December 2003

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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 involve ethical issues. And they have no stopping rule, 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, because they are so highly interconnected, require a holistic view of the problem situation (Mitroff and Linstone, 1993). Courtney (2001) has proposed a decision-making paradigm for decision support systems 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.

The design of a DSS for wicked problems is complicated by the multiplicity of the stakeholders involved 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 accommodate conflicting views into the design process itself. We know of no DSS design methodology suitable for use in such a complex, conflict-filled situation as this. Thus, one of the purposes of this study has been to develop a methodology for DSS design that identifies 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 this proposal, we will present an approach in the development of DSS for wicked situations by (1) extending Courtney's model by incorporating dialectic theory more explicitly (Figure 1), (2) developing a DSS design methodology based on the dialectic theory and multiple perspectives, and (3) conducting a case study to illustrate and implement the design methodology.

Dialectic Theory

Dialectic theory begins with the Hegelian assumption that organizational 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, which is designed to create a richer synthesis by revealing the underling assumptions (Churchman, 1971).
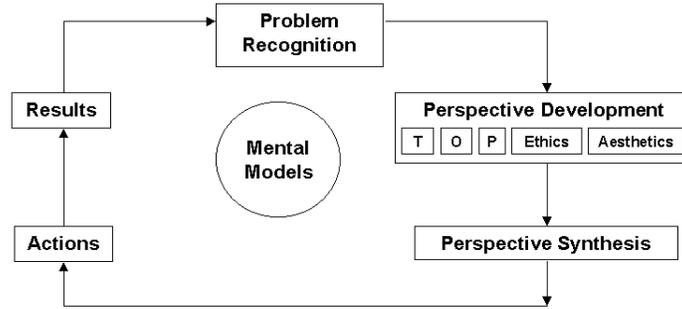
Figure 1. Courtney's Model of the Multiperspective Decision Process

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 usually 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 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 solely using the Technical perspective (T). The technical perspective is well suited to well-structured problems but generates many limitations when dealing with "wicked" situations (Linstone, 1999). Mitroff and Linstone (1993) have proposed the development of 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 to 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 three 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.

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 two 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 design.
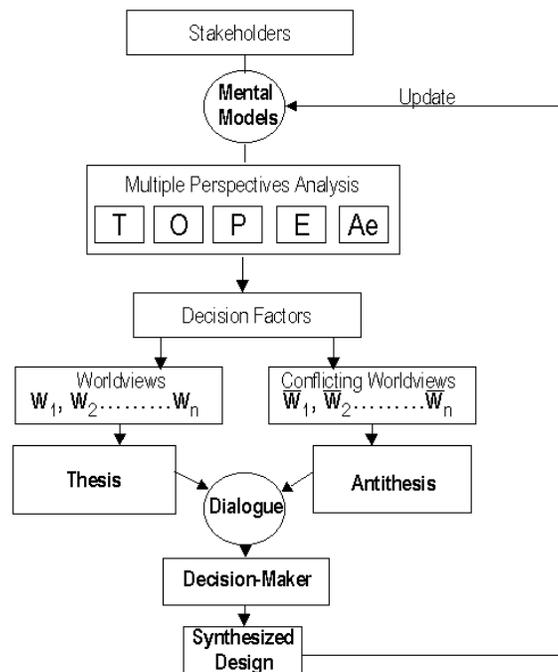

Figure 2. Multiple Perspectives and Dialectic Framework to Decision Making

MPDP Methodology - Based on the above framework we are developing 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 and Dialectic Approach (MPDP) methodology 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:

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. This step will help the designers assess the degree of conflict they are to be faced with so they can accommodate for it in their design.

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 perspectives identified 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. The worldviews represent ways of viewing the entire process and/or different stages of the process. Worldviews have a wealth of information embedded in them, which provide pictures of the alternative actions and hence what information is relevant and the ways it should be used.

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 synthesis. At this stage, both supporters of the design and the counter-design engage in a dialogue or a structured debate wherein an observer, the decision-maker (the designer(s)), will form a new and expanded plan - the synthesis. During this phase each decision factor is introduced and is interpreted by the opposing advocate to demonstrate how it supports their decision. The goal of the dialogue is to expose hidden assumptions and tacit knowledge, which would otherwise not be revealed. This is a crucial stage of the methodology where designers gain more insights and better understanding of the different perspectives and different approaches to making the decision. The role of the designer is to isolate the most plausible and strongest assumptions/worldviews in order to form the base for the synthesized design. The desired outcome of the dialogue is the 'ideal speech situation' in the Habermas sense, where all participants have equal opportunity to participate. This gives the stakeholders the right to assert and defend their worldviews and question any factual or normative claim of the conflicting worldviews (Stickle, 2001).

7. *Resolution evaluation:* seeks to assure that the newly formed synthesis at stage 6 is the viable solution. During this stage the newly-formed design is presented to the stakeholders. The designers role is to isolate any new conflicting worldviews with regard to the new thesis (synthesis). If there are no conflicting worldviews, the synthesis is declared the optimal decision and the process ends. Oftentimes, the process may not lead to a consensus, therefore the process may stop when resources (either time or funds) are depleted.

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 implications of the problem justify the costliness of the approach. The MPDP main advantage is the fact that the process produces multiple distinct designs, which increase the likelihood of arriving at the most effective design for the situation at hand. The entire MPDP process leads to ever expanding and more refined designs.

Pilot Study

Pilot testing is one of the important steps in successful research design. It helps the researcher ensure that the study will work from a practical standpoint. But most importantly, it provides a preliminary assessment of the theory (Dennis, Valacich, 2001). In our study, we conducted a pilot study to make sure that the methodology proposed is practical and achieves the hypothesized result. Additionally, it allowed us to refine our methodology before actual testing begins.

The Problem Domain

Each semester the CBA departments are faced with an important decision: the allocation of classrooms to the different classes and sections offered by that particular department. Most departments use the schedule and allocations from the same semester of the previous year as the starting point for the decision process. By default, each department is allocated two classrooms (almost exclusively) in the college of business building. Six months (approximately) before each semester, a meeting is schedule for all

departments where the decision makers from each department get together to determine classroom availability. They decide who gets which rooms and the times the rooms are available. At the end of the meeting, where lot of negotiations take place, each decision maker gets a list of the rooms and times that were allocated to them (in addition to the two rooms already allocated to them). Armed with this information, the decision makers then have to decide who is teaching which section, where and what time the classes are offered. There are two types of classes: graduate classes and undergraduate classes. Most graduate classes are offered at night and most undergraduate classes are offered during the day. Class category is only but one of the many factors that decision makers have to take into consideration.

Sample

Subjects of the study consisted of graduate students enrolled in a DSS class. To increase the students' motivation and to minimize threats to internal validity, the study was assigned as their term projects which consisted of 30% of their class grade. There were forty four students in the class. To assure a balance in the group members knowledge, we conducted a survey inquiring about their knowledge of programming and their level of expertise in using packages such as excel. Based on the results, six groups were formed.

Procedure

Three groups were assigned the MPDP methodology and the other three the prototyping methodology. Methods and department assignments were done randomly. The responsibility for each group was to design a DSS to help departments in their classroom allocations and class scheduling decisions. The two sets of groups were given presentations explaining the methodology to be used. Subjects were instructed that not to share their knowledge with other groups. Groups were then introduced to the chair of their assigned department and were given 5 weeks to accomplish the project. To assess the progress of the groups, they were required to submit progress reports every week. Since the MPDP methodology requires a debate between the stakeholders and the designers, a debate session was organized where all groups, those who used MPDP, presented their prototypes to the users followed by a dialogue session. During the dialogue sessions the department chairs expressed their opinions on the presentations and discussed the most feasible features in each of the designs presented. Armed with this feedback, the groups were to create the synthesized design. Given the short period of time for the whole project, only one debate session was organized. At the end of the project period, all subjects were asked to fill out a questionnaire. The survey included a manipulation check and asked their feedback on the methodology they used.

Results of the Pilot Study

Results of the pilot revealed that MPDP does provide better insight in the understanding of the problem to be solved. Many of the subjects appreciated the conflict driven approach of the MPDP and indicated that it "promotes more alternative ideas," and gives "the ability to see other point of view."

We feel that the one session debate was not enough to achieve better results. We believe that the dialogue component of the methodology could have been enhanced by adding tools such as discussion forum and bulletin boards to allow for more discussion between the designers and the users. We plan to use these tools in the actual study.

Research Approach

The next step of this proposal is to apply the MPDP to another wicked problem. We will adopt a case study as a research methodology. According to Yin (1994) a case study is an empirical inquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident. It is the preferred strategy when a "how" or "why" question is being asked about a contemporary set of events over which the researcher has little or no control. Qualitative research has been recently widely accepted and practiced in IS research (Orlikowski and Robey 1991; Walsham 1993; Myers 1994).

The design methodology outlined above will be applied in the design of a prototype DSS for an ill-structured situation. We are currently in the process of identifying potential candidates sites for the study.

Conclusion

In wicked situations, where there is a high level of interconnectedness, issues are overlapping and a multiplicity of stakeholders is 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 goal is to formulate the synthesis design, which is induced by the dialogue vehicle.

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