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December 2001

A Dialectical Approach to Decision Support Systems Design

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Abstract

The multi-perspective decision-making paradigm (Courtney, 2001; Mitroff and Linstone, 1993) is extended to include a dialectical process to assist in developing decision support systems in "wicked" situations with much conflict among stakeholder groups. To illustrate the model, a dialectical methodology is proposed and applied to a wicked decision problem, urban infrastructure management. The dialectical analysis highlights conflict among stakeholders and helps to focus DSS design attention on areas that may be problematical during implementation.

Keywords: Decision support systems, design, dialectics, inquiring systems, urban infrastructure

Introduction

As organizations continue to grow in size, reaching global proportions, they have ever increasing impacts on their environments, which themselves are changing radically and discontinuously (Kelly, 1998; Malhotra, 1997). Concomitantly, some believe that a much broader array of concerns should be brought into organizational decision-making processes, including greater consideration of social, political, ethical and aesthetic factors (Mitroff and Linstone, 1993; Courtney, 2001). Decision environments such as these are decidedly "wicked" (Rittel and Webber, 1973), in that they have no definitive problem formulation, in fact, formulating the problem *is* the problem. Further, the answers to wicked problems are not true or false, but good or bad; hence, wicked problems have no stopping rule, and the problem solver quits when resources are exhausted or a "satisfactory" solution has been found. In addition, wicked problems are highly interrelated, and each wicked problem is to be found in every other wicked problem.

It has been argued that Churchman's (1971) Hegelian (Chae and Courtney, 2001) and Singerian (Mitroff and Linstone, 1993; Courtney, 2001) inquiring systems provide frameworks for dealing with wicked problems. Wicked problems require a pluralistic approach in which the problem is viewed from the many and varied perspectives of the numerous stakeholders involved, and a holistic view of the problem situation (Mitroff and Linstone, 1993). Courtney (2001) has proposed a decision-making paradigm for decision support systems (Figure 1) based on the Singerian model and Mitroff and Linstone's multiple perspective approach. He illustrated some of the holistic aspects of the model in decisions related to urban infrastructure. This paper extends Courtney's model by incorporating dialectic theory more explicitly and also illustrates use of the extended model by presenting a dialectical approach to the development of a DSS for infrastructure decision making. The next section of the paper describes the objectives of the project, after which dialectical theory is described, and the extended dialectical model is developed, followed by a dialectical analysis of urban infrastructure decision making. In the analysis, we attempt to isolate conflicting perspectives of stakeholder groups, with the ultimate objective of accommodating those perspectives in the final DSS design and implementation.

Objectives

The ultimate objective of the project from which this paper emanates is to develop a decision support system (DSS) for urban infrastructure decision making for the city of Houston, Texas (Lomax, et. al., 1998). Infrastructure consists of constructed physical facilities for transportation, communication and public utilities. As cities age, yet continue to grow, infrastructure development and maintenance is becoming one of the major problems facing urban areas today. Yet infrastructure decision-making is embedded in a complex system that involves an array of stakeholders, ranging from the general public, to contractors, developers, public works departments, politicians, regulatory agencies, and many others. These factors influence the decision making process about infrastructure management in complex ways.

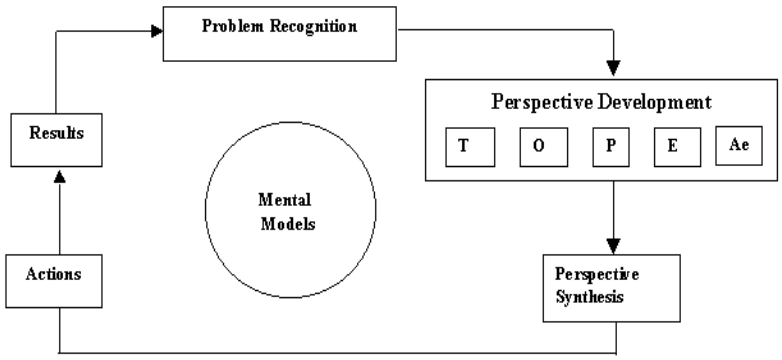

Figure 1. Courtney's Model of the Multi-Perspective Decision Process

The design of such a DSS is complicated by the multiplicity of stakeholders and the pervasive nature of conflicts among their perspectives. The work herein is predicated on the assumption that, for the results of a DSS to be acceptable to decision makers in this environment, attempts must be made to incorporate the consideration of conflicting views into the design process itself. The purpose of this study is to develop a methodology for identifying the nature of conflicting perspectives, so that they can at least be acknowledged, if not actually accommodated by the designers. Our approach to developing this methodology is based on dialectic theory and a multiple perspective approach. By using dialectic theory, we plan on isolating potential barriers to infrastructure DSS implementation and provide ways to overcome those barriers. The multiple perspective approach is used to avoid the pitfalls and the limitations of the technical perspective currently used in most DSS. In addition, we hope to design a DSS, the results of which will be more readily acceptable to infrastructure decision makers, especially the mayor, city council, and the staff of the public works department. Finally, we hope that the methodology will be extensible to wicked decision environments in general, since it rests on the broad shoulders of the well-developed theory of dialectics.

Dialectic Theory

Dialectic theory has a long history. Aristotle credits Plato with inventing the dialectic technique (McKinney, 1983). But the most predominant modern concept begins with the Hegelian assumption that entities exist in a pluralistic world of colliding events, forces or contradictory values that compete with each other for domination or control (Van de Ven and Poole, 1995). The dialectic process strives to dissolve these oppositions and meld them into a complementary whole, rather than simply finding a compromise. It is an argument designed to create a richer synthesis by revealing the underling assumptions (Churchman, 1971).

The starting point in a dialectic process is the thesis, a set of beliefs concerning an issue or problem. At some point in time the thesis appears to be inadequate, perhaps due to changes in the environment, or to changes in tastes and values. The inadequacy is revealed through the questioning of certain assumptions/worldviews of the thesis or by bringing to light certain of its properties that have not been obvious before (Singer, 1983). At this time, the antithesis, the opposite or negation of the thesis, emerges. Eventually, the antithesis then also shows itself to be inconsistent or inadequate. Both the thesis and antithesis are one-sided and they are ultimately brought together in a unified manner in a synthesis. It is important to note that both the thesis and the antithesis are drawn from the same set of data. The synthesis emerges as the result of debate and dialogue related to the elements of the thesis and antithesis. An observer of the debate takes the most plausible elements of each to form a synthesis, which ideally dissolves the previous conflict. The synthesis is different from both the thesis and the antithesis, but it includes them both, so that neither the thesis nor the antithesis continues to exist as a separate entity (Ford and Ford, 1994). But the dialectic movement does not stop at this stage. Oftentimes, the synthesis will reveal itself to be inadequate and will then serve as a new thesis (Singer 1983), eventually an antithesis emerges, and the process reiterates.

The guarantor of the dialectic approach is conflict (Churchman, 1971). In an organization, this conflict must be positive and productive. Decision-makers may encourage the development of opposing worldviews when making decisions. It is through the conflict of ideas that comes greater enlightenment (Churchman, 1971). For an effective and creative synthesis to emerge there needs to be open dialogue among conflicting parties. Dialectic and positive conflict cannot exist without dialogue. As Chae, et al., (2001) put it:

The concept of dialogue comes from the Greek origin dia (through) logos (meaning) and literally means when a group of people talk with one another such that the meaning (logos) moves through them (Senge, 1992; Ellinor and Gerard, 1998). As dialogue develops, contradictions are resolved in the way in which a topic is modified (Arnor and Bjerke, 1997). Thus dialogue is the basis of dialectic and may be viewed as collective reflection (Nonaka and Takeuchi, 1995; Senge, 1990).

Through dialogue, knowledge is shared and tacit assumptions are revealed. This revealing of assumptions helps stakeholders better understands the perspectives of others, and ultimately leads to more effective solutions.

Multiple Perspectives Approach

When dealing with complex problems or decisions, Mitroff and Linstone (1993) proposed the use of a multiple perspective approach, which promotes heterogeneous views of decision-making. In the past, DSS were designed predominantly on the basis of the Technical perspective (T). The technical perspective is well suited to well-structured problems but offers many limitations when dealing with "wicked" situations (Linstone, 1999). Mitroff and Linstone (1993) have proposed the organizational (O) and the individual (I) perspectives to overcome the limitations of the technical perspective. These perspectives are not intended to replace the technical perspective but the expand it. Using only one perspective is analogous to seeing a one-dimensional representation of a three-dimensional object (Mitroff and Linstone 1993).

In addition to the three perspectives, we have added two other perspectives: Ethics (E) and Aesthetic (Ae). The ethical and the aesthetic perspectives help to assure and justify the choices of decision factors and assumptions to input in the decision-making process. Mitroff and Linstone have recognized the importance of both the ethics and aesthetics and stated:

> "...The gap between what we desire and what we can accomplish are not merely measured by T, O, and P perspectives. Instead, they constitute ethical and aesthetic gaps as well. Consideration of aesthetic and ethics thus play a fundamental role in our selection of problems and in the means we use to address them."(Mitroff and Linstone 1993.)

The importance of considering multiple perspectives is most prominent when dealing with complex, ill structured problems where a variety of actors are involved. Each of these various actors sees the problem differently and therefore creates their own perspectives. Each perspective facilitates comprehension of the situation at hand.

In the past, infrastructure decisions, and decision support systems in general, have tended to focus only on the technical perspective (Courtney, 2001; Mitroff, Linstone 1993). This has contributed to the problems infrastructure is facing today, as too great a focus on technical concerns has overshadowed the political and social context in which infrastructure decisions are made. The multiple perspective concept seeks to provide a new problem-solving method by sweeping in not only the organizational and the individual perspectives, but also ethical and aesthetic concerns, and by developing a synthesis of broad worldviews. This new method seeks to overcome the limitations of the technical perspective and result in more effective solutions. Next we describe a DSS framework for wicked decision problems, which embraces the dialectic approach and multiple perspectives. Later, the Multiple Perspective and Dialectic Process methodology (MPDP) is described.

DSS Framework for Wicked Situations

The multiple perspective approach and the dialectic process bring many factors into the picture for decision making in wicked situations. Courtney (2001) has proposed a new decision making paradigm based on the Singerian inquirer and multiple perspectives. At the heart of his approach are mental models. The mental models, either personally or collectively, determine what data and what perspectives we examine. Mental models determine not only what is defined as a problem in the first place, but also the beliefs about causal relationships in a domain and what data is meaningful to collect in order to study problems in that domain (Courtney 2001). Our proposed framework (Figure 2) starts with these mental models. The mental models determine the factors that the stakeholders use to make decisions. The approach integrates the factors into a composite set, to assure that all stakeholders are using the same data set in their discussion of the issues involved and the decision to be made. Next, rather than jumping directly into analysis, the process consists of developing multiple perspectives. The model emphasizes that we must go beyond the technical perspective, and include organizational and individual views along with ethical and aesthetic concerns. Once these worldviews are formed, conflicting assumptions are isolated and the thesis and the antithesis are formulated. Next the opposing parties are engaged in an open dialogue to share their views with the intent of revealing tacit assumptions. The purpose of the dialogue is to help create a synthesis. The role of the ultimate decision-maker(s) who observe the dialogue, is to isolate the most plausible and strongest assumptions and formulate the synthesis. This synthesis represents new tacit knowledge,

and the intent is to update stakeholders' mental models. As the models are updated, insight is gained and better understanding of the situation is achieved. The process continues until there are no conflicting assumptions. The synthesis is progressive in that it contains what went before and in that it serves as the basis for the next stage (Ford and Ford, 1994). The final synthesis will then be used to produce the final decision.

MPDP Methodology – Based on the above framework we have developed a methodology to serve as a step-by-step guideline to the design of DSS based on both theories. The main goal of the Multiple Perspectives Dialectic Approach (MPDP) is to illustrate the stages presented in the above framework and to provide DSS designers with a procedure to organize data and construct the basis for the DSS. The characteristics of the MPDP methodology are as follow:

- MPDP is a conflict driven approach. It focuses on the isolation of conflicting worldviews using the same data.
- MPDP analyses the problem from a number of distinct perspectives or worldviews.

The MPDP methodology has seven major stages:

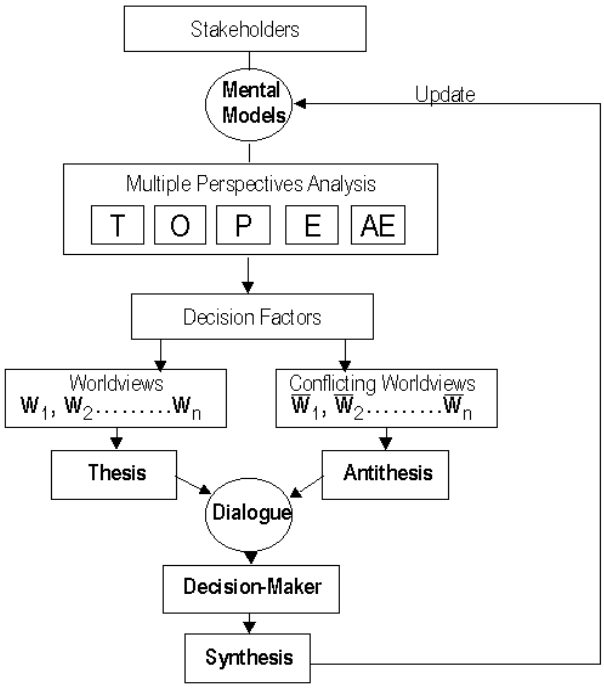

Figure 2. Multiple Perspectives and Dialectic Framework to Decision-Making

1. *Stakeholder identification:* This stage is concerned with gathering information about who is involved in making the decision, those who will be affected by it and those who will affect it. Concomitantly, stakeholders' views with respect to each other are revealed.

2. *Multiple perspective identification*: Seeks to classify the different perspectives into technical, organizational, individual, ethical and aesthetic. This stage is crucial to avoid considering only the technical perspective and thus escape its limitations.

3. *Decision factors determination:* Seeks to identify the factors upon which each group will draw its worldviews. This stage is concerned with defining factors that are relevant to the decision based on the identified perspectives in stage 2.

4. *Worldview formulation*: This stage is concerned with the generation of stakeholders' assumptions and worldviews with regards to the decision based on the decision factors identified in stage 3.

5. *Conflict identification:* Seeks to identify and formulate the thesis and the antithesis. This stage is concerned with forming the design and the counter-design. Both the design and the counter-design are derived from the worldviews formulated in stage 4.

6. *Resolution generation:* Seeks to formulate and generate the synthesized design. At this stage, both supporters of the design and the counter-design engage in a dialogue or a structured debate where an observer, the decision-maker, will form a new and expanded plan - the synthesized design. During this phase each decision factor is introduced and is interpreted by the opposing advocates to demonstrate how it supports their decision. The goal of the debate is to expose hidden assumptions and tacit knowledge, which would otherwise not be revealed.

7. *Resolution evaluation:* Seeks to assure that the newly formed synthesis at stage 6 is a viable design. During this stage the new-formed synthesis is presented to the stakeholders. If there are no conflicting worldviews with regard to the new thesis (synthesis), the synthesis is declared the optimal design and the process ends.

Every systems design methodology has advantages and disadvantages and MPDP is no exception. The MPDP methodology is not suited for well-structured problems. For clear-cut problems, conflict may be a time-consuming nuisance (Mason and Mitroff, 1973). MPDP is best suited to ill-structured problems where a variety of stakeholders are involved, conflict is present, and the costly nature of the process is justified by the importance and financial magnitude of the decisions involved.

Infrastructure Decision Making in Houston

A project at Texas A&M University (Lomax, et al. 1998) is used to exemplify the proposed model. The goal of the project is to develop decision support systems that will lead to improved decision making regarding urban infrastructure investments. Various stakeholders are involved in providing, managing and using infrastructure investments. They range from citizens, businesses, and the public in general who use the services, to the mayor and city council, which makes the final decision, and city departments such as public works, that plan, design and maintain the infrastructure. Also involved are contractors and developers that build the infrastructure, and numerous other city, county, state and federal agencies that regulate, provide funds, or somehow affect infrastructure decision making. The city of Houston, Texas, which is cooperating in the project, is serving as the test bed for the development of the infrastructure DSS.

Data Collection. The data for this project is being collected using semi-structured interviews. Questionnaires reflecting the multiple perspective views were developed to guide the interviews. Five interview guides were created to suit the different groups of stakeholders: elected officials, contractors/developers, neighborhood associations/citizens, and reporters/media. The interview guides included questions relating to technical, individual, organizational, ethical and aesthetic factors. Approximately 100 interviews are planned and 37 have been conducted to date, plus some 20 other informal interviews to collect specific data files and follow up on formal interviews.

Data Analysis. A preliminary analysis of selected interview transcripts has been conducted. In performing the analysis three goals were sought. The first goal was to identify the main factors that drive the current infrastructure decision-making process. The second goal was to isolate any presence of conflict. The third goal was to distinguish between the different perspectives within the groups and across the different stakeholder groups. Each author performed the analysis separately. Later, the two authors got together and compared their notes. Concomitantly, their notes were compared to notes from a previous analysis of the same interview transcripts.

Conflict seems to exist at many levels among the stakeholders. Several respondents indicated that there are "fights" and "arguments" among stakeholders on almost every project. Given the diversity of the stakeholders and their role in the process, they tend to have different perspectives with regard to infrastructure decisions. The main issue that is repeatedly mentioned by the interviewees as the most critical factor in infrastructure decision making is "money." One respondent was asked what the team should do to understand infrastructure decision making in Houston, the response was "Follow the money." At the end of the interview the final comment was also, "Follow the money." A respondent in the planning department seemed to agree, saying, “Economics drives everything.” This seemed to make sense to us, so we decided to take this advice and follow the money first.

Dialectical Analysis. In following the money, we took a dialectical approach and tried to understand how stakeholders relate to each other in regards to funds and services. Table 1 summarizes these perspectives on funds and, in some cases, services since they are often inextricably tied to funds. The top row of the table shows the different stakeholders and their predominant perspectives (O, T or P). Organizational and technical perspectives are most prominent in the city departments. The city departments include Public Works, Planning, Finance, and others, which use models and databases to design projects, forecast budgets and prioritize projects. Similarly contractors provide another technical perspective. The elected officials bring in a different type of organizational perspective and add their individual perspectives as well. Finally, citizens add their personal perspectives, and the media provide organizational and personal perspectives.

The main diagonal of the table represents how members of a stakeholder group relate to other members of their own stakeholder group with respect to funds and services, if relevant. In addition, Table 1 shows how members of one group tend to view members of each other group. For example, the cell in row 2, column 2 shows how elected officials relate dialectally to other elected officials. City council members vie with other city council members to get infrastructure funds allocated to the neighborhoods of their constituents. The mayor and council members build coalitions in which they view each other as allies to get funds for pet projects, and view those outside their coalition as adversaries. The cell at row 3, column 3 indicates that city departments vie among themselves for budget dollars, and view each other as competitors in that regard.

For cells not on the main diagonal, the entries show how members of the stakeholder group of row i view members of the stakeholder group in column j. For instance, the cell at row 3, column 2 shows that city departments view elected officials as a source of money (actually decision makers who allocate money), and as looking for ways to cut their budgets. On the other hand, the cell at row 2, column 3 indicates that elected officials view city departments as scavengers of money and padding their budget to get as many budget dollars as they can.

Table 1. Dialectical Perspectives of Stakeholder Groups with Respect to Each Other

	Elected Officials (O, P)	**City Departments (O, T)**	**Contractors (T)**	**Citizens (P)**	**Media (O, P)**
Elected Officials	Vie for $. Adversaries / Allies.	Vie for $. Pad the budget. Technicians.	Source of $. Vie for $. Builders.	Source of $. Vie for services. Constituents.	Biased observer. Whistle Blowers.
City Departments	Source of $. Cut the budget. Politicians.	Vie for $. Competitors.	Vie for $. Builders.	Vie for services. Source of $. Complainers.	Biased observer. Whistle Blowers.
Contractors	Vie for $. Source of $. Politicians.	Source of $.	Vie for $.	Use infrastructure. Provide tax $.	Biased observer. Whistle Blowers.
Citizens / Taxpayers	No new taxes! Provide for services. Politicians.	Provide services. Consume $. Complaint Dept.	Build infrastructure. Receive $.	Under-taxed. Adversaries / Allies.	Biased observer. Information Providers.
Media	The observed Politicians	The observed. Public servants.	The observed. Consumers of $.	Customers	Vie for stories.

Space does not permit a complete exposition of the relationships in the table. The shading of the cells is intended to show that the cells in corresponding positions of the upper right triangle and lower left triangle show how the corresponding groups view each other. For example, cell 3,5 shows that city departments view citizens as competing for services (pothole repair, for instance) and providing funds (through water and garbage fees, for example). Cell 5,3 shows that citizens view city departments, as providing services, consuming funds, and serving as complaint departments. The media serve as a sort of over-observer of the actions of the other groups, who seem to perceive them as biased observers. The table tries to get at the essence of the relationships with respect to funds and services, but of necessity, over-simplifies somewhat.

What the table gives us is a way of organizing our thoughts about conflicts arising in this environment, and situations where the DSS designers need to be cautious in how that conflict is handled during DSS design, and especially implementation. For example, elected officials who know how to use the present system to advantage may not want the increased "rationality" that a DSS may bring to the process, and may attack it, or results derived from DSS analysis. This table, coupled with the one below, can be used to anticipate potentially damaging conflicts, so designers can accommodate them.

Five groups of factors have been identified in a previous analysis of the infrastructure decision-making process: need, based on engineering studies, health care concerns and so forth; economics, based on the revenue and expenses the city expects, and the expected cost of possible projects; environmental, the ecosystems of the area; and politics, based on parties in power and their constituents, and ethical issues. Table 2, shows the degree of importance these factors have to each of the stakeholder groups. A plus sign (+) means the group prefers more of that factor, and a minus (-) sign indicates they prefer less. The size of the signs indicates the level of importance of the factor, the larger the size, the higher the level of importance. The entries are based on an analysis of a representative sample of the interviews and space limitations preclude a detailed explanation of their derivation. By examining this table, we can see where the greatest potential conflicts may arise. For instance, if we examine the columns for elected officials and city departments, we see they differ mainly in the rows for need and political concerns. The politicos thrive on political issues, or should if they want to survive, and the departments dislike them, but recognize they exist. Politicians prefer that needs not be so great, as it makes their decisions easier. Departments tend to be empire builders, and try to trump up needs to expand budgets. City departments and contractors tend to have compatible views, as do the citizens and the media. The greatest discrepancies arise between elected officials and citizens and the media. Both citizens and the media would like to impose higher ethical values on the other stakeholders, and place much more value on quality of life issues. Citizens and the media prefer less spending to more, except on their pet projects, of course!

Table 2. Decision Factors and Degree of Conflict among the Stakeholder Groups

Decision Factor Categories	Elected Officials	City Departments	Contractors	Citizens	Media
Economic	✚	✚	✚	–	–
Need	–	✚	✚	–	✚
Environmental	–	–	–	✚	✚
Political	✚	–	–	–	✚
Quality of Life	0	+	+	✚	✚
Ethical Issues	–	–	–	✚	✚

The model in Figure 2 suggests that stakeholders engage in a dialogue where worldviews are shared, and the tables indicate the degree of conflict among the worldviews and areas where communication may be most difficult. The DSS designers must consider these possible barriers to communication among the participants and realize they may not be equally willing to accept the results of the DSS analysis, unless their views are accommodated. The dialogue also provides a way to overcome some of the barriers to effective infrastructure decisions. Most respondents seem to agree that lack of information and lack of communication is the main barrier. Therefore dialogue, moderated by DSS output, provides one way to overcome these barriers. In this example, the dialogue is usually conducted in meetings where representatives from each stakeholder group present its worldviews. In these meetings, voting is often used as the criteria with which decision-makers choose the most plausible worldviews. A group DSS with embedded planning models is thus being considered for this environment.

Conclusion

In wicked situations, where there is a high level of interconnectedness, issues are overlapping and a multiplicity of stakeholders are involved, decision making is a very complex task. In this paper, we suggest a framework that shows the steps to effective decision making using multiple perspectives and dialectic theory. The principle theme of the multiple perspective dialectic approach is that decision makers learn about the key assumptions of the problem at hand and come to understand them by isolating conflicting assumptions and observing a dialogue between the thesis and the antithesis and their respective worldviews. The goal is to formulate the synthesis, which is induced by the dialogue vehicle.

We have attempted to exemplify the model by analyzing the Houston infrastructure project. This example allows us to see the complexity and wickedness of the situation. Future research might include the application of this model to multiple wicked decision situations to demonstrate the extensibility of the model, since it is based on two well-developed theories in decision-making, the multiple perspective theory and the theory of dialectics. We also need to continue to refine the dialectical methodology and tie it more closely into the DSS design process.

This project was partially funded by the National Science Foundation Award Number EAR-9875052.

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