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SUPPORT SYSTEMS FOR DECISION AND NEGOTIATION PROCESSES

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Editors:

Roman Kulikowski
Zbigniew Nahorski
Jan W. Owsiński
Andrzej Straszak

Systems Research Institute
Polish Academy of Sciences
Warsaw, Poland

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Names of first authors: **L-Z**

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COMPUTER-ASSISTED NEGOTIATION OF MULTIOBJECTIVE WATER RESOURCES CONFLICTS

Ernest M. Thiessen and Daniel P. Loucks
School of Civil and Environmental Engineering
Cornell University, Ithaca, New York 14853
USA

Abstract: This paper describes an interactive computer-assisted negotiation process support system called ICANS. Based on confidential information provided by each party in conflict via the interactive graphical interface, the negotiation process support system can indicate if there exist any alternatives that may be preferred to each party's desired alternative in the absence of a negotiated agreement. If such preferred alternatives exist, the system can display a range that represents the most preferred of these alternatives. Through a series of iterations in which each party's input data, assumptions, and preferences may change, ICANS assists the parties in a search for an acceptable agreement that may be preferred to what they may have agreed to without ICANS.

Keywords: water resources, multiobjective decision making, conflict resolution, analytical mediation, computer-supported negotiation.

1. Introduction

Conflicts over the allocation and management of water resources for multiple uses and purposes are common (Viessman and Smerden, 1989). Management disputes typically result from different parties having different and conflicting objectives or goals. These conflict management problems are compounded by the uncertainty of the water supplies and demands, institutional constraints, legal requirements, and a host of other factors. A large part of any water management agency's task is to resolve these conflicts in this constrained and uncertain environment.

One common approach to conflict resolution is through negotiation (Holznagel, 1986; McDonald, 1988; Delli Priscoli, 1988). The purpose of those engaged in negotiation is to identify, if possible, alternatives that all parties will find acceptable. Whether or not any such alterantives exist might be discovered in an iterative process in which parties explore the impacts of various decisions, and begin to understand the tradeoffs among the impacts associated with alternative decisions.

Without knowing the relative preferences among all the negotiation issues for each party in conflict, it may not be possible to identify whether or not any mutually acceptable alternative exists, and if more than one exists, which of them are better than the others in the opinions of all the parties involved in the conflict. It therefore seems to us that there could be substantial benefits derived from a computer-based negotiation process support system that all parties in conflict could easily understand and trust and would use to guide them toward their most preferred solution. This system could be used to first find out whether it is worth entering into or continuing a negotiation process and then, if negotiations are worthwhile, help identify alternatives that would likely make all of the parties in the conflict better off than they would be without an agreement (Antrim, 1987).

This paper describes an interactive computer-assisted negotiation process support system called ICANS and how it works to guide parties toward a mutually beneficial agreement. In actual negotiations this system would be part of a more complete negotiation support environment that may include both context models as well as negotiation process models.

2. A Negotiation Process Support System

ICANS, the interactive computer-assisted negotiation process support system developed at Cornell University, is a software package that can be used by anyone familiar with the basic operation of a microcomputer. Its interactive graphical interface is used by each party involved in the negotiation process to input information, to control program operation through menus, and to display information aimed at helping all parties involved reach a mutually acceptable and nondominated agreement. The program operates under DOS on IBM PC/AT or PS/2 compatible microcomputers having at least EGA color graphics display capabilities. Having a mouse for menu picking and data entry is highly advantageous.

Each party of the negotiation can have its own individual objectives or goals, which need not be revealed to others and need not be quantified. The degree to which each objective is satisfied will be a function of (i.e. dependent on) the negotiated decision values for the issues at stake and perhaps even on the process of obtaining them.

Although the set of issues being considered may change during the negotiation process, it is important that the final set of issues representing the decisions that are to be agreed upon be explicitly defined, understood and accepted by all parties. In addition, unless all parties accept an initial suggestion made by ICANS based on the specified negotiation ranges, each party must be willing to propose alternative solutions to the conflict expressed in terms of the decisions that have to be made.

To help parties realize how conflicting positions on issues might be resolved, ICANS has to know something about each party's preferences with respect to various possible alternative decisions. This is usually not the kind of information each party is willing to share with each other (Lax and Sebenius, 1986). Therefore ICANS keeps such information confidential in files accessible only to the party whose information is in those files.

The confidential information required from each party includes a range of issue values suggested by each party for negotiation. The range for each issue may consist of continuous numerical values, a series of discrete numerical or linguistic values, or just a yes/no, on/off, etc. Each party may also enter confidential information indicating the relative preferences associated with these possible decisions as well as information that allows the program to estimate each party's relative preferences among the different issues. This and other preference information is given to ICANS in confidence in order to overcome the logical reluctance of negotiating parties to share preference information. A tool like ICANS or some neutral negotiation facilitator that gains each party's confidence and uses this preference information without revealing it, allows parties to discover alternatives that may result in greater levels of satisfaction.

The particular form of the information can help ICANS guide the parties toward an acceptable, and perhaps even an improved agreement. Any information that is entered can be modified at any time during the iterative negotiation process.

ICANS uses a mixed-integer linear programming optimization model for approximating internally-derived nonlinear preference information and for identifying efficient (nondominated) alternative solutions, when

appropriate. Users of ICANS need not know anything about this methodology unless there exist relationships among various decision variables that need to be considered and maintained. In this case, these relationships must be defined as linear constraints and included in a file that the ICANS program accesses.

ICANS is designed to work with issues that are additive with respect to the impact they have on each party's objectives or feeling of satisfaction. If issues are non-additive, i.e. if the level of satisfaction associated with a change in one decision value is dependent on the value of another decisions, these two or more interdependent issues should, if possible, be combined into a single issue. A simple example (and there are many that are not as simple) would be the difficulty in determining the added satisfaction obtained by increasing the number of hours laborers work at a particular site over a specified time period without knowing how many laborers (together with their skill or productivity levels) there are. These two issues, the number of workers and the hours of work, can be combined into a single decision, the number of worker-hours (workers times hours). If it is not possible to avoid interdependent issues, more iterations with frequent updating of relative preference information will be required.

3. Some Experiences and Observations

To date we have used ICANS only in simulated conflict situations. In these simulations the confidential preference information of each party has been well defined. We, but not the participants, know the nondominated solutions. We have compared the results of these simulations both with and without the use of ICANS and we have concluded that the ICANS program does help negotiators find superior final negotiated agreements. Nevertheless, we are anxious to find out if, in actual situations, individuals or parties will be willing to think like we have as we developed ICANS and these conflict-solving simulations. Are people likely to think in terms of relative satisfaction values, equivalent alternatives, and the like? Will parties in conflict agree to a compromise alternative, or at least agree to consider it? Most of our ideas have come from the negotiation liteature, so we hope our assumptions are realistic, at least for some multiobjective conflict

situations some of the time. We shall see. In the meantime, readers should consider this methodology we have described as a proposal.

How could users of ICANS cheat? It might be possible for one party to take advantage of another party by falsly identifying (i.e. inflating the level of satisfaction of) its equivalent BATNA alternative, so that it is actually much better than its actual BATNA. This increases the possibility that no mutually acceptable alternative will be found in the negotiation process which could result in a potential loss compared to a negotiated agreement for all parties. Note, of course, that no party has to agree to any particular alternative proposed by anyone, including ICANS. It seems to every party's advantage to keep as many options open at the beginning as is reasonable. The potential for reaching a negotiated agreement that is preferred to each party's BATNA will be enhanced if all parties remain honest.

There is no advantage we can think of for any party to falsify any of its relative satisfaction functions or equivalent alternatives. This can only lead to alterantives which are less preferred by the offending party. Total satisfactions representing each party's preferences are relative to each separate party, each expressed in different units. Therefore, ICANS cannot compute total satisfactions to all parties, or weights favoring one party over another. It cannot propose any alternative that would be considered by some outside or neutral party to be better for one party than for another based on total satisfaction. It cannot propose any globally optimal (such as a maximum total satisfaction) solution from any single total party perspective. Therefore, there is no advantage to inflate any relative satisfaction functions of decisions values, or in some way distort the equivalent alternatives that influence the relative weights associated with each relative satisfaction function in the calculation of a relative total satisfaction to the particular party.

In designing ICANS, we tried to counteract the "fixed-pie" mentality that characterizes some negotiation processes (Bazerman, 1983). In this case negotiators assume that all parties consider all decisions or issues of equal importance. This leads them to argue the merits of each decision or issue individually rather than discussing the entire package of decisions. Erickson's (1974) experiments showed the impor-

tance of negotiating the entire set of issues simultaneously, rather than separately. In ths study, experimenters who considered all issues simultaneously and made tradeoffs among them tended to reach agreements having higher joint satisfactions than those who negotiated issue-by-issue. ICANS forces users to consider alternatives, i.e. all decisions or issues together rather than separately.

In conclusion, we welcome comments and requests from those who would like to experiment with ICANS in a simulated or real situation. We view our interactive negotiation process support system to be a specific application of current technology in data management and communication to an important problem frequently occurring in the management of water and environmental resources. Through the use of this and similar programs by professional mediators or facilitators, we will undoubtedly learn much more than we know now about how this technology can best assist those involved in negotiating multiobjective resource management conflicts.

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