. 1) in the present invention provides a means for an individual initiator or a group of initiators to input data that create the initial conditions which govern a collective choice process. These conditions include identification of an agenda (including an agenda name, list of agenda items, agenda and agenda-item background descriptions, and multimedia, multipurpose information attached to the agenda and agenda items), timing of the decisions (when they begin and end and whether they are synchronous or asynchronous), determination of participants, voter identification, participant privileges, and voting or scoring system.

A feature of the decision setup module in the present invention shown in detail in FIG. 2 is a menu-driven system for setting up an agenda topic, adding agenda items, and attaching multimedia, multipurpose files to items. This feature is useful because it allows anyone to make use of a multimedia environment to pool information and avoid telephone tag, electronic mail chasing, and face-to-face meetings to carry out their work. This menu-driven system makes use of all of the functionality of the user interface module in block of FIG. 1 and common data exchange module in block 12a of FIG. 2 for inputting, communicating, and outputting agenda information. This functionality makes it possible to use

different combinations of media for input and output to match the data entry requirements of the module with the needs and physical capabilities of users. The integration of multimedia information facilitates the use of industry standard files for graphics, images, animation, and video that can be located any place on a
5 network.

This feature is significant because it provides a level playing field of information used to render decisions. The significance of this feature is not only that decision makers can see and hear the same information in a timely manner, but that this information serves as a basis for improving the efficiency and
10 effectiveness of deliberation and debate.

A related feature of multimedia information in the decision setup module of the present and unique invention shown in detail in FIG. 6 is that multimedia files can be copied into the present invention and stored in the workspace of a user or accessed by reference (based on a network address).

15 This feature is useful because it allows users flexibility in accessing multimedia information. If files are not large, they can be stored locally. If files are large, network storage resources can be shared to maximize efficient use of network infrastructure. And if network reliability (e.g. in mobile communications networks) or file size (e.g. for stored video) makes it advisable to store files
20 instead of referencing them, the setup module allows users to determine what form of access is best for them.

A related feature of agenda setting in the decision setup module of the present 20 invention is a hypertext system in block 13 of FIG. 2 for relating agendas and agenda items. This menu-driven system is useful for searching across
25 active and inactive agendas for agenda items and related multimedia information. This hypertext system enables a group to have an electronic organizational memory by allowing identification of issues, opinions, data represented by multimedia files that can be used in current and future collective deliberations and decisions.

This hypertext system is also useful in allowing explorations of multiple related agendas when agenda items are video or animated representations (complete with sound) of products or designs. For example, suppose that a group is deciding among three designs for a disk drive and an initiator wants to see what happens if a part of one of the designs is replaced. Such an initiator can select the part with a mouse or pen or identify it by saying its name. Once the part is identified, it is highlighted and automatically triggers a search across all files in the network and archived agendas for information about alternative parts. Alternative parts are automatically pulled into an agenda in the setup module that allows ratings and evaluations of the possible replacement parts to be entered in the data collection module, which processes them and outputs them as inputs into the review module, where the collective outcome is compared with the original agenda situation.

This type of comparison is useful for providing insights into complex hypothetical situations in engineering and scientific work. The same comparisons are also useful as data points for constructing a network that delineates the relationship of collective decisions with each other over time. This representation of computer-supported cooperative work provides easy access to a history of problems and efforts to deal with them that can be instructive in on-going deliberations.

Another feature of the decision setup module in FIG. 2 of the present invention is a menu-driven system (shown in a representative embodiment in FIG. 6) for determining the timing of a collective decision. Users can employ all of the options in the user interface module in block T of FIG. 1 to enter data for synchronous and asynchronous decisions via the common data exchange module into the setup module. Synchronous and asynchronous timing setting options include natural language commands such as "now" and "tomorrow" as well as standard month-day-year-hour numerical entries. Settings can also be made for decisions that involve synchronous as well as asynchronous sessions. The time setup also allows a user to enter a command that brings up personal and group

calendars to allow an initiator to identify free time. All scheduling entries are input through the user interface module, which communicates the settings as output via the common data exchange module.

These features are useful for scheduling group meetings from the desktop.

5 They enable users to avoid telephone tag and the vagaries of ascertaining availability by electronic mail or phone. Individual priorities are automatically integrated into the process of selecting the best meeting time. This integration produces behavioral consequences such as better meeting attendance, better meeting preparation, more efficient and effective meetings, and greater participant

10 satisfaction. Moreover, these features provide incentives to overcome the "incentive compatibility" problem that prevents users from sharing information about their schedules in a group calendar (Arnold B. Urken, "Scheduling and Group Decision Support Systems," in D. Coleman (ed.), Groupware '92, San Mateo: Morgan Kaufmann Publishers, Inc.). Normally, users regard group

15 calendars as impositions on their privacy and react by filling them up with bogus information or by only using calendars on their personal computers. Participatory scheduling promotes greater productivity by making it reasonable for users to cooperate.

These features are also significant because they provide a basis for doing

20 pre-meeting work such as creating the agenda, setting agenda priorities, discussing agenda items, resolving disagreements, and delegating actions. This work can make many meetings unnecessary and make the remainder more efficient and effective.

Another feature of the decision setup module in the present invention in

25 block 11 of FIG. 2 is a menu-driven system (shown in a representative embodiment in block 5 FIG. 6) for determining the participants in a collective choice process. Users can employ all of the options in the user interface module to enter participants, who can be selected individually from a list of all users on the network, from a list based on organizational affiliation, position, role, and any

30 other criterion for categorization, or from predetermined lists of nominal

groupings of users created for personal or organizational purpose. This menu also includes an option for allowing everyone on the network to participate.

This feature is useful because it provides flexibility that makes it easy for an initiator or group of initiators to match participants with tasks to assure that the required information is pooled. For example, if an individual is choosing a word processor from an agenda of three options, the menu makes it easy to invite users who are familiar with all three word processors to participate. An initiator of such a group decision can pinpoint comparisons of three products by a group of experienced users who have a basis for rendering informed evaluations.

Another feature of the setup module in block 11 of FIG. 2 in the present invention (shown in a representative embodiment in block 5 of FIG. 6) is a menu-driven voter identification option that enables an individual or group initiating a decision to allow voters to remain anonymous or permit them to partially or fully identified. If anonymity is chosen the setup module invokes an omniscient initiator in the present invention, a computer process that knows the identities of voters, but does not make this information accessible to initiator(s) or participants. The omniscient initiator assures that ratings, votes, changed ratings and votes, and associated comments, and background information are controlled to provide privacy and reliable and consistent access to data. The omniscient initiator begins and ends its work in accordance with timing conditions in the setup module. If an agenda for a terminated collective decision is reopened, the omniscient initiator resumes operation for the new voting process based on stored information about voter identities.

A related feature of voter identification in the decision setup module in block 10 and block 13 of FIG. 2 of the present invention is use of a file architecture that prevents an initiator from owning the data collected in a computer-mediated voting process. For example, ratings, votes, and comments (including multimedia, multipurpose information) that are considered private by a voter are stored in directories accessible only by the individual voter. Unless the voter chooses to share this information with other participants, access is not

provided. Protection against unauthorized access is provided by the general cryptographic, security, and authentication techniques (such as digital signatures, distributed time stamping, and smart cards) that govern all transactions and database storage in the present invention. This protection also includes "watchdog
5 programs" that detect and track unauthorized entries. Such programs are effective due to the complexity of the data and the modular system in the present invention. Only the initiator (or initiators) can read data (e.g. rating or vote data) from each individual's file as input into the collective decision making process.

Anonymous participation is useful because it encourages participation by
10 voters who would otherwise not share their votes and opinions and contribute information that can enable the group to reach its objectives. Such participation provides a way of dealing with the classic management problem of trying to obtain feedback from subordinates who are reluctant to provide such information.

Another related feature of voter identification in the decision setup module
15 in block 11 of FIG 2 (shown in a representative embodiment in block 5 of FIG. 6) of the present invention is an option to set partial or complete identification. Complete identification allows users to communicate detailed and private information about their backgrounds. Such information includes name, photo, hologram, video, gender, work and home address, position, social security
20 number, driver's license number, date and place of birth, phone numbers, fax numbers, professional, religious, and other personal affiliations, family information, financial information (such as credit cards, income, wealth, property, and investments), and other demographic information. The input data are determined by each voter according to the request communicated by the
25 initiator(s) in the setup module. In some decisions, the definition of "complete" is simply one's name and electronic address. In other situations, complete information includes a description of one's organizational position.

Partial identification allows an individual to communicate information that describes his or her background without divulging a personal identity. For
30 instance, a participant can enter demographic information about items such as

gender, religion, income, birthplace and residence, religion, and organizational position in categorical terms that cannot be traced to one's name and position.

These options for voter identification are important because they enable individual and collective choices to be analyzed for patterns that are used to guide groups in resolving conflicts. For instance, a collective outcome that includes a tie between two agenda items, say A and B, two products designs, may be interpreted as a consequence of intraorganizational departmental or division conflicts based on homogeneous voting patterns. The ability to identify background characteristics of the voters makes it possible to gain insight by determining if, say, engineers and designers are split along departmental or divisional lines or if some engineers and designers agree with each other. This type of insight affects the choice of a strategy for resolving the tie. (This insight is output by the review module in which a decision analysis submodule analyzes patterns in voter preferences and judgments.) Flexibility in voter identification is also useful in allowing individuals to differentiate the types and quantity of information they share in a group decision making process. For instance, the present invention allows a voter to differentiate in sharing information by communicating complete identities (depending on the requirements input in the setup module) or providing less or more information than the standard input in the setup module. This option gives electronic voting a functional advantage over face-to-face, paper ballot, or mechanical voting by allowing individuals to avoid an all or nothing choice about identification. Individuals can control communication of personal information by receiving compensation in exchange for divulging certain aspects of their identity in a voting process. For example, a voter can enter financial information while participating in a poll and require that compensation in kind, credit, cash, or other numeraire be sent back or to a charitable organization, interest group, or political party. Delivery can be confirmed electronically in an individual accounting submodule in the setup module. This submodule is also useful in accounting for vote trading arrangements in which a voter casts votes in a certain way on one issue to obtain voting support from other voters on another issue. This accounting is useful for implementing "fungible voting" systems in which votes are traded

like money (Arnold B. Urken and Shamsul Akhand, (1976), "Vote Trading in a Fungible Voting System," Proceedings of the Annual Meeting of ORSATIMS.

Another feature of voter identification in the present invention is a voter identification profile:. This profile includes standing information about voter identity including preferences on recurring issues. The creation of a profile in the setup module allows a voter to avoid repeated input that defines the types of data and information that he or she wants to share in voting processes. The profile can be defined in relation to individuals, groups, and agenda topics or issues. For instance, this feature allows individuals to provide much information to friends and little information to strangers. Similarly, a manager rating employees could disclose a name to some participants and only communicate an organizational affiliation, the number of years of service, and measures of expertise such as number of papers published on a topic to other participants. This information is useful in analyzing conflicts that seem to be irreconcilable. For instance, if a tie occurs and a group (or individual initiator) wants to reassess the outcome based on the ratings (and associated reasons) of managers according to either their position, years of service or papers published as criteria of expertise, the present invention (in a review module) provides instant insight by determining if the tie can be resolved.

This feature of the present invention is also useful when it is used to support a group decision that is made in support of an individual decision. For example, to resolve a conflict about purchasing a product, choosing a room for a meeting, promoting employees, or any other choice, an individual can initiate a collective choice to gather recommendations (with explanations). If the collective outcome included a tie, the voter identification profile can be used to weight the votes subjectively in the review module to explore options for resolving the outcome.

Another feature of a voter identification profile in block 11 of FIG. 2 (shown in a representative embodiment in block 2 of FIG. 6) in the present invention is provision of standing preference orderings. A profile's standing

preference orderings are attached to agenda items to allow instant communication of votes within the data collection module and identification of collective outcomes in the review module that are communicated to an initiator(s) or participants depending on the initial conditions input in the setup module. This
5 functionality is useful in scheduling meetings. For example, if three users want to schedule a meeting, one of them or all of them can enter possible meeting times in the agenda in the setup module. (The actual entry can also be done by taking advantage of the interoperability functionality in the present invention by viewing a group scheduler or calendar to identify open times and then drag these times as
10 agenda items into the setup module). Users of the present invention can have profiles of meeting times rated in quantitative (e.g. on a scale from zero to one hundred) or nominal terms (e.g.s. great, OK, impossible). When the agenda is created in the setup module, these profile ratings are communicated to the data collection module, processed, and output to the common data exchange module,
15 which processes them and outputs them into the review module where they becomes inputs that are processed to create a collective choice outcome. This outcome is output that is communicated to the participants in the review module and also delivered via the common data exchange module back into the group scheduler or calendar, where the data are placed in the appropriate categories for
20 display on demand to users.

Another feature of the decision setup module in block 9 of FIG. 2 (shown in a representative embodiment in block 5 of FIG. 6) in the present invention is a menu-driven set of options for determining privileges of participants in a voting process. Such privileges are also known as "properties of a voting process" that
25 govern individual participation. These privileges include options for being enabled to cast votes, for editing an agenda, for previewing and reviewing collective outcome data, and for receiving notifications. If an initiator or group of initiators enables voting, participants are allowed to rate and score alternatives in the data collection module. Normally, if voting is disabled, it implies that agenda
30 editing is enabled, though this is not necessarily the case in the present invention because participants who cannot vote actually may be limited to reviewing the

collective outcome data and associated comments and discussion available in the review module. However if participants are also allowed to edit an agenda, this editing privilege allows participants to input comments on existing agenda items and additional agenda items via the user interface module and common data
5 exchange module.

Making participants vote-disabled and preventing them from editing an agenda enables an initiator to open up the review module to individuals and groups who did not participate in the collective choice process, but still want access to information about the collective outcome and the reasons behind the
10 collective outcome.

The vote-disabled, agenda-editing mode of participation is useful for 35 synchronous or asynchronous “brainstorming” sessions in which groups create and discuss an agenda by making lists of problems, solutions, or objectives. At a predetermined time or when an initiator or group of initiators decides that
15 sufficient deliberation has taken place, voting can be enabled by an initiator within the setup module. This input is processed through the user interface module as input for the setup module, which processes the information and outputs an enabling message via the common data exchange module participants.

A related feature of privilege setting in the decision setup module of the
20 present invention is the option of previewing and reviewing collective choice results. The previewing privilege determines if a participant can gain access to the review module before or after all participants have cast their votes. Preventing access to collective choice data and analysis before all votes are collected and processed is useful in prohibiting participants from monitoring incoming votes to
25 obtain information that can be used to bribe, pressure, or persuade voters. Restricting access to collective choice data even after all votes are in can be used in private polls in which data are considered to be confidential or sensitive.

A related feature of privilege setting in the decision setup module block 9 of FIG. 2 (shown in a representative embodiment in block 2 of FIG. 6) of the

present invention is a notifications option. This option is selected to control access to information about an ongoing collective choice process that is derived from processing inputs into the data collection module, where they are processed and output as inputs in the review module, where a decision analysis module within
5 the present invention analyzes patterns and gleans insights for users that are output within the review module.

Another feature of the present invention in block 11 of FIG. 2 (shown in a representative embodiment in block 3 of FIG. 6) is a menu-driven system for selecting a voting system for a group decision. Users can employ all of the options
10 in the user interface module to input choices that are processed and output to the common data exchange module which, in turn, processes them and outputs them as input in the setup module. A voting system is a set of rules which describe how voter preferences are represented by allocating votes and how votes are aggregated to produce a collective outcome. Voting systems filter voter preference
15 data that constitute a set of initial conditions that characterize voting processes.

A logical analysis of voting system comparisons is illustrated by a simple voting scenario presented in Tables I and 2. Table I shows four voters (1 - 4) who have cardinal preferences for choices A through C. This means that each voter's ranking shows how much one choice is preferred to another. For instance, voter 1
20 prefers choice A five times as much as choice C and rates choice B four times as high as choice C. The choices may involve meeting times, product designs, restaurants, or any situation that requires a group to choose among two or more alternatives. But all of these choices depend on common logical features of voting procedures.

25 The filtering affect of voting systems on this cardinal preference information is illustrated in Table 2, which contrasts two voting rules. One rule is one person, one vote (OPOV) and the other is approval voting (AV). Under OPOV rules, voters are restricted to casting one vote for their most preferred choice. If more than one choice is most preferred, this information will be lost in
30 the process because the vote cannot be divided to represent this condition. In

contrast, under AV, voters can cast one vote for each approved choice. Since approval voting involves a subjective judgment about what criterion to use is casting an approval vote, voters may have different thresholds for allocating approval votes, but in this exposition, it is assumed that voters act as if they vote
5 for each alternative that equals or exceeds their average cardinal rating. In Table 2, this means that since all the cardinal ratings in Table I are normalized on a ten-point scale, any choice rated 3 or higher receives an approval vote. Table 2 describes the impact of aggregation rules on collective outcomes. When the objective is to select a single choice, plurality or majority rule can be used. Under
10 OPOV, C gains the most votes, while under AV, B is the plurality outcome. When majority rule is employed, the outcome is indecisive under OPOV and AV. If the decision task is to produce a collective rank-ordering of the choices, OPOV and AV produce different interpretations of the voters' preference information. For OPOV, the group prefers C to B and A and is indifferent between A and B. In
15 contrast, AV suggests that voters are indifferent between A and C and prefer B to A and C.

This illustration shows that voting systems are not neutral and that voters who choose a voting system may unwittingly produce a collective outcome that they could avoid if they were aware of the consequences of their decisions and
20 options for choice. For instance, in this scenario, if A, B, and C are product designs, the group concludes that there is no consensus if it requires a design to receive a majority of votes. If a plurality of votes is required to define a group consensus, either voting method produces a decisive choice, though the outcomes are inconsistent (i.e. one system identifies C as the group choice and the other
25 determines that B is the group choice).

A feature of the voting system guidance module in the decision setup module in the present and unique invention is the resolution of this type of inconsistency by filtering the initial conditions of a voting situation through many voting systems. In fact, voting analysis provides insights into how groups can
30 achieve their goals by using decision analysis feedback to make use of

interpretations of dynamic, complex voting processes that would normally elude voters.

These insights are useful because they make organizations aware of the implications of group decision making procedures and enable them to avoid the risk encountering problems in implementing decisions that seem to be based on a consensus--even a "strong" consensus evidenced by a large majority of votes. Typically, in such cases, voters who disagree strongly with a group choice begin to practice delay and sabotage to scuttle the decision. These opponents are aided by the indifference or lack of strong preferences of the majority who supported the group choice. Moreover, if new questions arise or information is received that reinforces these moves away from consensus, an organization may encounter disarray without having any means of analyzing the underlying problem or determining what to do about it.

A feature of the present invention in block 11 of FIG. 2 (shown in a representative embodiment in block 3 of FIG. 6) is a menu-driven system for selecting and using all known voting systems and extracting information from them that is used to guide voters in setting up and analyzing a group decision making process. This system menu-driven system makes use of all types of inputs from the user interface engine module in block 1 of FIG. 1 and transmits these inputs via the common data exchange module in block 12a in FIG. 2 to the setup module in block 2 of FIG. 1, which processes them and then outputs them to the data collection module (block 3 of FIG. 1) and review module (block 4 of FIG. 1), where they are used to control the processing of information about a voting process.

In addition to one-person, one vote and approval voting systems, this voting-system selection feature includes but is not limited to voting systems such as Borda voting, Condorcet scoring, Copeland scoring, proportional voting (e.g. Single Transferable Voting), and different forms of weighted voting (including systems such as the demand-revealing process (T.N. Tideman and G. Tullock, (1976), "A New and Superior Process for Making Social Choices." Journal of

Political Economy.) and fair division schemes (S.J. Brams and A.D. Taylor, (forthcoming) "An Envy-Free Cake Division Protocol. American Mathematical Monthly. In weighted voting, votes can be weighted according empirical measures of expertise, self-assessments of expertise, intensity of preference, or subjective estimates. (H. Nurmi (1987). Comparing Voting Systems. Dordrecht: D. Reidel Publishing Company; Shapley, L. and B. Grofman (1984). "Optimizing Group Judgmental Accuracy in the Presence of Interdependencies," Public Choice.) Each of these systems is characterized by rules that govern representation of voter preference information by an allocation of votes and by rules that regulate aggregation or pooling of allocated votes. This aggregated information is then interpreted by listing agenda items according to the scores they received under a voting system. The same information is also useful for determining if one or more agenda items receives a certain required percentage of the total votes, e.g. majority. This requirement is also known a "decision rule" or "group decision rule."

A related feature of menu-driven system for selecting a voting system is in block 11 of the FIG. 2 in the present invention is the selection of a "multicriterion" or "multiobjective" decision making system. In this type of system, alternatives may be judged according to many criteria and the group must make collective decisions on each criterion (or objective) and integrate the information.

This feature is significant in complex decisions about the design of new products, projects, investment strategies, etc. that must be judged according criteria that are important to different parts of a group or organization. This feature is also important for organizations that take separate votes on agendas that are actually part of one multiobjective agenda and are faced with the problem of pooling the results encountered into an explicit multiobjective decision task. Both of these tasks can be carried out in the setup module of the present invention. For instance, this can be done by redefining an agenda in terms of more than one agenda data set.

A related feature of the setup module in block 11 of FIG. 2 in the present invention is multiple views of multi-objective decision making processes. Normally, setting up a multi-objective decision making problem is treated as a process of pooling individual preferences or judgments by looking at average or
5 total scores for the alternatives. Depending on the task, the individual decisions may take account of pessimistic or optimistic weightings reflecting the confidence or expertise of the decision makers. In such cases, the collective score may reflect different combinations of assessments such as minimizing the maximum damage or costs or maximizing the maximum expected benefits from a collective choice.
10 The same data can be used to produce a collective score using a variation of the Hurwicz criterion (L. Hurwicz (1979). "On Allocations Attainable through Nash Equilibria," Journal of Economic Theory) that combines the expected value of calculations of expertise/confidence and preferences by computing the total score of worst and best cases for each collective choice alternative and then comparing
15 them.

A related feature of multiobjective decision making in the present invention is that it helps individuals and groups detect and avoid the potentially
distorting information effects of characterizing group assessment of multiobjective choices in terms of a typical individual. The present invention
20 makes it possible to look at the consequences of pooling information through different collective choice mechanisms for one or more objective or criterion. This feature can be set so 1) that all objectives are filtered by all collective choice mechanisms or 2) that specific systems are selected for specific objectives. The first option in this feature makes it possible to determine if there are any
25 differences caused by filtering information through one or more voting systems. This present invention provides this insight instantly so that users can employ the information to guide their choices. The second option makes it possible to select a voting system that matches the information constraints and organizational culture of a set of voters. For example, if it is infeasible to gauge products or product-
30 parts on a cardinal scale (i.e. I prefer product X is five times as much as product Y), it may be feasible to obtain approval ratings for choices (e.g. I find products X

and Y acceptable, but not product Z). The voting system selection feature of the present invention is useful in two other ways. First, it allows organizations to make use of established systems that are part of their formal rules (e.g. charter, constitution) or informal rules (e.g. unwritten practices or traditions that have been
5 in place). Second, this feature makes it possible to deal with two forms of voting system breakdown: obvious and non-obvious. An example of obvious breakdown is what happens when a group is trying to choose a single alternative from an agenda, but can find no majority consensus. In this case, the present invention can be used to reanalyze the preference structures underlying the existing data or
10 design a new collective decision process that will provide more granularity of information to permit more detailed decision analysis and analysis of options. An example of non-obvious breakdown occurs when a group is trying to choose a single alternative from an agenda and produces a majority consensus for one alternative, but does not realize that the collective choice actually is not the
15 strongest interpretation of the underlying voting information.

Another feature of the menu-driven system for selecting a voting system block 11 of FIG. 2 (shown in a representative embodiment in block 3 of FIG. 6) in the present invention is that it can be accessed many ways to obtain insight to the implications of choosing a voting system. However, if an initiator already knows
20 which voting system he or she wants to use, a voting system can be directly identified and selected from the menu system. If an initiator needs guidance in selecting a system, online and written help including a userguide, handbook (with examples of how to use and apply systems), and explanations of each voting method can be accessed to facilitate an informed choice. If an initiator needs
25 further guidance, a dialogue mode can be accessed in the menu to obtain guidance in choosing a system. This level of guidance may prompt a user to help pinpoint the assumptions that must be considered in choosing a system. In addition, such guidance will obtain information from a user about the decision task, timing of the decision, the number of voters, their familiarity with the task, estimates of the
30 heterogeneity or homogeneity of voter preferences and judgments, and other factors that can be used to select a system of voting. This information can be used

to allow a user to make informed choices or to have a choice automatically made by the present invention.

Insights into choosing a voting system are created by having a user input information through the user interface module, which processes the information and outputs it to the common data exchange module, which enters the information into the setup module, where it is processed by a voting system guidance module. This guidance module employs a rule-based expert system to respond and direct output back through the common data exchange system to the user interface module, where the user responds. This interactive procedure continues until a voting system is finally selected.

The rules of the voting system guidance of the decision setup module used to create these insights are based on contingent relationships between the factors associated with use of a system (Arnold B. Urken, (1988). "Social Choice Theory and Distributed Decision Making." in R. Allen (ed.) Proceedings of the IEEE/ACM Conference on Office Information Systems). For example, if an agenda includes three or more agenda items and the objective is to select a single item, the voting system guidance module in the present and unique invention does not recommend one person, one vote voting, but guides a user to select a system that provides more information about the structure of voters' preference orderings. Approval voting is suitable unless there is strong disagreement among the voters. If this seems likely, another system such as Borda voting can be used in order to avoid the possibility of creating a tie (which, under heterogeneous preferences, can be five times more probable under approval voting than it is under one person, one vote voting). Alternatively, the voting system selection menu can be set up via the user interface engine module in block 1 of FIG. 1 and common data exchange module in block 6 of FIG. 1 to collect preference rating data in the data collection module in block 3 of FIG. 1 and to notify the decision analysis module of the review module in block 3 of FIG. 1 to analyze the voting process by processing the preference information through each voting system.

This feature is useful because it presents users with options for breaking ties by extracting information that can be used to make non-obvious distinctions among tied agenda items.

5 If the group's objective is to select the best two out of five agenda items, the voting system guidance module guides a user to include approval voting. Such guidance may suggest that the user include (or automatically include if the user chooses) the collection of data on voter preferences to enable the decision analysis module of the review module to describe a tied outcome that includes three or more agenda items. This type of analysis cannot be done unless the user enters
10 instructions in the setup module that create initial conditions for collecting the necessary information about voter preferences.

A related feature of the voting system guidance module in block 11 of FIG. 2 is that it makes use of implicit information about voter preference structures derived from a voting system setup to enable analysis of a voting
15 process to be done in the decision analysis module of the review module. This is true even if a particular voting system is selected directly through the voting system selection menu. For example, voting systems such as Borda voting contain information about individual preference orderings that can be used as inputs for other systems of voting to compare the collective outcomes with the results of
20 Borda scoring. Moreover, even categorical voting systems such as approval voting contains implicit information about the relative ordering (also known as the "ordinal relationship") of agenda items in voter preference structures that can be used in the decision analysis module of the review module to analyze collective outcomes to gain insight. For under approval voting, the "approved set" of agenda
25 items (which receive 1 vote each instead of 0 votes each) are implicitly ranked higher than the "disapproved set." This information may be useful in resolving a tied outcome under approval voting by making use of voting analyses of other systems in the decision analysis module of the review module.

These types of insights are useful because they enable a group to be more efficient in reaching a consensus. No extra time or effort is required to identify and resolve disagreements that can be avoided by choosing a voting system.

5 A related feature of this voting system guidance module in the decision setup module of the present invention is an option that allows an initiator to input a choice of a nominal voting or scoring systems using the menu. This input is entered using the user interface engine module, which processes the information and outputs it to the common data exchange module, which processes it and outputs to the setup module. A representative embodiment of menu choices for
10 this feature in the present invention include scaling systems such as "high, medium, low", "yes, maybe, no", "above average, average, below average," and an option that allows input of any set of nominal distinctions that are used to vote on or rate a set of agenda items.

This feature is useful in two ways. First, it allows voting to take place
15 using existing or new natural language systems that are frequently used in group choices. This makes it easy for users of the present invention to make use of methods of vote allocation that are non-quantitative and that are already used in a wide variety of tasks. And second, the implied ordinal relationships among agenda items rated on the basis of such natural language scaling systems are used to
20 enable analysis of a voting process to be done in the decision analysis module of the review module. The analysis works on the basis of the inputs that are entered in the voting system guidance module of the setup module. These inputs are processed and sent via the common data exchange module as output to the data collection module as inputs that establish a format for collecting nominal ratings.
25 The setup module also outputs the nominal voting system selection to the review module, which processes it and sends it to the decision analysis module, which automatically prepares to process voting data and to filter it to identify collective outcomes under different voting systems. (The operation of the decision analysis module is explained in a separate section).

This second application of this feature makes it possible for decision makers to make use of options in the review window for avoiding problems and for finding a “best” or “strongest” choice if one exists. Without such information, deadlock may seem inevitable when it is not and a weak choice may be mistaken
5 for the choice with the most support (and vice versa). Deriving these insights from nominal data improves the efficiency and effectiveness of decision making and provides a strong basis for successful implementation of group decisions.

A related feature of this voting system guidance module in the decision setup module in block 11 of FIG. 2 of the present invention is an option that
10 allows an initiator to input a setting that permits voters to indicate the confidence of the ratings entered in the data collection module. This input is entered using the user interface engine module, which processes the information and outputs it to the common data exchange module, which processes it and outputs to the setup module. A representative embodiment of menu choices for this feature in the pre-
15 sent invention include confidence ratings on cardinal, ordinal, and nominal scales. For example, cardinal ratings are voter expressions of confidence on a scale from 0 to 100 (low to high). Ordinal ratings use colors (e.g. blue, white, red) or nominal categories (very confident, confident, not confident) to indicate confidence ratings. Cardinal and ordinal and nominal representations can be combined to
20 facilitate use of an interface in the present invention.

An initiator of a group decision in the present invention accesses this confidence option by making a menu selection in the setup module via the user engine interface module. This selection is output to the common data exchange module, where it is processed and output to the setup module, which records the
25 setting in the voting system guidance module. The voting system guidance module automatically outputs the confidence option setting via the setup module and common data exchange module to the data collection module and review module. The data collection module processes the information to configure the data collection module to receive and record the confidence ratings in either
30 quantitative, graphical, color, or nominal representations. When the setup sends

the voting system guidance module setting to the review module via the common data exchange module, the review module processes the setting information as input and outputs it to the decision analysis module, which attaches it to the controls governing the matching agenda. When the voting data for this agenda is collected in the data collection module, it is processed and output to the common data exchange, which processes it and outputs it to the review module, where it is processed and output to the decision analysis module. The decision analysis module integrates this information into the computation of a weighted score for each item in the agenda.

10 This feature is useful in representing complex individual choices (and by implication collective choices) in which the confidence associated with an agenda item in the present invention is used to discount and adjust either a vote allocation or a preference intensity associated with the item. For example, managers must rate subordinates as part of a cross organizational performance review process, but are normally limited by their knowledge of the ratees. Some ratees are new, others are from a different part of the organization and known on the basis of limited contacts, and still other ratees are virtually unknown to the managers who must rate them. Confidence weighting of each ratee's score allows managers to differentiate among strong, moderate, and weak support for a rating and produces a more accurate collective choice representation of the organization's view of a ratee.

 A related feature of the voting system guidance module of the decision setup module in block 11 of FIG. 2 in the setup module in the present invention is an option that allows confidence weights to be defined and interpreted as measures of expertise. These measures of expertise can be empirical measures of performance in well-defined tasks. In addition, these measures can be subjective estimates used to weight the expertise of vote or rating data.

 This feature is useful in complex tasks in which groups of experts or single individuals must discount evaluations. For instance, a group of financial experts can have its expertise measured on the basis of individual records of success in

picking investments that meet well-defined criteria. These measures can be used as a profile for discounting the opinions of the group of experts and enable the collective choice to integrate investment preferences and investment skill. This type of insight is impossible to obtain without this feature of the present invention.

5 This expertise-weighting feature also allows the initiator or participants to assign weights based on their subjective estimates of the skill of each expert. This is useful when a group of experts disagree and the disagreement must be resolved or interpreted to clarify how to proceed. Subjective estimates can be assigned to individuals to gain insight into the non-obvious collective choice implications of
10 weight assignments. The confidence and expertise weighting features of the voting system guidance module are also useful for setting either individual or collective priorities for a to do list. Agenda items can be weighted either by confidence or competence/expertise when the objective is to order a list of tasks that one could do. Agenda items that are ranked high have to receive high
15 preference ratings and confidence or expertise scores. When such lists grow beyond 3 to 5 items, it becomes difficult to integrate such information and gain insight into one's true ordering.

A related feature of the present invention is the option of inputting either intensity of preference or competence/confidence information as ranges instead of
20 a single point. For example, it is often difficult, arbitrary, or impossible to rate a preference, confidence, or competence without losing information about the rater's perspective. Accepting an upper and lower bound from a rater makes it possible to take the median value of the range as an input for a voting system. Such data can be input via the user interface engine via keyboard, mouse, or voice. This
25 functionality extends the value of the present invention to users by making it applicable to fuzzy decision tasks.

Another feature of the decision setup module in the present invention in block 11 of FIG. 2 is that inputs into participant selection, properties, voter identification, and voting system guidance modules of the setup module can be
30 determined collectively. Each list of options in these modules can be called as an

agenda to allow participants to reach a consensus on rules that are used in a collective decision making process.

A feature of the present invention is that there are two ways of making data choices for the setup module in block 9 of FIG. 2. These choices are input
5 into the user interface engine module (in block 1 of FIG. 1), which processes them and sends output to the common data exchange module, in block 6 of FIG. 1) which converts the data choices into a proper format and outputs them to the setup module in block 9 of FIG. 2. These input choices can be determined collectively or individually. For many personal decisions, for example, an individual
10 determines all aspects of the initial conditions for group choice. In such cases, the individual inputs data for these conditions in the setup module which processes them, outputs them to the common data exchange module, which outputs the setup conditions to participants throughout the network. However the data choices entered in a setup module can also be determined collectively within the present
15 invention by making use of a data collection module (described below) in which the participants vote on the setup choices. The voting results output in the data collection module are output to the common data exchange, which processes them and outputs them to the setup module, where they become the inputs for a group decision process that are displayed to participants via the common data exchange
20 module.

A related feature of the setup module in block 11 of FIG. 2 in the present invention is that regardless of whether the initiator role is played by an individual or group, initiator choices to configure a collective choice situation can automatically set up all of the modules in the present invention to facilitate
25 processing of information about a particular task. This customization can be done in three ways.

First, an initiator may choose an existing "template" or task model from the setup module menu in block 11 of FIG. 2 (shown in a representative embodiment in block 4 of FIG. 6) and use it as is or modify it through the menu.
30 This can be done from the user interface module in block 1 of FIG. 1 by making a

selection in the setup module. For example, typical selections include performance review, allocation of merit raises, and product design. Once a template is either selected or modified and saved, the setup module processes this information and exports it via the common data exchange module to the data
5 collection module and review module, which take the inputs as settings for the display and processing of information in data collection and review modules. In a template, all menu options would automatically be configured in these modules. In the review module, the template would select and carry out options for analysis of voting data in the decision analysis module and the display of decision analysis
10 output (including options for further analysis) in the review module.

Second, an initiator can configure a template either at any step via the user interface module in block 1 of FIG. 1 in the setup module in block 11 of FIG. 2 (shown in a representative embodiment in block 4 of FIG. 6 or in other modules by selecting the File option from the menu and saving the existing structure as a
15 template (see the representative embodiments in block 1 of FIGS. 7, 7A, and 8).

Third, an initiator can enter a dialogue mode via the user interface module to answer questions in the setup module in block 11 of FIG. 2 about the characteristics of the decision task application. Answers to these questions are processed in the setup module to configure an interface for the setup, data
20 collection, review, and common data exchange modules. This dialogue setup creates configurations or forms that may not be available in an existing template and makes it unnecessary to proceed via the step-by-step procedure for configuring choice processing in the present invention.

Generation of these forms is significant because it provides flexibility in
25 creating new forms that are tailored to the decision task, culture, and information constraints of users.

All three options make it simpler to set up this tool for processing choices. Templates represent a tested structure for handling a decision task that can save time and avoid error for inexperienced users. Saving a constructed configuration

and automatically configuring the tool via dialogue provide institutional memory for more experience users and a source of new templates for less experienced users.

5 A related feature of block 11 of FIG. 2 of the decision setup module in this unique and original invention is the option of selecting real-time simulation of voting situations. These Monte Carlo simulations make it possible to update the collective choice inputs automatically while the voting process is ongoing. The choice of the inputs and the objective of the analysis are selected by the initiator via the user interface engine in the setup module and communicated to the data
10 collection module and review module.

The objectives of the simulation include predicting a group choice on the basis of historical data that describe a pattern of behavior for individual preferences and judgments, predicting the group probability of making a correct choice taking account of preference structures, and modeling the effects of vote trading
15 systems (e.g. fungible voting) (James S. Coleman (1973). "Political Money," American Political Science Review).

These simulations are significant because they provide insight into group performance that can be used to design measures for intervening to affect collective outcomes. For instance, historical data can be used to plan ahead for
20 contingencies such as indecisiveness or overwhelming support. Similarly, real-time analysis can lead to suggestions either for dealing with ongoing indecisiveness or for pinpointing the conditions under which voting system mechanisms should be invoked. For example, fungible voting's redistribution rule can be gauged and implemented according to such simulations.

25 A representative embodiment of the present invention for determining inputs for the decision setup module collectively is used in brainstorming tasks (shown in block 3a of FIG. 1). In these tasks, the (individually or collectively) predetermined objective is to list a set of problems, objectives, or solutions and then evaluate them. Working in this mode (set up by the initiator(s) in the decision

setup module). the group can input agenda items and add comments and other textual, image, and sound information to agenda items. New agenda items are input in the setup window (in block 9 of FIG. 2) and multimedia, multipurpose details on an item are directly entered or imported from the network via the menu
5 (via blocks 13, 12, and 12a of FIG. 2). As soon as a participant saves input entered in the decision decision setup module, the information is automatically displayed to other participants in the data collection module. In brainstorming mode, however, the decision setup module does not allow participants to enter voting data in the decision setup module and data collection module. Although the
10 decision setup and data collection modules are displayed simultaneously, only comments and supporting information can be added to agenda items in the data collection module. These comments include text and other information cut and pasted from the detail files in the data collection module on agenda items that can be input in submodules (e.g. private files or public bulletin boards) where
15 opinions and imported information can be added.

DATA COLLECTION MODULE AND DECISION ANALYSIS SUB-MODULE

Brainstorming in block 3a of FIG. 1 in the present invention can be conducted synchronously or synchronously and then made part of an ongoing
20 work process. This option is useful because synchronous brainstorming can involve time and other pressures that can lead groups to make uninformed, unconsidered choices. Often, the consensus itself, measured in strictly quantitative voting terms, distorts the underlying feelings and thoughts of decision makers. In asynchronous mode, brainstorming provides participants more time to obtain
25 information and to deliberate. Synchronous brainstorming may be useful when there is substantial agreement on goals and values, but its potential distortions of group opinion can lead to problems in the implementations of decisions because the complexity and intensity of group opinion has not been accounted for in the decision making process.

Another feature of the data collection module in the present invention also provides an environment for communicating one's ratings and comments via the common data exchange module (block 6 of FIG. 1) to another individual or a set of individuals (including everyone on the network). This communication takes place in an exchange system in block 12a in FIG. 2 that automatically integrates files containing text, graphics, images (still, animation and video) and distributes them to participants, making use of block 8 in FIG. 1. The files are transported by sound and data networks including local and wide area networks as well as satellite transmissions. Then at a predetermined time or after a group or initiator decides that brainstorming is done, the initiator(s) of the group decision can change the setup module to enable participants to vote.

A feature of the present invention is brainstorming functionality that permits a group to move back and forth between brainstorming and evaluation as required by new questions, information, and conflicts that arise in implementing group choices. For example, suppose that a group has brainstormed about meeting arrangements including separate agendas for time, place, and agenda and reached a consensus. If a conflict arises about any or all of these aspects of the meeting arrangements, the group can reenter the setup module and access the previous agenda information to resume deliberation. Such deliberation includes renewed brainstorming (entailing input of additional agenda items) as well as input of data for new collective decisions and sharing of information.

Another feature of the data collection module in block 14 of FIG. 3 in the present invention is that it pools information about agenda items synchronously or asynchronously according to inputs for all initial conditions of a collective choice communicated from the setup module in block 9 of FIG. 2 via the common data exchange module in block 19 of FIG. 3. The electronic environment of the present invention allows users to communicate and share information from their desktops sending and receiving mail messages that are transmitted in the common data exchange module. This information includes numerical, voice, graphical, and image data used to represent or provide additional information about voter

preferences or judgments. Communication also includes textual information that has been entered directly in module from the desktop or input by importing it from a network connection (wired or wireless) to other computers or computer-mediated communications devices. This mail functionality in the common data
5 exchange module automatically detects the communications protocol being used on the network and adopts the appropriate standard. For example, mail can be multimedia or it can be filtered to create ASCII versions of graphics or images; sound files can be transmitted via written versions and descriptions of sounds.

The functionality in the data collection module is significant because it
10 improves the efficiency and effectiveness of group decision making. All participants have access to multimedia, multipurpose background information without playing telephone tag, chasing each other via electronic mail, or attending long, difficult-to-schedule face-to-face meetings. Moreover, participants have a facility to exchange comments as part of a dialogue process that enables the group
15 to assess ideas critically.

The review module in block 22 of FIG. 4 receives data inputs collected from the data collection module in block 14 of FIG. 3 and processes them as they are received. Preference and judgment data are analyzed in a decision analysis submodule in block 24 of FIG. 4 according to the initial conditions input in the
20 setup module in block 11 of FIG. 2. The decision analysis submodule in block 22 of FIG. 4 processes the data to determine the collective ordering of the choice alternatives in an agenda. This submodule also provides instant identification of the scientific characteristics of a collective outcome such as "Condorcet winner(s)." (Arnold B. Urken, (1988) "Social Choice Theory and Distributed
25 Decision Making," in R. Allen (ed.) IEEE/ACM Conference on Office Information Systems. Palo Alto. A Condorcet winner is the agenda item with the highest score based on binary comparisons with all other agenda items in each voter's preference ordering. For example, in an agenda containing items A, B, and C, suppose that Jones, a voter, prefers B to A and A to C. This implies that Jones
30 prefers B to C. Jones' preference ordering is normally written: $B > A$, $A > C$ and,

by implication, $B > C$. Following the Condorcet method, B has a score of 2 (because Jones prefers it to A and C), A has a score of 1 (because Jones prefers it to C), and C has a score of zero (because Jones does not prefer it to any other agenda item).

5 The Condorcet score for a group choice is found by aggregating the preference orderings of all voters and processing the information as done for Jones. The Condorcet winner is the agenda item with the highest score. The processing of data in the decision submodule shows if the collective outcome includes a Condorcet winner or if more than one Condorcet winner exists. These
10 data results are communicated to participants in the review module numerically, graphically, and verbally. For example, the review module displays the collective ordering indicating ties by highlighting, symbols, or other means. Participants can also view the individual Condorcet ratings by making a menu choice. Graphical representations of the data can be invoked from a menu to gain insight into non-
15 obvious patterns of voting. For example, depending on the controls input in the setup menu, the organizational patterns of voting can be explored if voters make their identities public or even if they vote anonymously. The decision analysis module also outputs a verbal report about the collective outcome based on a rule-based system "filter" that reports the data results created by processing
20 information about individual preferences and judgments under different voting system submodules.

 The decision analysis submodule filters the inputs in the voting system submodules according to the controls that have been entered in the setup module. Depending on these controls and the nature of the input data derived from the data
25 collection module, the decision analysis submodule uses a rule-based expert system or artificial intelligence system to guide users in interpreting collective outcomes. A menu provides options for users to choose to explore the outcomes produced by different systems, determining if any of the rules output different results and if so, how those differences are related to the predetermined decision
30 task or objective.

A feature of the decision analysis submodule is that it makes use of a rule-based filter that matches collective choice data with scientific insights. This matching process includes taking the data type and other initial conditions output from the setup module, transforming data into appropriate form for analysis, outputting non-obvious results, communicating and displaying them to the initiator(s) and others in the appropriate form(s) (e.g.s. data, graphics, sound, video, animation) according to the specifications entered the setup module in block 11 of FIG. 2.

The decision analysis submodule in block 24 of FIG. 4 also provides broad insight when a collective decision is set up under a predetermined voting system (either because the user knows which system he/she wants to use or that the dialogue boxes in the setup module allow the user to choose a particular voting system). Regardless of the options chosen by the initiator(s), the decision analysis module extracts information output by the data collection module, performs an analysis, and communicates the results of the analysis to participants to improve their understanding of the information presented in the review module.

Depending on the controls that have been input in the setup module, outputs from the decision analysis submodule are reported during the voting process or not until all participants have voted. If analyses are reported asynchronously, the initiator(s) receive feedback and notifications about patterns of collective behavior that are selected in the setup module. For example, the present invention informs the initiator when a weak, strong, and any other type of consensus is identified even though all participants have not voted.

This asynchronous feature of the decision analysis module in block 22 of FIG. 4 operates by processing incoming preference and judgment data output by the data collection module in block 14 of FIG. 3. Preferences are converted into votes in voting system submodules and the output is analyzed to identify trends in the scores of the agenda items input in the setup module. Trend analysis includes identification of Condorcet winner(s) and other preference aggregation characteristics. The identification process takes account of outstanding voters by

analyzing all combinations in which their votes may be cast and by pinpointing the possibilities in which the group's decision objective can be predicted even though some voters have not cast their votes.

5 The asynchronous decision analysis module includes two subfeatures provide additional guidance in voting processes. One such feature is analysis of situations in which individual judgments are pooled solely on the basis of statistical description of voter preference orderings. Analytic results such as J.A.N. Marquis de Condorcet (1785), *Essai sur l'application de l'analyse a la probabilite des decisions rendues + la pluralite des voix*; and B. Grofman and G. Owen (1984), "Ten Theorems in Search of Truth," *Public Choice*) and Monte Carlo simulation results from A.B. Urken (1988) "Social Choice Theory and Distributed Decision Making," in R. Allen (ed.) *IEEE/ACM Conference on Office Information Systems*. Palo Alto are used in the decision analysis module to provide feedback to groups about the interpretation of voting data.

15 For example, Condorcet's theorem provides guidance in setting a decision rule (the rule that determines a percentage of votes that defines group consensus when voters cast a single vote in a two-item agenda (a "simple binary choice"). In this theorem, the skill or competence of voters, distributed from zero to one, is the major independent variable (though the number of voters can amplify or dampen the effects of this variable on the group probability of making a correct or optimal choice. An actual distribution of voter competencies is measured empirically over a sequence of decisions, contained in a database of measures of long-term performance, based on a statistical sample, or estimated on the basis of expert or subjective judgment. The decision analysis module compares average voter competence and the decision rule to predict the group's probability of making a correct choice. Depending on the average competence of voters (and the number of voters), processing in the decision analysis module will output a message to the review module confirming that a decision rule guarantees maximum group performance or that it should be lowered or raised. In the latter case, the decision analysis module recommends a specific change directly to the

initiator(s) or interactively in a dialogue box in which, for example, an initiator enters changes in the decision rule and the decision analysis module responds by approving the change or indicating that it is too small or too large. Another feature of the decision analysis module's analysis of voter competence in the present invention is weighting votes according to empirical measurements or subjective estimates of voter competence or expertise (L. Shapley and B. Grofman (1984). "Optimal Weighting Public Choice). In this protocol, the decision analysis module uses the same initial empirical or estimated individual voter competence data processed using the Condorcet theorem. But the Shapley-Grofman theorem describes conditions under which individuals' votes should be weighted differently or the same. When conditions indicate that the group would have a higher probability of making a correct choice if voter weights are not the same, the Shapley-Grofman theorem provides a weighting scheme for assigning a weight to each person's vote. The scheme is based on the $\log p/(1-p)$ where p is a voter's average competence and $1-p$ is a voter's incompetence.

This weighting scheme is only one of many possible methods for weighting votes that are employed in the decision analysis module of the present invention. The decision analysis module is designed to incorporate a variety of schemes. For instance, anyone looking at data in the review module can input subjective estimates of skill or competence to voters or attach actual weights assigned by experts to their own votes. The decision analysis module processes these estimates using the Shapley-Grofman theorem and determines what the optimal voter weights should be (given a set of voter competency estimates) or what the distribution of voter competence should be (given a set of voting weights).

This competency analysis feature of the decision analysis module in block 24 of FIG. 4 of the present invention is useful for determining if alternative methods of interpreting and processing data on voter competence make a difference in a group's probability of making a correct choice. Making such a determination is pure guesswork without the choice processing insights derived

from the present invention. And often the results are counterintuitive. For instance, suppose a poll is taken of experts about a "best" strategy for engineering a new material and that each expert attaches a weight to their recommendations. Also suppose that these experts are rated in a database by other members of your organization and that you assign your own subjective estimates of the experts' competencies. By asking questions in a dialogue box in the review module of the present invention, an initiator or a participant (privileged by data entered in the setup module) can determine if the processing methods make a difference and if so, how significant the difference is. In some cases, for instance, estimates for particular individuals or sets of individuals may be different, but the overall distributions may produce equivalent or nearly equivalent predictions about the group probability of making a correct choice. The present invention makes it possible to ask "what if" questions to explore the non-obvious collective consequences of using different methods for processing the data.

A second subfeature of the decision analysis module's processing of competence information in block 24 of FIG. 4 in the present invention is a protocol for interpreting voting processes that include data on voter preference structures or orderings as well as voter competencies or skills. In these situations, each voter is described by an average competence (determined from a database of empirical measurements or subjective estimates) as well as set of preferences for the items in an agenda. The preferences can be ordinal (where it is known that A is preferred to B, i.e. $A > B$) or cardinal (where it is known, say that Jones, a voter, rates A to be 5 and B to be 1, so we can infer that Jones prefers A five times as much as B).

Regardless of the type of voting data defined in the decision setup module in block 11 of FIG. 2 and pooled in the data collection module in block 14 of FIG. 3, the decision analysis module in block 24 of FIG. 4 identifies the initial conditions and processes the information through voting system submodules to provide guidance in the interpretation of the data. An initiator or participant enters queries via the review module to obtain advice. For instance, since ties (where

more than one agenda item satisfies a predetermined decision rule or indecisive outcomes (where no agenda item satisfies a predetermined decision rule) reduce a group's probability of making a correct choice, the feedback in the review module guides an initiator or participant by identifying ties associated with the scoring or voting system input in the decision setup module or selected in the review module.

DECISION ANALYSIS/REVIEW MODULE

A related feature of the decision analysis/review module in block 24 of FIG. 4 in the present invention is an analysis of voting data on voter preference structures and competencies in which dual decision rules are employed in pooling and processing voting information. A dual decision rule includes requirements for preference aggregation and group competence that must be satisfied before a collective outcome is, by definition, acceptable. A preference aggregation rule states the percentage of votes that a coalition must obtain to win, e.g. a 51% absolute majority. A competence decision rule describes how dependable the winning coalition is based on criteria such as its past performance (where this measurement is based on empirical data) and subjective estimates. The decision analysis/review module first determines if the preference aggregation requirement is satisfied and then continues to analyze the coalition's competence (Arnold B. Urken and Stephen J. Traflet, "Optimal Jury Design" Jurimetrics (1984).

If a preference aggregation rule is not satisfied under a predetermined decision rule or one that is chosen by an initiator or participant in a "what if" dialogue box in the review module, the decision analysis/review module does not continue to analyze the coalition's competence. Instead, the decision analysis/review module automatically processes voting information through voting system submodules to determine if the preference requirement is satisfied under another voting system. If the preference requirement can be satisfied under another system, the decision analysis/review module describes the system in the review module and asks initiators and participants if they want to continue with the analysis of group competence. This choice is guided by online help in the

review module that automatically spells out any differences between the original voting situation and the new one based on a different voting system. The second part of this dual decision rule assesses the coalition's dependability by using empirical data or subjective estimates of competence to compute the a priori
5 group probability of making a correct choice.

The decision analysis/review module carries out this computation using the Condorcet and Shapley-Grofman theorems, which provide a comprehensive assessment of the maximum group probability of making a correct choice. For instance, suppose that we require that a coalition be reliable 80% of the time and
10 the decision analysis module reports to us in the review module that our coalition does not satisfy requirement Then the decision analysis module will present options in the review module dialogue boxes to continue interpreting the data. For example, the decision analysis module will automatically recompute the voting data to find out if a subset of voters can be identified who meet the competence
15 and preference requirements.

This analysis is significant because it provides a non-obvious way of seeing that the group may have actually achieved its objective even though a conventional analysis suggests that the objective has not been obtained. Another feature of the present invention is a decision analysis/review module that provides
20 guidance when the decision objective is to select more than one agenda item from three or more agenda items. For instance, suppose two items must be selected from an agenda of ten items. In this situation, the decision analysis first searches for the two items that have the highest and next-highest scores in the voting method that is input in the setup module or entered in the "what if" option in the
25 review module. This search also automatically processes the voting information through all voting system submodules. The results of this processing are used as output in the decision analysis/review module to inform initiators and participants about the strength of the consensus.

If there is a tie or an indecisive outcome that occurs in pursuing the
30 decision objective of finding the top two of ten agenda items, the decision analysis

module automatically tailors the processing of information. For example, suppose that A, B, and C are in a three-way tie. The decision analysis module determines if any of the tied items is a Condorcet winner or has any other characteristic that can be used to resolve the outcome. Many possibilities are accounted for. If A and B
5 are Condorcet winners, this data is output in the review window by highlighting A and B in a collective outcome list and presenting written and oral interpretations of the display. If none of the tied agenda items are found to be Condorcet winners, the decision analysis module processes voting inputs to determine if there are any other non-obvious characteristics in the voting data that can be used to resolve the
10 tie. For instance, if A is found to be preferred to C under a different voting system, the decision analysis/review module communicates this insight to initiators and participants in the review module.

This feature is significant for initiators and participants because the feedback output from the decision analysis module provides insight that enables
15 the group to resolve a tied outcome that would otherwise involve inefficient deliberation and possible selection of C, a weak choice, as one of the two outcomes preferred by the group. The same type of feedback is provided to avoid error when the group decision objective is to select one agenda item. For example, if A and B are tied in a two-item agenda and the decision analysis module
20 determines that A is the Condorcet winner, this information is communicated to participants and initiators in the review module to enable them to select the strongest choice. Without this insight, groups typically resort to incorrect, distorting, and arbitrary methods of resolving a tie such as flipping a coin or allowing a designated or predesignated person(s) to cast a tie-breaking vote.

25 Another related feature of block 24 of FIG. 4 in the present invention 30 is the resolution of ties, regardless of the number of agenda items, when a two, three, or n-way tie occurs in a collective outcome where the objective is to select a single agenda item, the occurrence of a tie is seen as a sign of failure when, in fact, it is not. For example, a two-way tie might include two Condorcet winners,
30 so the group could flip a coin or allow an arbitrary choice without making an

error. This type of insight is impossible to gain without the decision analysis module in the present invention. Gaining such insight provides flexibility in implementing group choices. For example, this feature allows an initiator or group to evaluate the tied alternatives by taking account of factors external to the collective choice that may be important to the individual or organization (e.g. cost, timing, etc.).

Another feature of the decision analysis/review module in block 24 of FIG. 4 in the present invention is the provision of a verbal assessment of the strength of the consensus that underlies the collective outcome(s) produced. Verbal reports, based on the rules underlying the voting systems filter used in the decision analysis module, are produced by the decision analysis module and displayed in the review module. The rules of a voting filter are categorized according to the amount of detail provided about voter preference structures and judgments. When collective outcomes are consistent under all voting systems, a “maximum consensus” is reported. Gradations of verbal evaluations are reported between this extreme and a plurality winner produced under one person one vote voting when no other voting systems yield the same result. Online help (including tutorials) is provided in the menu.

A related feature of the decision analysis/review module in block 24 of FIG. 4 in the present invention is simulation of a completed voting process under different conditions. This simulation, unlike the real-time simulation options contained in the setup module, are concerned with retrospective analysis of a completed social choice process. This feature is accessed when a user makes a selection in the detail option in the review module via the user interface engine module and gains access to “what if” options for reinterpreting one or more collective outcomes. These options include the possibility of comparing the filtering of collective outcomes for the same agenda produced by two or more groups, reprocessing of voting information based on data derived from the partial privacy options contained in the setup module, and ad hoc selection of artificial

groups based on criteria such as preference structures or subjective or objective measures of skill or expertise.

This feature is significant because it allows integration of choice processing information from historical archives or from groups that carried out the same decision task without realizing it. The same feature allows reinterpretation of the same data without additional coding or data manipulation to facilitate exploratory analysis of a task. For instance, in performance review, reprocessing of voting information based on division, section, experience band, or other criteria enables an individual or group to ascertain if differences exist and what the underlying pattern of such differences is. Ad hoc formation of voting scenarios can provide the same insight into the data.

This feature is also significant because it helps pinpoint differences of opinion in an organization. This important because once the organizational parameters of disagreement have been identified, the setup module in the present invention can be used to establish new agendas to explore new options for gaining agreement and yielding stronger consensus.

Another feature of the simulation options in block 24 of FIG. 4 in the decision analysis/review module of the review module in the present invention is the determination of a best fit between voter preference structures and collective outcomes. This fit can be determined in two ways. If preferences are ordinal, statistical tests such as the Kendall Tau tests can be used to reduce the information about voter preferences to find out which subset of individual preferences accounts for 95% or more of the information. Then the identified subset can be compared with collective outcomes produced by different voting systems to find the highest correlation.

A user can access this analysis from the decision analysis/review module via the user interface module on an ad hoc basis or on an automatic basis. In the first case, a user may just want to explore or be prompted to investigate because his/her expectations or most preferred choice was not selected. In the second case,

a user wants the outcome checked to make sure that the results are reliable. In either case, the request is processed and sent to the decision analysis module, which processes it and outputs the results in a display window in the review module.

5 This feature is useful in giving an objective analysis of “the best” choice of a voting system either before or after the data have been collected. Before data have been collected, conjectures about the aggregate characteristics of voter preferences or actual measurements derived from historical data can be used to identify the initial conditions for the analysis. The result of the analysis is not
10 necessarily the choice of a single system, but identification of more than one system and a recommendation that takes account of the relative performance of the voting systems. After data have been collected, the data for a specific case can be analyzed retroactively to provide the same insight.

 A related feature of the decision analysis module in the decision
15 analysis/review module in block 24 of FIG. 4 of the present invention is an analysis of the relationship between individual and group competence under different voting systems. In this case, the Condorcet, Shapley-Grofman, and Monte Carlo simulation results (that can be conducted in real time) are used to determine the maximum difference of individual and collective behavior.
20 Consequently, statistical criteria for determining the worst fit and the direction of the distortion are used.

 If the decision situation permits collection of data for preferences and 5 competencies on a cardinal or ratio scale, this type of simulation analysis can be done with more powerful statistical tests. If either ordinal or cardinal data are not
25 available, a user can use the user interface module to input guesses to investigate “what if” scenarios. These data can be specific data by voter (useful in small group situations) or aggregate characteristics (more useful in large voting bodies). In both cases, differences in scenarios that are run to investigate hypothetical differences are displayed in multimedia displays in the decision/analysis review
30 module.

This analysis is useful in two ways. First, it provides insight into choosing a voting system before or after data collection. Second, this analysis can be combined with the "best fit" analysis to identify nonobvious tradeoffs between taking account of voter preferences and taking account of voter judgmental skills.

5 For example, a committee making investment decisions would benefit from looking at its choice process in three ways to guide its work: best preference fit, worst competence fit, and preference/competence tradeoff. This information can be useful to a committee in its deliberations, but it can also be useful to a superior (or another committee) who receives the committee's report and must decide how

10 to interpret it. A related feature of the simulation analysis in the decision analysis/review module in the review module in the present invention is the creation of databases that identify factors that explain deviations in individual and groups from predicted behavior under different voting systems. If the data are representative of ongoing decisions, they can be used to identify voting behaviors

15 in choosing a voting system for a future decision or reassessing a completed collective decision. In both cases, background factors can be identified either for groups (e.g. either by division, branch, sales or profits) or for individuals (e.g. education, job, income, psychological, preference structure, and competence) to determine the consequences structuring a choice. Group and individual

20 characteristics can be used to analyze situations in which voting options are limited, but the composition of the group is not. For example, ratio comparisons may not be reliable (in general or based on past behavior), but the makeup of a task force may be flexible. This feature allows a group or individual to build artificial voting bodies based on simulation results that provide insight into

25 expected characteristics of one or more collective outcomes. These characteristics include measures of strength of consensus and decisiveness appropriate to the task.

This feature is useful in situations in which a group is engaged in making choices with common substantive and logical characteristics. For example,

30 investment, engineering, and marketing choices have these characteristics.

A related feature of the simulation options in the decision analysis/review module in block 24 of FIG. 4 in the review module of the present invention is the ability to explore a voting analysis with a graphical or voice interface that represents a user's questions. This feature is "steering analysis." For instance, to
5 probe the strength of a consensus under preference aggregation, the dimensions of a probe can include the strength or weakness of a consensus, the decision rule (e.g. plurality, majority or even more complex rules including group competence or other social characteristics such as cost), and the number of voters. These dimensions can be accessed graphically or by voice in the decision analysis
10 module is of the review module via the user interface engine module. The decision analysis module responds to inputs that are nominal (e.g. strong consensus), ratio comparisons (e.g. maximum consensus), and ordinal comparisons (stronger consensus) to process the information and output the result data in the review window using multimedia information appropriate to the task.

15 The steering analysis feature also works with dimensions of analysis such as competence (alone) or competence combined with preference structure and background aggregate data if available (by organization or individual). In this mode, the objective of the analysis is to identify one or more ways of selecting an optimal choice.

20 In both forms of steering analysis, the definition of the objective itself can become a dimension of analysis. For instance, in assessing voter skills, the overall objective might be to select the three optimal choices from an agenda. In this case, a dimension of exploration would include choices such as "one out of three optimal choices" and "more than one out of three optimal choices" as inputs.

25 Similarly, in evaluating the prospects for consensus, exploration could include the objective of gaining a majority consensus on three items in a ten-item agenda. So typical exploration choices would include "more than one out of ten choices" and "three out of three choices."

A related feature of steering analysis in block 24 of FIG. 4 in the 35 present invention is that it outputs options to the user as dimensions and directions along various dimensions are changed. Multimedia output from the decision analysis module to the decision analysis/review module allows the user to identify
5 one or more voting systems that can be used to achieve the objective(s) used in the simulation.

The steering analysis feature in the present invention is useful because it simplifies the process of exploration for users, particularly those who do not have the time or skill to set up a quantitative analysis. This form of analysis can also be
10 used in query mode by allowing a user to input specific sets of voting system requirements and receive a report about the feasibility of using such requirements.

Another feature of the decision analysis review module in block 24 of 10 FIG. 4 in of the present invention is hypertree, the creation of a hypertext database block 27 of FIG. 4 relating collective decisions systematically to describe the
15 history of choice behavior among users. This database can show the relationship between a current decision and past decisions along dimensions including topic, time, and characteristics of the decision.

This hypertree feature enables users to keep track of trends and choices that are normally described in terms of influence diagrams or decision trees.
20 Influence trees are limited because they do not provide guidance about how to make a decision; they simply report the role of factors in the decision making process. Decision trees, in contrast, describe the logical process of producing options, but usually provide a limited view of what has happened in comparison to what could have or should have happened. Hypertree combines keyword and
25 character strings, background data, and voting records to identify reasons and influences in the decision making process.

Another feature of the decision analysis/review module in block 23 of FIG. 4 is that it includes coordinated displays that communicate multimedia,

multipurpose information to participants so that they can use it to deliberate about the interpretation of collective choice results.

The flexibility and power of modern operating system and windowing environments make it possible to use computers as more than super-adding machines that simply aggregate data based on a voting algorithm. The present invention provides an environment, embedded in a unique and original software tool, that constitutes an information base for decision analysis.

SECURITY

Another feature of the present invention provides an apparatus in block 6 of FIG. 1 for the reliable and secure operation of voting systems. The apparatus makes use of standard and non-standard network encryption and distributed cryptographic protocols to protect voting transactions and stored voting information (including quantitative and textual information). This feature guarantees the privacy of individual voting data and opinions that are input in the data collection module. The same feature protects the identity of the initiator(s) of a group choice as well as the names of voters who participate anonymously.

"FUNGIBLE" VOTING AND THEORETICAL TECHNIQUES

Another feature of the present invention provides an apparatus in block 11 of FIG. 2 for the implementation of voting methods or systems that have always been theoretically possible, but have not been used because no systems or mechanisms have been devised to handle the presentation and analysis of information, accounting, cost, and security problems. An example of this feature is establishment of an apparatus to support fungible voting, under which votes can be traded and saved like money.

Under this system or method, for example, voters are allowed to cast more than one vote per decision. Therefore they must decide how to allocate their vote endowment or resources taking account of the results of reallocating votes among decisions themselves as well as taking account of the consequences of trading

votes with others to influence collective outcomes. Feedback about outcomes as well as trends in ongoing decisions is provided in the present and unique invention to guide either individuals or groups about how to invest their resources. For instance, this feedback can guide voters in determining when to vote and how
5 many votes to allocate.

Similarly, under fungible voting, rules for reallocating votes allocated to a collective decision play a role in creating social stability (e.g. either by not allowing some voters to dominate or by preventing others from failing to achieve any positive payoffs because they are always outbid in collective decisions.
10 Reallocation rules determine if votes should be reallocated, when they should be reallocated, and how they should be reallocated. This dynamic analysis of fungible voting makes it possible to automatically regulate the redistribution of votes after each collective decision to balance voter gains and losses derived from the voting process.

15 It is important to note that this function goes beyond simple aggregation of information by providing background analysis tailored to provide insights to users for making intelligent decisions in a dynamic environment. This function also keeps track of voting transactions as well as the costs of making transactions including communications costs and broker costs.

20 This feature is significant because there are many unused voting systems that have desirable theoretical characteristics such as stability (James Coleman, "Political Money," American Political Science Review, 1973) and efficiency (J.M. Buchanan and G. Tullock, (1962, The Calculus of Consent. Ann Arbor: University of Michigan Press) and D.C. Mueller (1989), Public choice II,
25 Cambridge University Press). The complex and dynamic character of these systems requires computer-mediated guidance to identify trends and determine the proper time to begin actions such as redistributing votes.

EXTERNAL INTERFACES

Another feature of block 8 in FIG. 1 of the present invention provides communication between the invention's decision analysis and multipurpose functionality and other applications such as schedulers. A representative embodiment of these communications involves organizing them around a calendar
5 that provides an entry point for an integrated work environment for group decision making, multipurpose communications interoperability with products that handle scheduling, editing, accounting, project planning, spreadsheet work, data analysis, quantitative and non-quantitative database services, and specialized scientific is
10 packages such as chemical structure databases and analysis software and other elements of common work environments. This functionality provides original and unprecedented abilities for individuals and groups to carry out computer-supported collaborative work that provides guidance in information pooling and sharing.

This feature is important because it allows the present invention to be used
15 in an interoperable mode with other applications in a network. This functionality enhances the value of applications because the subject matter, data, graphics, images, or video information in any computer application can be invoked as input to set up a group decision from one's desktop, collect information analyze it, and, if appropriate, output the results to the original application. For example,
20 documents, spreadsheets, group calendars, data analyses, designs, and multimedia, multipurpose files can be processed in the present invention to add insight to the original application that would not have been derived without using a choice processor. In the case of a spreadsheet analysis, for example, the present invention provides original and unprecedented abilities for groups to make assessments, say,
25 of the most realistic simulation and then have the group outcome automatically exported via the Common Data Exchange Module in block 25 of FIG. 4 to the spreadsheet to compute an outcome on the basis of the collective choice.

In one representative embodiment of the present invention, a phone35 enabled version of the system makes it possible for users to input and receive
30 intelligent analysis of data, synchronously or asynchronously. This feature allows

callers to set up a group decision, collect the data, and analyze the results. The group decision setup includes dynamic question sets--already built into the multipurpose version of the system--that steer respondents depending on the patterns of their responses.

- 5 This feature is useful in electronic polling by phone for market surveys of consumers or for polls of mobile workforces. The data collected provide greater focus and insight about the structure of respondent preferences and judgments than polls that administer the same survey instrument to each subject.

- The present invention can also provide interfaces for "smart cards" or 10
10 password token records that can be used to manage the accounting of votes and security issues without jeopardizing voting secrecy. This feature is useful for simplifying the process of electronic voting by automating administrative aspects of participation. It is also useful in providing security without divulging voter identity or invading privacy (David Chaum, (1984), "Security Without
15 Identification," Journal of the Association for Computing Machinery).

- In another representative embodiment of the present invention, a mail-enabled version of the system enables users to participate in a client-server mode in synchronous or asynchronous computer-mediated decision making even though they are not directly logged into the present and unique invention. This version of
20 the system can operate in two modes.

- In one mode, the functionality obtained by mail is the same as the functionality provided by direct login. A representative embodiment of this feature of the present invention makes use of MIME (Multipurpose Internet Mail Extension) standards to allow users to make use of X-Windows emulators and
25 systems in a multivendor environment that complies with the MIME standard. For example, this feature enables international companies to pool information in the present invention without paying fees for direct network login privileges.

This mail-enabled feature of interaction in the present invention is useful because it makes it possible for users to employ Internet or other network mail node privileges, which not only lowers the cost of group decision making, but also makes it feasible for a distributed organization to communicate.

5 In another representative embodiment of the present invention, a mail-enabled feature allows users to export voting or choice data collected in another application automatically. This functionality is provided by establishing standards for other applications (including an EDI (Electronic Data Interchange)) that enable them to solve problems by mailing them to be processed in the unique and
10 original present invention. For example, if a tie occurs or if a decision by a group of experts is not very decisive, such outcomes can be sent via the common data exchange to the user interface, which will input the data in the setup module, which outputs the results to the review module and decision analysis submodules to process the voting information and display the output via the common data
15 exchange back through the MIME standard filter to the user's remote address. This feature will enable users to solve problems such as resolving ties remotely from applications that comply with standards established in the present and unique invention. This feature will not only allow users to resolve problems once they have occurred, but also allow them to avoid problems either by submitting data
20 collected asynchronously before all voting information has been received or by analyzing data before official results are announced.

Another feature of the present unique and original invention is a version of the modules that make up the invention that are tailored to situations in which nodes, machines, or processes are interpreted as if they were voters. In this
25 metaphor, the setup, data collection, and review modules as well as the common data exchange module provide a system for processing information about preferences and judgments from artificial actors (defined and created in software) that are processed to produce collective outcomes that efficiently and effectively resolve conflicts that arise in computer networks. (Urken, 1988, 1990) Explicit
30 use of voting methods has been applied to provide consistency (H. Garcia Molina

and D. Barbera, (1985). "How to Assign Votes in a Distributed System," Journal of the Association of Computing Machinery), manage distributed databases (R. van Renesse and A. S. Tanenbaum (1986). "Voting with Ghosts," Proceedings of the Eighth International Conference on Distributed Computing Systems), and
5 reorganize failed networks (D. Barbara and H. Garcia-Molina (1987), "The Reliability of Voting Mechanisms," IEEE Transactions on Computers), but none of these applications has made use of the voting systems for filtering information contained in the present invention. Moreover, the present invention's filtering of information makes it possible to extend the applications of voting methods to a
10 greater scope of tasks.

For example, a feature of the present invention is to provide consistency in computer networks by processing preference and judgment information of nodes to enable a group to achieve its objective. This is useful, for example, because voting systems based on "coteries" include no way of breaking ties. In the present
15 and unique invention, however, ties can be avoided by changing the voting system. This is useful because it makes the process of searching for consensus among nodes more efficient. This filtering can also be used to improve the reliability of the decision rendered by the voting nodes (Arnold B. Urken, 1990, "Distributed Control via Agent Voting" in R. Allen (ed.) Proceedings of the
20 IEEE/ACM Conference on Office Information Systems). This is useful because it accommodates the assumption that nodes are imperfect and compensates by choosing a voting system by processing the preferences and judgments nodes in the present and unique invention. Coterie processing and other voting techniques rely on the assumption that if a node is working (or "alive"), it is perfectly
25 reliable.

This strong assumption, limited by the fact that nodes can all be alive and render imperfect choices, is unnecessary in the present invention.

Another example of the usefulness of the present invention is in phone routing as a form of "dynamic routing" in the voting process is regulated to
30 control the congestion and load balancing of a phone network. By distributing the

voting process so that nodes form preferences (inversely related to the amount of congestion on a linkage) and judgments (from their experience) based on their positions in network linkages for assigning an incoming call, the efficiency of phone routing can be improved. Moreover, this technique serves as a basis for
5 creating a self-regulating phone network. (Arnold B. Urken, "Distributed Control via Agent Voting," Proceedings of the IEEE/ACM Conference on Office Information Systems, MIT, 1990).

Another example of the usefulness of the present invention is in managing access to resources in a network. This application provides an alternative to the
10 first come, first serve queuing that is used to resolve conflicts among processors about access to printer, disks, tapes, faxes, network gateways, and other resources. Each of these conflicts involve a group decision situation in which nodes and processes can formulate priorities according to internal rules and engage in a group decision making process mediated by the present and unique invention
15 (Arnold B. Urken, "Asynchronous Voting and Consensus in Computer Networks," Paper Presented at the Annual Meeting of the American Political Science Association, August 31, 1991).

HOW THE FEATURES ARE EMPLOYED BY A USER

Choice processing in the present and unique invention involves
20 transactions identifiable in terms of common logical characteristics including the role of the decision maker, the decision task or objective, the timing of the decision, and the analysis of voting information. This description of the invention is based on typical voting situations that embody these characteristics. The following descriptions of the invention first assume that the actor, agent, or user is
25 a human who opens a role. Then the operation of the invention is described for nodes or processes as if they were actors, agents, or users.

An actor opens a role in Fig. 1 at block I of the User Interface Module in the group decision making environment. The actor can choose among initiating a collective decision in block 2, voting or selecting in block 3, brainstorming in

block 3a, or reviewing a decision in block 4. Opening a role can be done by uttering a command, typing in information on a keyboard (e.g. at a command line prompt), using a mouse, roller ball, pen, or other mechanical device, or employing any other communications mechanism. Opening a role can also be done from
5 within another application that provides functionality that is compatible with the present and unique invention.

If an actor chooses to initiate a decision in the present and unique invention in Fig. 1, this choice is processed in block 1 and communicated to the Common Data Exchange module in block 6, which processes and sends it to the
10 Setup Module in Fig. 6, where it is processed to produce a display of information that presents a menu' of options contained in blocks 1 through 13 The actor uses the User Interface Module at block 1 to input choices via the Common Data Exchange at block 6 to set up a collective decision. Alternatively, an initiator may select a preconfigured set of inputs from block 1 that is a model or template. This
15 template, which may be the saved results of menu input of initial conditions for a collective decision, may itself be modified.

When inputs are entered via a menu in block 2 of Fig. 1, they are processed by the Setup Module in Fig. 6 and output to the Data Collection Module in Fig. 7 and Review Module in Fig. 8, where they are processed and used as
20 inputs for the parameters of processing of voting information. The following inputs are entered in Fig. 6 into the system in the following default order, though an initiator can modify this sequence.

An initiator of collective decision must first create an agenda by choosing the File option at block 1 in Fig. 6, selecting the New option. After an agenda name is added, a description of the agenda topic can be input in the display of the name in block 5 of Fig. 6 by double clicking on the name and filling in a popup window. Agenda items are added by entering a name in block 7 of Fig. 6 and then selecting the Add option in block 8 of Fig. 6. Selecting the Add option displays the item in a list in block 6 of Fig. 6. The initiator can then select an item and fill
30 in detailed information by selecting the Detail option in block 12. Attachments of

sound, graphic, animation, video, and multimedia documents are made via the menu at block 14 of Fig. 6. These files, located anywhere on the network, can be accessed by entering an address or entering the name or part of the name of a file to be searched by a daemon across the network. The daemon makes use of a filter
5 in block 13 that allows a search by file type across the network that produces a list of file choices that can be imported. Attached files or pointers to their network addresses are stored in a database contained in block 7 of Fig. 1. Agenda items can be edited by making use of the Delete option in block 9 of Fig. 6, the Change option in block 10, or the Undo option in block 11. Agendas can be modified by
10 entering their names in block 7 and selecting the same editing options.

If an initiator tries to set any of the setup inputs before opening an is agenda, a window opens in block 6 with a reminder that an agenda must exist before any other conditions are set.

Next, according to the default sequence, the initiator sets the properties of
15 the collective decision in block 2; who will participate, how they will be identified, and when they will participate. Participants can include the whole network, random sets of network users, random sets of users with specific demographic or other characteristics, identifiable groups of individuals (e.g. a division or unit of an organization), nominal groups (e.g., a task force or project
20 team), or groups selected on an ad hoc basis by the initiator by scanning a listing of all users. Then the initiator sets voter identification options in block 2. These options allow participants to act frilly identified, anonymously, or with gradations of anonymity. The latter option allows a participant not to divulge a name, but communicate other information (e.g. sex, job description, income, and other
25 characteristics).

The next default input is the scoring or voting system in block 3. If the
30 initiator wants a specific voting system, a selection can be made from the menu in block. Different levels of help on choosing a scoring system are available from the menu. Descriptions of systems facilitate initiator choice, but the initiator can enter a dialogue mode in block 2 to obtain further guidance in choosing a voting

system. This guidance is based on collecting information about the parameters of the collective decision (e.g. the number of voters and the decision task(s)) so that a choice of systems or a specific system can be recommended in a display in Fig. 6.

5 If guidance in choosing a voting system involves a specific situation or a sequence of decisions in which other parameters of a voting process can be analyzed, the Review module [Fig. 8] opens automatically to allow the initiator to analyze the non-obvious implications by selecting menu options.

10 In a single collective decision, for instance, the initiator can enter data in block 4 of Fig. 8 to explore “what if” scenarios associated with the preferences and competencies of the voters. (This analysis is possible because the initiator has already specified the group in block II of Fig. 2 shown in a typical representation in block 2 of the Setup Module, [Fig. 6]. These simulations allow the initiator to analyze and formulate expectations about the incidence of ties, indecisive
15 outcomes, Condorcet or Copeland-efficiency (gauging the strength of the consensus) under different systems, and different ways of weighting votes. In each case, a single decision is randomly selected from the scenario composed by the initiator in Fig. 8. This analysis makes it possible to scrutinize the implications of complex decision tasks and gain insight into the choice of a voting system.

20 If voters have established preference profiles in block 7 of Fig. 1, this data can be used as input for a voting system analysis in block 4 of Fig. 8 to guide the choice of a voting system. Similarly, if experts have established records of performance, measurements of their reliability contained in block 7 of Fig. 1 can be incorporated into the analysis.

25 For a sequence of collective decisions, the initiator can select a simulation that is based on 1) conjecture or educated guesses entered in block 4 of Fig. 8 or on 2) empirical estimates of patterns of behavior derived from a database in block 7 of Fig. 1. In the first case, the simulation randomly selects a number of cases (specified by the initiator) and repeats the selection process enough times to yield

statistically reliable predictions. In the second case, the simulation makes use of measures of preference structure and competency to provide the initial conditions for the analysis.

In both cases, the simulation allows the initiator to explore what 30
5 happens if decision requirements for preference aggregation and competence are defined (e.g. 51% of the votes plus an a priori group probability of .8 of making a correct choice). For simulations that take account of measured past behavior or conjectures about long-run patterns of behavior, this analysis compares measures of collective competence including the Condorcet "jury theorem" and the
10 Shapley-Grofman theorem to determine if there is a difference. Differences are presented in a popup window in Fig. 8 to allow an initiator use the information in selecting a scoring system.

Since the composition of a group of voters can affect the inputs of a collective decision process, the initiator can modify any simulation by changing
15 the definition of the participants in block 4. If changing of votes is expected to be a significant factor in a collective choice (e.g. if voting is asynchronous and takes place over a period of days) the simulation includes options for taking account of this by allowing the initiator to select menu options for determining how many voters are likely to change votes, how many times they are likely to do so, and the
20 average or expected number of vote exchanges and trades. The implications of these changes are described by showing if and how changes in individual votes effect the collective outcome (including the collective ordering). This allows the initiator to explore the likelihood of finding stability or an equilibrium in a dynamic collective choice process. This is particularly important if the initiator
25 wants to explore the possible consequences of using fungible voting (where votes can be traded).

All of the simulations provide the initiator with reports comparing the analysis in quantitative and qualitative terms. For example, these reports show the probability of a decisive outcome (under different decision rules such as majority)
30 allowing the possibility of partially achieving a goal (e.g. selecting two out of ten

choices, but not the three out of four choices required). These reports, displayed in block 6 of Fig. 8, also take account of strength of the consensus and, if appropriate to the decision task, competence. Tradeoffs among these results are highlighted in these reports.

- 5 When the initiator selects a voting system in Fig. 8, the selection is displayed automatically in block 3 of Fig. 6, Fig. 8 is closed, and the input of initial conditions by the initiator continues.

Next in the default sequence of setup inputs block 2 of Fig. 6 is timing. The beginning and end of the collective decision making process is specified for
10 decisions that are synchronous (same time) or asynchronous (different time).

The next default input in block 2 is the privilege to edit the agenda. This privilege is reserved for the initiator unless it is shared with some or all of the participants. If sharing is selected in block 2, then brainstorming mode is automatically selected. This selection means that when the setup inputs in Fig. 6
15 are completed and the agenda file (to which all of these settings are attached) is saved and closed in block 1 of Fig. 6, participants with the editing privilege can add items to the agenda or delete items that they have added.

If the initiator selects brainstorming in block 3a of FIG. (shown in a representative embodiment in block 4 of FIG 6), participants cannot vote or score
20 alternatives in block 3 of Fig. 6. I shown in a representative implementation in blocks 5, 6, and 7 of Fig. 7 and the default setting for scoring is automatically “disabled” rather than “enabled” in block 5 of Fig. 6. In this mode, when the initiator completes the setup inputs in Fig. 6 and closes this module, every member of the group invited to participate receives a mail message sent via block
25 12a to the list of names associated with an agenda in block 13, the Agenda Database. This message notifies participants that they are scheduled to take part in an agenda. In brainstorming mode, a participant can add and delete items from block 6 in Fig. 6 by making use of the active window in block 7 and the editing options in blocks 8 through 13. As soon as a participant in brainstorming saves

any changes to the agenda, these inputs are displayed to other participants in block 4 of Figure 7. The functionality in blocks 6 and 7 is disabled or not displayed, but information about each item listed in block 5 can be entered publicly or privately in block 4 and exchanged via mail in block 3 of Fig.7.

5 The mail messages sent when an initiator saves an agenda in block 1 of 20 Fig. 6 or when a participant shares comments about agenda items in block 3 of Fig. 7 make use of a MIME (Multipurpose Internet Mail Extension) compliant standard in block 6 of Fig. I, transparent to the user. This standard allows a remote user to see the agenda with background information just as it is in Fig. 6. The
10 MIME filter automatically provides ASCII versions of image and sound files and text for remote users who cannot display these files when accessing the information via block 8 in Fig. 1 These information transactions are processed via blocks 5, 6, 7 and 8 of Fig. I.

 A user who has been invited to participate in a decision can respond via
15 block I in Fig. 1. If agenda participants are outside of Fig. 6, Fig. 7, or Fig. 8, they can be notified by synchronous communication (e.g. beeper) if they have set up their mail profile in this way for a particular agenda. Alternatively, the icon or voice interface in Fig. I the receipt of a mail message can be indicated by a flashing add-on to the icon or a repeated voice reminder. Either of these
20 notifications allows a participant to access the mail message(s) by touching the mail portion of the icon with a mouse, pen, or finger or by responding with a vocal command. The response to this notification can be made by vocal commands, by graphical interface, or from a command line via Fig. 5, transparent to the user. When a participant chooses the Vote module in Fig. 3, the information
25 in this display is automatically configured to show the agenda created by the initiator (or group of initiators). Brainstorming agendas are distinguished from voting agendas and brainstorming agendas are further identified as scoring enabled or scoring disabled. A pop-up window also automatically opens to indicate the properties of each agenda (from block 2 in Fig. 6) 50 that the user
30 does have to open or reopen the entire display in Fig. 2. This window can be

closed and reopened again if necessary from within Fig. 3 shown in a representative embodiment at block of Fig. 7.

If a user has been invited to participate in more than one agenda, a directory of pending agendas is automatically opened in block 14 of Fig. 3 50 that
5 the users can set their own priorities. This directory includes the name of the agenda, initiator(s), and schedule; agendas in brainstorming and vote mode are identified.

When a participant chooses an agenda in brainstorming mode, the setup module Fig. 6 and data collection module Fig. 7 automatically open. Participants
10 (and the initiator) can add or delete items in the agenda list. This list can consist of problems or solutions that have to be evaluated. As participants add and delete items and provide background information on this list, these changes are displayed in Fig. 7 as soon as the files are saved in block I of Fig. 6. ~ block 4 of Fig. 7, participants can access background information on agenda items and can
15 make public or private comments. Participant comments can include imported multimedia files accessed via blocks 5 and 6 of Fig. I. These files are requested in block 28 of Fig. 5 and processed in block 29 of Fig. 5, file controls in blocks 30 and 31 are invoked depending on the type of file. Participant comments can also be commentary that is directly related to multimedia information that is cut from
20 background information windows in block 4 of Fig. 7 and copied into a private comment window that opens in the same block.

Participants can also use this module to exchange private comments via the mail option in block 3 of Fig. 7. Selecting this option brings up a mail submodule that allows a participant to identify the recipients of a message and
25 permits a participant to attach a cover note. Sending the message automatically extracts private comments and (when scoring is enabled in block 5 of Fig. 6) scores related to all agenda items.

Mailing the message is done using a MIME (Multi-purpose Internet Mail Extension) compliant interface in Fig. 7. This enables a sender to choose

electronic mail, voice mail, or fax for sending a message. The outgoing mail is automatically filtered to display in a mode that is appropriate to the recipient of a message.

Agenda participants who receive mail related to an agenda will be notified
5 if they are working in Fig. 6, Fig. 7, or Fig. 8 so that they can retrieve the message and respond appropriately. For example, a message may lead to new comments or to new mail messages to clarify issues and arguments.

If agenda participants are outside of Fig. 6, Fig. 7, or Fig. 8, they can be notified by synchronous communication (e.g. beeper) if they have set up their
10 mail profile in blocks to evaluate and score.

Once the initiator or a group has enabled voting, participants can vote in Fig. 7a, making private and public comments as part of the process of informed deliberation. The option for mailing personal, private opinions from the menu in Fig. 7 now includes the possibility of exchanging scores and votes as well as
15 comments. These mail exchanges allow users to develop a dialogue to refine arguments. Votes may be changed in response to this dialogue or new comments may be entered explaining one's choices.

If the initiator has set up the privileges in Fig. 2 to allow participants to review the results of the vote, the review module in Fig. 8 can be accessed. This
20 access will automatically be provided once a participant has voted and saved the scores. Regardless of whether a participant is in Fig. 2 or Fig. 3, information analyzed in Fig. 4 can be obtained by providing a voice command, graphical interface command, or command line command via Fig. 5. If a participant is currently a member of only one ongoing agenda, analysis of data for that agenda
25 will automatically be displayed in [Fig. 4]. Otherwise, a directory of agendas a participant is working on or has worked on will be displayed to allow the user to choose which agenda(s) to review.

When the roles of initiator, selector, or reviewer are played by nodes or processes instead of humans, the invention operates in the same way, though the interface for obtaining and sharing information may differ. If an intelligent robot or similar actor is programmed to act as if it were human, blocks 2, 3, and 4 of Fig. 1 (represented in Figs. 6, 7, and 8) would operate in the same way. However if the intelligent actor is software defined, only, the input and output would be tailored to predetermined rules for making decisions that are part of a template designed for one or more specialized tasks. Such tasks include the same logical characteristics of agenda creation, scoring system setup, data collection, and decision analysis. These tasks include distributed database management, reorganization of a failed network, resolution of conflicts about scarce network resources, and routing of phone calls.

In a typical task, an initiator makes use of block I of Fig. 1 to create the initial conditions in block 2 for a collective decision that is processed in the data collection phase in block 3 and review phase in block 4. In phone routing, for example, the options in Fig. 6 are preset by a programmer to allow maximum flexibility in the choice of a voting system to enable the network to achieve goals such as load balancing, minimum average delay, and responsiveness to radical changes in demands for service. To facilitate goal attainment, a template is created on the basis of simulations to identify the conditions under which data about preferences should be represented in different ways and analyzed to guide decision makers.

As calls arrive to be routed, each node formulates preferences by inversely rating each choice for routing a call. Votes are then allocated according to the rules. Preference ratings and votes are broadcast throughout the network so that each node obtains the same voting information and processes it. Here review of the data can work in 3 of Fig. 7 in this way for a particular agenda. Alternatively, in the icon or voice interface in block I of Fig. I, the receipt of a mail message can be indicated either by a flashing add-on to the icon or by repeating a voice-message reminder. Either of these notifications allows a participant to access the

mail message(s) by touching the mail portion of the icon with a mouse, pen, or finger or by responding with a vocal command.

Only the initiator of the brainstorming session can "enable" voting in block 5 of Fig. 6 50 that participants can begin evaluating the list by scoring or voting on the agenda items in blocks 5, 6, and 7 of Fig. 7a. However this choice, like all the other menu options in the setup module, can itself become an agenda that participants use in two ways. First, each node can act as if it had initiated a decision and were acting to pool and analyze the information in an advisory way. Since all nodes have the same information and operate on it with the same rules, there is no clear distinction between individual (node) and collective decision making. Second, data can be transmitted to a node designated as the official vote recipient and data analyst.

BRIEF DESCRIPTION OF THE PSEUDOCODE

The logic of the exemplary processor is illustrated in the following sequence of steps:

1. Set choice conditions: timing, notifications, privileges, agenda items, background information in block I of FIG. 9.
2. Determine voting method in block 2 of FIG. 9: if method is directly chosen based on existing help, use dialogue boxes to guide choice to make maximum filtering of information available for monitoring the choice process and reviewing the collective outcome.

if method is not directly chosen in block 2 of FIG. 9, use dialogue boxes to select the best method of voting and provide maximum filtering of information available for monitoring the choice process and reviewing the collective outcome.

if a template is chosen for a particular task in block 2 of FIG. 9, the is voting method is preset.

3. Voters examine agendas and vote in block 3 of FIG. 9: information may be added to agenda item detail windows and data from public windows can be copied to private comment windows for comments; private comments can also be shared votes allocated in a way that is consistent with the settings. depending
5 on setup conditions, the group

can opt to brainstorm to modify the agenda by invoking the brainstorming template in block 2 of FIG. 9 and can move back and forth as appropriate between brainstorming and voting in block 2 of FIG. 9

votes and private comments can be mailed to share information in block 4
10 of FIG. 9.

4. Review of voting outcomes in block 4 of FIG. 9:

in process reports are made that indicate trends based on a comparison of different voting methods.

voting outcomes for different systems are compared to assess the
15 strength of a consensus based on the inferences that can be drawn from individual and collective ordinal and cardinal ranking information. Verbal reports and individual and collective scores are provided.

individuals and groups can review the interpretations of data and obtain guidance to deliberate on ties, indecisive outcomes, assessment of expert choice,
20 and special situations such as the selection of more than one choice from an agenda. Each report is based on the comparison of voting outcomes in all of the voting algorithms contained in block 4 of FIG. 9.

GLOSSARY, NOMENCLATURE, AND DEFINITIONS

The following descriptions are presented to clarify the generic
25 characteristics of the present invention for gauging group choice processes. "Voting" is a metaphor for actions that communicate information about preferences and judgments about a set of choices and enable us to define a

collective outcome. There is no generally accepted standard scientific notation for voting methods that provides a consistent guide between scientific analysis and practical usage of voting methods. Our experience in developing this invention indicates that "voting" activities may be more appropriately presented using terminology such as "selecting" or "choosing" and "scoring system" in the interface. For this reason, the invention includes the option for using different descriptors for parts of a voting process. Although verbal metaphors such as "voting with one's feet" are still commonly used, quantitative representations of voter preferences and judgments involve algorithms that have been discovered and lost several times (see I. McLean and A.B. Urken (eds.) *Classics of Social Choice* (in press) University of Michigan Press). Since the eighteenth century, however, these algorithms have been named and formalized mathematically in axiomatic, algebraic, and probabilistic terms.

The present invention makes use of the information about (and derived from) voting algorithms in the context of three stages of a group decision process: either 1) the formation of voter preferences and judgments, 2) the filtering and representation of preference and judgment information by voting rules for allocating votes, or 3) the aggregation of allocated votes by group decision rules (e.g. majority rule).

The preference information that serves as input for a voting process can be measured or defined on either a cardinal or ordinal scale. Cardinal inputs are numbers or numerical comparisons that indicate how much more one alternative is preferred than another. Ordinal preferences simply show if one alternative is preferred to another and do not measure intensity of preference. Ordinal comparisons can include nominal classifications such as "good" or "average" that implicitly indicate that one set of classified items is preferred to another.

Complex voting systems such as "fungible voting," where votes can be saved and traded like money, involve dynamic patterns of action that have not been supported by mechanisms such as those provided in this invention. The present invention not only provides a structured framework for supporting such

systems, but also offers dynamic analyses that guide users in making decisions about the best use of their resources in pursuit of their objectives. These systems implicitly include the notion of same time (synchronous) and different time (asynchronous) action.

5 In the present invention, the notion of an “agenda” is a fundamental organizing concept for structuring, a group decision making process. Sometimes the term “agenda” is used to describe the substantive topic of a choice, but the system and method used in this invention defines an “agenda” to include
10 attachments that explain what the choices are (including multimedia attachments that provide background information), who makes the choices (including different definitions of voter identity consistent with gradations of privacy as well as privileges set by the initiator), and how the choices will be made (including the timing of the choices and voting systems used to process information). This organizing concept provides a basis for treating an agenda as a collection of
15 objects both in abstract terms as well as in computer programming terminology. In computer programming terms, an agenda is not only an object for “object oriented programming,” but is also an object in the sense of an Electronic Data Interchange (EDI), a standard object or format for communicating voting information so that it can be analyzed in the present invention.

20 It is important to note that the use of the terms “multimedia” and “multipurpose” are not necessarily redundant. The latter term, associated with standards such as the MIME (Multipurpose Internet Mail Extension) standard, is used to indicate the purpose of a part of a message that includes non-textual information. In contrast, “multimedia” refers to the use of more than one medium
25 to convey information without being more specific. The description of present invention follows the emerging convention of using both terms to communicate both to audiences that understand the general idea of messages that incorporate more than one medium and to audiences that expect a more specific description of the relation between the use of a computer-mediated medium and the purpose of a
30 message.

What is claimed is:

1. (New) A method of determining dynamically weightable consensus comprising the steps of:
 - a. defining collective decision objectives;
 - 5 b. selecting at least one from a set of applicable scoring rules and statistical methods;
 - c. selecting applicable group parameters;
 - d. assembling a group characteristic of said parameters;
 - e. providing said group with distinguishable options;
 - 10 f. tabulating responses to said options by members of said group;
 - g. processing said tabulation applying said selection from said set of scoring rules and statistical methods;
 - h. identifying at least one coalition of said responses within said tabulation;
 - 15 i. quantifying the strength of each said coalition within said tabulation;
 - j. identifying judgments and preferences within said tabulation;
 - k. applying said collective decision objectives to said tabulation;
 - l. depicting the outcome; and
 - 20 m. applying at least one of steps a through l recursively to said outcome.
2. (New) A method according to claim 1, further comprising the steps of:
 - a. performing an analysis of said outcome for properties related to said collective decision objectives; and
 - 25 b. preprocessing said tabulation to refine said outcome incorporating said properties; and
 - c. performing an analysis of said outcome recursively to refine said properties.
3. (New) A method according to claim 1, further comprising the steps of:
 - 30 a. adjusting said outcome for the competence of said group;

- b. preprocessing said tabulation to compensate for said competence;
 - c. providing options for demanding at least one of that respondents reply to follow-up questions with structured choices about unanswered items or explain unanswered items using free-form comments.
- 5 4. (New) A method according to claim 1, wherein said members are prompted for an explanation of any of said responses which are incomplete comprising the steps of:
 - 10 a. defining the responses to a set of items that are incomplete because they at least one of are missing voting data or include responses that are inconsistent with each other;
 - b. detecting said incomplete responses;
 - c. prompting for one of said response or an explanation for the absence of said response;
 - 15 d. optionally incorporating the explanation into the outcome; and
 - e. determining if the incomplete data would change said outcome.
- 5. (New) A method according to claim 4, wherein said outcome is refined by incorporating an analysis of said explanations recursively.
- 20 6. (New) A method according to claim 1 comprising the further steps of:
 - a. performing a conjoint analysis identifying at least one distinguishing characteristic of said members that exhibit common preference order in said outcome; and
 - 25 b. adjusting said outcome to account for said characteristic.
- 7. (New). A method according to claims 1 comprising the further steps of:
 - 30 a. determining whether said outcome was biased by the sequence in which binary responses to options are ordered against each other; and

- b. disclosing how to alter said selection from said set of scoring rules and statistical methods to compensate for said bias in said outcome.
8. (New). A method according to claim 1 further comprising the steps
5 of:
- a. prompting for what-if hypotheticals; and
- b. preprocessing recursively said tabulation to apply said what-if hypotheticals.
9. (New) A method according to claim 1 comprising the further steps of:
10
- a. storing said outcome, and
- b. comparing said tabulation to said stored outcome to discern trends over time.
10. (New) A method according to claims 1 wherein said method comprises a digital storage device with an operating system, addressable memory and
15 executable software and further comprises the steps of:
- a. performing said steps using executable software;
- b. prompting an of said method interactively; and
- c. storing said tabulations using a database access method.
11. (New) A method according to claim 10 wherein said method comprising
20 an applications program interface enabling at least one of initiation, tabulation, and reporting by a software tool.
12. (New) A method according to claim 11 wherein said method comprises an object in a distributed network applications program interface enabling at least one of said software tool to function remotely.
- 25 13. (New) A method according to claims 1 wherein said method comprises a communications network with circuits, nodes, and intelligent network management apparatuses and the steps of:
- a. analyzing the utilization of said network;
- b. allocating resources;
- 30 c. routing messages;
- d. compensating for faults;

- e. optimizing traffic utilizing said network;
 - f. scheduling resources of said network;
 - g. depicting said utilization; and
 - h. suggesting optimum configuration for said network.
- 5 14. (New) A system for representing a dynamically weightable consensus said system comprising:
- a. a means for defining collective decision objectives;
 - b. a means for selecting at least one from a set of applicable scoring rules and statistical methods;
 - 10 c. a means for selecting applicable group parameters;
 - d. a means for assembling a group characteristic of said parameters;
 - e. a means for providing said group with distinguishable options;
 - f. a means for tabulating responses to said options by members of said group;
 - 15 g. a means for processing said tabulation applying said selection from said set of scoring rules and statistical methods;
 - h. a means for identifying at least one coalition of said responses within said tabulation;
 - i. a means for quantifying the strength of each said coalition within said tabulation;
 - 20 j. a means for identifying judgments and preferences within said tabulation;
 - k. a means for applying said collective decision objectives to said tabulation; and
 - 25 l. a means for depicting the outcome.
15. (New) A system according to claim 14, further comprising a means for tabulating said responses where said group includes non-human members.
16. (New) A system according to claim 14, further comprising a means for tabulating said responses where voting data are communicated by at least one of
- 30 sound, numbers, text, or graphics.

17. (New) A system according to claim 14, further comprising a means for tabulating said responses where said voting data are communicated by at least one of a computer-mediated wired or wireless network.
18. (New) A system for representating a dynamically weightable consensus
 5 among choices selected from an agenda of options, input from a group of individual voters under the direction of an initiator of a decision, said system comprising:
- a. means to determine media for:
 - i. said input of said choices, and
 - 10 ii. output of said consensus;
 - b. means to interface with said media;
 - c. means to limit the distribution of said consensus;
 - d. means to accept direction from said initiator;
 - e. means to determine characteristics of said individual voters;
 - 15 f. means to select among said individual voters to compose said group;
 - g. means to determine attributes of said group in the aggregate;
 - h. means to create said agenda from which said choices are selected;
 - i. means to select one of synchronous or asynchronous modes of
 20 interaction;
 - j. means to interact with said voters using said mode;
 - k. means to store said choices;
 - l. means to select at least one from a plurality of scoring methods;
 - m. means to dynamically weigh said consensus among said choices
 25 applying each of said scoring methods to:
 - i. aggregate preferences of said group;
 - ii. impute competence to said group;
 - iii. ascertain how said preferences might vary under another of
 said scoring methods,
 - 30 iv. resolve any ties among said preferences,
 - v. determine said consensus,

- vi. assess strength of said consensus,
 - vii. simulate retrospective alternatives,
 - viii. recommend a "best choice" from said consensus,
 - ix. facilitate what-if analysis of said consensus,
 - 5 x. explain deviations within said consensus from predictive norms, and
 - xi. conduct "steering analysis" of said consensus;
 - n. means to create a hypertext database; and
 - o. means to coordinate user cognizable displays to said voters;
 - 10 p. means to output said representation of said consensus to said initiator.
19. (New) The system of Claim 18, wherein said scoring method further comprises "fungible voting."
20. (New) The system of Claim 18, wherein said system further comprises a
- 15 means to compensate said voters.
21. (New) The system of Claim 18, wherein said individual voters comprise non-humans.
22. (New) The system of Claim 21, wherein said non-human voters further comprise at least one of telecommunications routes, network nodes, machines or
- 20 processes.
23. (New) The system of Claim 21, wherein said storage further comprises data encryption.
24. (New) The system of Claim 18, wherein said interface to said media further comprises data encryption.
- 25 25. (New) The system of Claim 18, wherein said system further comprises an application program interface to compatible external applications. –

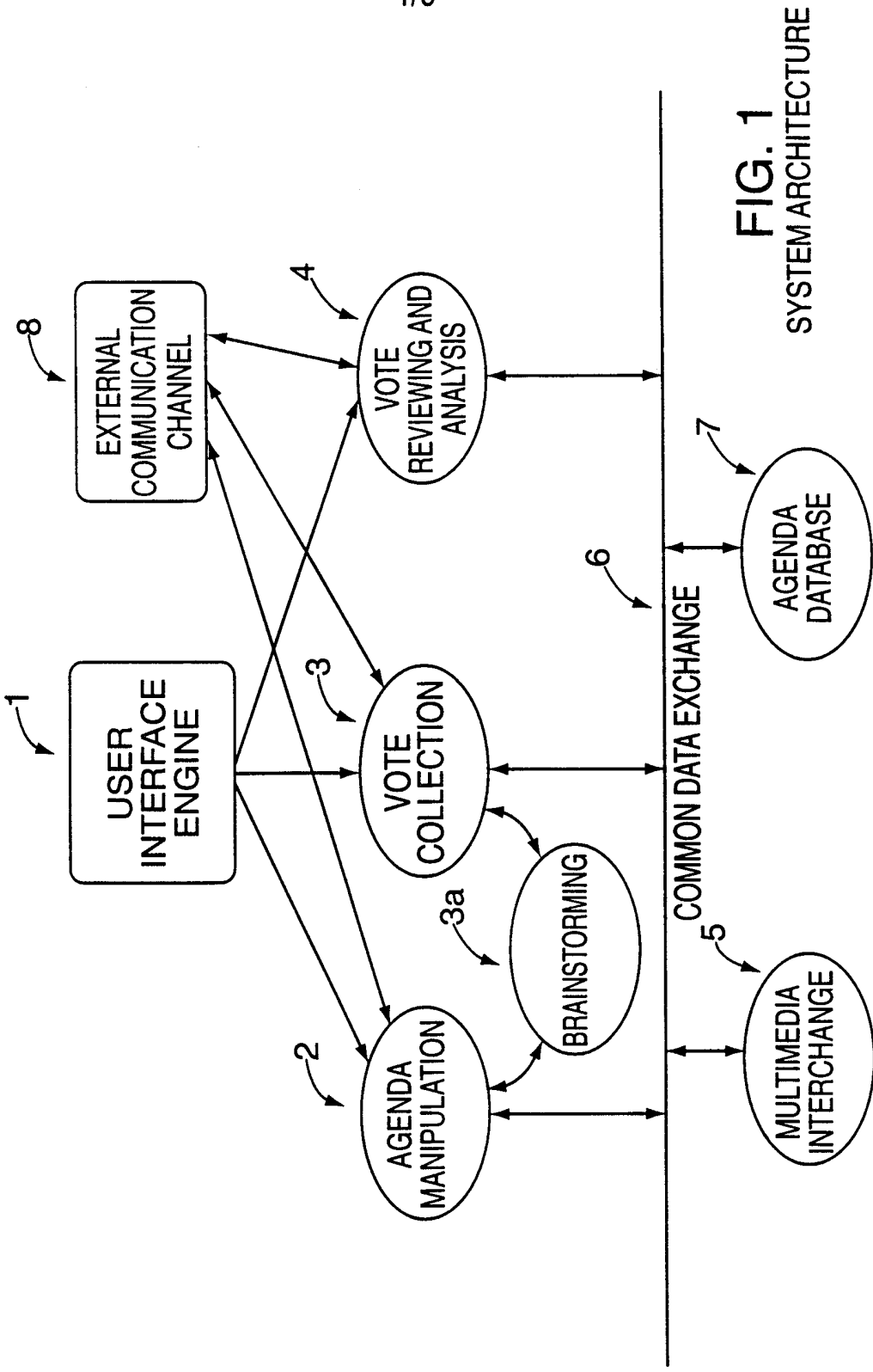
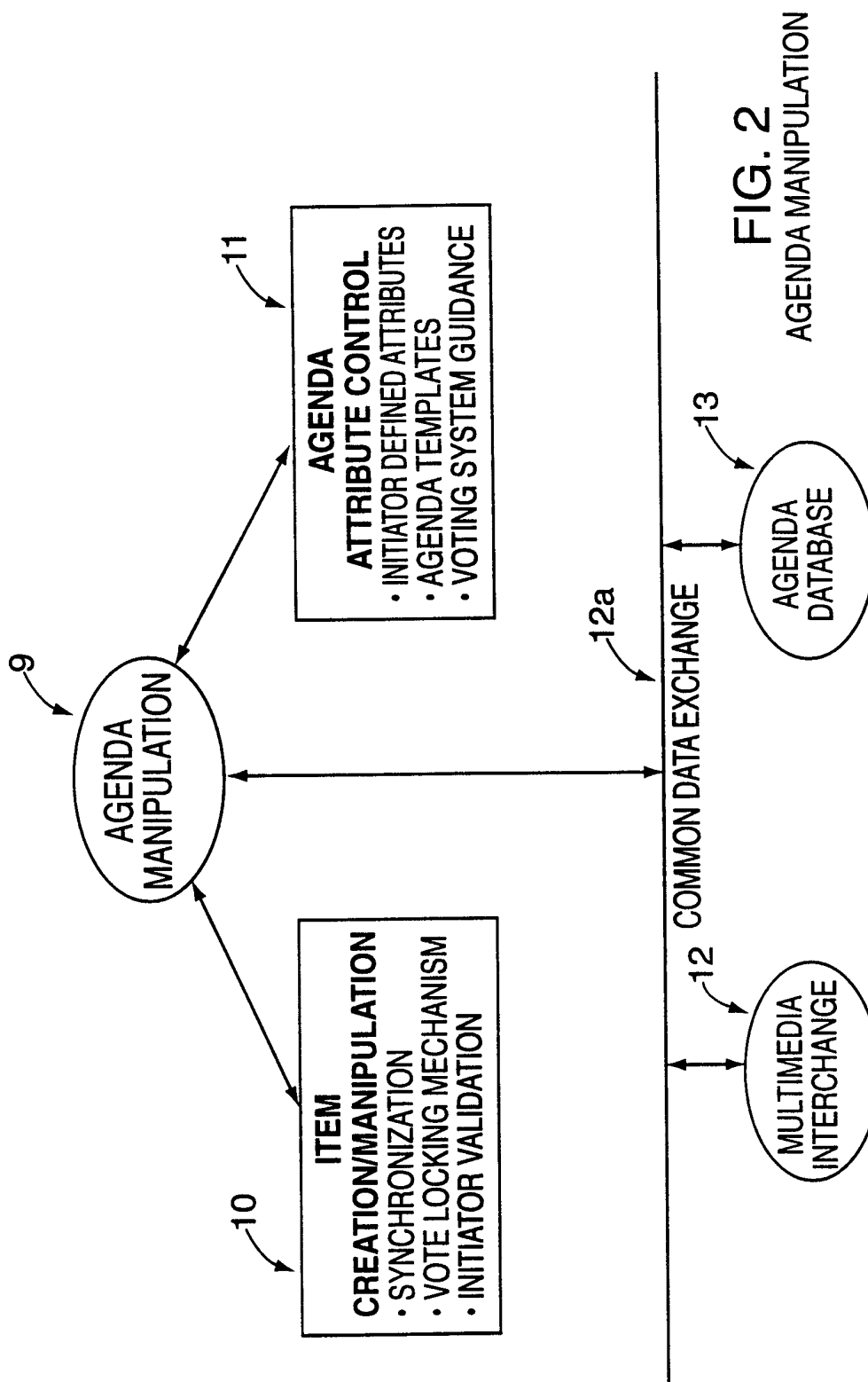
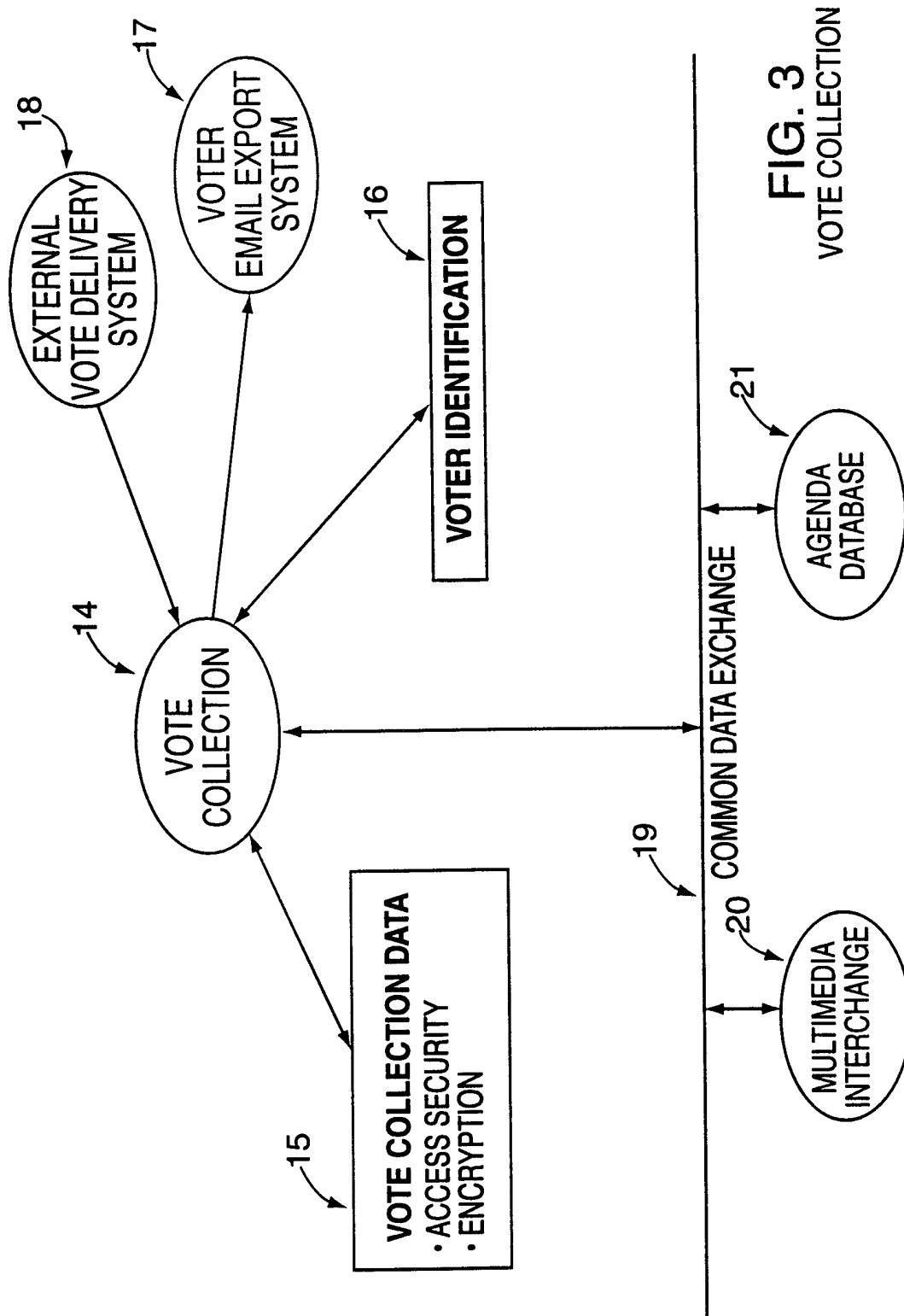


FIG. 1
SYSTEM ARCHITECTURE

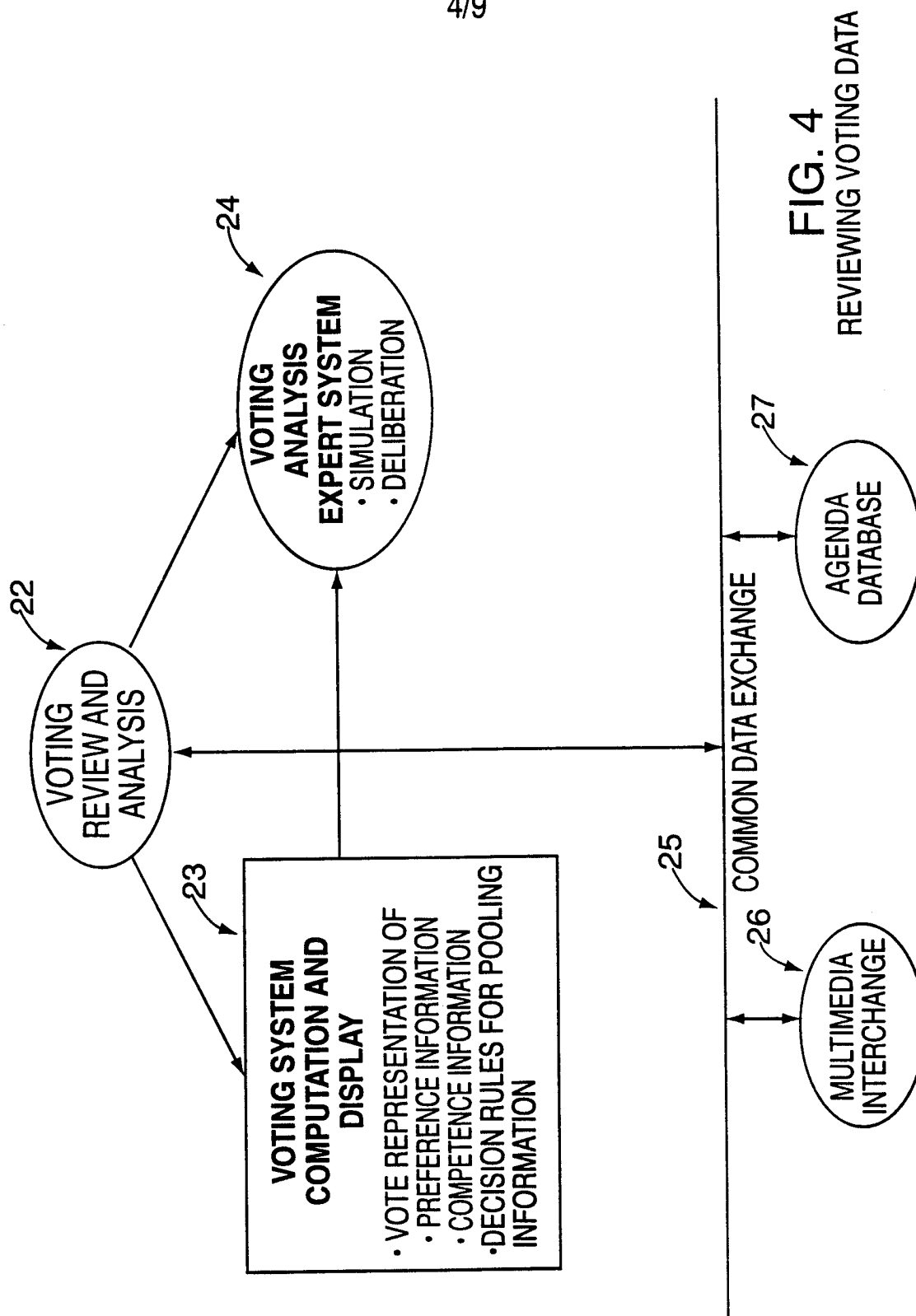
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**FIG. 2**
AGENDA MANIPULATION

3/9



4/9



5/9

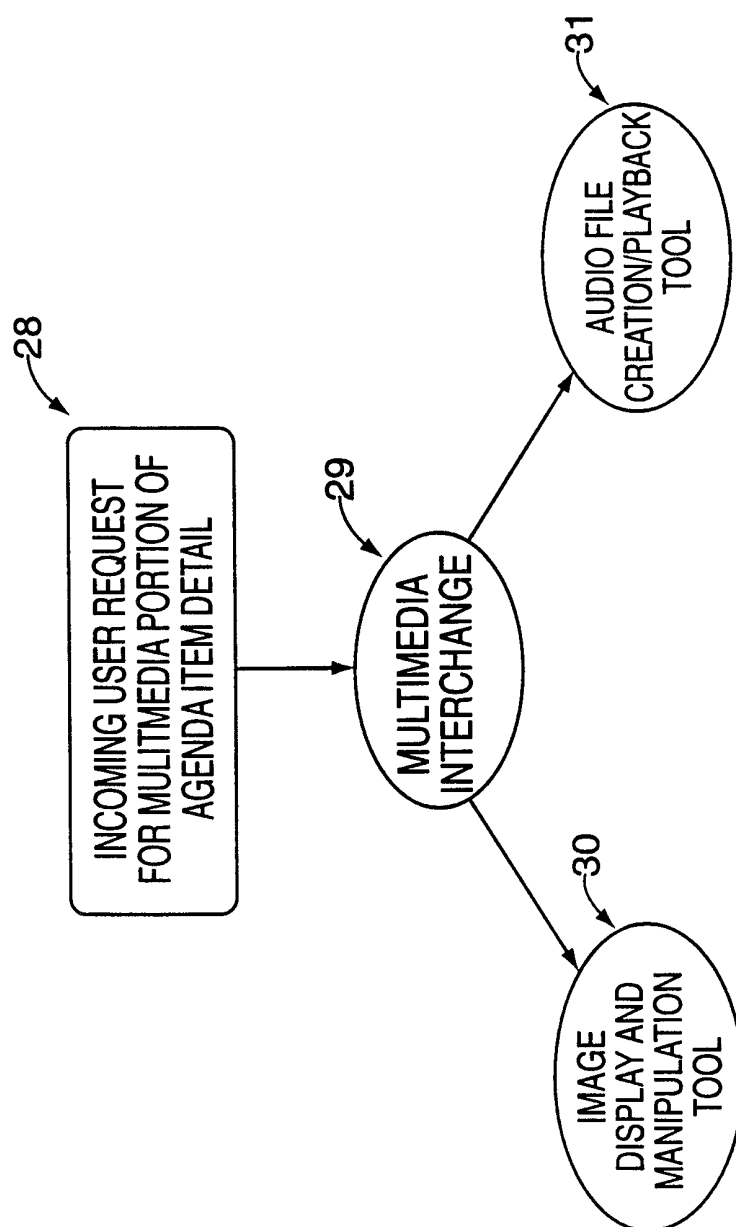
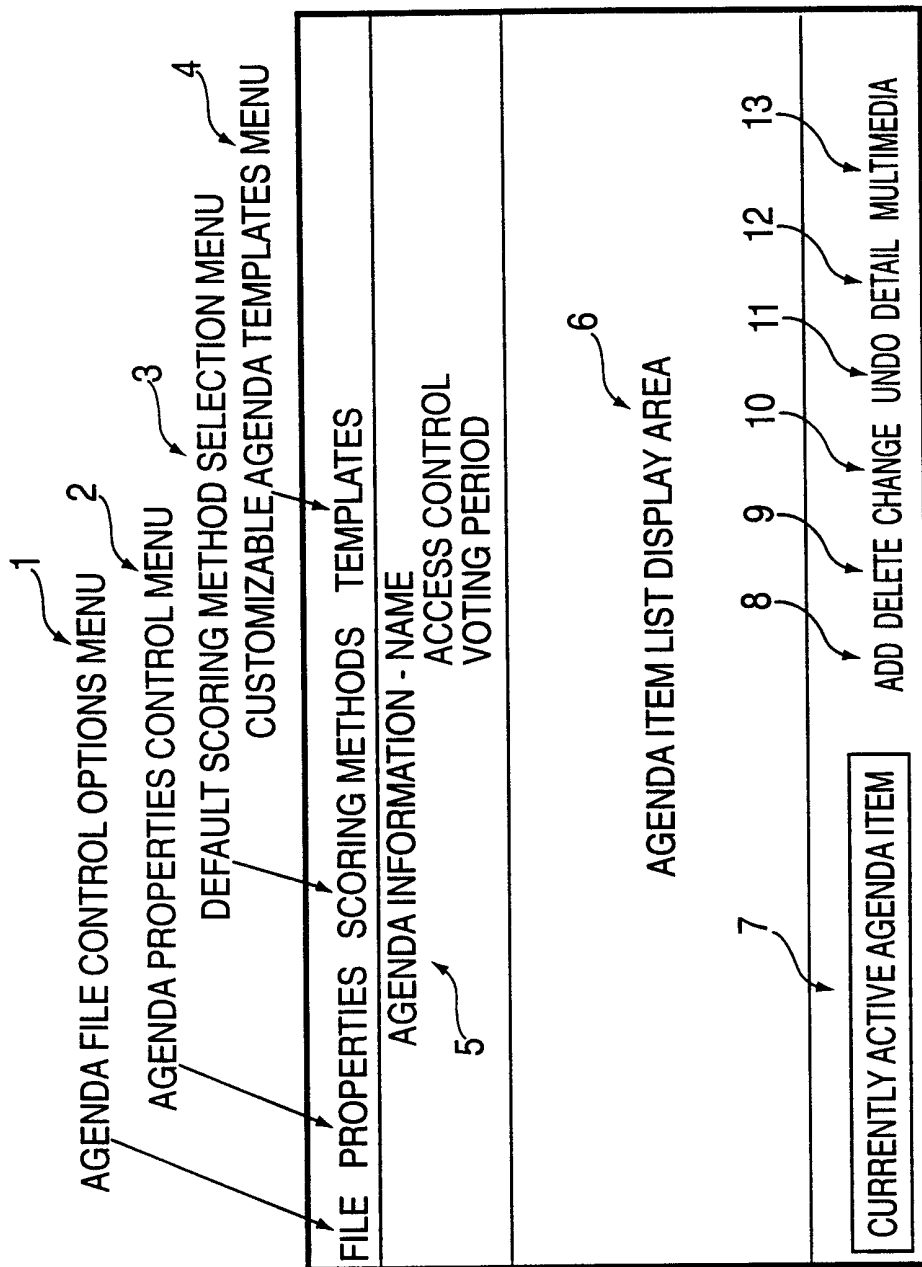


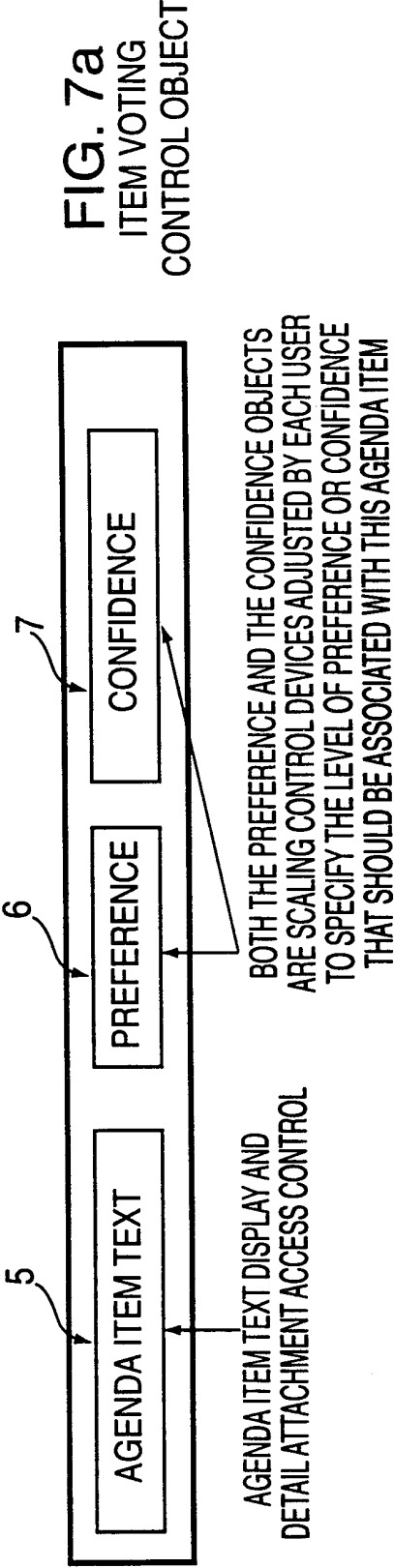
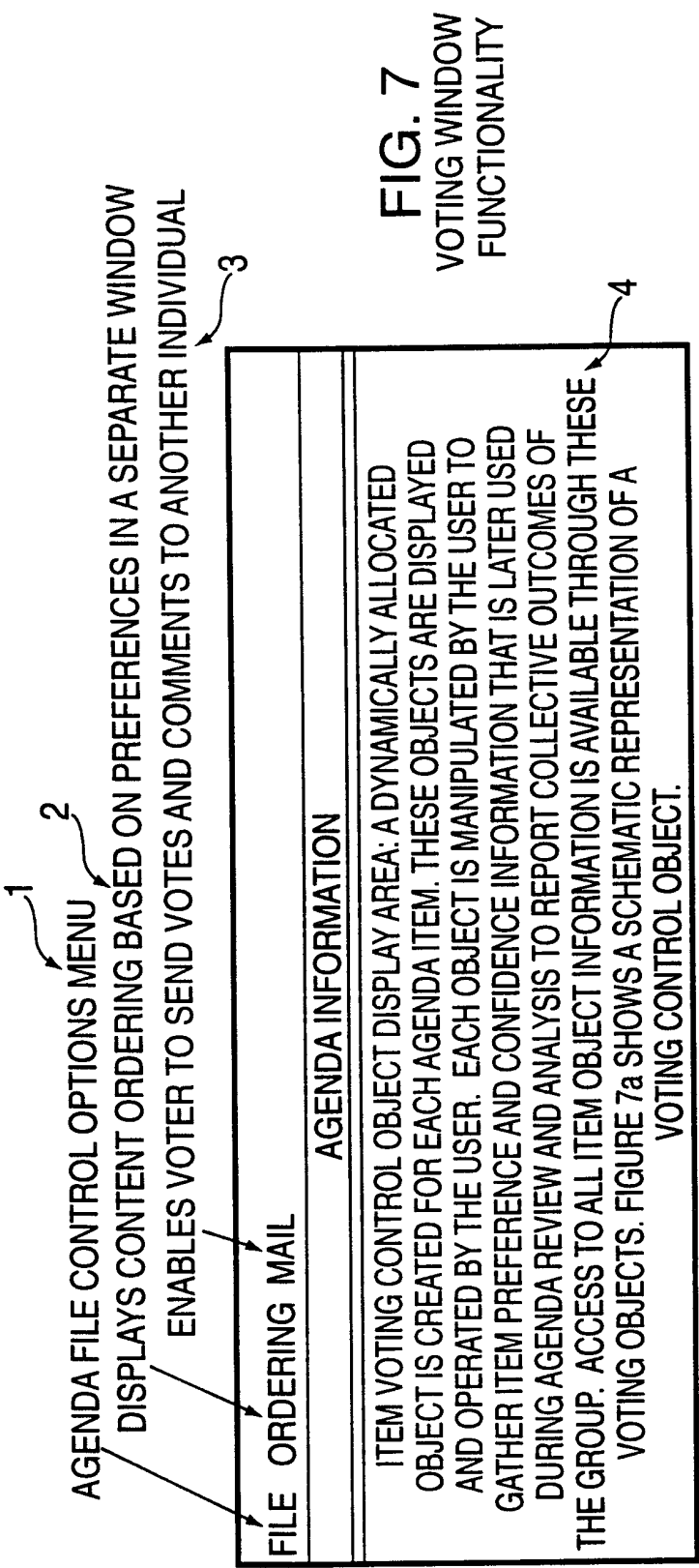
FIG. 5
MULTIMEDIA CAPABILITIES



AGENDA ITEM EDITING AREA- EDITING OPERATIONS INCLUDE ADDING, DELETING, AND CHANGING AGENDA ITEMS, AS WELL AS, UNDOING LAST EDIT OPERATION AND ATTACHING DETAIL AND MULTIMEDIA DATA TO EACH ITEM.

FIG. 6

AGENDA SET-UP WINDOW FUNCTIONALITY



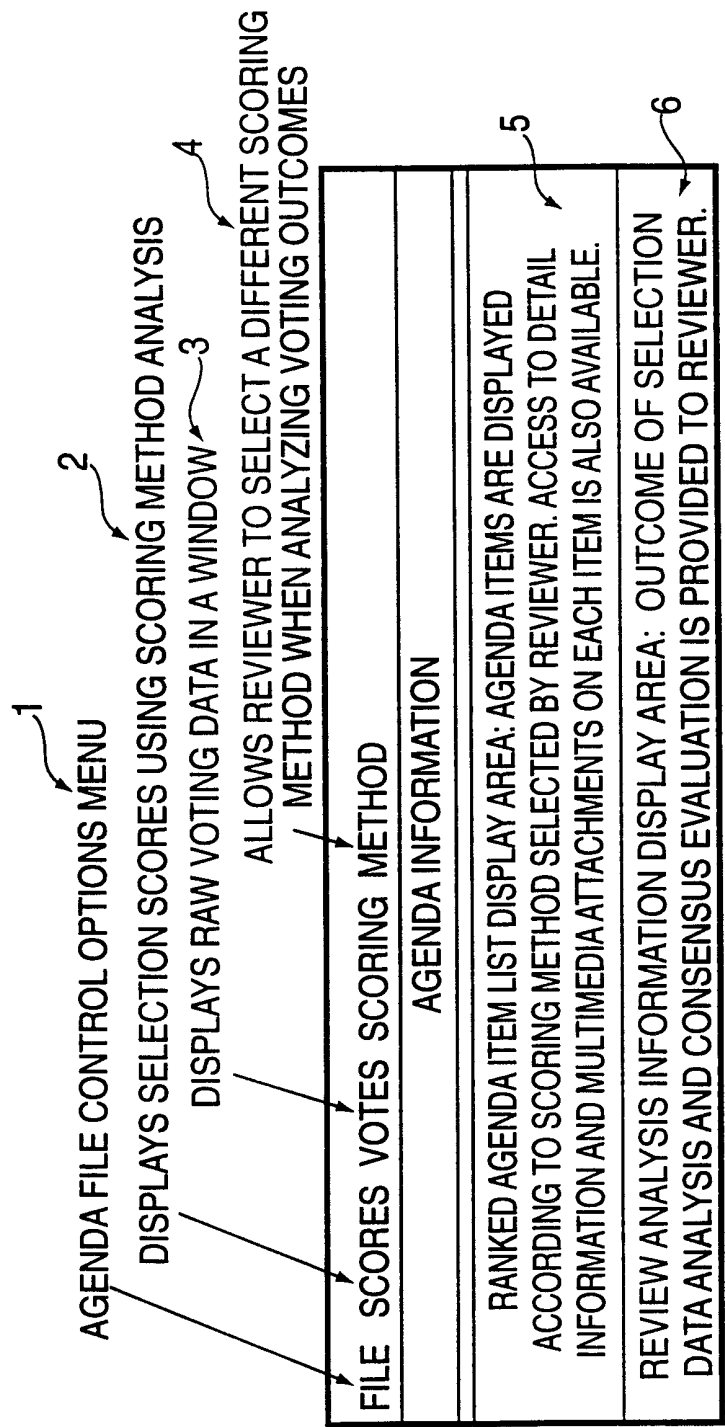


FIG. 8
REVIEW WINDOW FUNCTIONALITY

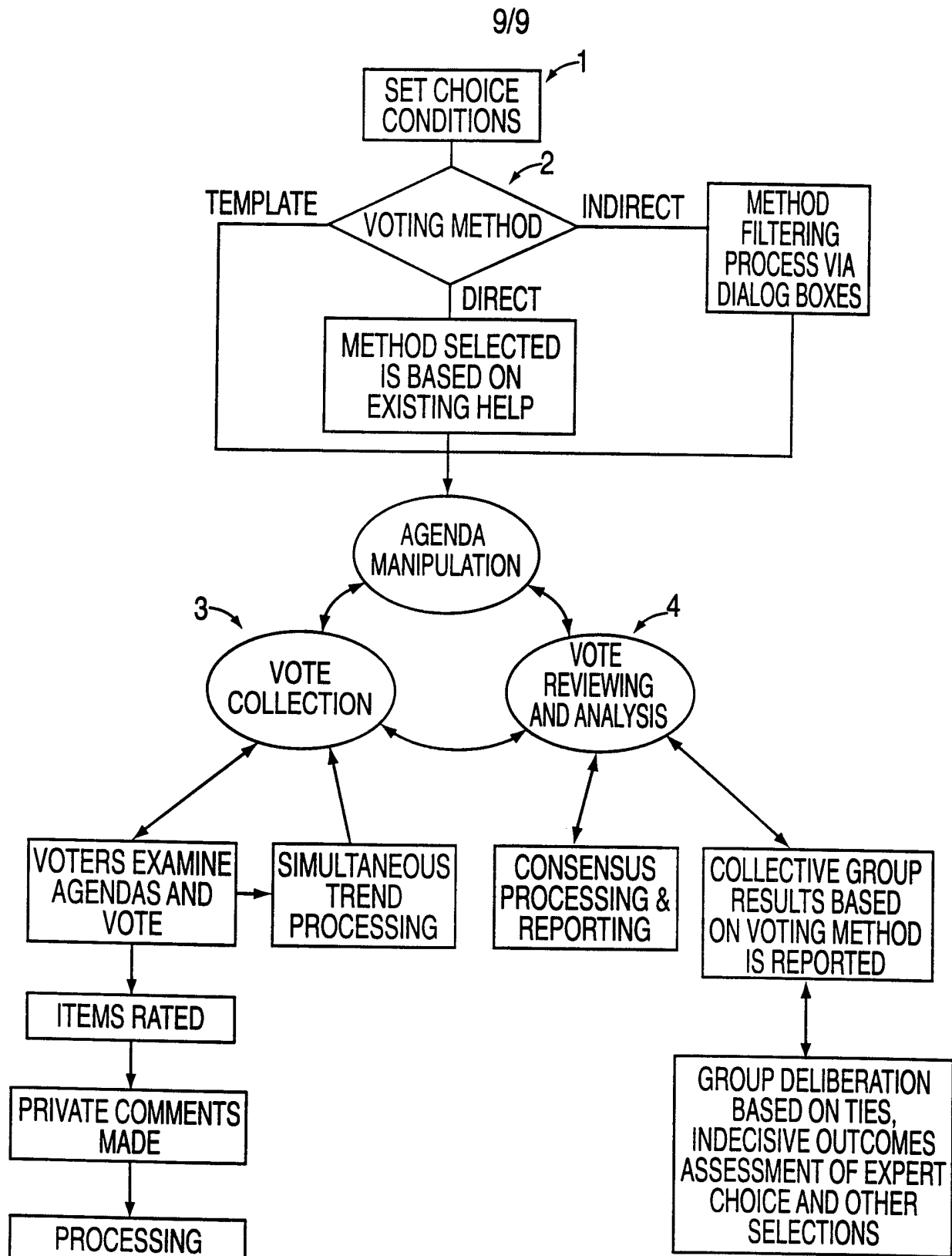


FIG. 9
EXEMPLARY PROCESSOR STEPS