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Towards a prescriptive negotiation support system[1]

by

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Negotiations can be a complex process for which sufficient foresight and planning are required. A negotiator must be prepared both strategically; and tactically. A negotiation support system is presented that proactively assists the user in planning and preparation. Both forms of preparation, strategic and tactical, are incorporated into the architecture. The decision making paradigms of the strategic support are drawn from conflict analysis, while a rule-based system provides tactical support. The specific goals and characteristics of the negotiator are reconciled with the possible plans of action generated by the tactical and strategic support systems through the use of a multicriteria decision making technique called the Ordinal Hierarchy Method. The precise definition and implementation of this system is currently being completed.

Keywords: Negotiation Support Systems, Strategic Support, Tactical Support, Conflict Analysis, Rule-Base Systems

1. Introduction

Negotiations are a fact of daily life in varied and numerous settings. As an example, when purchasing a computer system for either home or office use, an interaction between the seller and buyer occurs where the particulars of the deal are decided. A parent and child may bargain over an appropriate curfew for Friday night. A more traditional and formal example is labour- management negotiations for a new contract. Here there can be many issues, but still essentially two parties. More complex negotiations can arise in a multiparty setting. The negotiations that are taking place between the European Community and other European nations such as Austria, Sweden, Poland and Hungary about

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increased cooperation and integration are an example of highly complex political and business negotiations. Business and strategic negotiations on the international stage have taken on a more important role in the past few years. This has resulted in a heightened need for careful planning for negotiations. Further, a recent example of failed negotiations, the turmoil between Serbia and Croatia, is additional evidence of the importance of negotiations. To this end, a tool that allows for better negotiated settlements or an increased chance of such resolution would be a useful analytic construct. The motivation for the use of a formal computer based model towards this goal is given in the next section along with a statement of principles underlying and guiding the development. The latter sections of the paper give a detailed definition of the proposed system including descriptions about operational components.

2. Motivation and Philosophy

Lewicki and Literrer (1985) define three conditions that must exist before negotiations can take place that are:

(i) there is a conflict of interest between two or more parties;
(ii) there is no set procedure to deal with the conflict or the parties feel a better settlement can result if they work outside the system; and
(iii) the parties prefer to search for agreement rather than fight, capitulate, break off contact or appeal to an arbitrator to end the dispute.

In other words, negotiations can occur only if the parties have the will to resolve their dispute and no mandatory resolution procedure exists.

A tool that can improve the preparation of negotiators is a Negotiation Support System (NSS). A NSS is a Decision Support System that is designed especially for use with negotiations. Sprague and Carlson (1982) define decision support systems as interactive computer-based systems that integrate data access and analysis models to help decision makers scrutinize ill-structured problems. Negotiations are ill-structured problems from an analytic perspective (Sycara, 1990). While the use of NSS is not widespread, Nyhart and Goeltner (1987) found seventeen instances of practical use. Since that time, interest has increased on both academic and industry levels (Jones and Sanford, 1990) with many proprietary systems having been implemented.

While negotiations may seem at times as much art as science, a formal structure is useful in allowing the decision maker to understand the negotiation environment, the objectives and constraints of the parties and the possible resolutions (Kersten and Szapiro, 1985). A primary goal of a NSS is to improve the decision-making capabilities of the user by providing a framework for the planning and development of strategy. Raiffa (1982) reports a study where 32 senior lending officers of a large U.S. bank were asked what they perceived as the most important characteristic of a good negotiator. The most frequently mentioned characteristic was preparation. Meticulous planning is counter to the style of

many business people. Managers are more likely to take action rather than to reflect passively about a situation (Mintzberg,1973). Lewicki and Literrer (1985) suggest four reasons that negotiators fail to achieve their goals. These are:

(i) failure to set clear objectives;
(ii) lack of preparedness which leads to a failure to understand the negotiator's strengths and the opponent's weaknesses;
(iii) deficiency of understanding about the opponent's historic bargaining positions and needs; and
(iv) prepared to negotiate with one plan only and an inability to react unexpected actions.

A NSS can help to remedy the above failures.

Negotiations are often confused with debates. The purpose of a debate is to defeat one's opponent and the goals of the participants are diametrically opposed. While the parties in negotiations may have divergent aims, the purpose of negotiating is to find a middle ground acceptable to all parties (Jandt,1985). A design goal of a NSS should be to help the participants realize their joint gains. The use of a computer model may remove personality conflicts that could impede compromise.

Since an NSS, or more generally a DSS, imbed analytic models, a coherent approach to analysis should be adopted. Bell *et al* (1989) discuss three orientations to negotiation analysis: descriptive, normative and prescriptive. Descriptive analysis reflects how people behave in certain situations. Normative analysis attempts to state how people should act in an idealized world. Prescriptive analysis develops advice for an individual that allows the individual to make better choices. A prescriptive orientation is of most interest to practitioners.

In addition to the orientation, the philosophical underpinning of the methodology must be specified before an NSS can be constructed. An approach would attempt to develop strategy that advances the goals of only the user. This approach would develop purely competitive strategy. A second approach would be to have the NSS serve as a mediator and try to bring the parties together at a fair middle ground. The problem with the former paradigm is that it is not a good negotiation practice, if negotiations between the parties may occur again, to take advantage of a party's weaknesses unfairly. The latter approach is too altruistic for many negotiators whose goal is to achieve a favourable settlement for their side. Further, fully cooperative negotiations require that each party be truthful and open about their goals and aspirations. This is not always desirable or advisable for a negotiating party. An additional complication is that the parties may disagree about what constitutes a fair division of rewards.

Between these lies the methodology that attempts to describe the situation and the goals of the opponents but provides advice to only one party. Raiffa (1991) calls this the Asymmetrically Prescriptive-Descriptive Approach to negotiations. This approach is an underpinning of the NSS proposed in this paper. Research into this type of methodology has been suggested by Wilfrid Siebe (1991) under the auspices of the Processes of International Negotiations

(PIN) Project at the International Institute of Applied Systems Analysis as a useful marriage of game theoretic and decision analysis techniques. Siebe argues that negotiation counterparts can not be expected to act completely rationally in the game theoretic sense, but that the combination of techniques allows the user to have a behavioural model of the counterparts that can be used to develop effective strategies.

The system described in this paper develops both the theoretical and practical frameworks leading to a prescriptive negotiation support system. It is prescriptive in that it is designed to provide information to a single participant rather than act as a mediation tool and to provide information that enables a user to take direct and personal action. Currently, research in this area is being done at numerous locations. However, the research has not resulted in the development of a flexible and practical system. Existing NSS either attempt to serve as a mediator or simply to model the negotiation process. Neither of these approaches satisfies the requirements of the negotiator whose job is to reach a settlement that, while being fair, is the best possible for himself or his client. To meet the existing needs of negotiators, the system has three primary components: strategic support, tactical support and an integrative interface. Strategic support deals with general negotiation planning, tactical support with advice about specific bargaining situations and the interface with the synthesis of the information.

The strategic support system, based on conflict analysis (Fraser and Hipel, 1984), is used to model the dynamics of the negotiation. The user is able to investigate the ramifications of a change in bargaining conditions, the use of bluffing to fool an opponent and the formation of coalitions in multiparty negotiations. With this information, the negotiator is able to select strategies without the element of risk involved in taking the action. The tactical support system assists the bargainer in selecting the proper tactics, and in being aware of the tactics that opponents may use. This allows the user to prepare better arguments, which helps the user to avoid being surprised tactically by the counterparts. To tie the information from the above subsystems together, and reconcile the possible actions with the user's goals, an integrative interface is contained. The purpose of the interface is twofold; first, to aid the user in specifying the goals, and second, to evaluate the strategies with respect to these goals. Detailed descriptions of the system elements follow in the remaining sections.

3. General System Architecture

Figure 1 illustrates the NSS architecture (grey ovals depict the system components). Development of strategy is accomplished within the strategic and tactical components and the interface is used to reconcile the user's goals with these strategies. The information provided to the user allows for more thorough planning and understanding of the problem, which should improve the quality of the decision making process.

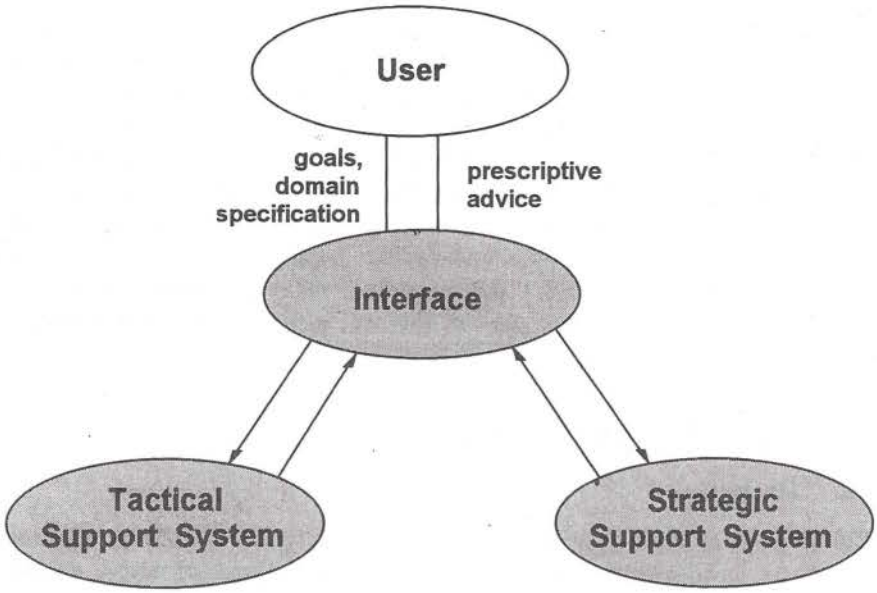

Figure 1. NSS Architecture

The strategic DSS encompasses considerable theoretical development. The interaction of the negotiation participants is be modelled using ordinal game theoretic techniques and employs hypergames, dynamic analysis, and coalition formation. Hypergame theory is applied to model acts of bluffing that occur in bargaining. Further, the options available to a negotiator may vary over time and it is likely that preferences may also change. This leads to a requirement for a method of analyzing the conflict dynamically. For example, during a strike, preferences of the parties may change as the economic realities of a long strike transpired. Coalition analysis permits the identification of players with similar interests. A reasonable general coalition metric has been developed for use with conflict analysis (Meister *et al*, 1991b). Together, these components form the foundation for the strategic support provided to the user. The tactical support rule-based system gives advice about what bargaining tactics to apply given the parameters of the situation. For example, if the negotiator is congenial or aggressive, advice could be provided recommending a course of action given these personality traits. The goals of the user, defined using the interface, are also incorporated. The information for the database is drawn from literature rather than human experts. The inference engine could be used to provide possible strategies, each of which would have a different confidence level.

The interface has a dual role. The first is to guide the user through a definition of the negotiation environment so that the proper analytic tools can

be applied. Part of the definition process requests the user to state long and short-term goals. This information is be used to set the parameters for the subsystems and aid in the integration of the analytic results from the strategic and tactical components. The integration of results is the second role for the interface. Possible courses of action are evaluated using the Ordinal Hierarchy Method (OHM) (Meister and Fraser, 1991). OHM assists the user in selecting the best decision alternative using only ordinal importance relationships between issues or criteria and ordinal preference relationships between alternatives. Within the NSS, OHM is used to evaluate the possible negotiating strategies with respect to the goals of the user so that a preferred strategy can be identified.

4. Strategic Support System

4.1. Design

The purpose of the Strategic Support System is to assist the user in realizing the effects, both positive and negative, of certain courses of action during negotiation. Figure 2 shows how this subsystem accomplishes its task. The initial model definition is performed by the user in the interface subsystem. The strategic support system then leads the user to perform either coalition analysis, to find prospective partners or wise concessions, or hypergame analysis to discover the potential outcome of bluffing.

A coalition formation metric measures the similarities of the preferences, or goals, of a decision maker with other decision makers. Cardinal coalition metrics have been developed by numerous authors including Shapley (1953), Luce and Raiffa (1957) and Riker (1962) whereas Kuhn et al (1983) formulated an ordinal coalition metric. A shortcoming of Kuhn's metric is that it uses a more computationally expensive preference structure. Fraser and Hipel (1989) suggested a metric based on a more compact preference representation method that had a limited scope of application. The FH metric was then generalized by Meister et al (1991b) to handle most cases. Comparison of various coalition formation metrics led Meister et al (1991a) to conclude that their coalition metric provided information that was valuable for decision making.

Hypergames are a method of modelling games in which at least one of the decision makers has a misperception about some part of the model (Fraser and Hipel,1984). The misperception may concern the preferences or the available options of the other decision makers or, possibly, even the existence of relevant decision makers. An example of the latter would be a hostile takeover bid where a "white knight" appears at the request of the firm threatened with the takeover to the surprise of the bidder.

A criticism of hypergames is that, by definition, it is impossible to know that a misperception exists, and as such hypergames are of limited use. This criticism is not relevant for the purposes of negotiation research. The use of

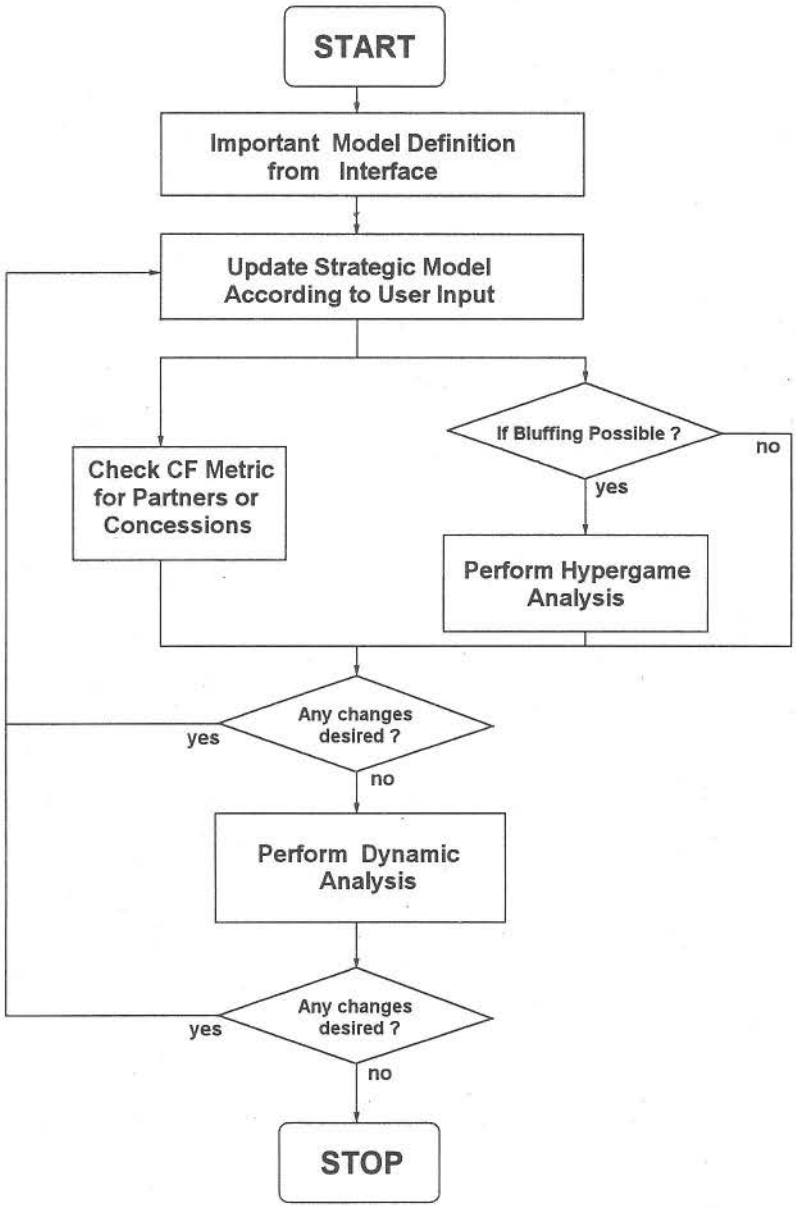

Figure 2. Strategic DSS Flow Chart

hypergames falls into two categories. First, hypergames can be used to model bluffing on the part of the user. Second, hypergames allow the user to perform a sensitivity analysis of the other parties' preferences.

After completing coalition and hypergame analyses, the subsequent stage in Figure 2 permits the user to update the specifications of the model. For example, if a likely coalition exists between two parties and the user wanted to merge these participants, he would be able to do so. Additionally, a comprehensive system must recognize the fact that the options and preferences of the participants may change over time. This necessitates consideration of the negotiation dynamics and, therefore, development of techniques to perform dynamic analysis. There are at least three possible approaches to consider when developing a dynamic analysis methodology. One possibility is that the user would develop a series of independent static models at the times that are deemed important. The advantage of this approach is that no additional techniques need to be developed to get useful results. However, the method relies a great deal on the user's ability to select the appropriate times. This introduces an unnecessary source of uncertainty into the model and restricts the prescriptive nature of the NSS. An other extreme proposal would create a structure where all feasible actions, preferences and even relevance of decision makers are mapped to a time line so that specific time intervals would be necessary. Such a structure would comprehensively model the negotiation but has potential difficulties in extracting the information from the user and representational and computational complexity.

A moderate approach is to tie changes in the model to various states of the world that might change. This is similar to the approach advocated by Kersten and Szpakowicz (1990). It differs in that the exogenous events and actions (circumstances outside the control of any decision maker) available to the decision makers are treated as different types of happenings. Further, the user need not define the entire environment but, rather, only the important transitional events. This is not as extensive as the second approach or as simple as the first but has two primary advantages. First, it reflects how the participants' preferences change and, second, it is a convenient method to acquire the necessary information from the user. To expand on these two points, consider a labour-management negotiation and assume that the management negotiator is using the methodology. The original model may be defined a few months before the contract is to expire. In this case, the system would inquire about what circumstances would cause the preferences to change. The negotiator might indicate that if the recession were to deepen, the company's preferences would change. After the preferences for the altered circumstances were entered, the NSS would link the new preference structure to the occurrence of the relevant event.

This requires an additional structure beyond that currently provided by conflict analysis. The user must have a way of explaining and defining the world. Events that would go into the world model would be events over which no decision maker has strategic control such as fair election results, economic conditions

or weather. A reasonable way of performing this task might be to model a decision maker called Fate that did not have any preferences between the outcomes, and as such did not add any equilibria to the model. Preliminary investigation using the DecisionMaker (Waterloo Engineering Software,1992) computer program has provided promising results.

The latter approach permits the user to revise the model based on the information generated, to reflect upon the results, to make further modifications and to save the various strategies for evaluation using the integrative interface. The interactive nature of this subsystem assists the user by unfreezing an ingrained way of thinking about the problem and by helping the user identify good strategies (Anson and Jelassi,1990).

4.2. Implementation

The current research status of system components differ. The coalition formation metric has been developed and implemented for both microcomputer and mainframe environments. No new theory is being developed with respect to hypergames. However, the integration of hypergame theory into a structured NSS is a new development. Hypergame modeling capabilities have been recently added to the DecisionMaker program (Waterloo Engineering Software, 1992). Structures and methods for dynamic analysis are a current research priority.

5. Tactical Support System

5.1. Design

The general design of the Tactical Support System is as a rule-based system. Pedersen (1989) poses a series of questions that can be used to determine the suitability of an rule-based system to a certain domain. Upon evaluation the selection of bargaining tactics seems to be a reasonable rule-based system application. The questions are

1. *Is the domain well-defined?* A domain that is well-defined is better suited to an rule- based system application. Tactical bargaining does not occur within a precise domain. However, it is possible to categorize various bargaining situations and tactics by creating a taxonomy of general situations based on the work of Raiffa (1982) and Karrass (1970).
2. *Is the problem's solution dependent on common sense?* Pedersen states that problems requiring much common sense to find an answer are poor candidates for rule-based systems. At first glance, selecting proper bargaining tactics is a task that uses common sense. However, it can be argued that intuition is used to select the specific time that a tactic is employed and that it is possible to logically decide which tactics are relevant to a situation.
3. *Does solving the problem depend on sense data?* While sensing a counterpart's reaction to tactic, or general mood, is important in selecting the

mode of application of a tactic, planning for negotiations is primarily a fact-based exercise.

4. *Is the domain stable?* Since bargaining is a long established human endeavour, it is likely that most successful tactics have been identified making the domain relatively stable.
5. *Does solving the problem rely more on heuristics than algorithms?* It is not possible to develop an accurate model of tactical bargaining behaviour using procedural computer languages such as C or Pascal. This fact implies that it is necessary to employ a heuristic system such as an rule-based system.
6. *Does the expert deal more in symbols than in numbers?* When it comes to selecting tactics, numbers matter much less than the general parameters that define the interaction.
7. *Can results be evaluated?* For the tactical support system, it would be very difficult to determine whether the system improves bargaining skill. No straightforward way exists to evaluate whether the advice is appropriate until the advice has been acted upon. However, it is possible to use case-based analysis of the final system to determine its effectiveness.

From the above information, it is concluded that while tactical bargaining is not ideally suited for use with an rule-based system approach it is a reasonable approach.

5.2. Implementation

A rule-based system prototype has been developed using VP-Expert, an expert system shell package. Various negotiation techniques have been incorporated. The system relies on the user to answer questions about characteristics such as the goals of the negotiation, their own personality traits and the structure of the negotiations. The goals are used to determine the importance of reaching a settlement, of dealing fairly with the other participants and other matters that effect the selection of bargaining tactics. The self-defined personality attributes are used to filter out undesirable recommendations. For example, the goals and structure of the negotiations may imply that aggressiveness on the part of the negotiator could be a useful tactic. However, if the negotiator is a stoic or quiet individual, it is unlikely that aggressiveness could be convincingly exhibited. The structure of the negotiations would define, among other concerns, whether there are two or more participants in the negotiation and whether there is a single issue or multiple issues. This is important as the complexity of the negotiations can negate or accentuate the effect of different tactics. The main benefit of a tactical support system is that the user is guided in a structured approach to defining the entire negotiation environment and then is given a list of applicable tactics.

6. Integrative Interface

The purpose of the Integrative Interface is to facilitate the user in defining the goals, the parameters and the proper strategies for the negotiation. The general architecture of the interface is given in Figure 3.

6.1. Negotiation Environment Specification

The methodology inherent in the integrative interface assists the user in defining the negotiation environment. The user structures the negotiations by identifying the relevant parties to the negotiations. The goals of the user are then identified as well as the actions that are available to further those goals. The feasible actions of the other parties involved are specified at the next stage in the model development. The information gathered at this stage is then used by the strategic and tactical subsystems when generating prescriptive advice.

6.2. Evaluation of Alternative Strategies

Various methodologies such as the Analytic Hierarchy Process (Saaty,1980) and Électré (Roy, 1985) have been developed to select between alternatives on the basis of a set of criteria or issues. These methods use cardinal values, assigned by the user, to select the best alternative. However, it is not always possible for a user to assign a cardinal value with a satisfactory degree of confidence. On the other hand, it is usually feasible to rank the capacity of the each alternative to satisfy each issue. A methodology, the Ordinal Hierarchy Method (OHM), that uses ordinal relationships to evaluate the alternatives has been developed (Meister and Fraser,1991) and is undergoing case testing.

OHM is based on the following principles. First, it is possible for the user to give state the relevant issues and give an importance ordering of these issues. The ordering does not need to be strictly ordinal as there may be equally preferred issues. Second, it is feasible for the user to, when given two alternatives, state that one alternative is better than the other for an issue or that the two alternatives are equivalent for that issue. The user then performs the pairwise comparison for each issue. Logical supposition is then used to deduce which alternative, from this pair, is better by using a principle similar to that of dominant strategies from the game theory literature. Finally; such a comparison is performed for each pair of alternatives. The result is a ranking of alternatives that is, while not necessarily transitive, accurately reflects the user's preferences.

7. Conclusions

Two design goals were given as appropriate for a prescriptive NSS. Specifically, they were that the system should allow the participants to realize their joint goals and that, the pre-planning process would be improved. Joint gains are highlighted by to the user of the proposed NSS as Pareto optimal outcomes

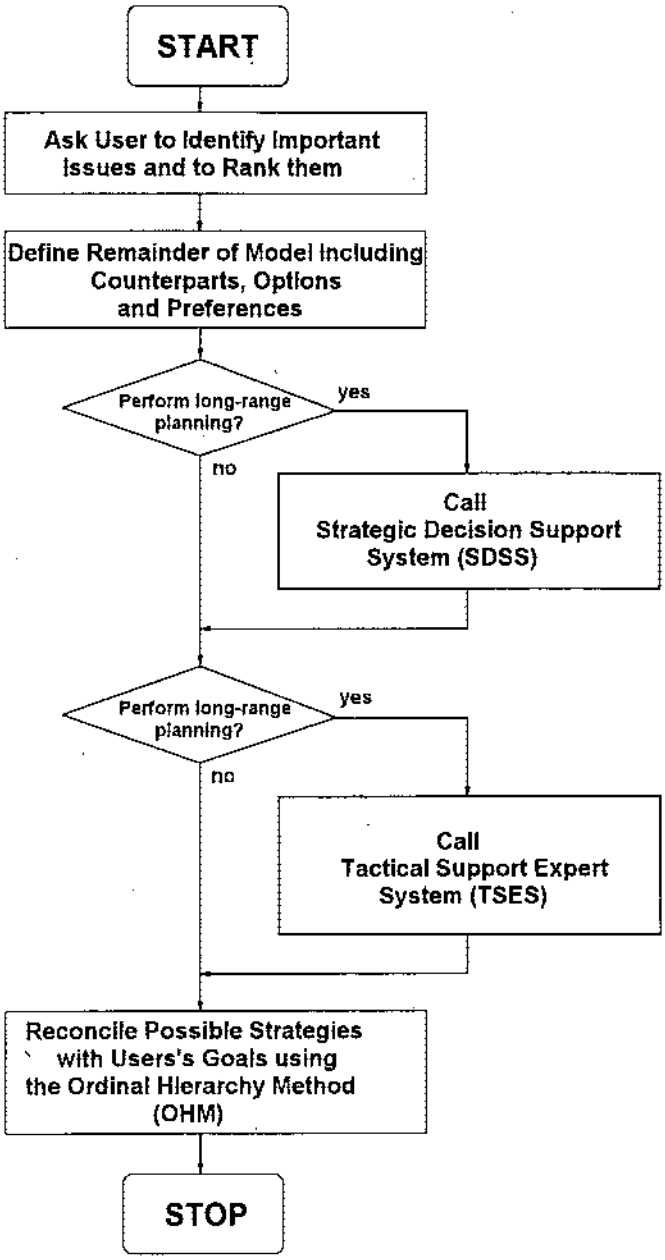

Figure 3. Integrative Interface Flow Chart

when the various situations are considered in the Strategic Decision Support System. The pre-planning process is improved over an informal preparation for negotiation as the user clearly identifies the negotiation goals and environment. Therefore, the design goals have been met.

A distinctive feature of the NSS is the interface. A primary advantage of the integrative interface between the user and the tactical and strategic support systems lies in modeling simplicity. The user is not required to incorporate goals such as fairness into actions that must be modelled. The system structure allows the user to define concrete courses of action within the strategic and tactical support systems and to develop strategies based on the available actions only. Then, the user can evaluate the strategies against a set of goals that need not be directly related to the actions. This creates a simpler modeling environment in that the user is not required to force goals into actions.

The NSS architecture presented is prescriptive since the user is guided towards beneficial types of behaviour through the tactical support system and effectual strategy is developed using the strategic support system. Substantive development towards the realization of the system has been accomplished. The methodology of the integrative interface has been developed as has a prototype for the tactical support system. A coalition formation metric has been developed and a dynamic analysis technique is being investigated. Further, the traditional benefits of Negotiation Support Systems (Anson and Jelassi, 1990) are realized by this NSS as explained in the main text. Thus, the NSS outlined provides a powerful and useful tool for negotiators in practical, complex situations.

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