THE FUTURE OF DECISION SUPPORT: AN EXAMINATION OF MANAGERS' INFORMATION NEEDS

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ABSTRACT

Decision makers today continue to rely on "old-fashioned" techniques like the telephone for information acquisition, even when newer technologies, including decision support and executive information systems, abound in the marketplace. Some of their reluctance to adopt new technology can be attributed to anxiety associated with changing old methods. Yet these individuals readily promote the introduction of new technology into other functions of the organization. This paper takes a close look at the fit between current decision support technology and managers' information needs. The result of this appraisal is an infrastructure for designing new types of systems based on what we know about managers instead of what we know about technology.

INTRODUCTION

The original aim of management information systems (MIS) was to provide information in the form of reports to managers faced with decisions to be made. The literature is replete with tales expounding the failure of MIS to provide managers with information that they would truly find "useful" ([11],[21]). To counter these complaints, IS researchers proposed decision support systems (DSS) and executive information systems (EIS) as the tools that managers could use to support their decision making. These systems did a better job of meeting managers' needs, and yet we find that managers have not relied on these systems to the extent that researchers had originally conceived ([11], [12], [24], [28], [29]).

Decision makers today continue to rely on "old-fashioned" techniques like the telephone for information acquisition, even when newer technologies, including decision support and executive information systems, abound in the marketplace. Some of their reluctance to adopt new technology can be attributed to anxiety associated with changing old methods. Yet these individuals readily promote the introduction of new technology into other functions of the organization.

Why are these tools not being used? One possibility is that a discrepancy exists between the capabilities of the systems and those desired by the manager/user. Recently, a number of articles have appeared that speculate on the managerial support system of the future ([10], [17]). Possibilities range from document-based decision support systems to multi-media office systems to intelligent electronic mail. The purpose of this paper is to identify or propose relationships between managerial needs for information and current and proposed technologies thought to meet those needs. The result of this appraisal is an infrastructure for designing systems based on what we know about managers instead of what we know about technology.

THE DECISION MAKING PROCESS

Much of the literature on DSS suggests that this technology is intended to support all of the activities comprising the decision making process [e.g., [12]]. Figure 1 replicates a frequently cited linkage between Simon's description of the decision making process and DSS [30]. In fact, most of the systems in use today focus on providing analytical tools to support the evaluation of alternatives which are usually furnished by the user ([11], [31]).

Unfortunately, the analytical focus of these systems does not reflect the managerial decision making process as noted by Mintzberg and others ([19], [23]). In these studies, managers' were found to spend from 41% to 64% of their time requesting, gathering, reviewing or giving information. This contrasts to the 15% to 21% of their time spent in actual decision making. One might argue that since information acquisition is the dominant activity in the manager's work day, there will be many opportunities for increasing the efficiency or effectiveness of the time spent on these activities through well-designed technological support.

These studies also point to an obvious mismatch between the activities comprising a manager's decision making process and those supported by DSS. The promoters of EIS recognized that a discrepancy exists. One of the original advocates of EIS, David Friend, remarked that

> "DSS and EIS are not the same thing. One of the senior executives at Gillette summed it up nicely. 'To me,' he said, 'EIS is having just enough information to ask an intelligent question, and DSS is what the other guy uses to get me some answers.' EIS tends to be for highly structured reporting, sometimes

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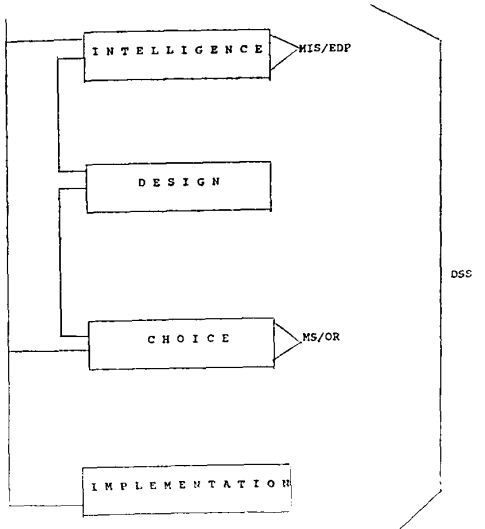
FIGURE 1 PHASES OF DECISION MAKING



from Sprague and Carlson (1982)

referred to as 'status access'. DSS, as you know, has become almost synonymous with modeling and unstructured, ad hoc queries." ([11] p. 38]

EIS (sometimes called ESS) have been defined as

"the routine use of a computer-based system, most often through direct access to a terminal or personal computer, for any business function. The users are either the CEO or a member of the senior management team reporting directly to him or her. Executive support systems can be implemented at the corporate or divisional level." ([28], p. 16).

EIS are data-retrieval oriented, contrasting to the model orientation of DSS. They also place more emphasis on communications. Rockart and DeLong point out a number of ways in which EIS can be distinguished from DSS and office automation. They find that EIS supports a broader range of applications. Its software is tailored to senior executives' use. It introduces a new set of implementation issues related to its executive audience. Additionally, it will have organization-wide impacts, compared to the departmental impacts of the other types of systems.

Between the two, EIS and DSS support a sizeable percentage of managers' data needs. EIS excels at supporting problem assessment strategies that detect patterns or inconsistencies in numerical data. Some EIS support external retrieval of non-numerical information, but still the focus is on providing easy access to internal data. EIS focuses on aiding in the identification of a problem area once symptoms have been perceived. It is chiefly a retrospective technology, meaning that trends or other indicators in historical data indicate that some action is to be taken.

DSS allows the decision maker to manipulate the data after he has identified the problem and selected one or more analytical techniques. DSS effectively has evolved into a reactive technology, aiding the decision maker in working on a problem or opportunity that has already been discovered.

EIS and DSS are fairly successful at helping to understand and analyze a problem once it is internalized to the organization. Lower level managers, who perform more analysis of internal problems and spend less time searching for information, are more comfortable with present DSS technology. Higher-level managers spend a larger proportion of their time in the information search activities that precede this analysis. Their inclination to rely on human and text sources may be due, in part, to a deficiency in the types of support that technology currently provides.

ENVIRONMENTAL ANALYSIS

Kurke and Aldrich [19] note that top-level managers are boundary spanners, spending about half of their time in external contacts. Although the subject of these contacts was not recorded in their studies, it is safe to assume that at least some, and probably most, of this time is spent on gathering information to be used in their planning processes. In a study of CEOs' sources of strategic information, El Sawy [8] counted 148 mentions of external sources compared to 49 internal sources. Tables 1 and 2 record the frequency with which CEOs mentioned various external and internal information sources. The more frequent use of external information was also noted in studies by Aguilar [1] and Keegan [16].

Fahey and Narayanan [9] discern that organizations rely on various environmental analysis practices as means to support strategic planning in organizations. These include scanning, monitoring, forecasting and assessment. Table 3 presents the distinctions among these types of analyses. Of these, scanning and monitoring involve the search for and acquisition of information, both internal and external to the organization. The results of these two activities become the data sources for forecasting and assessment.

Forecasting and assessment employ analytical techniques which are much more in line with the "traditional" view of DSS. Much of the data used by these techniques is amenable to being stored in a structured data base, and studied using models such as time series and regression analyses.

However, not all forecasting and assessment techniques are quantitatively based. Others, including Delphi, cross-impact matrices and scenarios [9] rely on human experts to make qualitative evaluations.

Recent advances in Group DSS [7] propose to provide computerized support for some of these methods. GDSS aims to expand the usability of DSS

TABLE 1 EXTERNAL STRATEGIC INFORMATION SOURCES: HARBITUAL AND SPECIFIC

External Information Source	Number of times mentioned Habitual	Specific
-Trade journals	17	10
*Friends in industry	16	11
*Customers	16	23
-Market research publications	8	4
-Conferences/symposia	6	1
-Trade shows/travel	6	8
-Business/political publications	6	5
*Financial community	3	-
*Consultants	2	-
*Competitors	-	3
*Suppliers	-	2
*Manufacturers of complimentary products	-	1
*Acquisitionee	-	1
*Total external PERSONAL sources	37	41
-Total external IMPERSONAL sources	43	28
TOTAL EXTERNAL SOURCES MENTIONED	80	69

from El Sawy, 1985

TABLE 2 INTERNAL STRATEGIC INFORMATION SOURCES: HABITUAL AND SPECIFIC

Internal Informatin Source	Number of times mentioned Habitual	Specific
VPs/managers in marketing	11	14
Other VPs/managers	8	9
Board of Directors	2	1
Engineers/technical people	2	2
TOTAL INTERNAL SOURCES MENTIONED	23	26

from El Sawy, 1985

technology beyond the individual level of support to the group level. In the process, it has extended the range of forecasting and assessment strategies assisted by information technology. It has not yet reached a level of sophistication where it has successfully replaced human interchange.

The more difficult environmental analysis stages of scanning and monitoring have not received the same level of technological attention as the latter two. To a certain extent, computerized scanning and monitoring has been around for decades. Bibliographic retrieval systems and econometric data bases have been employed by corporations, and in fact have been growing in popularity in recent time ([13], [14]). These information sources are not as effectual as they might be, due partly to the training needed by the intermediaries who must interact with them, and also to the imprecision of their search strategies. Thus, even though they are being used more now than ever, they do not directly support the individuals who formulate business strategy and plans.

This leaves an identifiable gap between the people who need quick access to potentially unidentified information sources and the mechanisms for finding the information. As Fahey and Narayanan [9] note, managers rely on their own reading and the advice of experts to gather potentially useful data.

El Sawy [8] found that CEOs prefer to conduct their own scanning rather than to delegate it. He proposes that this unwillingness is due to the potential for uncertainty absorption, which occurs when inferences are communicated in the information rather than simply evidence. One CEO in EL Sawy's study noted: "I do a lot of scanning myself...there may be subtleties that others won't see..."(p.56). Alternative explanations, which El Sawy attributes to Mintzberg [22], are that managers tend to store much of their scanning information in their minds, and not in company documents. This would preclude them from delegating this activity. Also, CEOs are privy to gossip or rumors that would not be picked up without their personal contacts.

El Sawy, like Fahey and Narayanan, argues that there are multiple modes of scanning. He talks about unsolicited reception or passive scanning, where the CEO is given unsolicited information. In reactive scanning or problemistic search, the CEO is faced with a specific problem about which he scans for information. Coincidental surveillance is a proactive mode, where information of an unspecified but relevant nature is gained from non-habitual sources. Routine monitoring, which is also proactive, is a systematic search of habitual sources. Note that these different scanning modes are similar to the scanning and monitoring activities of Fahey and Narayanan. Table 4 shows the prevalence of proactive scanning activity, especially routine monitoring. This clearly shows that the CEOs maintained a specific pattern of scanning, and that they know where to look for potentially important information.

The preference for routine, personal scanning implies that any system designed to augment this process would necessarily need to be customized, but not all-encompassing. The list of preferred sources in Tables 1 and 2 tells much about the delimiters of such a system.

First, the impersonal sources listed are, for the most part, publicly available documents. These sources would be the easier ones to include in a system, both because of their general availability and predictability of mode of presentation. This is not to say that this would be an easy task. Indeed, we have yet to design a system that can understand the contents of a document and be able to easily choose relevant passages based upon a profile of the user.

Secondly, all of these activities take a certain amount of time, knowledge, or contacts. The ability of a system to save on these would

TABLE 3 Distinctions Among Scanning, Monitoring, Forecasting, and Assessment

	Scanning	Monitoring	Forecasting	Assessment
Focus	Open-end viewing of environment Identify early signals	Track specific trends and events	Project future patterns and events	Derive implications for organization
Goal	Detect change already under way	Confirm/disconfirm trends	Develop plausible projections of future	Derive implications for organization
Scope	Broad, general environment	Specific trends, patterns, events	Limited to trends, patterns, and issues deemed worthy of forecasting	Critical implications for organization
Time Horizon	Retrospective and current	Real time	Prospective	Prospective and current
Approach	Unconditioned viewing Heterogeneity of stimuli	Conditioned viewing Selective stimuli	Systematic and structured	Systematic, structured, and detailed
Data Characteristics	Unboundable and imprecise Vague and ambiguous	Relatively boundable Gains in precision	Quite specific	Very specific
Data Interpretation	Acts of perception intuitive reasoning	Weighing evidence Detailing patterns	Judgments about inferences	Judgments about inferences/implications
Data Sources	Broad reading Consulting many types of experts inside and outside of the organization	Focused reading Selective use of individuals Focus groups	Outputs of monitoring Collected via forecasting techniques	Forecasts, Internal strategies Competitive context, etc.
Outputs	Signals of potential change Detection of change under way	Specification of trends Identification of scanning needs	Alternate forecasts Identification of scanning and monitoring needs	Specific organizational implications
Transition	Hunches regarding salience and importance	Judgments regarding relevance to specific organization	Inputs to decisions and decision processes	Action plans
Organizational Outcomes	Awareness of general environment	Consideration and detailing of specific developments Time for developing flexibility	Understanding of plausible futures	Specific actions

from Fahey, 1986

TABLE 4. STRATEGIC SCANNING MODES REPORTED: AGGREGATE NUMBER OF MENTIONS

	Mentions
Routine monitoring (proactive)	52
Problemistic search (reactive)	29
Unsolicited reception (inactive)	9
Coincidental surveillance (proactive)	1
TOTAL	91

from El Sawy, 1985

increase the amount of scanning that could be conducted by reducing the costs associated with the process. For example, a system could conceivably perform much of the routine monitoring for the manager. The interpretation of "routine" in this application would necessarily entail a much more sophisticated retrieval process than any used elsewhere in the organization. Artificial intelligence understanding of natural language and multi-media file structures are two of the advanced technologies that would be incorporated in such a system. Nevertheless, the potential for generating high quality information through monitoring of the manager's usual and infrequent sources is high, and may actually increase the set of sources that he might regularly peruse.

Another example of expanding the base of scanning involves the unsolicited reception of information, which, to be understated, will surely increase with electronic mail. Both good and bad transmissions should increase, yet a competent message filter would also improve the usefulness of this as a scanning mechanism [20].

Third, many of the sources are human, and represent both verbal and written transmissions. Some of these represent hard facts, while others, as noted above, may convey innuendo or rumor that are not amenable to computerization. This means that not all of these sources could or should be included as inputs to a system. Although this information would not be obtained through a system, the ability to amend notations and links about this to other stored information may improve the usefulness of scanning aids to the decision maker.

DYNAMICS OF INFORMATION

One of the main difficulties with providing information to decision makers lies in the myriad of characteristics related to the nature of information and its sources. Not all information sources are equally desirable in all situations. Dramatic differences in the desirability of various information sources have been observed, even without considering the preferences or biases of individuals.

The literature on the impact of uncertainty and equivocality in information processing on the choice of media explains much of the difficulty

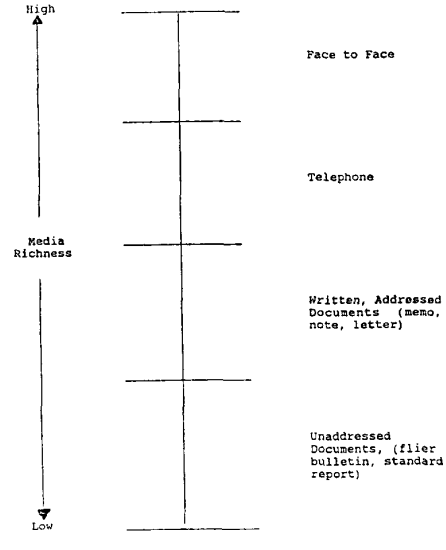
that information systems designers face when attempting to introduce a traditional system into a task domain confronting highly equivocal problems. Uncertainty refers to the absence of information, and equivocality is interpreted as ambiguity, where multiple and conflicting interpretations of information exist. According to Daft et al. [6], "Uncertainty leads to the acquisition of data. Equivocality leads to the exchange of subjective views among managers to define the problem and resolve disagreements" (p. 357).

Studies have shown that, when faced with equivocality and uncertainty, decision makers prefer to get their information from "information rich" sources. According to Daft and Lengel [5], communication media vary in their capacity to process rich information. They have found that, in order of decreasing richness, preferred media classifications are (1) face-to-face, (2) telephone, (3) personal documents such as letters or memos, (4) impersonal written documents, and (5) numeric documents. Note in Figure 2 that rich media are personal and involve face-to-face contact between managers, while media of lower richness are impersonal and rely on rules, forms, procedures, or data bases.

Richness of media is based on four criteria: timeliness of feedback, the number of physical and visual cues, the range of meaning and precision conveyed by the language variety, and the perception of a personal focus. Daft et al. [6] show that effective communication of information results from a proper match between media richness and message equivocality. Too rich a media may be equally undesirable as one that does not provide enough of these cues. Werner [33] concurs, noting that a communicator who imposes too great or too small a psychological distance by choice of media does not have as much impact as one which is appropriately personal.

Since high-level decision makers deal with highly equivocal situations on a regular basis, traditional information systems and DSS, which exhibit relatively few of the cues associated with rich information sources, would not provide the appropriate media match to the problems at hand.

FIGURE 2: HIERARCY OF MEDIA RICHNESS



From Daft, et al, (1987)

QUALITY AND ACCESSIBILITY

Many researchers have studied the relationship between the quality and accessibility of an information source and frequency of use of the source ([2], [26], [27]).[1] Although not all of these studies involved managers as subjects, there is a positive association established between these concepts. That is, higher quality information is used more frequently, as is information that is easier to access.

This is not to say that technology could ever replace human interaction entirely. Symbolic cues [32] associated with the choice of personal or technological contact will always remain as a factor in media choice, even when issues of time, geography and content have been addressed. Although Trevino et al. did not study their relative importance directly, they did find that situational determinants (e.g., time and geography) were mentioned more than symbolic cues or content (i.e., potential for equivocality) as the impetus for choosing rich media over lean media. Table 5 shows the relationship between the media used and the reasons they were selected.

TABLE 5. RELATIONSHIP BETWEEN MEDIA CHOICE AND REASON CATEGORIES

	Face-to Face %	N	Telephone %	N	E-Mail %	N	Written %	N	Row Total %	N
Content Reasons	46	(139)	25	(54)	23	(69)	28	(104)	366	(31%)
Symbolic Reasons	37	(110)	24	(52)	15	(46)	29	(105)	313	(26%)
Situation Reasons	17	(51)	51	(109)	62	(189)	43	(157)	506	(43%)
	100	(300)	100	(215)	100	(304)	100	(366)		

x^2 - 137.15, df-6, p< .00001

[1]This connection is called into question in a study by Boynton [3], in which the linkage was not significant or found to imply a negative correspondence. This discrepancy may be due to problems in the development of adequate measures, as the author himself points out.

Trevino et al. interpret Table 5 to say that situational determinants were the most important of the three factors for deciding on a medium. The situationally-determined reasons, listed in Table 6, pertain to many of the features for which people turn to computerized systems. These are things at which technology excels, ways in which technology can enhance the process of information acquisition. However, knowledge of the extent of equivocality and the implicit symbolism conveyed in a situation should certainly be considered when designing the DSS of the future.

TABLE 6. REASONS FOR MEDIA CHOICE SITUATIONAL DETERMINANT CATEGORIES AND RELATIONSHIP TO MEDIA CHOICE

Reasons	F-F	MEDIA TEL	E-M	WRI	Row Total
1. Close proximity, short distance	87% (13)	7% (1)	0% (0)	6% (1)	100% (15)
2. Span long distance	0% (0)	58% (25)	19% (8)	23% (10)	100% (43)
3. Quick, easy, convenient	11% (20)	37% (70)	40% (76)	12% (23)	100% (189)
4. Personal preference	11% (5)	11% (5)	72% (32)	4% (2)	100% (40)
5. Accessibility, reach someone who is busy, frequently absent	10% (4)	10% (4)	49% (19)	31% (12)	100% (39)
6. Reach many receivers at one time	0% (0)	0% (0)	41% (19)	59% (27)	100% (46)
7. Have technological capability already in system	0% (0)	0% (0)	90% (9)	10% (1)	100% (10)
8. No record required	14% (1)	29% (2)	57% (4)	0% (0)	100% (7)
9. Presentation aid (attachments)	11% (2)	6% (1)	0% (0)	73% (15)	100% (18)
10. Provides a permanent record	6% (5)	0% (0)	24% (22)	70% (63)	100% (90)
COLUMN TOTALS #	(50)	(108)	(189)	(154)	

X^2 = 343.78, DF=27, P <.00001

From Trevino, et al, 1987

NEW MEDIA

Many of the studies on the desirability of alternative information sources do not include sophisticated information systems in their choice of media. Those that do consider computer-generated information do so in the form of prespecified reports. Other studies focus on electronic mail as a means of communication, but not directly as an information source [32].

Kasper and Morris [15] studied the differences among paper, electronic mail, audio and audio/visual presentation media. These were compared in terms of comprehensibility of a message, perception of its difficulty, and reception time. Written media (paper and electronic mail) were preferred to voice (videotape and audiotape) for message comprehension, and required less reception time than the voice media for less difficult passages. Perception of difficulty was the same for both types of media.

In another study focused on written, audio or videotaped messages, Chaiken and Eagly [4] found that, for difficult messages, persuasion and comprehension were greater with written media than with audio or video. For easy messages, however, persuasiveness was highest with verbal communication, followed by audio, then written. There were no differences among the three for comprehension. Computer-based technology was not included in this study.

In a study of a combined voice and electronic mail system, Nicholson [25] found that voice mail was more frequently used for more informal, person-to-person communication, while written electronic mail was preferred for formal communications. Voice mail was sent to fewer recipients than its written equivalent, typically replacing a face-to-face meeting. Nicholson concluded that voice is better suited to informal commentary on a document, because of its ease of use and speed of access. Written text was needed as a source of referenced data.

Daft et al. [6] speculate on the generalizeability of their findings to other media than those covered by their study. Some new media, particularly electronic mail and group DSS, are seen to conform more to the richness criteria than their technological predecessors. The ability of technology to cut through barriers of time and geography, coupled with awareness of the cues desired by decision makers facing equivocal situations, may result in new forms of DSS to meet the needs of a previously overlooked populace. In addition, the substitution of technology may have other, perhaps unanticipated effects on decision making.

In a series of studies of the interaction among members of computer-mediated groups, Kiesler et al. [18] found differences in the processes adopted by computer-mediated and face-to-face groups. They found that computer-mediated groups took longer to reach a consensus, exchanged fewer remarks, participated more equally, and showed significantly higher choice shift than their face-to-face counterparts. They raise questions about the differences in decision making processes, noting the difficulties of coordination resulting from lack of feedback, the absence of social influence cues for managing discussions, and the depersonalization imposed by the lack of nonverbal cues and absence of social norms. Their results underline the potential for changes in the flow of information within an organization, with a coincident change in the power structure aligned with the use of information.

IMPLICATIONS FOR DSS

The implications of the research examined here are of the good news/bad news variety. The bad news is that much of what we have focused on in DSS and EIS research has been addressing only a small piece of the process. Our systems are good at retrospection, evaluation and analysis, yet managers spend much more of their time searching for information. We need to concentrate more of our effort on the information gathering and communication activities of managers.

We have been designing systems for managers in need of rich information sources, but doing so with inappropriate technology. Even though systems aimed at supporting information acquisition activities may be providing needed information, they are not as useful as we had intended them to be. These managers cannot obtain the information they need under the criteria they prefer (feedback, multiple cues, language variety and personal focus). It is not enough to save on time or geography; richness of media and symbolic significance must also be embraced.

The good news is that we are progressing in the right direction. The succession of MIS to DSS

and EIS shows much improvement in managerial support. New technologies that surmount the "media richness" barrier are now or soon will be available to continue this progression.

Some of the studies summarized herein have demonstrated the usefulness of new information technologies such as electronic mail and GDSS relative to their manual counterparts. The demand for quick access to high quality information underscores the advantages information technology has to offer. Recognition of the need for sophisticated scanning and monitoring activities provide the impetus for designing multi-media, document-based DSS and intelligent communication systems.

The unpredictable and highly equivocal nature of strategic decision making forces information technology to take a back seat to human interaction as a preferred source of information. Even so, we can take advantage of the capabilities of technology to improve upon other sources such as the telephone, written documents, and standard reports.

The four criteria defining information richness will need to expand to include modes of technological expressiveness not available through non-computerized means. For example, Kiesler et al. [18] recall that computer conferees developed ways to express emotion by sending computerized screams, hugs and kisses.

Other changes in information acquisition activity are also inevitable. The ease with which a message can be sent to a large number of recipients will permit a request for information to cheaply reach a much larger audience than before[2]. Time zone differences can also be circumvented, so that international sources of information can be accessed at any time.

Organizational hierarchies will no longer limit the flow of information from within. Strong personalities may no longer dictate the course of action, as more democratic communication and negotiation systems are introduced. Many changes are inevitable, and a long, perhaps painful, learning process will precede the successful implementation of the next advance in DSS.

ACKNOWLEDGEMENT

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[2]This, of course, immediately leads to a need for monitoring incoming messages as a source of junk mail. Malone et al. [20] address this issue in their intelligent electronic mail system by providing an intelligent monitor of the content of all incoming messages.

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