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The Problem of Unshared Information in Group Decision-Making: A Summary of Research and the Implications for Command and Control

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EXECUTIVE SUMMARY

In any group decision-making environment, each participant can contribute two types of decision-relevant information. One type is Shared Information, i.e., information known to all group participants. In a command and control environment, shared information items might include rules of engagement, order of battle, Commander's Intent, the OPLAN, etc. The other type is Unshared Information, i.e., decision-relevant information that is uniquely held by one (or more, but not all) of the group participants. Unshared information can result from either a unique information search path used by a participant during the decision-making task, or from the aggregate of information the participant has acquired from his past experiences and personal contacts. Potentially, unshared information can impact the pool of shared information by either adding new relevant items to the pool, or by modifying (positively or negatively) the credibility, importance, timeliness, etc., of information items that are already in the pool. Note that the total amount of information available to the decision-making group is a function of shared information plus unshared information. This is an important point because, as will be demonstrated below, given the existence of unshared information, a rational group choice made without consideration of the unshared information may in fact be dramatically different from the rational choice the group would make if all the unshared information were actually transformed into shared information.

This report contains a detailed review of the literature on the use of unshared and shared information in a group decision-making situation. Two basic conclusions can be drawn: (1) People are not very effective in communicating unshared information—groups tend to focus their discussion on information that is already shared, with the result that little, if any, unshared information moves into the shared environment, and (2) when unshared information does move into the shared environment, participants tend to ignore or discount this information and not factor it into their decision process in an effective manner. The net result is that many group decisions are based upon incomplete information, i.e., decisions do not take into account information that would be available to the group if they were optimally exchanging and integrating unshared information. Group decisions can easily be sub-optimal when critical information is held by individuals and is not effectively shared.

The preponderance of the literature on group decision-making is based upon experimental groups working in a face-to-face environment. Thus, the findings have been attributed to a variety of influences, both social and cognitive. In contrast, much of modern military command and control decision-making is not predicated on face-to-face groups, but rather on time/place asynchronous collaboration where the decision process is often distributed over time and location. In asynchronous collaboration, information is generally exchanged via text transcribed from radio traffic, e-mail, messages, etc. These communication modes tend to be more impersonal and thus tend to minimize social factors that might inhibit the exchange of unshared information. Consequently, we believe the primary obstacle to the effective utilization of unshared information in asynchronous collaboration is the cognitive burden placed on both the sender of unshared information and the recipient of new information. The sender needs to answer such questions as, is the item indeed unique, is it the best example to send, who should be the recipient, and when should it be sent? The recipient has the task of determining how (or if) this newly arriving information should be integrated into his/her ongoing decision process. To minimum this cognitive burden, we propose a research program called START (Structure, Tag, And Release Templates). The START process begins by developing group consensus on critical decision evaluation categories, parameters, and qualifying values. Group participants associate information items with information categories and assign (tag) to each item parameter values utilizing a set of easy to use point-and-click templates. Participants can then invoke a "release" process that uses a suite of manual, semi-autonomous, and autonomous algorithms to ensure the optimal exchange and integration of previously unshared information into the group's overall decision process.

CONTENT

1. PURPOSE

As military command and control operations become more global, it is clear that the military group decision-making process has become increasingly more distributed in both place (geographic location) and time. The traditional face-to-face meeting has been replaced by asynchronous collaboration where group participants are located in different regions, each with potentially different time-availability considerations. A significant consequence of this is that much of the decision-relevant information is also distributed across the participants. Because of their location, previous experiences, differing access to databases/people, etc., each participant has uniquely held information items that can significantly impact the decision-making task. Clearly, this uniquely held information can only impact the group decision if it is effectively transformed into shared information so that the group can review, evaluate, and integrate all the relevant information into their final decision.

The purpose of this report is to (1) review the current state of research on the use and exchange of unshared information in group decision-making processes, (2) assess the implications of this research for military decision-making, and (3) propose a research plan to develop procedures, processes, and technologies that will improve the quality of command and control by improving the sharing and integration of uniquely held information items. Specific emphasis will be on asynchronous collaboration issues.

2. INTRODUCTION

In any group decision-making (DM) task, there are always two categories of decision-relevant information. There is Shared Information (SI), i.e., information that is known to all the DM participants. In a command and control environment, SI information items might include rules of engagement, order of battle, Commander's Intent, the OPLAN, etc. In a business environment, these might include items such as CNN reports, newspapers, widely circulated company documents, ticker quotes, etc. In any group, there is also Unshared Information (UI), i.e., decision-relevant information that is uniquely held by one (or some, but not all) of the DM participants and not shared with the remainder of the participants. This UI can result from either a unique information search path used by a participant during the DM task, or from the aggregate of information the participant has acquired from past experiences and contacts. Examples of UI could include corporate knowledge held by a former employee, findings from a person with access to a restricted database, assessment of a nation's infrastructure by a recent resident, a person capable of reading foreign language newspapers/reports, etc. UI impacts the pool of information by either adding a new relevant item to the pool, or by reflecting (positively or negatively) on the credibility, importance, timeliness, etc., of information items that are already in the pool.

The basic assumption in this report is that the greater amount of UI that is moved into the SI environment the better will be the quality of the group decision. The next two sections discuss the current research findings on the use of SI and UI and the parameters that influence the exchange and utilization of UI.

Unfortunately, the vast preponderance of SI/UI research reported has been conducted in the academic environment with very little focus on military DM tasks and problems. The collaborative medium has almost uniformly been face-to-face (F2F) group meeting where all group participants are in the same room at the same time. In the experiments, a given distribution of SI and UI is created by giving all members certain decision-relevant information items (the SI) while also giving members one or more information items that only they possess (the UI). The amount of UI that gets exchanged and its impact on decision quality are the typical performance measures.

3. RESEARCH REVIEW

The review of the research literature is divided into two major components: (1) how well people exchange/share their UI and which factors influence the level of sharing, and (2) if the UI does indeed become shared, how well people use and integrate this arriving UI into their decision-making process.

3.1 EXCHANGE OF UI: OVERVIEW

The early and classic work in the field is by Stasser and Titus (1985). Participants in a F2F environment were asked to review hypothetical job applicants and select the best candidate. In one condition, each participant had all the relevant information, e.g., if there were five items to consider on an application, each participant had possession of all five items. At the conclusion, it was judged that this group had made the correct decision about 83% of the time. In another F2F situation, all the information was "on the table" but was distributed across the participants such that each participant had some SI items as well as some UI items, but no one had all of the information items. It was clear that the UI items were not shared properly since the percent of correct decisions for this group dropped to 24%. As an explanation, Stasser and Titus (1985) noted that in the distributed group, a disproportionate of time was spent discussing the SI items, resulting in very few of the UI items ever being brought up for discussion. This resulted in what they called "sampling bias" and the resulting absence of UI caused the significant degradation in the quality of the decision-making. They proposed a probabilistic information-sampling model to account for this finding. Basically this notion is that SI is more likely to appear in group discussions because it can be sampled (recalled) from all group participants, while UI can only be sampled from the one participant that holds that information. Wittenbaum and Stasser (1996) later showed that since this concept does not take into account the social factors that could also influence the level of UI exchange, it cannot fully account for some of the more recent research results. Wittenbaum et al. (1999) consequently expanded the concept by including a "mutual enhancement" explanation that attributes the increased level of SI discussion to the fact that it permits group participants to mutually confirm each member's expertise in the DM task.

This basic finding showing increased group discussion of SI items at the expense of sharing the UI has been repeated in numerous studies by Stasser and others (Christensen et al., 2000; Fisher, 1980; Gigone & Hastie, 1993; Gigone & Hastie, 1997a; Larson, Foster-Fishman, & Keys, 1994; Stasser, Taylor, & Hanna, 1989; Stasser & Stewart, 1992; Stewart & Stasser, 1995). This is a potentially serious decision-making flaw since it is clear that many group decisions are made in situations where all the relevant UI has not been moved into the shared environment (Gigone & Hastie, 1997b).

The following sections address some of the specific parameters that have been shown to influence the level of shared UI.

3.1.1 The "Hidden Profile" Problem

One of the most insidious consequences of failure to utilize UI is found in what has been referred to as the "hidden profile" task. Consider the follow data:

Member 1	Member 2	Member 3	Member 4	Member 5
A1	A1	A1	A1	A1
A2	A2	A2	A2	A2
B1	B2	B3	B4	B5

We have five group members (1-5) who must decide between Option A or Option B. Each member has three items of information, two favoring Option A (items A1 and A2) and one item favoring Option B (either B1, B2, B3, B4, or B5). Working independently, and with no unique items shared, each member would recommend Option A since the preponderance of the information favors that option (i.e., two items favor A, one item favors B). A group vote would thus result in a unanimous decision in favor of Option A. If, however, all the unique information was made available to everyone, the reverse decision (Option B) would be reached, since there are now only two items favoring Option A (A1 and A2) and five items favoring Option B (B1, B2, B3, B4, and B5). Hidden profile situations have been studied by Christensen et al. (2000), Cruz, Boster, and Rodriguez (1997), and Johnson and Johnson (1992).

3.1.2 Task Type/Goals/Importance

Researchers investigating group DM often differentiate between intellective tasks and decision-making tasks. An intellective task is one where there is indeed a discoverable correct answer, e.g., "which route between these three cities will consume the least fuel?" "What sensor distribution pattern would result in the highest probability of detection?" A decision-making task is viewed as a judgmental process where there is no true discoverable correct answer, e.g., "which route between these three cities would be the most scenic?" "Which sensor distribution pattern would be the most confusing to the enemy?" Research has shown that more UI gets exchanged if the DM participants are led to believe that they are working on a task that has a discoverable solution (Stasser & Stewart, 1992).

Several researchers have shown that more UI is exchanged when the goal of the task is viewed in terms of information exchange rather than simply decision consensus. (Cruz, Boster, & Rodriguez, 1997; Van Knippenberg, Nijstad, & De Dreu, 2000; Wittenbaum, Merry, & Stasser, 1996).

Perceived task importance can also influence the exchange of UI. Larson, Foster-Fishman, and Keys (1994) showed that when group participants view the task as being of higher importance, there is an improvement in the exchange of UI.

3.1.3 Group Diversity

Generally speaking, military DM groups are relatively homogenous, at least in terms of age group, culture, religion, generic background training, political views, health/physical fitness, computer sophistication, etc. However, coalition operations add personnel from markedly different cultures, religions, and training levels. Disaster relief and humanitarian assistance missions create an even more diverse group with widely differing goals and political views. As might be expected, research has shown that as group diversity increases, the level of UI that is shared decreases (Gruenfeld, 1996).

3.1.4 Group Size

Stasser, Taylor, and Hanna (1989) compared the use of SI/UI by groups that had either three or six participants. Members of six-person DM groups spent more time discussing the already shared information than did members of the three-person groups. These results indicate that as group size increases, there is a decreased likelihood that the group will share UI.

3.1.5 Training/Prior Experience

Although Wittenbaum (1998) showed that prior experience on the task did not improve information exchange, Larson et al. (1994) demonstrated that actual group training in decision-making increased the amount of both SI and UI that was discussed. Training also impacted the timing of when UI was introduced into the discussion, with trained groups discussing UI all during the discussion while untrained groups introduced it only in the later phases of the discussion (i.e., after all the SI has been discussed).

3.1.6 Experts/Team Leaders

Other research has investigated the influence of "experts," i.e., participants that the experimenter has specified to the group as being experts or people with more decision relevant knowledge/ information. Some research has used actual participants with varying levels of expertise (i.e., nurse, intern, medical resident). Results are fairly uniform and indicate that the recognition, by the group, of a participant as having "expert" knowledge usually results in a greater sharing of UI (Larson, Sargis, Elstein, & Schwartz, 2002; Stasser, Stewart, & Wittenbaum, 1995; Stasser, Vaughan, & Stewart, 2000).

A closely related topic is the influence of a team leader on the sharing of UI, since in many cases, the top expert is also the team leader. As might be expected, the results are generally similar, i.e., team leaders repeated substantially more information items (both SI and UI) than did other members, were more likely to ask questions, and (perhaps most importantly) repeat unshared information (Larson et al., 1996; Larson et al., 1998). The style of the team leader also influenced performance. Participative leaders discussed more SI and UI information than more directive leaders, but directive leaders were more likely to repeat UI information than participative leaders (Larson, Foster-Fishman, & Franz, 1998).

3.1.7 Groupware

As some researchers have noted, groupware systems should have a positive influence on the level of information exchanged (DeSanctis & Gallupe, 1987). This is usually based on the assumption that the increased level of anonymity that is available in a groupware system should mitigate some of the negative influence of the social factors present in a F2F environment. As Dennis, Haley, and Vandenburg (1996) note, however, groupware can increase the amount of both relevant and extraneous information that gets exchanged, causing possible cognitive overload problems. As might be expected, the results on the effect of groupware on UI and SI exchange are varied and conflicting. In their recent meta-analysis of groupware results, Dennis, Haley, and Vandenburg (1996) conclude that groupware improves decision-making in some situations but has little or even negative effects in other situations.

3.1.8 Pooling of Text

In asynchronous collaboration, the influence of social factors is decreased because the primary collaborative information exchange is textual, i.e., e-mail, chat boxes, etc. The negative consequences of this are that it is more difficult to find and process information when information in groupware is presented in such a pool of text (Dennis, 1996). Evidently, it is easier to ignore information in a pool of text because no one is actively placing it in front of the participants, i.e., there is no "advocate" giving special emphasis to one or more of the items of information. Thus, the pooling of text found in a collaborative asynchronous mode (as versus F2F verbal interchange) may increase the likelihood that critical items of information may be missed or ignored by the DM group.

3.2 THE USE/INTEGRATION OF UI: OVERVIEW

It is a widely held assumption that the more information that is made available, the better will be the quality of the decision-making. In an UI/SI environment this would mean that the more that UI becomes shared, the better the decision quality. For example, Gigone and Hastie (1997a) found that groups sometimes overturn the majority opinion of their numbers and move in a direction supported by the UI, and several studies have shown that the pooling of UI (but not SI) improves decision-making (Larson et al., 1998a; Winquist & Larson, 1998). The majority of studies, however, have produced results that indicate that group members discount the UI and typically base their decision on the original shared information. As one researcher in this area accurately entitled his article, "You can lead a group to information but you can't make it think" (Dennis, 1996), meaning, of course, that getting all the relevant information does not improve decision-making if that information is ignored. Another group of researchers (Lavery et al., 1999) concluded, "the vital role of group discussion was not to exchange information but to aggregate member preferences into a consensual group judgment." A large number of research results indicates that UI is not effectively utilized once it is shared, is repeated less often that original shared information, is recalled less accurately than SI and generally discounted in one form or another (Dennis, 1996; Dennis et al., 1997; Gigone & Hastie, 1993; Gigone & Hastie, 1997b; Hightower & Sayeed, 1996; Larson et al., 1998b; Lavery et al., 1999; Stasser & Titus, 1985; Stasser et al., 1989; Stewart & Stasser, 1995; Thompson, 1991). Gigone and Hastie (1993) have referred to the phenomena of over-weighting SI information and undervaluing the UI information as the "common knowledge effect." Gigone and Hastie (1997b) referring to their 1993 work, noted, "Information pooled during discussion had almost no effect on the group judgments. It was as if the group members exchanged and combined their opinions but paid little attention to anything else."

As section 3.1 indicated, most UI/SI research has focused on factors that influence the <u>exchange of UI</u>. The follow-on discovery from such research was that even when the UI becomes shared, it is often not utilized and there is poor <u>integration of UI</u> into the overall decision-making process. Generally, the non-use of UI has been attributed to (1) the social influences of a F2F environment, or (2) the cognitive expenditure demands in a groupware situation. Unfortunately, not much research has been directed at this next step of exploring the factors that would improve the integration of UI and SI and produce better quality decision-making performance. Below are some of the research findings.

3.2.1 Distribution of UI

Research on groups performing intellectual tasks found that if at least two members of a group shared the same UI item with the rest of the group it was more likely to become a focus of attention in the group (Laughlin, 1980; Stasser et al., 1989). Information known only by a single individual may be treated as mere opinion, or the individual may lack the motivation to bring it to the group's attention (sometimes referred to as "mind-guarding"). Stasser and Titus (1987) examined the ability of a group to recall UI items that came up for discussion. It was found that when 66% of items were SI, only 10% of recalled items were UI items whereas when 33% of items were SI, 32% of the recalled items were UI items. Both of these findings indicate that the more widely distributed the UI is among the participants, the more likely are the participants to recall and use the UI in formulating their decision. Single instances of UI seem to have little impact.

3.2.2 Use of Decision

Weldon and Gargano (1985) found that group members who were told their judgments would be combined with others used less information and less complex strategies as versus participants who assumed their judgment would be treated individually. They referred to this as "Cognitive Loafing" (cf. "Social Loafing"). This result would indicate that emphasizing the importance of a decision and particularly the importance of each individual contribution would enhance the use and integration of UI.

3.2.3 Number Versus Persuasiveness of Arguments

Arguments for and against an action or decision can vary either in the number (count) of arguments or on the persuasiveness (salience) of each argument. Hinsz and Davis (1984) showed that when individuals selected a riskier option, they cited the persuasiveness of the arguments, rather than the number, as the more important factor. When selecting lower risk options, the number of arguments was more important. In a UI/SI environment, if we assume that the decision relevance of each information type is the same, the absence of UI items that would add to the total number of SI items could, in effect, reduce available support for low-risk options. In other words, minimizing the number of items in SI might, under certain conditions, bias a group decision process toward high-risk options.

4. RESEARCH IMPLICATIONS FOR MILITARY COMMAND AND CONTROL DM

Extrapolating results from previous research to a modern military command and control environment is difficult because of the basic differences in the collaborative environment. As noted, the vast preponderance of previous work is based upon F2F situations, i.e., all participants working in the same room at the same time and with the primary collaborative information exchange process being voice conversations. As such, it is reasonable for those researchers to have chosen to concentrate on the social factors that influence the exchange and integration of UI/SI. In contrast, group decision-making in a modern command and control environment often operates in a highly asynchronous time/place mode with the primary collaborative information exchange occurring via message text, graphics, and perhaps single-point or conference call phone connections. In such a distributed command and control environment, the social effects that impede UI/SI exchange are minimal at best. Rather, the problem is the overwhelming amount of data that can be made available to every participant. Within a highly trained, highly motivated military group decision-making environment, it is our hypothesis that the primary cause of poor UI/SI exchange is the cognitive overload associated with the transformation of data into useful information.

The holder/sender of an item of UI has a number of issues that must be addressed to determine whether or not to share the item with other participants. Is the item indeed unique to him/her or is it likely that other participants have seen the item and sending it will only result in more data redundancy vice adding relevant new information? Is the item important enough to be communicated to other participants? How should such communication be formatted for maximum effect? How does the item impact SI? Does the item contradict any thing in SI? All these issues plus many more place a significant cognitive burden upon a potential sender. The consequence is that he/she engages in a very coarse-grain filtering process that effectively reduces his/her cognitive overload problem but often at the cost of the group losing critical decision-relevant UI. Note that the issues confronting a potential sender of UI are largely irrelevant when considering existing SI. Thus, a participant can easily avoid increasing cognitive load by avoiding the transformation of UI into SI and attending only to existing SI.

From the recipient's perspective, the arrival of UI also creates a cognitive overload situation. He/she needs to determine how (or if) the new item or items affect his/her on-going decision process. To which particular decision parameter does this item relate? Is it a positive or negative influence? Is it credible and timely? How persuasive is it? If it discredits other information he/she is using, what is the "domino effect" of that information now becoming unreliable? All of these are complex questions and it is easy to see how the recipient of new, incoming UI might adopt an attitude of "If I ignore it, it will go away." Again, a recipient can avoid cognitive work by ignoring UI except for that which can be easily incorporated into the participant's own understanding of the decision task. While this approach would certainly reduce the cognitive burden, it obviously may also result in decisions that are based upon incomplete and perhaps even erroneous information.

We suggest that the most promising research approach to improving the exchange and integration of UI in military distributed decision-making is one that is directed at supporting the cognitive processes involved in selecting and sharing UI as well as in integrating received UI into the final decision process. Recall for a moment the "Hidden Profile" problem described in section 3.1.1. DM support systems that focus on automating various approaches to consensus construction (sometimes including automated derivations of individual preference functions, utilities, etc.) are vulnerable to hidden profiles. While automation that supports rational group decision processes is necessary for effective decision support, it is not sufficient for optimal decision-making. The best decisions are made when all relevant information is made available to the group decision process. This latter issue, the distribution of information in the group, is the objective of this research. Our proposed research plan is to develop an approach to decision-support that reduces the cognitive overload associated with the exchange and integration of UI/SI. Our approach is referred to as "Structure, Tag, And Release Templates" (START). We believe this objective can be accomplished through new information structuring techniques, improved user-computer interface design, and an integrated suite of manual, semi-autonomous, and autonomous information exchange processes/agents. The following section addresses our proposed approach in more detail.

5. RESEARCH PRIORITIES/PLAN

In specifying any DM research plan, the first step is to define in detail the parameters of the particular DM task to be investigated. Our proposed target decision-making group is a command and control staff that has been asked to make an option-selection recommendation. The primary task assigned to the group is to recommend, as a group, one option out of a set of two or more options. The recommendation can range from a binary yes-no, action-no action choice ("Does this situation call for the establishment of a Joint Task Force?") to a selection from multiple courses of action (COAs), e.g., "Should we use Japan, Okinawa or Singapore as the refueling point?" In our project emphasis, the target group is not dealing with a brainstorming task that involves the generation/creation of COAs, but rather is required to collect and analyze the information needed to select the best option from an already existing list. We also do not address open-ended "report" type tasks, e.g., "What are the consequences if this regional government loses the election?"

Our basic assumptions are that the target group:

1. Is not under exceptionally critical time pressure, but may have hours or days to produce a product.
2. Works asynchronously, both in terms of time and place.
3. Most often must make a choice where there is no inherently correct answer.
4. Is comprised of individual participants who collect information in a relatively independent manner, and then collaborate in order to reach an overall consensus on the option recommendation.
5. Gets its information from documents, message traffic, specialized databases, intranets and the internet, personal contacts, and past experiences.
6. Utilizes collaborative technologies that are primarily textual, i.e., e-mail and chat boxes, but may also make use of audio record and playback, virtual rooms, telephones, and limited VTC.
7. Has no specific limitation on group size, but for research purposes it is assumed the group size will be restricted to 10 or fewer participants.
8. Will initially be relatively homogeneous in terms of age, rank, education, computer sophistication, and areas of expertise. Subsequent test groups will include participants that vary in terms of age, rank, education, computer sophistication, and especially in areas of expertise.

The first task in START is to ensure that the group conceptualization of the DM task is structured in a way that is rational and consistent with task objectives. Assigning a group the task of deciding "Which new car should we buy" is not likely to be productive nor are they likely to reach consensus in a timely manner. Is speed or fuel efficiency a more important characteristic? Is cost or comfort/ styling more important? How important is the audio system? The DM task can proceed only if the participants can either agree on, or accept as given, a set of decision parameters that can be used to compare and/or contrast decision options. In the example above, the task could be modified to "Which new car should we buy? Base the decision upon trade-in value, cost, fuel requirements, expected repair history, and safely features. For each decision parameter, give each option (car) a score from 1 to 10, 10 being best. " (For simplicity, we assume independent decision parameters.) Here, a set of five decision parameters has been attached to the task, so that during the information-gathering mode of the group decision-making process, each participant has a clear-cut template for determining the relevance on an incoming information item. These decision parameters can be either included as part of the initial task assignment to the group or, if missing, developed on a consensus basis by the group itself. In either case, it is critical that the structure parameters be in place if the subsequent information search mode is to be of any real use.

After the Structure component has been completed, the next two phases of the START process involve “Tag and Release.” In this approach, each participant completes a two-step process for each new item of information that he/she may find during a search for specific decision-relevant information. First, the item is “tagged” with amplifying information that supports the incorporation of the item into the group decision process. The tagging process allows the participant to associate with the item the appropriate decision parameter (does it relate to fuel, cost, repairs, etc.), the decision direction or valance (is it supportive or not to a Yes/No decision or a particular COA), relevance (how significant/important is this item), timeliness (how recent is the information), credibility of the source (can I believe this information), etc. Assuming it is an item he/she wishes to retain, after tagging the next step is to determine the disposition or “release” of the item: Should it be made available for browsing by others? Should it be sent to all participants, or just some? Send it now or later? Should it be kept private until more information is received?

The tagging process has three primary purposes. First, the tags assist the finder of the item with integrating, in an “on-the-fly” basis, this newly arriving information into his/her on-going decision task. When the finder switches from the information-gathering role to the option-evaluation role, the tags help make explicit how and why the item may be useful information. Second, tags can help another participant to quickly assess the value of a particular here-to-fore UI item to his/her own decision process. For example, critical information may reside in a tag element, perhaps verifying that an important SI item is, in fact, unreliable or irrelevant. Third, tags simplify the construction of automatic agent support. Because item tags correspond to important information parameters, relatively simple computer-based agents can be used to perform a variety of useful functions including searches for unique UI items, inconsistent tag values, etc. Note that there are two basic types of tagging categories. One type specifically relates to the decision task at hand and addresses the decision structure parameters used by the group, such as cost, repairs, etc. These categories would change from one decision task to another. The other type is categories that are needed to assess any incoming information item and are essentially independent of the specific decision task. These would include credibility, timeliness, relevance, valance, etc.

The “release” component enables the finder to either immediately send a significant item to the other participants, make the item available to the other participants when they have time to browse their open files, or to protectively store the item from view until he/she feels the information is sufficiently reliable/valuable for release.

As noted above, our approach assumes that SI/UI difficulties in an asynchronous environment are related to anticipated cognitive overload problems. Yet we are now asking each participant to add a new tag and release task to each information item he/she wishes to retain. This only makes sense if we assume that the tag and release process is simple to learn and perform and its benefits outweigh the cognitive costs it imposes. Without any decision support tools, participants either do not know how to address the problems associated with UI/SI integration, or the problems are basically ignored. We expect that the benefits of the START approach to the SI/UI problem area can be clearly demonstrated and that this, combined with a comprehensive user interface research program designed to minimize the cognitive effort in tagging and releasing, will produce significant improvements in both the use and integration of SI/UI.

From an experimental design perspective, one distinct advantage in examining asynchronous collaboration is that the group does not really have to exist. Running true group experiments can be a very tedious and frustrating process. The major problem is that if you need four people to show up to create the experimental group, but only three show up, the three that did show up can't be used. Since an asynchronous group is "virtual" you can run one subject at a time in the "group" experiment. All that is needed is to create the impression that he/she is dealing with other on-line participants who may or may not actually be present in real-time. The e-mail analogy immediately comes to mind, where information is only exchanged when you sit at your computer and read or send e-mail. There is no interaction with the other people except for the electronic exchange of textual information. This asynchronous process enables one to design on-line experimentation that has the subject log on to an internet site (at his/her convenience), enter an assigned password, and then participate in the experiment. When and where he/she logs in is his/her choice and the "responses" he/she receives from the other "group participants" can be preprogrammed and tailored to his/her response profile. This is a very efficient way to collect performance data, reduce scheduling/lost data problems, and optimize the use of the experimenter's time, since there is no need to be present while the subject is participating in the experiment.

In summary, research indicates that people are poor at both exchanging and utilizing UI. In F2F collaboration, this deficiency is attributed to both social and cognitive factors. In asynchronous collaboration, social factors are minimized and the inefficient use of UI is due more to the cognitive processing burden placed upon both the sender and recipient of new information. We have proposed a research program which focuses on improving the individual and group management of decision relevant UI, without placing an excessive cognitive burden on any of the participants. The three-step process involves structuring a set of decision evaluation criteria, tagging relevant information search items with appropriate amplifying parameter values, and then using these information tags to drive both manual and autonomous processes for the optimum exchange and integration of UI among the participants. Critical research emphasis will be placed on the design of simplified user interfaces to ensure that this process does not place any undue cognitive burden on the user. It is expected that the majority of the experimental research can be conducted in an on-line internet environment, which is a good facsimile of the asynchronous collaborative processes at the focus of this research.

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