# ELECTRONIC MEETING SYSTEMS TO SUPPORT GROUP WORK

"Almost every time there is a genuinely important decision to be made in an organization, a group is assigned to make it—or at least to counsel and advise the individual who must make it." [21, p. 459]. No one works completely independently. Almost everyone is part of at least one group, typically several groups at any point in time.

Groups communicate, share information, generate ideas, organize ideas, draft policies and procedures, collaborate on the writing of reports, share a vision, build consensus, make decisions, and so on.

However, group meetings are often not as effective as they could be [42]. Meetings may lack a clear focus. Group members may not participate because they are apprehensive about how their ideas will be received or because a few members dominate discussions. Hidden agendas may promote political decisions that are not in the best interests of the organization. Meetings may end without a clear understanding or record of what was discussed. Yet in spite of these problems, little computer support is available for meetings—which is somewhat surprising given the ubiquitous nature of computer support in modern organizations.

A new form of meeting environment, which we term an Electronic Meeting System (EMS), has emerged which strives to make group meetings more productive by applying information technology. EMS technology is designed to directly impact and change the behavior of groups to improve group effectiveness, efficiency, and satisfaction. Our definition of a meeting is broad—including any activity where people come together, whether at the same place at the same time, or in different places at different times (see Figure 1) [5, 12].

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The purpose of this article is to present the research conducted at the University of Arizona in developing and using same-time/same-place and same-time/different-place EMS technology.[1] The Arizona research program includes two types of research defined by Ackoff et al.[1]. The first type is developmental, which attempts to create improved work methods. The second type is empirical, which attempts to evaluate and understand them. The initial phase of the research program focused on the development of tools and techniques to support groups of analysts

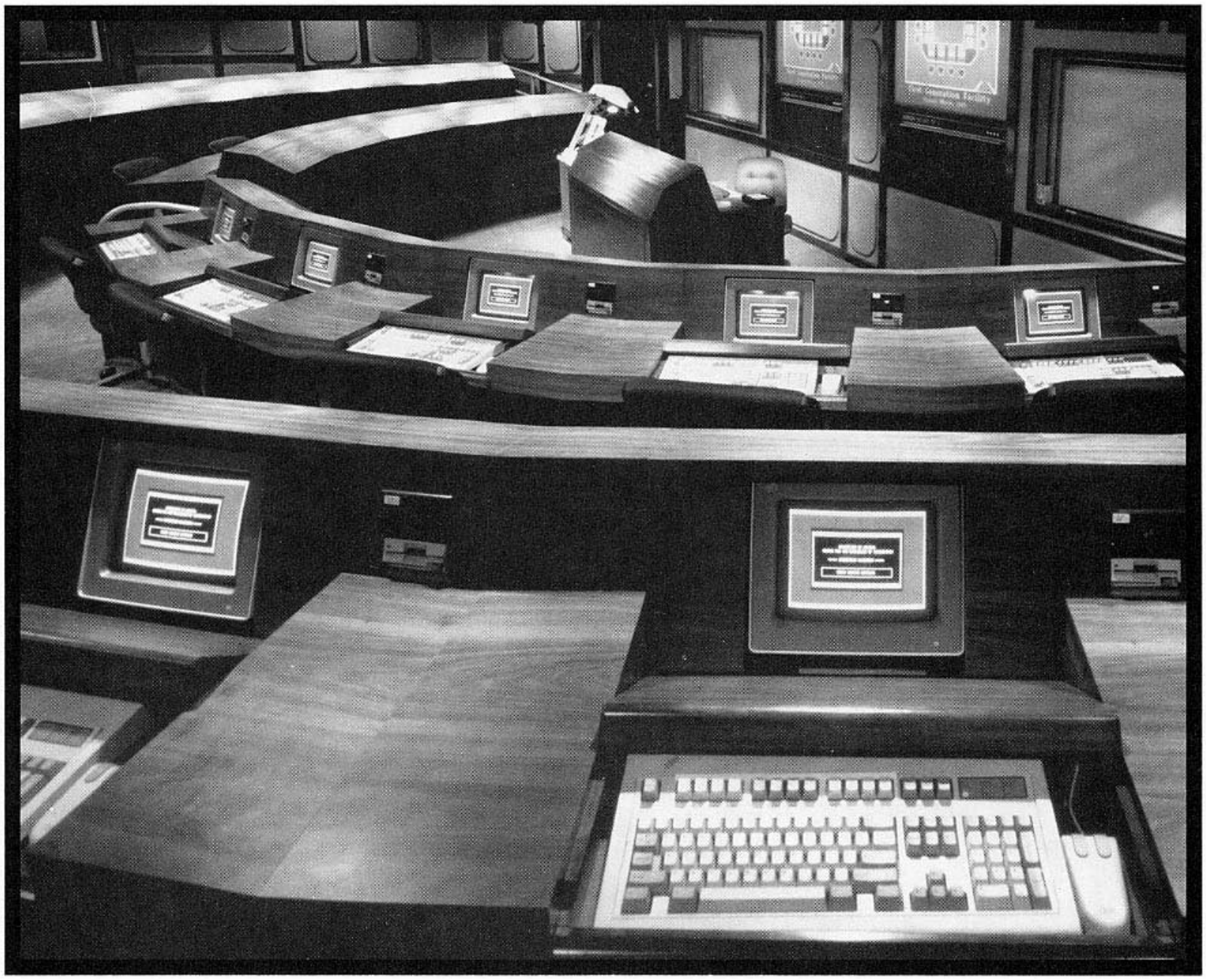

**PHOTO 1. The Collaborative Management Room at the University of Arizona**

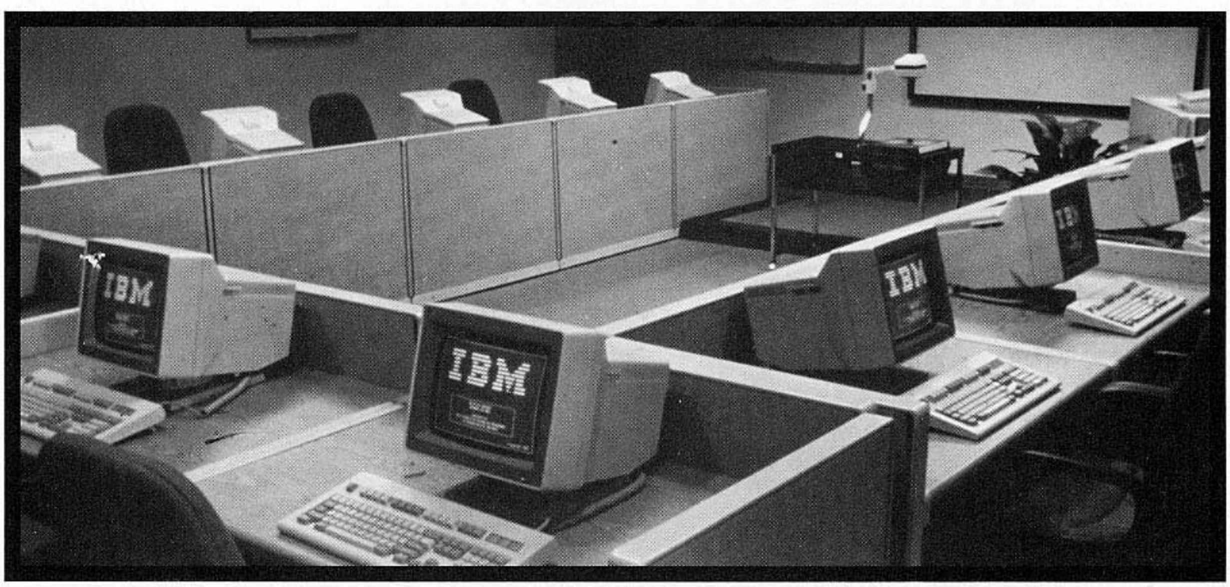


**PHOTO 2. The Electronic Meeting Room at IBM Decision Support Center, Boulder, Colorado**

and users in the construction of information systems. The second phase began in 1984 with the construction of a special-purpose meeting room to support the same-time/same-place meetings of these groups. This meeting room and the ones that followed are based on a series of networked microcomputer workstations arranged in a U-shape, around a table, or in tiered legislative style (see Photo 1). A large-screen video display is provided at the front of the room, from where the meeting leader/facilitator guides the meeting. Other audio-visual support is also available—typically white boards and overhead projectors [5, 36, 51, 53].

The realization that this technology enabled groups to perform many tasks beyond system development (e.g., strategic planning), led to the third phase which began in 1986 with the establishment of four major research projects with IBM. The number of EMS facilities at Arizona grew from one in 1985 to the three we have now. Four additional facilities are scheduled to open later this year. Each of these new facilities addresses a different cell in Figure 1; one is a large group meeting room, one is a small group meeting room, one supports distributed large groups, and the fourth is a meeting room-to-meeting room teleconferencing facility.

During this phase, new software was developed (University of Arizona GroupSystems[2]) and was installed at EMS facilities at more than 22 universities and 12 corporations, such as BellSouth and Greyhound Financial Corporation. IBM has built 36 GroupSystems facilities (e.g., see Photo 2), with an additional 20 scheduled to be operational by January 1992. More than 25,000 people have used GroupSystems within IBM; more than 3,000 others from 200 public and private organizations have used the Arizona GroupSystems facilities. Another 2,000 have used GroupSystems in more than 20 laboratory experiments and 15 doctoral dissertations that have been conducted at Arizona.

While GroupSystems supports a variety of different tasks, many groups follow a common sequence of use. The group leader meets with a GroupSystems meeting leader/facilitator, who assists in developing an agenda and selecting the GroupSystems tools to be used. Meetings typically begin with participants generating ideas (e.g., "How can we double our sales over the next four years?" see Figure 2). As they type their comments, the results are integrated and displayed on the large screens at the front of the room, as well as being available on each workstation. Everyone can see the comments of others, but without knowing who contributed what. Participants can build on each others' ideas, independent of any positive or negative bias about who contributed them—ideas are evaluated on their own merits, rather than on the basis of who contributed them. These ideas are then organized into a list of key issues (e.g., "Stronger ties with customers"), which the group can prioritize into a short list. Next, the group could generate ideas for action plans to accomplish the important issues, followed by more idea organization and prioritization, and so on. The result of the meeting is typically a large volume of input and ideas, and a group consensus for further action. In many cases, final decisions are not made during the meeting, but are made later by the group leader and/or other participants after considering all the information, knowledge and opinions shared. The EMS meeting can enable wide participation so that broad input has been obtained, ownership established, and consensus developed.

For example, Greyhound Financial Corporation has used GroupSystems on several occasions for a variety of tasks, including the development of a mission statement, strategy formulation, evaluations of senior managers, and information systems (IS) planning.[3] One meeting was a one-day session to develop proposals to create competitive advantage, in which 30 managers from all departments used a structured idea generation process (a variant on the value chain technique) to develop proposals. On post-session questionnaires, 88% of participants reported that particular meeting was more effective than previous non-EMS meetings [7]. Said CEO S.L. Eichenfield: "I found that we accomplished 100% of our objectives. People usually reluctant to express themselves felt free to take part, and we were surprised by the number of new ideas expressed. We also reached conclusions far more rapidly."

The experience of this group is typical of the other groups in our field research. Our laboratory research generally supports our findings in the field. In this article we shall argue that EMS facilities can improve group work in many situations because it:

- enables all participants to work simultaneously (human parallel processing);
- provides an equal opportunity for participation;
- discourages behavior that can negatively impact meeting productivity;

[1]Much valuable EMS and related research has been conducted elsewhere. However, space limitations preclude us from discussing it, since an attempt to compare findings across different EMSs is appropriate only with a careful consideration of the different functions they provide. We encourage readers to examine the contributions made by other developers and empirical researchers (see [5, 39] for reviews of this work).

[2]GroupSystems evolved from the Plexsys Research Program.

[3]See "Strategy on the Screen," An Open University Videotape, Production Centre, British Broadcasting Corp., 1991.

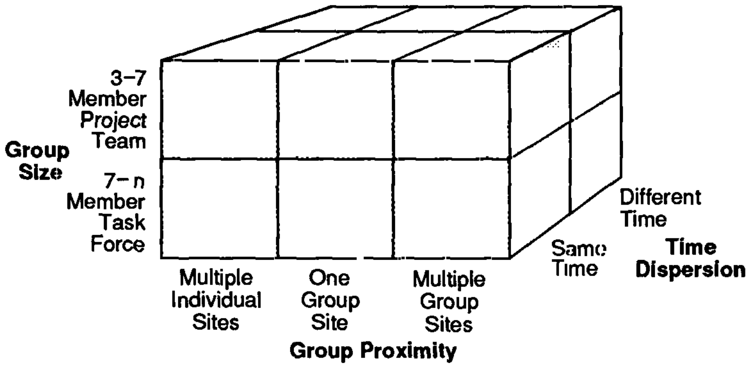


**FIGURE 1. EMS Domain**

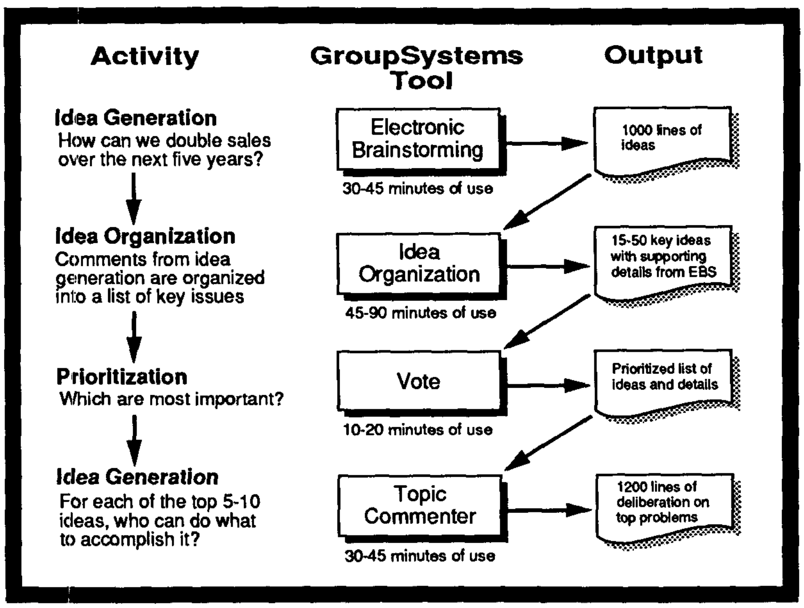


**FIGURE 2. One Sequence of Use**

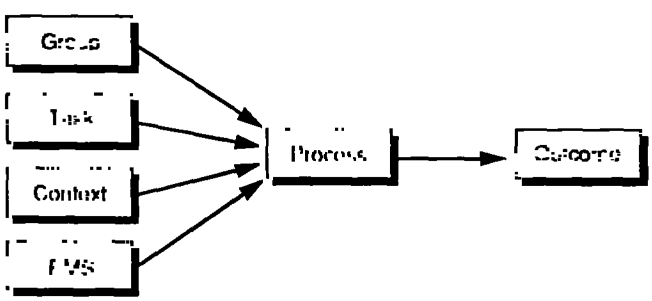


**FIGURE 3. Research Model**

- enables larger group meetings which can effectively bring more information, knowledge, and skills to bear on the task;
- permits the group to choose from a spectrum of structured or unstructured techniques and methods to perform the task;
- offers access to external information; and
- supports the development of an organizational memory from meeting to meeting.

We begin by discussing the theoretical foundations of GroupSystems. These foundations provide the basis for understanding the design and implementation of both our EMS software and facilities. We argue that EMS design is one of four contingencies, along with the group, the task, and the context, that affect the process of group meetings which in turn affects meeting outcomes [5]. We will then focus on the key elements in the design of GroupSystems, and how these elements interact with these contingencies. We examine one example of each type of contingency, using the findings from our empirical research to illustrate our arguments.

## Theoretical Foundations

Prior research and theory with non-EMS-supported groups provides a rich starting point for EMS research. However, as information technology has the ability to profoundly affect the nature of group work [26], it becomes dangerous to generalize the *outcomes* or *conclusions* from research with non-supported groups to the EMS environment.[4] A better approach is to examine underlying theory that explains *why* these events occur and consider how EMS use and various situational characteristics may affect the theory to produce different outcomes.

[4]For example, such commonly accepted conclusions as larger groups are less satisfied than smaller groups, or that groups generate fewer ideas than the same number of individuals working separately (i.e., nominal groups [13, 27, 30] have been shown *not* to hold with EMS-supported groups [10, 11, 48, 49]).

Figure 3 presents a high-level view of the research model that has guided our work and has evolved with our research program. We contend that the effects of EMS use are contingent on a myriad of group, task, context and technology factors that differ from situation to situation [5]. Group characteristics that can affect processes and outcomes include (but are not limited to) group size, group proximity, group composition (peers or hierarchical), group cohesiveness, etc. Task characteristics include the activities required to accomplish the task (e.g., idea generation, decision choice), task complexity, etc. Context characteristics include organizational culture, time pressure, evaluative tone (e.g., critical or supportive), reward structure (e.g., none versus individual versus group), etc. Meeting outcomes (e.g., efficiency, effectiveness, satisfaction) depend upon the interaction within the meeting process of these group, task, and context factors with the EMS components the group uses (e.g., anonymity). Thus, it is inappropriate to say that EMS use "improves group task performance" or "reduces member satisfaction"; all statements must be qualified by the situation—the group, task, context and EMS to which they apply. One approach, then, is to conduct developmental research to build an EMS providing certain components that may improve meeting outcomes and empirical research to determine what effects these components have in what situations.

To understand these interactions, we need to examine group processes at a lower level of detail. Certain aspects of the meeting process improve outcomes (process gains) while others impair outcomes (process losses) relative to the efforts of the same individuals working by themselves or those of groups that do not experience them [22, 47]. Meeting outcomes are contingent upon the balance of these process gains and losses [3]. Situational characteristics (i.e., group, task, and context) establish an initial balance, which the group may alter by using an EMS.

There are many different process gains and losses. Table 1 lists several important process gains and losses, but this list is by no means exhaustive. Each of these gains and losses vary in strength (or may not exist at all) depending upon the situation. For example, in a verbal meeting, losses due to *air time fragmentation,* the need to partition speaking time among members, depend upon group size [13, 27, 30]. Air time fragmentation is a greater problem for larger groups, as the available time must be rationed among more people. If everyone in a 3-member group contributed equally in a 60-minute meeting, each person would speak for 20 minutes, while each member of a 15-member group would speak for 4 minutes.

## EMS Effects

There are at least four theoretical mechanisms by which the EMS can affect this balance of gains and losses: process support, process structure, task structure, and, task support (Figure 4). Process support refers to the communication infrastructure (media, channels, and devices, electronic or otherwise) that facilitates communication among members [12], such as an electronic communication channel or blackboard. Process structure refers to process techniques or rules that direct the pattern, timing or content of this communication [12], such as an agenda or process methodology such as Nominal Group Technique (NGT). Task support refers to the information and computation infrastructure for task-related activities [5], such as external data bases and pop-up calculators. Task structure refers to techniques, rules, or models for analyzing task-related information to gain new insight [12], such as those within computer models or Decision Support Systems (DSS).

For example, suppose a group was charged with generating a plan to encourage more European tourists to visit the U.S. Providing each group member with a computer workstation that enabled him/her to exchange typed comments with other group members would be process support. Having each member take turns to contribute ideas (i.e., round-robin) or agreeing not to criticize the ideas of others would be process structure. Task support could include information on when, where and how many European tourists visited last year, or about tourist programs run by other governments. Task structure could include a framework encouraging the group to consider each U.S. region (e.g., New England, California) or different types of tourists (e.g., tour clients, businessmen), or an economic model of potential impacts.

These four mechanisms are the fundamental means by which an EMS such as GroupSystems affects meetings. These mechanisms are not unique to EMS technology. The EMS is simply a convenient means by which to deliver process support, process structure, task support, and task structure. But in many cases, the EMS can provide a unique combination that is virtually impossible to provide otherwise. We hypothesize potential effects for each mechanism. These effects are those suggested most strongly by prior research, and again, this list is necessarily incomplete. As we will discuss, each mechanism can have many separate effects on process gains and losses, some positive, some negative. The combined effects are contingent on strength of the preexisting gains and losses and the strength of the EMS impact on them (e.g., if the EMS reduces a weak process loss, we would anticipate few effects on outcomes). For

**TABLE 1.**

**Important Sources of Group Process Gains and Losses**

| | |
|---|---|
| **Common Process Gains** | |
| **More Information** | A group as a whole has more information than any one member [30, 42, 47]. |
| **Synergy** | A member uses information in a way that the original holder did not, because that member has different information or skills [38]. |
| **More Objective Evaluation** | Groups are better at catching errors than are the individuals who proposed ideas [21, 22, 42]. |
| **Stimulation** | Working as part of a group may stimulate and encourage individuals to perform better [30, 42]. |
| **Learning** | Members may learn from and imitate more skilled members to improve performance [22]. |
| **Common Process Losses** | |
| **Air Time Fragmentation:** | The group must partition available speaking time among members [13, 27, 30]. |
| **Attenuation Blocking:** | This (and concentration blocking and attention blocking below) are subelements of "production blocking." Attenuation blocking occurs when members who are prevented from contributing comments as they occur, forget or suppress them later in the meeting, because they seem less original, relevant or important [13, 27, 30]. |
| **Concentration Blocking:** | Fewer comments are made because members concentrate on remembering comments (rather than thinking of new ones) until they can contribute them [13, 27, 30]. |
| **Attention Blocking:** | New comments are not generated because members must constantly listen to others speak and cannot pause to think [13, 27, 30]. |
| **Failure to Remember:** | Members lack focus on communication, missing or forgetting the contributions of others [13, 27]. |
| **Conformance Pressure:** | Members are reluctant to criticize the comments of others due to politeness or fear of reprisals [21, 42]. |
| **Evaluation Apprehension:** | Fear of negative evaluation causes members to withhold ideas and comments [13, 27, 30]. |
| **Free Riding:** | Members rely on others to accomplish goals, due to cognitive loafing, the need to compete for air time, or because they perceive their input to be unneeded [2, 13]. |
| **Cognitive Inertia:** | Discussion moves along one train of thought without deviating, because group members refrain from contributing comments that are not directly related to the current discussion [27, 30]. |
| **Socializing:** | Nontask discussion reduces task performance, although some socializing is usually necessary for effective functioning [42]. |
| **Domination:** | Some group member(s) exercise undue influence or monopolize the group's time in an unproductive manner [27]. |
| **Information Overload:** | Information is presented faster than it can be processed [23]. |
| **Coordination Problems:** | Difficulty integrating members' contributions because the group does not have an appropriate strategy, which can lead to dysfunctional cycling or incomplete discussions resulting in premature decisions [21, 24]. |
| **Incomplete Use of Information:** | Incomplete access to and use of information necessary for successful task completion [24, 34]. |
| **Incomplete Task Analysis:** | Incomplete analysis and understanding of task resulting in superficial discussions [24]. |

simplicity, this discussion treats each mechanism separately; interactions are discussed later. This discussion assumes the group actually uses the mechanisms described; any mechanism that is provided by the EMS but is not used, obviously has few effects. In our discussion of these four mechanisms, the one that has been central to our research, process support, will be emphasized.

*Task structure* assists the group to better understand and analyze task information, and is one of the mechanisms by which DSS improve the performance of individual decision makers. Task structure may improve group performance by reducing losses due to incomplete task analysis or increasing process gains due to synergy, encouraging more information to be shared, promoting more objective evaluation or catching errors (by highlighting information). Methods of providing task structure include problem modeling, multicriteria decision making, etc. While task structure is often numeric in nature, it is not necessarily so. For example, Greyhound used a variant of the value chain technique. Many other non-numeric approaches to providing task structure are also available—e.g., stakeholder analysis [32].

*Task support* may reduce process losses due to incomplete use of information and incomplete task analysis, and may promote synergy and the use of more information by providing information and computation to the group (without providing additional structure). For example, groups may benefit from electronic access to information from previous meetings. While members could make notes of potentially useful information prior to the meeting, a more effective approach may be to provide access to the complete sources during the meeting itself. Computation support could include calculators or spreadsheets.

Task support is also important at an organizational level. Simon argues that technological support for organizational memory is an essential part of organizational functioning [45]. An EMS can assist in building this organizational memory by recording inputs, outputs and results in one repository for easy access for subsequent meetings. Although the importance of such an organizational memory has been recognized in system development (e.g., CASE tools), it has not yet been widely applied to other organizational activities.

*Process structure* has long been used by non-EMS groups to reduce process losses, although many researchers have reported that groups often do not follow the process structuring rules properly [21, 27]. Process structure may be global to the meeting, such as developing and following a strategy/agenda to perform the task, thereby reducing process losses due to coordination problems. The EMS can also provide process structure internal to a specific activity (local process structure) by determining who will talk next (e.g., talk queues) or by automating a formal methodology such as NGT. Different forms of local process structure will affect different process gains and losses. For example, the first phase of NGT requires individuals to work separately to reduce production blocking, free riding, and cognitive inertia, while subsequent phases (idea sharing and voting) use other techniques to affect other process gains and losses. Process structure has been found to improve, impair, and have no effect on group performance [cf. 21, 24, 42]. Its effects depend upon its fit with the situation and thus little can be said in general.

*Process support* can be provided by the EMS in at least three ways: parallel communication, group memory, and anonymity. With parallel communication, each member has a workstation that is connected to all other workstations, thus providing an electronic channel that enables everyone to communicate simultaneously and in parallel [5]. No one need wait for someone else to finish speaking. Process losses from air time fragmentation, attenuation blocking and concentration blocking should be significantly reduced. Free riding may be reduced as members no longer need to compete for air time. Domination may be reduced, as it becomes difficult for one member to preclude others from contributing. Electronic communication may also dampen dysfunctional socializing [54]. Parallel communication increases information overload (as every member can contribute simultaneously). Process gains may be enhanced due to synergy and the use of more information. Increased interaction may also stimulate individuals and promote learning.

The EMS can provide a group memory by recording all electronic comments, which is typically done by many, but not all EMSs [e.g., 43]. Participants can de-couple themselves from the group to pause, think, type comments and then rejoin the "discussion" without missing anything. This should reduce failure to remember, attention blocking and incomplete use of information, and may promote synergy and more information. A group memory that enables members to queue and filter information may reduce information overload. A group memory is also useful should some members miss all or part of a meeting, or if the group is subjected to interruptions that require temporary suspension of the meeting [34]. The EMS may also provide other forms of group memory that do not capture all comments. An electronic black-

A group memory that enables members to queue and filter information may reduce information overload.

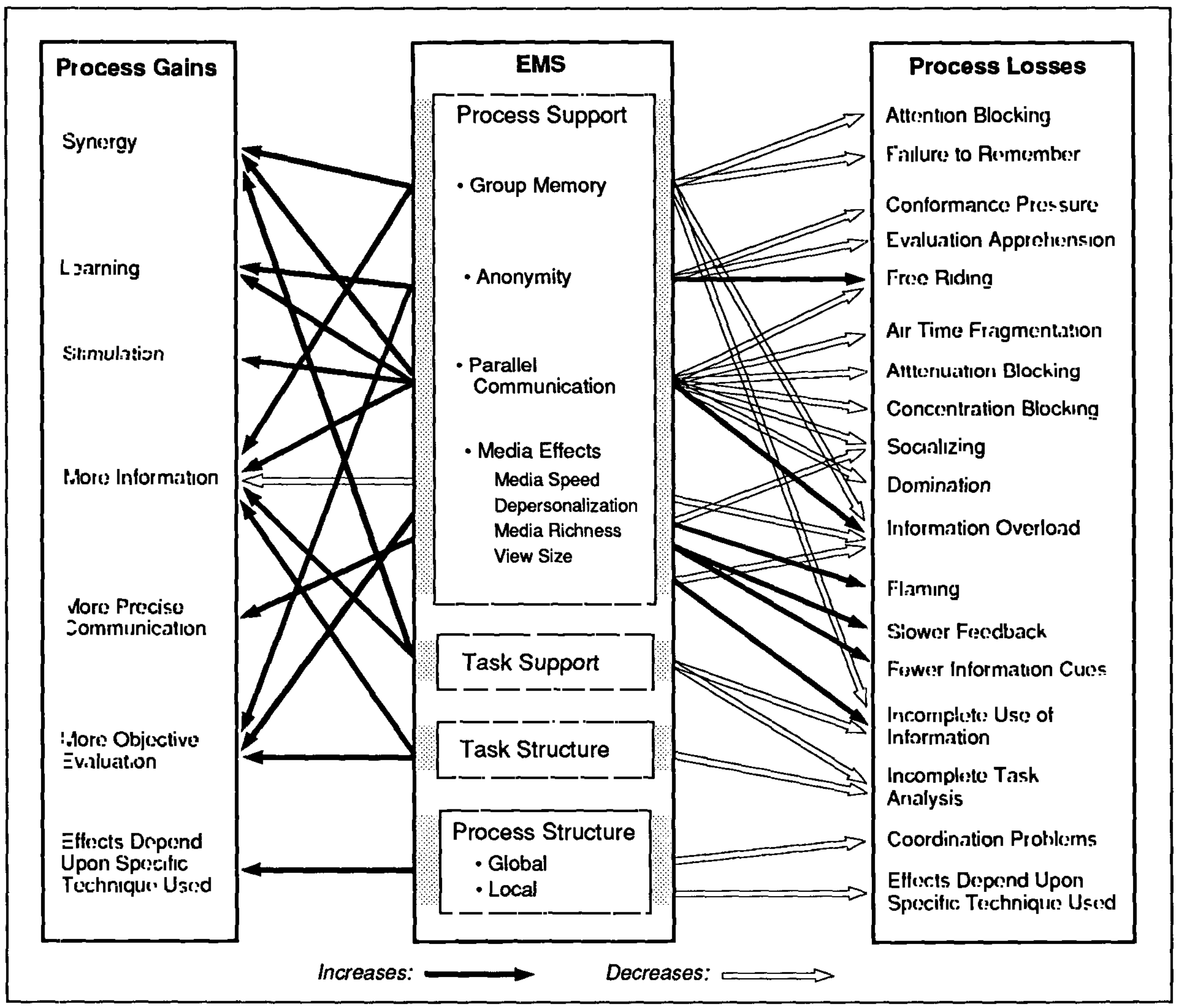


**FIGURE 4. Potential EMS Effects**

board, for example, may reduce failure to remember by presenting a summary of key information and reduce dysfunctional socializing by increasing task focus [46].

The electronic channel may provide some degree of anonymity. Anonymity may reduce the pressure to conform and evaluation apprehension, but may also increase free riding, as it is more difficult to determine when someone is free riding [2]. However, when the group meets at the same place and time, the lack of process anonymity (i.e., members can see who is and is not contributing) as opposed to content anonymity (i.e., members cannot easily attribute specific comments to individuals) may reduce free riding [50]. Anonymity may encourage members to challenge others, thereby increasing process gains by catching errors and a more objective evaluation. Anonymity may also provide a low-threat environment in which less skilled members can contribute and learn.

The use of electronic media may also introduce media effects that reflect inherent differences between verbal and electronic communication. These include *media speed, media richness, depersonalization/deindividuation* and *view size.* Media speed refers to the fact that typing comments to send electronically is slower than speaking (which can reduce the amount of information available to the group and introduce losses) while reading is generally faster than listening (gains) [54]. Electronic media are less rich than face-to-face verbal communication, as they provide fewer cues and slower feedback (losses), but typically promote more careful and precisely worded communication (gains) [4]. Depersonalization is the separation of people from comments, which may promote deindividuation, the loss of self- and group-awareness [54]. This may reduce socializing, and encourage more objective evaluation and more error catching—due to less negative reaction to criticism, and increased group ownership of outcomes—(gains). But reduced socializing and more uninhibited comments like "flaming," may reduce group cohesiveness and satisfaction (losses). Workstations typically provide a small screen view for members (e.g., 24-line screen), which can encourage information chunking and reduce information overload (gains). But this can also cause members to lose a global view of the task [35, 36], increasing losses due to incomplete use of information.

## The University of Arizona GroupSystems EMS

Here we summarize the developmental research conducted at Arizona. We have primarily focused on supporting large groups that meet at the same place and time—legislative sessions [5, 12]—although recent work has studied small project teams and distributed groups meeting at the same time in different places. This focus arose from our early work with a variety of organizations in which project teams of 10–20 members were typically assigned to address key issues.

What are the needs of large groups meeting at the same place and time? Research with non-EMS-supported groups has shown that larger groups have a greater need for process structure [42], particularly if members do not share the same information [21]. Large non-EMS-supported meetings are usually less effective and less satisfying than small group meetings [42], due to sharp increases in process losses as size increases [2, 47]. We concluded that, in general, high levels of global process structure and process support were appropriate.

Task structure and task support also depend on task characteristics. Since the groups with whom we worked often faced strategic issues, we developed several tools providing task structure and support for strategic planning (e.g., stakeholder analysis), as well as general-purpose tools capable of supporting a variety of task structure and support needs. As strategic tasks are often associated with political and highly competitive groups [32], process support components such as anonymity became important.

### GroupSystems Architecture

The general design for GroupSystems builds on three basic concepts: an EMS meeting room, meeting facilitation, and a software toolkit. Although many different meeting room designs have been used, the minimum configuration provides a separate networked, hard disk-based, color graphics microcomputer workstation to each participant, with another one or two workstations serving as the meeting leader/facilitator's console. A large-screen video display is provided as an electronic blackboard, with other audio-visual support also available (e.g., white boards and overhead projectors) [5, 36, 51, 53].

*Meeting leader/facilitator:* The person who chairs the meeting is the leader/facilitator. This person may be the group leader, another group member or, more commonly, a separate, neutral, individual who is not a group member. Using a nonmember enables all group members to actively participate, rather than losing one member as the chair. A nonmember can be a specialist in EMS and group work, but may lack the task and group knowledge of a regular member. The meeting leader/facilitator provides four functions. First, this person provides technical support by initiating and terminating specific software tools, and guiding the group through the technical aspects necessary to work on the task. This reduces the amount of training required of group members by re-

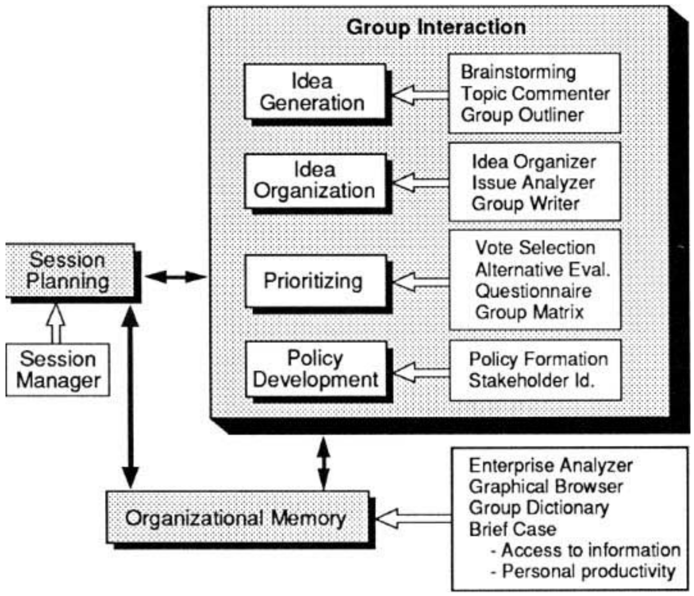


**FIGURE 5. GroupSystems Tools**

| Chauffeured | Supported | Interactive |
|---|---|---|
| • One person enters group information<br>• Electronic black-board can provide group memory<br>• Verbal communication predominates | • All group members can enter comments<br>• Electronic black-board can provide group memory<br>• Both verbal and electronic communication | • All group members can enter comments<br>• All comments in group memory accessible via workstations<br>• Electronic communication predominates |

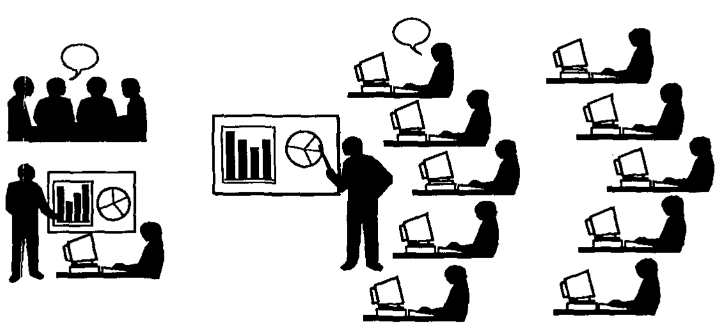

**FIGURE 6. Electronic Meeting Processes**

moving one level of system complexity. In some cases, technical support is provided by an additional technical facilitator.

Second, the meeting leader/facilitator chairs the meeting, maintains the agenda and assesses the need for agenda changes. The meeting leader/facilitator may or may not take an active role in the meeting to improve group interaction by, for example, providing process structure in coordinating verbal discussion. This person also administers the group's knowledge. In EMSs designed without support for meeting leaders/facilitators, any member may change or delete the group memory. When disagreements occur, members' competition for control can become dysfunctional (e.g., "Scroll Wars" [46]). While this is manageable for small collaborative groups, it is much less so for larger groups with diverse membership, where competitive political motives and vested interests exist. With GroupSystems, members can view the group memory and add to it at their own workstation, but in general only the meeting leader/facilitator can modify and delete public information.

Third, the meeting leader/facilitator assists in agenda planning, by working with the group and/or group leader to highlight the principal meeting objectives and develop an agenda to accomplish them. Specific GroupSystems tools are then mapped to each activity. Finally, in on-going organizational settings where meeting leaders/facilitators are not group members, they provide organizational continuity by setting standards for use, developing training materials, maintaining the system, and acting as champion/sponsors, which is key to successful technology transfer [31]. The roles of the meeting leader/facilitator may also change over time. For example, after a group has some experience using EMS, the need for technical support and agenda planning advice may decrease.

*Software toolkit:* Many first-generation EMSs were task-driven, as defined by Huber [25], in that they were designed to support one single group task. Second-generation EMSs, such as GroupSystems, provide a software toolkit, similar to a DSS model base, which is a collection of generic tools for various group *activities* such as idea generation and voting rather than being one indivisible system to support the entire *task* like strategic planning. Such EMSs are activity driven.

The key advantage provided by a toolkit is flexibility. Each tool provides a different approach to support a particular activity, thus the EMS can provide various combinations and styles of process structure, process support, task structure and task support during any one meeting. Groups use many approaches and often do not proceed in a straightforward manner [40]. The tools can easily be mixed and matched and combined with non-EMS activities in whatever order the group believes is most effective. This philosophy also enables new tools to be easily added to the toolkit and existing tools to be customized to specific needs.

While flexibility is important, it is also important to restrict the number and type of functions available to participants [44]. Restrictiveness provides a more powerful intervention, increasing the liklihood that groups will use the EMS as intended by its designers; this has proved a problem with non-computerized techniques [21, 27]. Restrictiveness promotes the use of more effective techniques and prevents less effective ones, fosters learning, promotes consistency, and provides coordination to ensure that all group members are using the same tool at the same time. But it can also constrain creativity and exploration, limit the applicability of a system, promote user dissatisfaction, and be seen as manipulative, resulting in non-use of the system.

GroupSystems balances these issues by being both highly flexible *and* highly restrictive. The system is flexible in that a wide variety of tools are available, but each tool is locally restrictive so that users can perform only certain functions. The selection of which tools will be used for a specific meeting is done during a pre-meeting planning meeting. During the meeting itself, the system is restrictive, so that members use only those tools determined to be the most appropriate during pre-planning. While agendas sometimes change, it is the group leader or the group as a whole who makes changes, not individual members.

Development of GroupSystems tools has not followed either the Software Development Life Cycle model or the rapid prototyping model, although we do believe in prototyping as a means to determine requirements. GroupSystems tools have typically been "grown." The basic concept for a tool typically comes from prior group theory and research (e.g., NGT), from a specific task domain (e.g., stakeholder analysis [32]) or from our own experiences. The concept is first developed and tested within our research group, before being refined into an initial production version. This initial version is intentionally not a complete version of the tool, as it is difficult to determine exactly what functions are needed until the tool is actually used by groups. As the tool begins to be used, new functions are identified, and the capabilities of the tool grow. Significant changes are not unusual in the first few months after tools are added.

The GroupSystems toolkit provides tools in five areas:

1. session planning and management;
2. group interaction;
3. organizational memory;
4. individual work; and
5. research data collection.

Tools in the first three areas are discussed in Figure 5. Those in the latter two areas are not, because they are not central to our theme of improving group performance.

### Tools for Session Planning and Management

The GroupSystems tool to support this activity, Session Manager (SM), has three components: pre-session planning, in-session management, and post-session organization. SM supports pre-session planning by providing an electronic questionnaire to ensure that important planning information is not overlooked, and an agenda tool to assist in agenda development. An expert system to assist this stage is currently under development. SM provides in-meeting management via the control menu; all tools are initialized, started, and ended via SM. SM also provides a task assignment tool to record information about the tasks assigned to specific individuals. Members are provided read-only access to this list but only the facilitator is allowed to add to or modify its contents. Post-session organization involves the logical organization and physical storage of the session outputs as part of the organizational memory. Various components can be indexed and stored, task assignment reports generated and distributed, and paper printouts copied and distributed to better integrate information between this session and subsequent sessions.

### Tools for Group Interaction

The purpose of these tools is to provide process structure, process support, task structure and task support for group interaction. While there are many possible combinations of the process support functions (i.e., parallel communication, group memory, anonymity), GroupSystems provides three dis-

As the tool begins to be used, new functions are identified and the capabilities of the tool grows. Significant changes are not unusual in the first few months after tools are added.

**TABLE 2**

**Group Interaction Tools**

| | Activities Supported | Process Support | Process Structure | Task Support | Task Structure |
|---|---|---|---|---|---|
| Electronic Brainstorming | 1,2 | ● | ● | ◐ | ○ |
| Electronic Discussion* | 1,2,3 | ● | ○ to ● | ◐ | ○ |
| Topic Commenter | 1 | ● | ○ | ◐ | ● |
| Group Outliner | 1,2 | ◐ | ○ | ◐ | ● |
| Idea Organizer | 2,1 | ◐ | ◐ | ● | ◐ |
| Issue Analyzer | 2 | ◐ | ● | ● | ◐ |
| Group Writer | 2,1 | ● | ○ | ◐ | ○ |
| Vote Selection | 3 | ● | ◐ | ◐ | ● |
| Alternative Evaluator | 3 | ● | ○ | ◐ | ● |
| Group Questionnaire | 3 | ● | ● | ◐ | ● |
| Group Matrix | 3 | ◐ | ○ | ◐ | ● |
| Stakeholder Identification | 4 | ◐ | ● | ◐ | ● |
| Policy Formation | 4 | ◐ | ● | ◐ | ● |

Activities Supported:
1. Exploration and Idea Generation
2. Idea Organization
3. Prioritizing
4. Policy Development and Evaluation

*EDS is used for laboratory research only

Process & Task Support & Structure
○ Low ◐ Medium ● High

tinct styles of process support which blend these functions with different amounts of electronic and verbal interaction: a *chauffeured* style, a *supported* style and an *interactive* style. These styles can be combined with each other and with non-EMS verbal discussion at different stages of any one meeting. We first describe these three styles (see Figure 6) and then consider the process gains and losses that each affects.

With a chauffeured style, only one person uses the EMS, either a group member or the meeting leader/facilitator. A workstation is connected to a public display screen, providing an electronic version of the traditional blackboard. The group verbally discusses the issues, with the electronic blackboard used as a group memory to record and structure information. A supported style is similar to a chauffeured style, but differs in that each member has a computer workstation that provides a parallel, anonymous electronic communication channel with a group memory. The meeting proceeds using a mixture of verbal and electronic interaction. The electronic blackboard is still used to present and structure information, but with each member able to add items. With an interactive style, the parallel, anonymous electronic communication channel with a group memory is used for almost all group communication. Virtually no one speaks. While an electronic blackboard may be provided, the group memory is typically too large to fit on a screen, and thus it is maintained so that all members can access it electronically at their workstations.

The interactive style is the strongest intervention (but not necessarily "the best") as it provides parallel communication, group memory and anonymity to reduce process losses due to air time fragmentation, attenuation blocking, concentration blocking, attention blocking, failure to remember, socializing, domination, interruptions, evaluation apprehension and conformance pressure. Information overload may increase, and free riding may be reduced or increased. Process gains may be increased due to more information, synergy, catching errors, stimulation and learning. Media effects increase and decrease process gains and losses as noted previously.

The weakest intervention is the chauffeured style (but not necessarily "the worst"), for which the EMS does not provide a new communication channel, but rather addresses failure to remember by providing focus through a common group memory displayed on the electronic blackboard. An increased task focus promoted by this style may also reduce socializing. Few other process gains or losses are affected.

Between these styles is the supported style. When verbal interaction is used, the effects are similar to a chauffeured style; when electronic interaction is used, the effects are similar to an interactive style. But there are several important differences. First, while anonymity is possible with electronic communication, its effects on evaluation apprehension and conformance pressure are substantially reduced with the supported style because non-anonymous verbal communication occurs. Second, attention blocking (and possibly failure to remember and information overload) will be *increased* beyond that of a traditional meeting (or an interactive style) as members must simultaneously monitor and use both verbal and electronic communication channels. Third, process losses due to media speed, media richness and depersonalization will probably be less than with the interactive style, as members can switch media as needed (e.g., if media richness proves a problem when using the electronic channel, members can switch to verbal interaction).

Each GroupSystems tool was initially designed to use one of these meeting styles to support one specific type of group activity. There are many useful ways of classifying group activities [42]. We use four categories. The first, exploration and idea generation, involves the development and exploration of issues relevant to the task. The second category, idea organization, involves the synthesizing, structuring, and organizing of ideas into specific alternatives which may follow the generation of ideas; if a group has previously discussed an issue, a meeting may begin with idea organization without idea generation. Tools in the third category, prioritizing, support the individual members in evaluating alternatives. The final category contains tools that provide formal methodologies to support policy development and evaluation, such as stakeholder analysis. The tools may be used in whatever order the group chooses; there is no mandatory order, although many tasks follow a natural order of idea generation, idea synthesis, prioritizing, and exploration of important issues.

Table 2 summarizes the activities and process support, process structure, task support, and task structure of each group interaction tool. The levels of process support (low, medium, high) correspond to the three meeting styles (chauffeured, supported, interactive) respectively. While most tools can be used in chauffeured mode or in different ways according to the direction of the meeting leader/facilitator, they are described as they are normally used at Arizona. All tools provide at least a medium level of task support due to BriefCase, a memory resident organizational memory tool. For more information, see [7, 51].

*Exploration and idea generation:* The objective of these tools is to assist the group in exploring issues and generating ideas and alternatives.

Electronic Brainstorming (EBS) provides an interactive style in which participants enter comments into many separate discussions contained in separate files that are randomly shared throughout the group. The high degree of process structure from this random sharing of many discussions attempts to reduce cognitive inertia by precluding the group from focusing on one approach. Process support and structure are thus high, while task structure is low. Electronic Discussion System (EDS) was developed for laboratory research to support exploration and idea generation, idea organization and voting. Its support for exploration and idea generation works in a manner similar to EBS, except that it can also be configured to provide low process structure. All comments can be placed in one central file accessible by all participants at all times, thus providing only one discussion. Topic Commenter (TC), which uses an interactive style (high process support), provides a high level of task structure; comments are collected from participants using a task-specific framework. TC operates like a set of index cards, with each card having a name. Participants select a card, enter comments, and read comments entered by others. Group Outliner works similarly to TC, but enables the group to develop the set of cards (which may be hierarchically structured) using a supported style and then discuss them with an interactive style.

*Idea organization:* The purpose of idea organization is to identify, synthesize, formulate and consolidate ideas, proposals or alternatives—that is, to build a task structure for ideas. Idea Organizer (IO) provides a supported style, while Issue Analyzer (IA) provides a more structured two-phase approach that first *identifies* (via an interactive style) and then *consolidates* (i.e., achieves consensus on) ideas (via a chauffeured style). With both tools, each participant works separately to create a private list of ideas which are submitted to the group. Comments from a previous idea generation activity may be available as task support and may be easily included. As the list grows, the meeting leader/facilitator assists the group in combining similar ideas to move to consensus. Group Writer is a multiuser word processor that enables a group to jointly write and organize documents. Most group interaction is electronic, but verbal communication is used to coordinate members' activities (e.g., who works on what).

*Prioritizing:* There are a variety of prioritizing methods available in Vote Selection (e.g., yes/no, multiple choice, 10-point scale rating or ranking in order), which employ an interactive style to collect votes, followed by a chauffeured style to discuss the results. Alternative Evaluator (AE) is a multicriteria decision-making tool that uses a similar interactive/chauffeured set of styles. With AE, the group rates each alternative on a 1-10 scale for each criterion. Criteria can be considered equally important, or can be assigned different weights. With Group Questionnaire each participant completes an electronic questionnaire, which may branch to different questions based on user responses. Group Matrix is a consensus-building tool that enables participants to dynamically enter and change numeric (or text) ratings in a two-dimensional matrix. Typically groups initially enter ratings with an alternative style. These ratings are then discussed and revised using a supported style.

*Policy development and evaluation:* Tools in this category implement formal methodologies to support policy development and evaluation. Stakeholder Identification and Assumption Surfacing (SIAS), based on the strategic assumption surfacing and testing techniques developed by Mason Mitroff [32], is used to assess the potential impact of a plan or policy by identifying those individuals and organizations that affect (or are affected by) the plan (i.e., the "stakeholders"). SIAS provides a highly structured supported style, in which participants first identify stakeholders and then their assumptions, before rating assumptions for importance to the stakeholder and importance to the plan. Policy Formation (PF) provides a structured multi-phase supported style for reaching agreement in the exact wording of a policy statement. Each participant independently drafts one version of the policy, which is sent to the public screen at the front of the room. Each of the drafts is discussed verbally, and then the policy is sent out to be redrafted again by each participant.

### Tools for Organizational Memory

The primary purpose of the organizational memory tools is to provide task structure and task support. Thus far, many EMSs have supported meetings as independent, autonomous events. GroupSystems views the meeting as one part of a larger whole. While improving meeting outcomes is important, it is also important to capture the additions to organizational memory and to provide access to them in subsequent meeting(s). The organizational memory tools provide this organizational memory. Some of the files it contains are knowledge bases in the artificial intelligence sense (e.g., semantic nets) while others are text files or databases.

Briefcase (BC), mentioned earlier, is a memory resident tool that provides immediate read-only access to any text file in the organizational memory at any point during the session. The user simply presses the appropriate keys and is presented with a menu describing each text file. BC also provides a calculator, notepad and calendar. Enterprise Analyzer (EA) facilitates the structuring and analysis of group information in a semantic net using a variety of user-defined modeling techniques (e.g., IBM's Business System Planning (BSP), Porter's

Value Chain). Information can be viewed in tabular form, or in graphical form with the Semantic Graphics Browser (SGB). SGB enables the user to move through the organizational memory and "zoom-in" on specific areas to view details, "zoom-out" to obtain a high-level view, or "explode" a view to display detail information under a node. Group Dictionary enables the group to develop and store formal definitions for use in current or subsequent meetings.

## EMS in Practice: Lessons From Using GroupSystems

Our research strategy has been to build on theoretical foundations from prior research to develop EMS environments which are tested via empirical research. Our empirical research has included both laboratory experiments [e.g., 3, 10, 11, 14, 15, 18, 19, 28, 29, 48, 49, 50, 51, 55] and field research [e.g., 6, 7, 9, 20, 35, 36, 37, 51, 52], as we believe that both are important in understanding the impacts of EMS, and in developing the EMS components appropriate for various tasks, groups and organizations. While most studies have found EMS use to improve effectiveness, efficiency and satisfaction, they have also found different effects in different situations. Perhaps the most important conclusion is therefore that even within the same EMS, effects depend on the group, the task, the context, and the EMS components used. This should not be surprising; Figure 4 suggests that the effects depend on interactions among more than three dozen constructs in the meeting process.

We believe it will be difficult to find universal truths. In the meantime, we believe it is important to develop contingency theories to identify the best fit between specific EMS components and the specific group, task, and context characteristics. Isolating the individual effects of specific situational characteristics and EMS components is difficult, as most studies have examined the combined effects of many factors simultaneously. In this section, we return to the contingency model in Figure 3, which hypothesizes that processes and outcomes depend upon the interaction of four sets of characteristics: context, group, task and EMS. There are dozens of potentially important contingencies. We consider only five: one from the set of EMS characteristics (anonymity), two from group characteristics (size and proximity), one from the context (evaluative tone) and one from task (task activities). For each, we present theoretical arguments and empirical evidence that lead us to hypothesize certain effects. In each case, however, more research is warranted.

### Anonymity

Anonymity is possible in interactive styles and in the electronic component of supported styles, but not with the verbal component of supported and chauffeured styles. Anonymity can affect EMS use by reducing or eliminating evaluation apprehension and conformance pressure, as well as social cues. The reduction of evaluation apprehension and conformance pressure may encourage a more open, honest and free-wheeling discussion of key issues. However, the reduction of social cues can lead individuals to behave in ways that are outside of the realms of socially prescribed behavior. Some evidence of the deindividuation associated with the reduction of social cues has been found in some forms of computer-mediated communication, the most extreme form of which is "flaming" [cf. 43].

Changes in evaluation apprehension, conformance pressure and social cues brought about through anonymous communication should have some effect on the meeting process, which should in turn affect the meeting's outcomes. The relaxation of social cues in anonymous EMS groups has been found in varying degrees in five laboratory experiments conducted at the University of Arizona. Groups using anonymous EMS have been found to generate more critical comments than groups using EMS where the author of each comment was identified [3, 28, 50]. Jessup and Tansik [29] also found that anonymous, non-proximate groups generated the most critical comments. However, only one of five experiments found anonymous groups to have increased performance compared to non-anonymous groups [3]; there were no performance differences in the other studies [19, 28, 29, 50].

Participants in field studies have usually reported that anonymity was important, particularly in cases where there were power and status differences in the group (e.g., more than two management levels present) [6, 9, 35, 36]. We infer that student groups in the laboratory have lower evaluation apprehension and conformance pressure, and thus while anonymity may reduce these process losses, there are fewer noticeable effects on outcomes. In situations where evaluation apprehension and conformance pressure are high, anonymity appears to have a more significant impact on meeting outcomes.

In all of the laboratory studies referenced here, anonymity was treated as a discrete variable, i.e., communication was either anonymous or it was not. However, the Valacich, Dennis, and Nunamaker [50] study suggests that anonymity may be better thought of as a continuous variable—it may be more appropriate to think of degrees of anonymity. In this study, there were two independent variables, anonymity and group size. The small anonymous groups in this study were more critical than small identified groups, but there were no differences in the level of criticalness among small and large anonymous groups and large identified groups. Because the groups were composed of so many members, there was already a degree of anonymity built into the structure of the group. This was not the case in the smaller groups, where the relative intimacy of the group reinforced existing social cues.

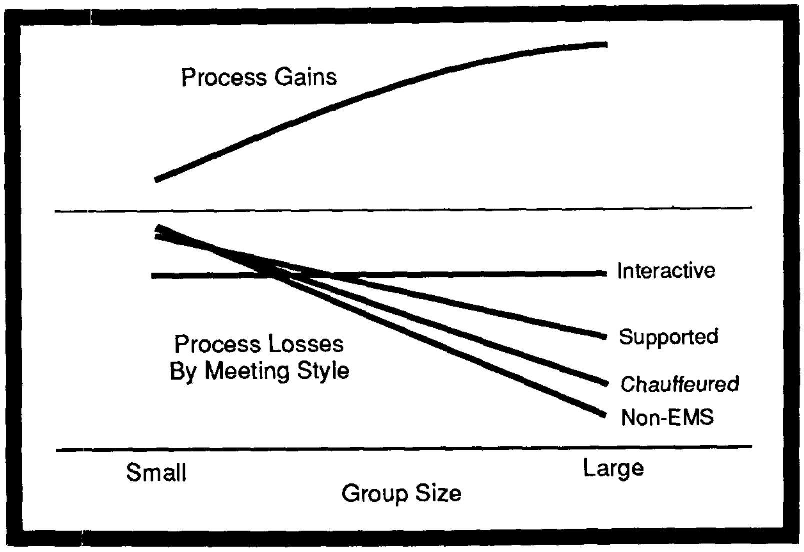


**FIGURE 7. Gains and Losses**

### Group Size

In general without EMS, process losses increase rapidly with group size [47]. Previous non-EMS research has concluded that in general, regardless of the task, context or group, the "optimal" group size is quite small, typically 3–5 members [42], because process losses quickly overtake any process gains from increased group size. Our EMS research draws a different conclusion: the optimal group size depends upon the situation (group, task, context, EMS), and in some cases may be quite large.

In theory, each of the three EMS styles (chauffeured, supported, interactive) can reduce or increase process losses in varying degrees. A chauffeured style reduces a few process losses. Thus compared to traditional non-EMS meetings, process losses do not increase quite as fast with group size (see Figure 7). A supported style introduces more fixed process losses initially (e.g., media speed), but reduces the rate at which losses increase with group size. An interactive style addresses most losses (and thus they should increase very slowly with size) but introduces more fixed losses initially. Thus we hypothesize that interactive styles will be preferred for larger groups, and supported or chauffeured styles for smaller groups.

There is some empirical evidence to support these hypotheses. One measure of process losses is participation, as it is directly affected by air time fragmentation, production blocking, free riding, etc. A laboratory experiment with small groups found that participation was the same between groups using a chauffeured style and non-supported groups [14], suggesting few differences between the two styles. Another experiment found participation to be more equal in groups using an interactive style than in non-supported groups, suggesting differences between the two [19]. Experiments studying interactive styles have found per-person participation levels to remain constant regardless of the size of the group [10, 48, 50], suggesting that process losses may remain relatively constant as size increases. Other experiments have found outcome measures such as effectiveness and member satisfaction to *increase* with size for interactive styles [10, 11, 49]. Another laboratory experiment built, tested and confirmed a model of group performance which proposed process losses from interactive styles to be relatively constant across group size [49]. Our field studies also provide some support for these hypotheses. Participants in studies with larger groups (i.e., 12–20 group members) have reported that interactive styles were more important than supported styles [37].

### Task Activities

The type of activities that must be performed to accomplish the task (e.g., idea generation) [42] has a significant impact on the balance of gains and losses. One primary goal of most group activities is the exchange of information among members [12], and thus the form of this information will have significant effects. Zack and McKenney [56] contrast three general states of information [also see 4]. Ambiguity exists when there is both a lack of information and a lack of a framework for interpreting that information. Uncertainty exists when a framework exists, but there is a lack of information. Equivocality exists when there are multiple (and possibly conflicting) interpretations for the information or the framework.

Equivocality requires negotiation among group members to converge to consensus on one interpretation, and media providing information richness are preferred [4]. In contrast, ambiguity and uncertainty require someone in the group (or the group as a whole) to provide, locate, or create the needed information or framework components. Thus the degree of media richness is unimportant; the ability of the group to rapidly gather information and framework components becomes paramount, especially if members of the group have different information, perceptions, and viewpoints.

Exploration and idea generation is more often a problem of ambiguity or uncertainty than of equivocality. It is a divergent activity, as members work individually to report information, propose elements of the framework, and respond to the comments of others. Prioritizing is also a divergent activity, as members work individually. In contrast, synthesizing and organizing ideas, building consensus on a framework, or interpreting the meaning of vote to achieve consensus are primarily problems of equivocality, as the group focuses on the same issues at the same time to resolve different viewpoints to converge on one interpretation.

Therefore, for divergent activities that are problems of uncertainty, such as idea generation, we hypothesize that an interactive style is more appropriate as its parallelism and anonymity facilitate rapid development of ideas. For convergent tasks that are problems of equivocality (such as synthesis and consensus building), process losses from reduced media richness in the interactive style increase dramatically. In this case, the relatively horizontal line for the interactive style in Figure 7 would move beyond the lines for supported and/or chauffeured styles for most group sizes, making them more appropriate.

Our laboratory and field research provide weak support for this hypothesis. A laboratory experiment of idea generation—a task of uncertainty—found groups using an interactive style to generate more ideas and be more satisfied than verbally interacting groups [18]. A similar study using GroupSystems at Indiana University had similar findings [16]. Experiments using purely interactive style for generating and choosing tasks (tasks which begin with ambiguity but evolve into equivocality) have found no performance or satisfaction differences compared to verbally interacting groups [19, 55]. The EMS groups in one of these studies also required longer to reach consensus [19]. Groups in our field studies have typically used interactive styles to generate ideas, options, and analysis framework components, but used supported or chauffeured style to resolve equivocality.

### Group Member Proximity

In our definition of an EMS [5], we note that groups may be distributed with respect to both space and time, although the majority of our research to date has focused on groups interacting in a single room at the same time. Other researchers have also argued that advanced computer-assisted communication and decision technologies, such as an EMS, can be important for project-oriented work groups and temporary task forces that may be distributed geographically and temporally throughout an organization [e.g., 26].

From a theoretical perspective, group process and performance for distributed groups may be substantially different from proximate groups. Social facilitation research has shown that the presence of others can improve a person's performance for easy tasks and hinder performance for more difficult tasks [57]. Remoteness may also foster increased anonymity, and increased anonymity may have several effects on the group, ranging from reduced apprehension to increased social loafing and deindividuated behavior as noted previously. Further, several small group researchers have found that close group proximity may foster liking and fondness among group members [57], and in EMS environments, proximate groups have been as satisfied [48] or more satisfied than distributed groups [29].

Our initial research in this area has built on our growing body of idea generation research (i.e., a problem of uncertainty not equivocality), where groups communicate only through electronic communication. One laboratory experiment found no difference in the number of ideas generated between proximate and distributed groups, but found proximate groups to be more satisfied [29]. A second study using a similar research design found distributed groups to generate more ideas than proximate groups, with no satisfaction differences [48].

During these experiments, proximate groups were interrupted more often by disruptive movements or by laughter prompted by a humorous electronic comment. Social facilitation research suggests that such reaction will generally be stronger when a person is proximate to other group members than when working alone in a distributed group [57]. Thus, we believe that the primary explanation for these performance effects in the laboratory was that distributed groups remained more task-focused than proximate groups.

However, the effects of the proximity manipulation may have been different if this research had been conducted in the field. Our groups worked without outside interruptions. Yet, there are many potential interruptions for group members working alone in the privacy of their offices by events that cannot be helped (e.g., a call from the boss) or by purposely working on other tasks. As a result, distributed groups in the field may, or may not, be more task focused than groups working together in the same room, and thus may find different effects.

### Evaluative Tone

Several researchers have advocated a supportive, non-judgmental atmosphere as a means to enhance group productivity by lowering evaluation apprehension and encouraging "freewheeling" stimulation. The withholding of criticism is a cornerstone of many idea generation techniques [38]. However, other researchers have proposed that group productivity may be stimulated by a more critical atmosphere where structured conflict (e.g., dialectical inquiry or devil's advocacy) is used to stimulate group members [e.g., 41]. In any event, there are two very distinct, and opposing, positions related to this construct.

> We are convinced that the use of EMS technology can improve group processes and outcomes in many cases...

Connolly, Jessup and Valacich [3] used a laboratory experiment which crossed anonymity (anonymous or identified groups) with the meeting tone (supportive or critical as manipulated by a confederate) to test whether the effects of evaluative tone were moderated by anonymity. Not surprisingly, anonymous groups and critical groups made more critical remarks than groups that were identified or supportive. Groups working anonymously and with a critical tone produced the greatest number of ideas of the highest quality. However, groups in supportive and identified conditions were typically more satisfied than groups in critical and anonymous conditions. This suggests that the combination of a critical tone and anonymity may improve idea generation, but also may lower satisfaction.

Observations from our field studies provide some insight into possible reasons for these effects. The anonymity may have encouraged group members to detach themselves from their ideas, allowing them to view criticism as a signal to suggest another idea:

> "I noticed that if someone criticized an idea of mine, I didn't get emotional about it. I guess when you are face-to-face and everyone hears the boss say 'You are wrong' it's a slap to you, not necessarily the idea. . . . [Here] no one knows whose idea it is, so why be insulted? No one is picking on me. I think I'll just see why they don't agree with me." (manager, Hughes Aircraft).

This runs counter to the typical knee-jerk reaction that might occur in a traditional verbal meeting where a critical comment may be seen as directed at the contributor, not the idea (e.g., "I wasn't as uncomfortable when I saw someone being critical of someone else's idea, because I thought 'nobody's being embarrassed here at all.'" manager, Hughes Aircraft).

## Conclusion

The Arizona EMS research program using the GroupSystems Concept has included both developmental and empirical research. Our developmental research has produced more than two dozen software tools currently in use at more than 70 EMS facilities worldwide. Our empirical research has studied EMS use in the laboratory and in the field by more than 30,000 individuals from more than 200 organizations. In this article, we have discussed several key aspects in the theoretical foundation of EMS, have illustrated how these aspects are reflected in the Arizona facility and software designs, and have highlighted the contingent nature of EMS effects. Nonetheless, much more research is needed to develop new group work methods embodied in facilities and software, and to empirically test the many contingencies involved in their use.

While still recognizing the need for future research, we are convinced that the use of EMS technology can significantly improve group processes and outcomes in many cases—but effects *are* contingent on the situation. For example, we would expect fewer benefits from EMS use for small cohesive groups in supportive contexts, as they face fewer process losses. Based on the theoretical foundation of process gains and losses, and our observations of EMS use in the field and the laboratory, we believe that EMS use may provide benefits because:

- Parallel communication promotes broader input into the meeting process and reduces the chance that a few people dominate the meeting;
- Anonymity mitigates evaluation apprehension and conformance pressure, so that issues are discussed more candidly;
- Group memory enables members to pause and reflect on information and opinions of others during the meeting and serves as a permanent record of what occurred;
- Process structure helps focus the group on key issues and discourages irrelevant digressions and unproductive behaviors; and
- Task support and structure provides information and approaches to analyze it.

We have drawn four general conclusions about conducting EMS developmental and empirical research. First, the effects of EMS use are contingent upon the situation. Thus we believe that it is critical to clearly document specifics about the group, task, context, and EMS in all research. Who were the group members and were they a cohesive team, strangers, or competitors? Exactly what did the task entail? Were group members motivated? What did the EMS provide at what points, and exactly how did the group use them? Without such detail, the contribution of a study cannot be clearly interpreted or extended.

Second, the results of any one study will not apply to all group work, so it is important to explicitly consider the bounds to which the findings can be generalized. Do they apply to large or small groups, chauffeured, supported or interactive styles, choice or idea generation activities, etc.? We agree with Huber [26] that even apparently subtle differences may have significant impacts. For example, in theory, slower system response time should increase process losses due to attenuation and concentration blocking; one experiment found groups using EBS with a few seconds slower response time to generate significantly fewer ideas than those using the standard version [17]. Only by carefully defining the scope of a study and interpreting the results within it can we extend our understanding of EMS effects.

Third, much EMS research to date has addressed the "what" of EMS technology; researchers have compared EMS and non-EMS groups to determine if there are differences between the two, which is typical of initial research into new technologies. From this research, we know that EMS and non-EMS meetings *are* different, but cannot completely explain *why*. While there is still a place for such research, we believe that it is now more important to understand why EMS encourages different effects in different situations. The research question becomes "does this factor explain why EMS use produces these results in this situation?" rather than "is there a difference?" To understand the "why," it is necessary to compare situations that differ only in the one or two factors of interest. As EMS and non-EMS groups can differ in so many ways (e.g., production blocking, media richness), this research will typically not involve a comparison between EMS and non-EMS groups, as there are too many potential differences to draw conclusions. Field research presenting qualitative investigations of EMS effects on group process in different meeting situations and over the long term will also become important. Our future empirical research will continue to develop contingency models to isolate and explain why certain EMS features (i.e., types of process support, process structure, task support and task structure) are of value for certain groups, tasks and contexts.

Finally, we believe that in developing new EMS tools, it is important to strive to understand what EMS components are useful in what situations. A focus on these four mechanisms may help clarify the needs of specific situations. It will become increasingly important for developmental researchers to work closely with empirical researchers to best fit the components offered by different configurations of EMS technology to user needs. In the early years of EMS, there was little empirical research to guide developers. Developers built EMS environments, gave them to users to see what happened, and then redesigned them in an iterative cycle of design-test-redesign. Today, there is a growing base of empirical research, and while iterative development remains important, developers building on this empirical foundation can provide more successful initial environments requiring less redesign.

The study of EMS is still in its infancy. It is reminiscent of the early days of the automotive industry when a motor was put into a carriage giving the world a horseless carriage. We are now in the horseless carriage phase of EMS, having installed computers into existing manual processes. We need to learn how best to support groups and group meeting processes, to build on these experiences to create systems that take better advantage of the abilities of technology and of groups. We may discover that many current EMS components (e.g., a facilitator) are the buggy whips of this horseless carriage phase. We are only beginning to discover what functions are robust and valuable, from which will emerge the next generation of EMS. Nonetheless, based upon research and experiences to date, we are convinced that this technology is fundamentally changing the nature of group work.

**Acknowledgments**
This research was partially supported by grants from IBM. Additional funding for several laboratory experiments was provided by the Social Sciences and Humanities Research Council of Canada. We would like to acknowledge the efforts of the following people who have been involved in the GroupSystems project: Erran Carmel, David Chappell, Kathy Chudoba, Bob Daniels, Mark Fuller, Glenda Hayes, Barbara Gutek, Bruce Herniter, Suzanne Iacono, Ben Martz, Jolene Morrison, Mike Morrison, David Paranka, Mark Pendergast, V. Ramesh, Ed Roberts, Bill Saints, Craig Tyran, Lee Walker, and Suzanne Weisband. We would like to thank Brent Gallupe, Karen Judson, the anonymous reviewers, and the editor for particularly helpful comments on earlier drafts of this article. C

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**CR Categories and Subject Descriptors:** H.1.2 [**Models and Principles**]: User/Machine Systems—*human information processing;* H.4.2 [**Information Systems Applications**]: Types of Systems—*decision support;* H.4.3 [**Information Systems Applications**]: Communications Applications—*computer conferencing and teleconferencing;* H.5.3 [**Information Interfaces and Presentations**]: Group and Organization Interfaces—*synchronous interfaces; theory and models;* J.1 [**Administrative Data Processing**]: General.

**General Terms:** Design

**Additional Key Words and Phrases:** Communication, computer-supportive cooperative work, electronic meeting systems, group decision support systems, groupware, group work, multiuser systems

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