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Abstract

Although GSSs provide a variety of problem solving methods, current GSSs do not provide groups the capability to employ traditionally used diagramming techniques. This paper presents a tool specifically designed to support collaborative cause and effect (C&E) diagramming. The C&E tool takes advantage of both GSS and representational approaches and provides a unique problem formulation and identification aid. The place of the GSS tool in a cumulative program of information systems research is described.

Introduction

This paper is in support of a presentation which describes a software tool under development by the authors. The paper's purpose is to provide background about why we are developing this particular piece of software, why the software has the characteristics it does, and how it will be used in a program of research.

The benefits of taking a "cumulative" approach to information systems research are well known (Dickson, DeSanctis, and McBride, 1986; Jarvenpaa, Dickson, and DeSanctis, 1985; Dickson, Lee-Partridge, Limayem, and DeSanctis, 1996). We are currently embarking on a cumulative approach to research in the area of Group Support Systems (GSS). The general task domain we are researching is problem formulation/identification in the area of Total Quality Management (TQM). We found that existing GSS software systems do not incorporate tools frequently used in a TQM setting.

Thus, the main motivation for the development of the software tool to be described is that it is needed by our research program. Second, we believe that the tool will be useful by TQM practitioners and will fill a gap which currently exists with GSS software. The research group wanted to focus its activity in an important area that, to date, has received relatively little attention, problem formulation/identification (Smith, 1989, Volkema, 1988). Although Gallupe, DeSanctis, and Dickson, 1988 related GSS to problem finding, little work has been done since in this area. We also wanted to explore the role of GSS in the problem formulation area in the context of a visible, and important area of practice. This is why we picked TQM as an area to examine the effectiveness of a GSS as an aid to problem formulation. As will be seen, the specific features of the GSS to be described are related to identifying problem causation (we will use the term, "problem formulation" to refer to what, in our case, is the determination of the cause of a quality problem) in a quality management setting. To begin, we will explore problem formulation, groups, GSS, and visual GSS tools.

Analysis of Complex Problems

Many problems confronting organizations today are complex. These problems do not lend themselves to structuring and formulation by solely quantitative models, nor simple intuitive problem solving (Rosenhead, 1992). Making sense of these ill-structured problems is complicated by the difficulty in specifying and understanding the relationships between relevant problem variables (Cartwright, 1973; Volkema, 1983, 1988).

Unfortunately, an additional characteristic of complex problems is that oftentimes the activities of problem structuring and formulation are confounded by the multiplicity of individuals and groups with various and conflicting interests (Rosenhead, 1992). These individuals and groups -- perhaps representing different functions within an organization -- may have very different perspectives about the nature of the problem to be solved. Furthermore, the expertise needed to make sense of a situation, rather than residing with one individual or group, may be distributed across many organizational actors. For example, determining the root cause of a quality problem more than likely will require input from design, manufacturing, and marketing -- perhaps even external actors such as suppliers and customers. Unquestionably, a limited field of view is the greatest threat during the activities of problem structuring and formulation. As such, the attempt should be made to broaden the problem solvers' perspective by considering alternative ways of perceiving, structuring and formulating the problem to be solved (Volkema, 1988; Smith, 1989).

The use of groups to analyze complex problems is a common way to gain access to diverse perspectives, multiple lines of reasoning, and expertise. Perhaps more importantly, through group interaction and members probing and challenging each other, the "whys" behind a particular perspective or line of reasoning may be uncovered. Additionally, differences may be brought to light and be available for group discussion, negotiation, and resolution (Grabowski, et al., 1991). Moreover, Turoff and Hiltz (1982) suggest that when a situation is complex and confusing, individuals need to communicate with others to determine what information is, in fact, relevant. Ultimately, through group interaction, a mutually agreeable common set of elements and relationships may be established.

quality of the group outcome is dependent upon the sharing of individual problem perspectives, information, The literature suggests that Group Support Systems can facilitate the creation of a non-inhibiting, synergistic environment in which group members are comfortable sharing ideas (e.g. Alavi, 1993; Connolly, et al., 1990; Dennis and Gallupe, 1993; Gallupe, et al., 1992; McLeod, 1992; Valacich, et al., 1995). However, the extant literature also presents somewhat disappointing results in terms of the ability of both computer-supported and face-to-face groups to access unique pieces of information that may be relevant to understanding, defining problems, and solving problems (Dennis, 1994; Stasser and Stewart, 1992; Stasser et al., 1989; Massey and Clapper, 1995; Clapper and Massey, 1995). Because communication typically revolves around verbal or text-based interactions, miscommunication can occur. Assuming others will understand, individuals often speak in generalities. Furthermore, because interactions generally focus on a particular issue at a time, other issues may be overlooked or forgotten. This can result in a reduction of communication, and potentially group effectiveness as relevant information is never shared with the group (Carley, 1988). These findings lead us to explore additional means -- specifically representational decision aids, such as cause and effect diagrams -- to support groups in the context of problem exploration and structuring.

TQM and GSS

In the current highly competitive industrial environment, the continuing need to manage and improve the quality of products and services is of paramount importance. The current emphasis on TQM programs is one initiative which reflects a response to this environment. Recently, GSS technology has been incorporated as part of a TQM program in order to identify and address quality problems (Jackson, et al., 1995). Briefly, a GSS offers the potential to increase the effectiveness and efficiency of group meetings by reducing the negative impacts of group dynamics, allowing for parallel and anonymous input of ideas by participants, and providing an electronic means to gather and record ideas during meetings (DeSanctis, et al., 1991).

However, while GSSs provide a variety of problem solving methods (Bounds, et al., 1994; Shoji, et al., 1993), current GSSs do not provide teams the capability to employ traditionally used diagramming techniques for problem exploration and structuring. For example, while cause-and-effect (C&E) diagrams are one of the most widely used graphical methods for quality problem assessments (Farnum, 1994; Smith, 1991), this method is not available in current GSS software programs. In fact, despite the widespread use of C&E diagrams, there are very few quality control software packages that allow individuals -- let alone groups -- the option of electronically creating a diagram (Farnum, 1994). In the next section we will focus on justifying a GSS tool in the form of a visual representational aid as it relates to problem causation.

Representational Aids

Representational decision aids are purported to facilitate groups in information exchange as members attempt to find relevant elements of a problem situation, structure the relationships between these elements, and formulate the problem to be solved (Zachary, 1986). The aim of these approaches is to at least partially model previously unstructured situations. Additionally, they help overcome limitations in mental resources and extend human processing capabilities (Pracht, 1990; Pracht and Courtney, 1988; Rosenhead, 1992) by providing, as Larkin (1989) suggests, an "information storage resource". These decision aids should assist individuals and groups in communicating and representing the relationships among problem elements.

Individuals utilize internal "mental models" as the basis for communicating their understanding of a situation. As noted earlier, verbal and text-based communication is limiting, however, when the task is complex. By introducing a conceptual model through representations like pictures, diagrams, maps, cause and effect diagrams, or flowcharts those communicating can interact with a final goal of reaching a common and appropriate model of the system. Larkin and Simon (1987) demonstrated that a graphical representation can shorten the time it takes for an individual to communicate their problem interpretations. They suggest that attention should be focused on perceiving and developing the visual representation, rather than relying solely on logical inferences based on interpretations of language.

This research focuses on a specific analysis approach, generally termed causal diagnosis (Smith, 1989). Cause and effect diagrams (also referred to as an Ishikawa diagram or Fishbone diagram) are, in fact, representational aids which allow the root causes of a problem to be systematically determined. This approach was first introduced in 1943 by Dr. Kaoru Ishikawa in conjunction with a quality program at the Kawasaki Steel Works in Japan (Bergman and Klefsjo, 1994). However, despite the widespread use of C&E diagrams and the relevance of groups for problem analysis, electronic support for groups collaboratively creating C&E diagrams is currently unavailable. The primary purpose of this research is the development of such a tool -- simultaneously capitalizing on the benefits associated with GSSs and representational decision aids. We want to be explicit in noting that C&E diagrams are quite distinct in their nature and purpose from casual maps. Although the latter have been used in a GSS context, they should not be confused with C&E diagramming approaches. Space limitations do not allow a comparison, but GSS research involving casual maps is related but distinct from what we are doing. Readers interested in the distinction should see Rohrbaugh, , 1992 and Eden and Ackerman, 1992.

Cause and Effect Prototype

The GSS C&E prototype was developed using VisualBasic 4.0 and Access 2.0 and, once installed, runs over Novell Netware-based local area networks. At the first or highest level of the C&E diagram, the interface shows the problem, the major bones (i.e. potential causes) and the first level of minor bones (i.e. subcauses). When users want to add an idea they click on the insert key and an Input Dialog box appears. The users must create a short cause description and then add details in the form of a longer description. In order to maximize the number of causes that can be seen on the screen, only short descriptions are shown. However, the long description is available by clicking once on any item. In a given screen, only four first level causes can be seen at one time. However, additional causes are accessible by scrolling the diagram to the left by using an arrow key shown at the bottom of the screen. Thus, users can easily scroll back and forth to examine the highest level causes identified by the group. To move to lower levels, i.e. "drill down" into the diagram, uses click on the label of an item they wish to examine or work on. The presentation supported by this paper will provide a brief demonstration of the prototype software in order to illustrate its use which, because of space limitations, we cannot do here.

Present Status and Future Plans

In addition to the authors, the program of research which will utilize the C&E GSS tool will involve researchers at other US universities as well as those in Europe and Asia. At present, eight research sites are involved and data will be gathered at all sites. We intend to pursue a process modeled on that used by

Watson, DeSanctis and Poole, 1988. Utilizing this process, performance baselines must first be established. Currently, the task has been developed and two preliminary pre-tests conducted. Another pre-test is about to be conducted in another of the research sites. All the pre-tests have not involved the GSS technology, the task has been performed by subjects unaided by any process or technology. The pretests, so far, have been conducted on an individual basis rather than a group basis.

As soon as the research group is satisfied with the task and measurement schemes, group studies will be conducted. Consistent with Watson, et al., three manipulations will be conducted. One will be a baseline condition in which groups perform the task unaided by any process or technology. The second condition, manual, will consist of groups performing the task trained in the C&E diagramming process, but using flip charts rather than a GSS. The third condition will be exactly like the manual condition except that groups will use the GSS with the C&E tool.

We anticipate that these experiments will be conducted in the fall of 1996. This first set of experiments will establish a base of data to which other studies conducted by the research group can be compared. At present, there are at least two directions that we see the research taking. One is to create and use another GSS tool that is text-based (Stryker, 1965a, 1965b) in order that group performance using a visual GSS tool can be compared with a text-based GSS tool. A second direction involves utilizing the visual tool to explore group performance under a "hidden profile" condition (Stasser and Stewart, 1992).

References available on request from the third author. (Gary_Dickson@ncsu.edu)