INDIVIDUAL NEGOTIATION SUPPORT IN GROUP DSS

Rajan Srikanth
and
Matthias Jarke

April 1986

Center for Research on Information Systems
Computer Applications and Information Systems Area
Graduate School of Business Administration
New York University

Working Paper Series

CRIS #118

GBA #86-30

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

Table of Contents

1. INTRODUCTION 1
2. APPROACHES TO UNDERSTANDING NEGOTIATIONS 2
   2.1. Game Theory - Bargaining 3
   2.2. Economics - Decision Making Under Uncertainty 4
   2.3. Process Analysis - Joint Decision Making 6
   2.4. Sociology 8
   2.5. Industrial Relations - Collective Bargaining 9
   2.6. Psychology 10
3. A UNIFIED MODEL 11
   3.1. The Model 11
   3.2. Relationship to the other Models 14
4. DESIGN OF AN INDIVIDUAL NEGOTIATION SUPPORT ENVIRONMENT 15
   4.1. MEDIATOR Overview 16
   4.2. Individual Negotiation Support Environment 17
5. CONCLUSION 19

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

INDIVIDUAL NEGOTIATION SUPPORT IN GROUP DSS

ABSTRACT. Negotiation support is an important aspect of multiperson decision support systems. Besides mechanisms for representing and evolving group joint problem representations, such DSS should also provide an environment in which decision makers are supported in developing, analyzing and reinforcing their individual negotiation position. Recognizing the diversity of research approaches to negotiation modelling in the literature, this paper synthesizes an integrated model from which a knowledge-based individual negotiation support environment using tools from different areas can be designed. Role and architecture of such a component are described in the context of MEDIATOR, a database-centered negotiation support system under development at NYU.

1. INTRODUCTION

In an increasingly complex and turbulent business environment, decision makers will have to rely more and more on advances in information/communication technology for support [Huber and McDaniel, 1986]. While traditional single-user decision support systems (DSS) help explicate individual decision makers' problem views, thus improving managerial communication [Sanders et al., 1984], modern office communication technology [Tsichritzis, 1985] can serve as a vehicle to support multiperson decisions more directly.

A number of researchers have begun to study the design and potential impact of so-called Group DSS [Gray 1981, Huber 1982, Turoff and Hiltz 1982, Bui and Jarke 1984, DeSanctis and Gallupe 1985, Goncalves, 1985]. Knowledge sharing and negotiation support in different time/space organizational settings have emerged as critical goals of such systems [Jarke, 1986]. While knowledge sharing refers to the cooperative aspects of GDSS, negotiation support is needed where there is a conflict of interests.

The MEDIATOR project at New York University attempts to integrate both of these aspects into a comprehensive DSS architecture for multiperson decision making that is not necessarily cooperative. A common static framework for knowledge sharing and negotiation protocols is achieved by a specialized database architecture [Jarke et al., 1986]. Process aspects of multiperson decision making are embedded into a framework of evolutionary systems design [Shakun, 1981]. MEDIATOR offers two kinds of negotiation support components: group negotiation support for integrating individual positions into a group decision, and individual negotiation support for each party to defend its position. The former has the main purpose of achieving a common representation of the problem

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

and then evolving this representation through consensus-seeking (via problem redefinition) and compromise (via concession making) towards a jointly acceptable agreement. Since communication is the main goal, a relatively simple mutually understandable language must be used for the joint problem representation.

In contrast, an individual negotiation support component has to provide a rich set of tools for analyzing the decision makers' perceptions of their own as well as their opponents' bargaining position. This requires an understanding of the mechanics and dynamics of the cognitive aspects of the negotiation process. Each of the many research areas that have contributed to our understanding of negotiations has modeled this problem in its own idiosyncratic way. Unfortunately, none of the approaches represents the full richness of negotiation processes and outcomes. This paper is an attempt to integrate major contributions of several disciplines into a unified model of negotiations that in turn serves as the basis for the design of a knowledge-based individual negotiation support environment within the MEDIATOR architecture. While we cannot claim to have developed a comprehensive *theory* of negotiations, we at least expect to provide a model for a uniform *systems environment* in which tools from different areas can be applied. Future work will have to show to what degree general theories can be developed from the integrated model.

This paper is organized as follows. Section 2 reviews the contributions of six reference disciplines with respect to their potential usefulness in individual negotiation support: game theory, decision-making under uncertainty, process analysis, sociology, industrial relations, and psychology. Section 3 presents the integrated model along with two examples, and provides some justification by mapping the approaches taken by each area into it. Section 4 provides a brief overview of the MEDIATOR architecture and describes a knowledge-based design for its individual negotiation support component based on the model. In section 5, relationships to other GDSS, potential application areas, limitations and future plans are discussed.

2. APPROACHES TO UNDERSTANDING NEGOTIATIONS

Negotiations are a part of everyday life. Whenever there is disagreement or conflict of interest between two or more parties, they negotiate. However, negotiations vary substantially in their fundamental characteristics like the underlying motivation, the nature of the relationship between and within the parties, the specific features of the issue under negotiation, and the negotiation process itself (see [Raiffa, 1982] for a detailed analysis).

Theories to explain the negotiation process have been proposed by researchers from different disciplines, including Game Theory (bargaining), Economics (decision making under uncertainty),

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

Process Analysis (joint decision-making process), Sociology, Industrial Relations (collective bargaining), Politics (international negotiations, terrorism, etc.) and, Psychology (behavioral styles and negotiation strategies, etc.). It is the purpose of this section to summarize major contributions of these areas as far as they appear to be related to the goal of designing a negotiation support system. In doing so, we shall compare the approaches on their: *focus* of attention - what parts of the negotiation process they seek to describe, *level of analysis* or detail, *realism* or extent of simplifying and limiting assumptions, and *determinancy* or prescriptive power.

2.1. Game Theory - Bargaining

Game theory attempts to model negotiation behavior as a rational-choice, self-interested behavior toward a given array of values. It is primarily geared toward analyzing the decision "to negotiate or not to".

Elementary game theory assumes two parties, or organized collectivities, making choices from among a set of alternatives to reach an agreement. The set of all alternative courses of action open to both "bargainers", the relation between each possible pair of actions chosen and the bargaining outcomes, and the utilities assigned to these outcomes, are assumed to be known to both bargainers. The pattern of demands and concessions was shown to lead to an agreement which maximizes the product of the utilities of the two bargainers [Nash, 1950, 1953; Zeuthen, 1930].

Harsanyi (1956) suggested the concept of "maximum risk of no agreement" to explain the process by which the Nash outcomes were reached. This introduced considerations of uncertainties and probability into the bargaining process. Harsanyi (1962), extended this method to cases where the two parties "do not know (and know that they do not know) each other's utility function (preferences and attitudes towards risk)". This, he suggested, leads to "compounded expectations" which converge by two mechanisms: the usage of "stereotype utility functions" and the process of mutual "adjustment" of expectations as bargaining proceeds.

The implications of no agreement or "stalemate" on the bargaining process were studied by Schelling (1963) and later on by a host of others. Schelling pointed out that the time required to reach an agreement was costly to (both) bargainers and that this cost was an important factor in determining the final outcome. Bishop (1964) introduced "discount rates" to model concession making behavior and suggested that the bargainer with the lower discount rate has the bargaining advantage. Cross (1969) developed a detailed theory for the implications of this "time cost" on bargaining. He suggested that each bargainer chooses the demand that maximizes present value, discounted according to the time it would take to get it. A very important contribution of this work

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

was the concept of disproportional effects of the bargaining process on the two bargainers because of subjective estimates and asymmetric information.

After Harsanyi (1962), Cross was the first to revitalize the concept of "learning" in the game by suggesting that the bargainers perceptions of their own time costs --and expectations about their opponent's-- evolves in response to bargaining behavior and its consequences. Bargaining can be visualized as the process of reducing and eliminating the gap between the final outcomes estimated by the two participants on the basis of their perceptions of their relative bargaining strengths. Harsanyi (1967-68) tackles the problem of uncertainty about the pay-offs for the opponent by proposing that each bargainer actually imagines that he is faced by a probability distribution of different types of bargainers --each with characteristic pay-offs-- and bases his strategy on the expected value. He also uses estimates of his opponent's expectations about him. In [Harsanyi, 1972, 1976; Harsanyi and Selten, 1972], a two-person bargaining game with incomplete information is reinterpreted as an n-person Bayesian game. Selten (1975) notes: "the dynamics of the bargaining process appear to be a vehicle for credible exchange of information". Limiting assumptions that each of these theories makes are discussed in [Crawford, 1985].

Research on non-cooperative games and dynamic game theory takes a slightly different approach. Rao and Shakun (1974) model concession-making as a sequential decision problem and develop a dynamic programming model to solve it. Going one step further, Shakun (1981) models conflict as a problem with initially no feasible solution. Redefinition of the problem is required for a feasible solution to emerge. Shakun develops a "goals/values referral process" as a possible model to describe how the system is redefined in search of a solution.

Game theory views negotiations as strategic exercises and is perhaps the only area that has attempted to address all aspects of a negotiation. It is, however, handicapped in its attempts to model the negotiation process because it deals with a scenario where the values or preferences are fixed and so outcomes are inherent in the very structure of the game. The process of change in the values is something that game theory does not capture.

2.2. Economics - Decision Making Under Uncertainty

Uncertainty in a negotiation process can arise from two sources: (1) uncertainiy about the outcomes/states of nature also called "risk", and (2) uncertainty about the opponent's preferences.

Analysis of decision-making under "risk" has been dominated by the expected utility theory. It is widely accepted as a near normative model of rational choice and a particularly good determinant of

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

economic behavior. [Arrow, 1971; Keeney and Raiffa, 1976; Savage, 1954]. The assessment of alternatives under the expected utility theory is based on: the expected utility of the outcomes/consequences of the alternative, "asset integration" which refers to whether or not the utility resulting from the choice increases the total "wealth" of the decision maker and, "risk aversion" or the preference for certain returns compared to uncertain ones. The utilities of outcomes are weighted in the ratio of their probabilities. If two outcomes have the same utility, then the one with greater probability was always preferred.

The expected utility model is basically a "constant utility" model; it assumes that each outcome has a time-invariant utility value [Luce, 1959]. In the "random utility" model, the utilities are described as random variables [Coombs, 1958] and this assumption is often used to explain the "intransitivity of alternatives" and changing utilities for outcomes. Coombs, et. al. (1970) have sought to explain the cognitive processes behind such a phenomenon. They conclude that different decision rules are used under different situations by the same decision maker and propose a contingency approach to choice theory, using cognitive factors, particularly information processing variables, to determine the "how much" and "how" of information storage and retrieval, how a decision problem is formulated and consequently, how it is solved.

Simon's (1947) theory of bounded rationality shows that human beings use "decision heuristics" in their decision making to reduce the information processing overhead. These decision heuristics are entirely subjective and as a result tend to be biased. Kahneman and Tversky (1979) have shown experimentally that expected utility theory is systematically violated. They identify a "certainty effect" -people prefer certainty, a "reflection effect" -people are risk averse in choices involving sure gains but risk seeking in choices involving sure losses (this phenomenon is often referred to as the problem of "framing"), and an "isolation effect" - people disregard components that alternatives share, and focus on components that distinguish them. The isolation effect explains how inconsistent preferences and intransitive preferences could happen. In their Prospect Theory, Kahneman and Tversky propose that people evaluate the desirability of an alternative not by the new total state that results from the choice but by the net gains or losses in choosing that alternative. This value function, is concave for gains and convex for losses with a steeper slope. Yet another decision heuristic that is often used is the "availability" of relevant information. This refers to the vividness with which the information is stored. Vivid information is more readily "available" and so tends to bias decision making [Nisbett and Ross, 1980]. Clear unambiguous feedback from the negotiation aids in the formulation of more such heuristics. There are many of these heuristics that contradict the expected utility maximization theory and its basic tenets.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

Notwithstanding the effects of cognitive limitations, decision and judgemental biases, expected utility theory is still the major normative theory of decision making. However, the use of the "utility maximizing" concept is tempered by combining it with the "satisficing" concept proposed first by March and Simon (1958) (see also [Raiffa, 1982] and [Tietz, 1983]). Another major theory that needs to be mentioned is the "equity" theory [Adams, 1965] which emphasizes people's desire to achieve fair outcomes as a result of its easier acceptability [Schelling, 1963], and the ability to maintain goodwill in recurrent relationships [Morgan and Sawyer, 1967]. This theory has since been extended by Walster, et. al (1973) to incorporate a "mixed-motive" flavor into it - to maximize own gain as well as divide outcomes equitably.

In summary, this approach has focused on the *decision-making* process in a negotiation. Its normative models form the backbone of most present-day scientific business decision-making. The disadvantages of such an approach are that though it is high in its determinancy, the sources of such determinancy are artificial constructs like indifference curves, pareto-optimality etc. Some of the concepts are in reality unoperationalizable or tend to have poor construct validity. Moreover, the rationality assumptions ignore as irrational many interesting aspects of negotiations like preference intransitivity, power, persuasion and coercion, etc.

2.3. Process Analysis - Joint Decision Making

Based on earlier economic theory, Siegel and Fouraker (1960) view the process of negotiation as a joint decision making problem involving a combination of concessions and convergence. Two negotiators start from distinct initial positions that represent the initial aspirations or the positions they want the opponent to believe they desire. They then inch incrementally toward each other by making concessions until they converge to a common point. Cross (1969) and Bartos (1974) view negotiation as a "learning process" in which the parties "react" to each other's concession behavior. But this theory assumes symmetry of information. "Findings of the concession/convergence approach are available to both parties. So there is no advice on how to bargain best that is not equally accessible to the other side". This obviously results in a stalemate. Another problem of this approach is that it has not overcome the problems of determinancy [Coddington, 1973; Tracy, 1975]. Concession rates cannot be calculated easily and change over time. This approach does not allow for considerations such as use of power, tactics and negotiation skills which might affect the concession rate at any point in time.

A remedy that has been suggested for this is that the negotiation could be considered a "teaching process" instead of a learning process, but this further reduces the already low determinancy of the

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

theory. A more fundamental question is whether it reflects the nature of real-world negotiations. Often the approach is applicable only when the variables under discussion are quantifiable and discretizable. Only then can distinct initial positions be identified and incremental concessions made. Since only the concession rates are considered to the exclusion of other variables, an incoherent mosaic of piece-by-piece concessions may emerge. Another very important aspect of negotiations ignored in this approach is that frequently the list of items under negotiation is in itself a matter of negotiation.

As an answer to the drawbacks of the concession/convergence approach, Zartman [1977] presents a formula/detail approach: negotiations proceed by finding the proper "formula" before implementing "detail". According to Zartman, "negotiators begin by groping around for a jointly agreeable formula that will serve as a referent, provide a notion of justice, and define a common perception on which implementation details can be based; power makes the values fit together in the package and timing is important to making the formula stick". His emphasis is on the process of negotiation as a process of "searching" - first for a single formula (similar to Shakun's (1981) goals/value referral process) and then for the implementation of this formula through the specification of details. He claims that while the concession/convergence approach is by nature "reactive" and passive, the formula/detail approach is associated with an "active search for a solution" and thus enhances the probability of creative solutions. It also leads to greater satisfaction than concession-making approaches since concessions tend to be viewed as losses. This approach allows for the inclusion of power as added value in the process of selecting and modifying values. The concession/convergence approach can be thought of as the process of negotiation of detail after a formula has been found. Unfortunately, this approach suffers from a total lack of determinancy.

In the "progressive construction" approach [Wall, 1975], the issues under discussion are decided upon only one issue at a time. This can be conceptualized as a group decision making situation on a complex topic that is spread out over time, like disarmament.

The analysis of negotiations as joint decision making processes focuses attention on a macro-level observation of the process and its dynamics - the "how" of negotiations. As is to be expected in such an analysis, the underlying mechanics of individual values, preferences and motivations - the "why" - is ignored. The advantage of such an approach is that it gives us a way to look at negotiations as a dynamic search process - incremental and goal oriented. Theoretically, this opens up the possibility of applying search techniques developed by areas such as artificial intelligence to analyze and possibly support a negotiation.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

2.4. Sociology

In a sociological scenario, negotiations are seen as involving dual, conflicting motivations: the individual's (competitive) desire to maximize his own utility and the collectivistic (cooperative) desire to reach a "fair" solution. Literature in anthropology emphasizes the significance of "reciprocity". Reciprocal exchanges create bonds of friendship that hold society together. Homans' (1961) rule of distributive justice says that men view as fair, rewards that are proportional to the receipent's contribution to society. This norm of fairness can be seen as a state of equilibrium. Any deviation generates forces that attempt to restore it - that is why it became a norm in the first place. In addition, society institutionalizes and imposes sanctions on deviants.

In agreeing to reach a "fair" solution through the equal distribution (not division) of the maximum pay-off that each side can rationally expect, this approach does not allow for strategic misrepresentations or "bluffing". It is in the interests of each negotiator to make his opening bid as close to giving zero pay-off to his opponent as possible. This way, each negotiator can through the initial tentative acceptance form an idea as to his opponents position and what he can rationally expect from the negotiation.

Once the initial tentative offers have been accepted very reluctantly, the size of the opening concession gains importance. This is invariably a function of some factors extraneous to the negotiation process itself - psychological or social. A rational bargainer in this approach will expect a reciprocation of his offer. The rule of thumb that can be used to judge whether a particular concession has been reciprocated equally is seen as the state such that the negotiators have no need to revise their original expectations about the ultimate agreement. This implies that the fairness in question is only "perceived fairness". Failure to match concessions is not seen as "unfair" if the negotiator perceives that his opponents preferences have changed. Response to unfairness comes either as withdrawal or in the form of behavior that maintains the negotiators expectation about the outcome. Unexpectedly large concessions lead to revision of opponents expectations and unexpectedly small ones bring sanctions or stop further opponent concessions. Negotiators must be skillful enough to spot fair concessions and discriminate unfair ones.

The notion of the desire to achieve fairness as being the driving force in a negotiation has some limitations. It is based on a decision heuristic that is very vague and ill-defined -- the concept of "fairness". By its very nature, such an approach lacks determinancy and is open to a multitude of interpretations. However, this approach reveals the importance of societal norms, group norms, and ethics as factors of interest in studying negotiations.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

2.5. Industrial Relations - Collective Bargaining

Labor negotiations can be described as "the deliberate interaction of two or more complex social units which are attempting to redefine the terms of their interdependence" [Walton and McKersie, 1975].

Three major propositions underly the explanation of conflict in this approach: (1) differences in goals, interests or values of the two parties [March and Simon, 1958; Axelrod, 1970, Pondy, 1969; Deutsch, 1971; Cormick, 1971], (2) interdependence among the parties [Walton and McKersie, 1965; Walton et al., 1969], and (3) perceived opportunity for interference [Mack and Snyder, 1957; Goldman, 1962; Pondy, 1967].

Perrow [1961] describes operative goals in an organization as being "those that are embedded in the major operating policies and daily decisions of the personnel". They could refer to both means and ends. In general, greater incompatibility in goals leads to greater conflict. Dispersion or distribution of power among the bargaining parties was also important in determining the extent of conflict [Cormick, 1971; Dubin, 1960; Darkenwald, 1971]. In general, the more evenly distributed the power, the greater the conflict. Control structure as one determinant of official power also influences the occurence of conflict. Ambiguity about jurisdiction, i.e., differences in perception of authority relationships also affects conflict formation [Walton et. al., 1969]. Deutsch (1973), in a socio-psychological approach to understanding negotiations, identifies six major sets of variables that affect negotiation behavior: characteristics of the conflicting parties, prior relationships between/among conflicting parties (the first time a concept of "history" has been introduced), nature of issue giving rise to conflict, social environment within which conflict occurs, strategies and tactics employed by the conflicting parties and, the consequences of conflict to each of the participants.

Kochan et al. (1975) suggest that the most effective strategy for resolving conflict lies in recognizing the underlying goals that the parties are seeking in the process and accepting the legitimacy of their efforts to pursue their goals.

The Industrial Relations approach recognizes the fact that conflict is dynamic as manifest in the constantly changing nature of the goals but does not attempt to understand the actual mechanisms of this process. It does not discuss the effects of individual differences in risk-taking propensity, motivation, perception etc., and their dynamics. It does however, provide an approach where the existence of power-dependency relationships is formally acknowledged as an important determinant of negotiation outcomes.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

2.6. Psychology

People, as participants in a negotiation, communicate positions, send signals by making demands and concessions, respond to signals from the opponent, and through a sequence of such exchanges arrive at a solution to the problem under negotiation. Negotiation, in this approach, can be defined as a process of value and behavior modification through exchange of communications.

Spector (1977), identifies four primary factors that affect the negotiation process from the "microlevel perspective" of negotiator psychology: (1) the individual personality needs of the negotiator; (2) the personality compatibility among negotiators; (3) negotiator perceptions of his opponents strengths, weaknesses, positions, values, preferences, alternatives and intentions and his expectations of the opponents strategies and actions; and (4) persuasive mechanisms actually employed to modify the bargaining positions and values of the opponent to achieve a more favorable (from his point of view) convergence of interests.

Several researchers have studied links between single psychological factors and negotiation behavior [Rubin and Brown, 1975; Spector, 1975; Druckman, 1973]. The results have been mixed. The failure to find intuitively obvious relationships has been explained as being the result of poor operationalization of the psychological constructs. However, a significant amount of research and case studies have shown that negotiator "personality" as manifested in predispositions towards the opponent and his motives for actions are important determinants of negotiation behavior [deFellice, 1976]. Similarly, perceptions of the opponents' strengths, weaknesses, intentions, commitments and goals affect the negotiator's response, the tone of interpersonal communication, and the learning process. Mutual power and influence relationships, employed effectively and credibly, provoke changes in negotiator values/perceptions and can lead to eventual concessions and convergence to an agreement [Zartman, 1974]. Finally, the interaction between the personalities of the two bargainers (soft against hard, etc.), and the interaction between the bargaining context and personality factors (certain characteristics are triggered by certain situations) decide the bargaining style of the negotiator, according to this approach.

Trying to understand the psychological aspects of negotiation gives a feel for its micro-level elements: the underlying factors and motivations that drive a negotiation. If we can look beyond manifested negotiation behavior to its origins and identify the *driving* factors distinctly, the negotiation's objective of *value change* is half achieved. The problems with the psychology approach are its obvious lack of determinancy and the almost too intricate and involved inter-relationships among the innumerable variables. Its strength is itself its weakness in some ways - it focuses on the negotiating parties, and their ability to modify the values of the issues at stake. It does not deal

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

extensively with the negotiation process itself. Moreover, as yet, there is no single unified theory which combines all the single-trait research into a meaningful overall psychological theory of negotiations.

3. A UNIFIED MODEL

We have seen how the negotiation process has been studied and explained by researchers in different fields. They vary in perspective and in focus, in the level of analysis, the level of detail, in their assumptions and in their objectives. In short, the approaches present different "windows" to understanding negotiations, even though a few of these approaches address a number of aspects of negotiation (e.g., game theory or the model by Deutsch (1973)).

In contrast, a negotiation support system needs a more wholistic approach that integrates the different perspectives into a uniform model that enables us to design a DSS to support the negotiation process. While this may not be feasible in the short run, the model to be constructed in this section should at least be sufficient to serve as the foundation of a negotiation support environment in which a decision maker can embed existing and forthcoming tools from any of the different areas. Inasmuch as these approaches seek to describe the same phenomenon, it appears possible and indeed desirable to integrate them, relaxing their assumptions and enhancing their descriptive power, in a joint framework that captures all major dimensions of the negotiation process.

3.1. The Model

As a starting point, we propose a two-person model of negotiations as shown in Figure 1. (Extension to other cases will be briefly discussed at the end of this section.) The model claims that for describing or prescribing a negotiation we need information about: the environment, negotiator needs and values, perceptions and expectations, available experience, the decision-making process(es) that are used, the manifested bargaining behavior and the evolving state-of-the-problem as the negotiation progresses. These components influence and change each other dynamically, as indicated by the arrows in the figure. Since at present many of these relationships lack empirical validation as to their direction and strength, the following discussion focuses mainly on the components. It is our claim that these components can be used as a backbone structure for a negotiation support environment. As there is no coherent theory of the interaction between the components, the decision maker must apply judgement and intuition when using the tools provided in the system.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

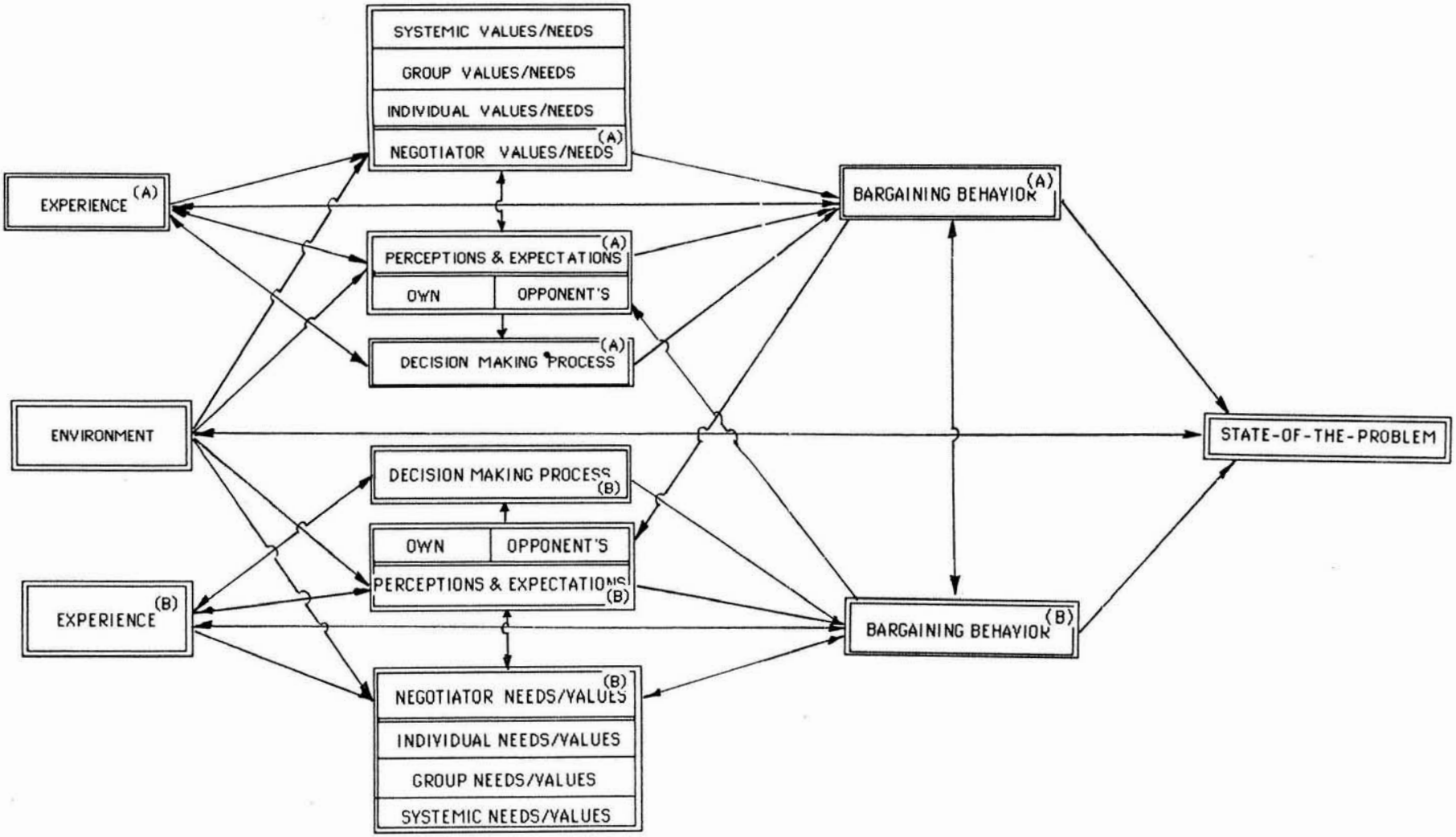

FIGURE 1. A UNIFIED MODEL FOR UNDERSTANDING NEGOTIATIONS

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

* **Environment**: This refers to the state of the world, i.e. the aggregation of technological, economic, political and social factors of the environment in which the negotiations is set.

* **Experience**: This refers to the accumulated and possibly aggregated store (in the negotiators memory- primary storage, or in the memory of those who are accessible to the negotiator for consultation- secondary storage) of information about former experiences- both general and specific. This can mean the history of former experiences, the inferences drawn from them (stereotypes), the patterns of strategies used under various environmental circumstances, their results, generalizations (decision heuristics), etc.

* **Negotiator Needs and Values**: These stem from three sources:

    1. The *systemic needs/values* refer to the specific manifestations of characteristic motivations and preferences imposed on the negotiator by the "system" in which he exists. For instance, the legal system enjoins in its members a need for fairness and a respect for authority- the law.

    2. The *group needs/values* refer to the needs and values that a negotiator inherits by virtue of his being a member of certain groups. These groups might be the actual constituents he is representing in the negotiation or they might be the subconscious affiliations of the negotiator. In the former case, the needs/values are consciously imposed upon the negotiator in the context of the negotiation. In the latter case, they act as subconscious referrents for the negotiator. Which of these actually surfaces or dominates is a function of the negotiation context at any particular point in time. For example, a union representative has a conscious affiliation and allegiance to the needs/values of the labor he represents, but also show subconscious affiliation to groups like sex, countrymen etc., and demonstrates needs/values that are representative of them.

    3. The *individual personality* refers to the individuals own needs, motivations, and preferences, such as need for social approval, need for cooperation and friendship, need for achievement, needs for play, seduction, exhibitionism and so on as well as his preferences among these needs and the values he attaches to them.

    Which of these three catagories of needs/values dominates or which combination manifests itself is also influenced by the environment (both physical and psychological), and by the negotiation and previous experience. Note that both of these change over time as the negotiation progresses.

* **Perceptions and Expectations**: This represents the negotiators "problem representation". It constitutes the "psychological" aspect of the environment for each individual negotiator where he visualizes positions or "states-of-the-world", the objectives/goals, the issues under consideration, the alternatives available, attitudes towards those alternatives, constraints towards making choices among alternatives, commitments, intended actions, and the possible strategy to be used. He does this evaluation for himself and also makes a subjective estimate for his opponents. The problem representation undergoes constant modification and change. It can be modified by changes in the physical environment, changes in the state-of-the-problem as the negotiation progresses, changes in needs and values occasioned due to various factors, changes in experience through the availability of new information on past precedents, and very importantly, feedback from the actions or bargaining behavior of the opponents. The

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

perceptions and expectations of one's own position are influenced by and in turn influence those of the opponent's position.

* **Decision-Making Process**: This represents the inferencing part of the model where alternative actions are evaluated by the use of decision models or judgemental and decision heuristics/biases. Examples of these would be the estimation of expected utility, aspiration levels, axioms of equity and fairness, mixed-motive optimizations etc. The outcome of this process is a set of choices among the alternative actions for a given state of the physical environment, a given set of experience histories of decision processes and inferences, and a given subjective evaluation by the negotiator of his own and his opponent's problem representation as moderated by his needs and values at that point in time. It is a dynamic process that changes nature continuously as a function of these other components of the negotiation process.

* **Bargaining Behavior**: This represents the actual bargaining behavior of the negotiator; it includes the making of demands, offers, concessions, threats, promises, strategic posturing through suppression, distortion or misrepresentation of information, deception and bluffing, the use of power and influence strategies etc. This process is influenced by the manifest needs and values of the negotiator, his perceptions of his and the opponents problem representation, the outcome of the decision making process and, very importantly, the pattern of bargaining behavior of the opponent. At any point in time, the actual bargaining behavior is a complex function of these variables and any one of them may be overridden by the other, particularly the lower order variables (that do not show a hierarchical influence relationship over this process in Figure 1).

* **Outcome - State-of-the-problem**: This represents the offers and concessions of the bargaining entities and shows the state of the problem resolution effort at any point in time. When agreement has been reached between the offers of the bargaining entities, it represents the culmination of the negotiation process. In the stages prior to agreement, it serves as a referrent state for the revision of expectations and perceptions by each bargainer, and as a vehicle of change for the environment at each stage of the negotiation process.

Figure 2 gives two illustrations of the model. The first example uses the model to describe negotiations among management and labor in a manufacturing firm that is trying to cut personnel costs due to severe financial problems. The second example describes negotiations among the marketing and engineering departments of a car manufacturer working with different goals on the design of a new car for the 1990's. This example is based on a real application studied in the MEDIATOR project but, as the first one, is highly simplified for purposes of exposition.

Our model has sought to integrate the complexities of the negotiation process into a simple framework of interacting components in what we hope, is an intuitively sound manner. The model derives its strength from two factors: first, its ability to accomodate a global perspective of the negotiation process without sacrificing the insight that a narrower focus on one or a few of the components can provide. and second, its emphasis on the dynamic nature of such a process. The

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

	Example 1. The Union-Management negotiation		Example 2. Interdepartmental Negotiation	
	Union Representative	Management Rep.	Engineering Department	Marketing Department
Environment	* General recession - rising unemployment/costs	* Severe financial loss	* advances in fuel-efficient engines. * projected shortage in steel supply 5 years from now.	* Competitors have announced the "car of the century" * projected growth in the market for luxury sedans
Experience	* Past experience of union/management in negotiating with each other. * Settlements reached by other unions in same circs	* Strategies used by other companies	* Exp. with mktg. in last proj. - they want the impossible!! * That Mktg.Mgr cares only about his image.	* Engg -"they are unimaginative and lazy" * Last time had to invoke the director's authority..
Negotiator needs and values	* Minimize retrenchment & losses to constituents * Constituents must recogn -ize my efforts - must keep face.	* Cut costs to an acc. level and save company * Use the oppurtunity to reinforce position of strength.	* Must keep down: workload on body shop, minimize retooling, and redeployment/retraining. * Must show that Mktg.Mgr that he cannot shove me around.	* Must beat competitors product * Inc. market share by ~30% * I have got to look good - I must make it to the VP's post
Perceptions and Expectations	* Possible alternatives- take pay cut,agree to phased lay-off, or bargain for min retrenchment. Mgmt will be tough but reasonable. Will reciprocate. Must ensure min retrenchment.	* There may be other choices. The union will come up with something Will accept anything reasonable.	* Design should have very good fuel economy. Other things are not too important. Marketing will propose total change - too costly.	* Design should have lots of new/extra features. Styling must be improved. Engg. will possibly resist any change on grounds of cost. * We must show that we can earn more thro' better pricing.
Decision-making process	* Maximizing approach -must minimize losses to constit -uents, yet be "fair".	* A target reduction in costs. Will accept any proposal that satisfies	* Minimize tooling expenses, R&D investment reqd., and steel consumption.	* Maximize saleable features May accept compromise on some
Bargaining behavior	* Begins stridently opposing -concede mild pay cut,limit -ed lay-off, and so on.	* Proposes drastic retr -enchment, marginal conc -essions. Threatens shut-down when union "unreaso -nable". New proposals..	* Start - propose just a new engine - make alt. proposals/ concessions - at times refuses to take responsibility for the project.	* Start with "dream car" - often complain that Engg is unreason -able - threaten to again go to the director - make concessions
Outcome "state-of-the-problem"	* Position of union/mgmt totally at odds. Concessions bring them closer. New proposals change focus. Finally reach agreement.		* Start with seeming total disagreement. Concessions/new proposals bring them closer to an agreement. Changes in environment force constant revisions till the product is finally on the road..	

FIGURE 2. TWO REAL-LIFE EXAMPLES IN TERMS OF OUR MODEL

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

major drawback to this model is that we do not yet have empirical evidence to support the choice of components and interactions directly. However, some validity is given to the model by studying its relationship to the reference displines -- see the following subsection. Inasmuch as our goal is not to develop new negotiation techniques, but to support existing and forthcoming ones by computer/communication technology, this degree of validity may be sufficient. In order to provide realistic negotiation support, the two-person model is easily adapted to other typical decision settings:

* Full cooperation: There is no necessity for individual perception and expectation components because a joint problem representation can be used instead. The bargaining behavior is limited to an exchange of offers; no strategic bargaining occurs.

* More than two parties: Each player's individual negotiation support system provides the same components as in the two-person case. The only extensions needed are in the perceptions and expectations component where each individual has a seperate representation for his perceptions and expectations of each of the other parties as well as his own. While in principle this may lead to complex information structures, these are simplified as it is often assumed that n-person bargaining situations can be considered as a two-party situations because of coalition formation.

* Third party intervention in the form of a mediator or arbitrator: The mediator/arbitrator can be considered a third player in the game but with no personal interest or motivation except to help both parties reach an agreement.

3.2. Relationship to the other Models

In an attempt to justify the proposed model, this subsection interprets the approaches described in section 2 as special cases of the unified model which emphasize the study of particular components and make simplifying assumptions about the others.

* **Game Theory**: This subset of the model focuses on some aspects of the Bargaining Behavior and some aspects of the Perceptions and Expectations component (particularly in games with unknown opponent utility functions). It assumes away the Decision-Making Process as being rational utility maximizing and assumes that the needs/values of the negotiator do not change. There is little consideration of the effect of former experience (through stereotypes) or the dynamics of the environment (except time costs). Dynamic game theory does consider the feedback from the changing state-of-the-problem.

* **Decision Making Under Uncertainty**: Here, the main focus is on Decision-Making Process, and Perceptions and Expectations. The effect of a dynamic Environment in altering the perceptions and expectations as well as the appropriateness of the decision-making process or decision heuristic are also considered. Certain standard Needs/Values (risk aversion, fairness or equity, mixed-motives) are included while others are ignored. The main subject of this kind of model is the interplay between perception as affected by cognitive limitations, bounded rationality etc., and decision heuristics/biases.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

* **Joint Decision Making**: This approach concentrates on the components of State-of-the-problem and the interaction between Bargaining Behaviors. It takes cognizance of the important changes in Perception that occur during the course of bargaining, as well as the effect of cognitive limitations but other Perceptions as being constant. The Decision-Making Process,, for instance, is perceived as useful only to determine the intial position from which bargaining may commence. The theories look at negotiations as a process of search through the problems space to find a solution.

* **Sociological Approach**: This theory assumes that the Decision-Making Process is one of own utility maximization subject to a need for fairness. The Perception of fairness/unfairness of the opponents' bargaining behavior shows concern for the feedback process that changes Perceptions and Expectations and so determines Bargaining Behavior. Little consideration is given to effects of Experience or the Environment (except social norms which can be thought of as group needs/values).

* **Industrial Relations**: Here the focus is almost exclusively on the Perceptions and Expectations component as the main driving force behind conflict. Group needs/values are thought to dominate the negotiator values and shape Expectations and Perceptions of the Environment - the interdependence and the chance of interference as well as beliefs about power distribution, control etc. The dynamic nature of Perceptions and Expectations is viewed as a function of feedback from the state-of-the-problem, bargaining behavior of opponent and changes in the environment and consequent changes in group needs/values. The role of the individual needs/values of the bargainer and of the decision-making process are largely ignored.

* **Psychology**: This approach analyses the interplay between the different subcomponents of the negotiator's needs/values and their effect on the Bargaining Behavior. To a limited extent, psychology also studies the Perceptions and Expectations component as it can be affected by Bargaining Behavior. It does consider the effect of the Environment in triggering certain needs and fixing certain values.

We have attempted to show how the different approaches can be visualized as subsets of our model. In doing this we have concentrated on the main thrust of assumptions and research approach in each field. Some of the more intricate and involved pieces of research in some fields had to be omitted, but can be fitted into the model as well.

4. DESIGN OF AN INDIVIDUAL NEGOTIATION SUPPORT ENVIRONMENT

Our primary objective in studying the different approaches to understanding negotiations and developing a unified model was to develop a framework that would be capable of facilitating the assessment of negotiation situations from the viewpoint of individual decision makers in a multiperson decision support system setting. Before doing so, we summarize the global multiperson DSS architecture (MEDIATOR) in which the individual negotiation support environment is to be embedded.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

4.1. MEDIATOR Overview

Based on experience with a GDSS for cooperative multiple criteria group decision making called Co-oP [Bui and Jarke 1984; Bui, 1985], the MEDIATOR project at New York University attempts to develop a comprehensive multiperson decision support system which also addresses issues of non-cooperation. Work on MEDIATOR thus far has focused on aspects of decision maker interaction and system structure rather than individual negotiation support [Jarke et al., 1986], and on case studies in interdepartmental negotiation support [Giordano et al., 1985].

From a *system perspective*, MEDIATOR can be understood as a specialized multiuser micro-mainframe database management system as depicted in Figure 3. Decision makers or players employ private data and tools on individual workstations -- and data from shared corporate or external databases -- to come up with an individual problem representation they are willing to share with a human group leader or mediator (though possibly not with other negotiating parties). A section of the global database contains a group joint problem representation synthesized by the mediator from individual problem representations using specialized private data and tools. The group joint problem representation is visible to all members of the group but not outside the group. Database transaction concepts similar to those used in CAD/CAM databases are being developed to enforce these rules.

The use of database concepts carries over partially to the *problem representation perspective*. Relational decision matrix structures generated by interactive multiple criteria decision methods [Jacquet-Lagreze and Shakun, 1984] are employed for the individual and group joint problem representations. Extended view definition facilities coupling model bases and databases are used for the creation of individual problem representations, and view integration techniques from database design are employed for synthesizing group joint problem representations [Jarke et al., 1986].

Finally, there is a *process perspective*. Expanding on an idea by Shakun (1981), negotiation is viewed as a process of cooperative evolutionary system design where the "system" is the group joint problem representation and the design goal is to reach a representation in which at least one decision alternative is acceptable to all players. In contrast to traditional system design, the problem is represented as a time-varying mapping from control space (the decision alternatives) to criteria space (the criteria used by any of the decision makers) to utility space (the preference structure of each decision maker). After the initial view generation and integration steps which are intended to achieve an initial common terminology and background knowledge, the main tools for evolving the group joint problem representation are those for *consensus-seeking* through problem redefinition in any of the three spaces (e.g. expansion of the set of alternatives or criteria considered), and for *compromise* through concession-making or application of axiomatic game-theoretic solution methods.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

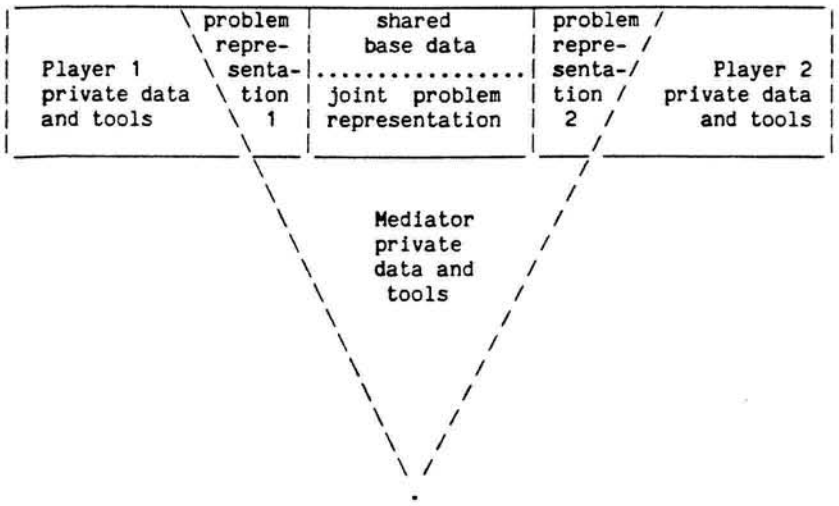

FIGURE 3: MEDIATOR Design -- Communication through Data Sharing

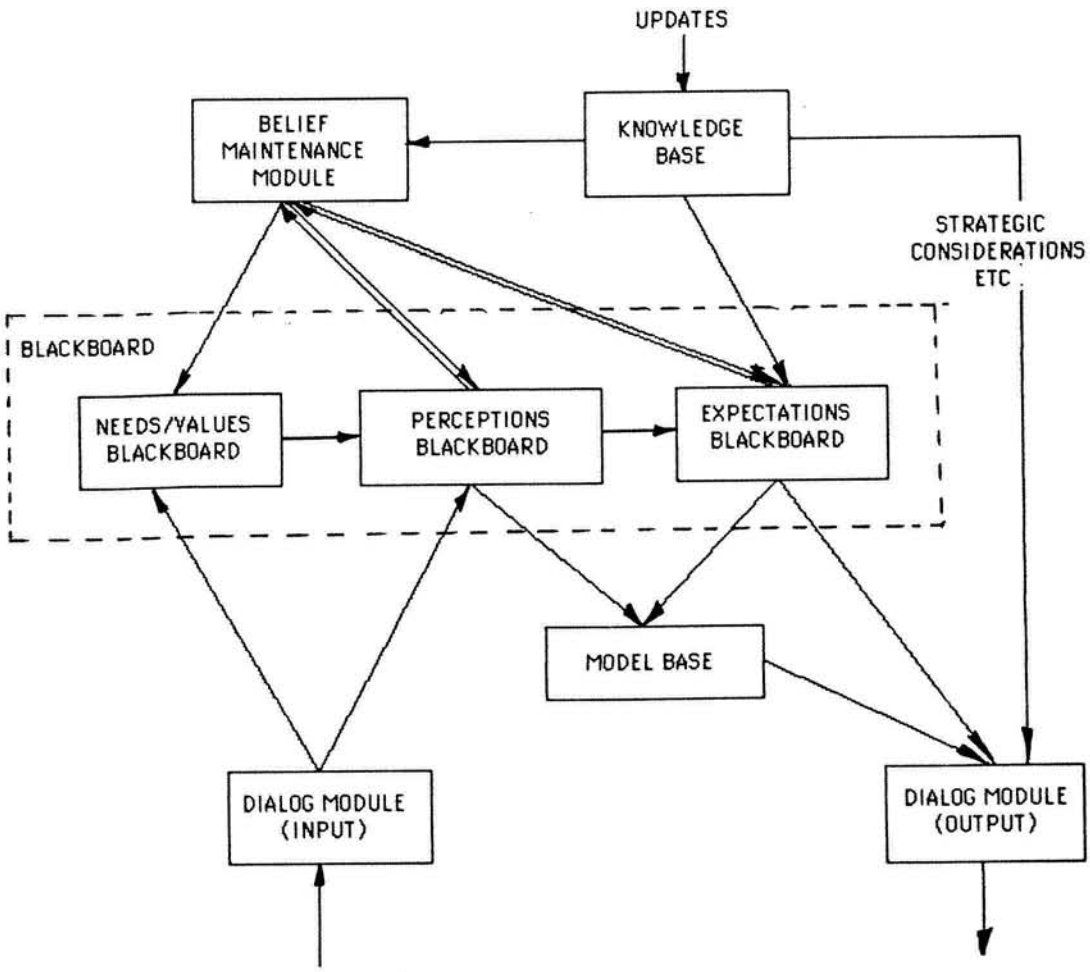

FIGURE 4. ARCHITECTURE FOR AN INDIVIDUAL NEGOTIATION SUPPORT SYSTEM

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

4.2. Individual Negotiation Support Environment

In the context of MEDIATOR, the individual negotiation support environment comprises a major part of the "private data and tools" offered to each player in his or her local workstation. It should enable a negotiator to consciously analyze his own and his opponents' behavior, and to articulate and examine the underlying motivations, assumptions, attitudes and strategies (cf. also [Henderson, 1986]). Such an analysis, though perhaps infeasible in the midst of a heated negotiation, would serve a very useful purpose as a preparatory exercise before a negotiation, as a tool for analysis during protracted negotiations, for post-negotiation review, and possibly for training and refining negotiation techniques.

However, the internal mechanics of the components of the unified model and their interactions are too complex, dynamic and numerous for a human to keep track of. To overcome this limitation, knowledge-based systems could be envisioned as "cognitive aids" to the process. That, in a nutshell, is what the individual negotiation support system attempts to be. The cognitive process in the context of a negotiation can be structured in terms of the unified model, and instantiated with insights and specific methods that the different approaches supply. The structure of a system built around the unified model is proposed in Figure 4. The main components of this system, as well as their relationship to each other and to the unified model can be described as follows.

* The **knowledge base** manages relatively stable information in three areas. *Psychological models* take the form of psychological profiles and rules about the possible characteristic needs/values, attitudes, patterns of possible behavior, etc. *History of experiences with specific opponents* contains a selective record of previous behavior toward and by opponents and all that is known about them. The *general experience bank* accumulates knowledge of possible negotiation scenarios, typical strategies in such scenarios etc.

* The **model base** manages a variety of decision-making models and heuristics that might be used by decision makers based upon personal predisposition, perceptions and expectations, or perceived state-of-the-problem (see [Bui, 1985] for a description of a "content-oriented model bank" in GDSS which contains a subset of the models needed for this component).

* In contrast to the knowledge base which provides general and relatively temporally stable memory aids, the **blackboard** captures information about the evolving state of a particular negotiation problem. The *needs/values blackboard* contains the verbalized own needs/values and perceived needs/values of the opponent as moderated by the knowledge base. The *perceptions blackboard* stores the verbalized perceptions of own and opponent's "problem representation" -- the goals/objectives, issues under discussion, alternatives available, preferences, constraints, commitments, etc. as moderated by the perceived needs and the knowledge present in the knowlege base about the opponent and that relevant to his perceived psychological profile. Finally, the *expectations blackboard* contains the expectations about the opponent's possible actions and intentions as moderated by the perceptions blackboard content and the information available in the knowledge base about

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

the opponent's past behavior and that of others in similar situations. Each of these subcomponent blackboards consists of two (and more if there are more than one opponent) parts that have to communicate and cross-check each other for internal consistency. They are all constantly under revision by the users perceptions of the bargaining behavior of the opponent and by changes in the environment in addition to the moderation mentioned above. This concept is similar to actor formalisms as proposed by Hewitt (1976).

* The **belief maintenance module** is responsible for the maintenance of internal consistency in the decision maker's belief system (cf. [Doyle, 1979]). It keeps track of the changing perceptions (which can be thought of as assumptions), state-of-the-world, environmental factors and available knowledge (psychological models, past experiences with opponent, general experiences). In accordance with these, it revises the perceived needs/values, the perceptions of own and opponent's problem representation, and the expectations.

* Finally, the **dialog module** of the individual DSS has to be enhanced to guide the user throughout the negotiation process. This involves eliciting information concerning his perceptions of opponents' and own needs, problem repesentations and expectations. It also includes blackboard manipulation, wholistic problem understanding, and attention focusing. The dialog module lets the user access data and model management facilities [Elam et al., 1980] to select decision-making models, to generate possible actions, and to present reports of expectations, choice of action, and summaries of historical records of strategies used in similar situations.

Space restrictions prevent a deeper discussion of this architecture and many details are yet to be worked out. Nevertheless, it seems a feasible though ambitious approach which implements the unified model and relies on components operational in existing AI systems. Moreover, a comparison of Figures 1 and 3 demonstrates a good fit between the global MEDIATOR architecture and its subjective mirror image in each individual negotiation support environment. This correspondence was further highlighted in a recent experiment by Defour and Shakun (unpublished) that employed MEDIATOR for simulating a real hostage negotiation case, in order to study the usefulness of the multiperson model for individual negotiation support (in this case: support for the negotiator who attempts to get the hostages released).

A number of negotiation support tools reported in the literature could be embedded into such an environment. Many of these tools come from the domains of game theory and multiple criteria decision making, possibly combined with considerations of uncertainty (e.g., [Bui, 1985; Kersten, 1985; Shakun, 1985]). A commercially available system [Nierenberg, 1984] claims to assist in the training of negotiators by helping them articulate and therefore clearly understand their perceptions of the problem from their own and their opponent's viewpoints. While this is just a surfacing tool with no prescriptive suppport, another commercial package (Negotiation Edge by Human Edge, Inc.) asks its user a structured set of questions from which advice on a negotiation strategy is inferred.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

Unfortunately, no support is given for adapting this strategy to the course of the negotiation process, and the large number of questions to be answered prevents frequent repetition of system usage during the negotiation. Undoubtedly, more tools will appear in the future.

5. CONCLUSION

The discussion in this paper should have demonstrated one negative and one positive result. On the one hand, the multitude of representations proposed by the different areas appears to make it presently impossible to come up with a comprehensive *group* negotiation support system that "objectively" covers all aspects of a negotiation situation in a fashion acceptable to all group members. Machine communication among group members will therefore have to be limited to relatively simple, mutually understandable representations.

On the other hand, the unified model proposed in this paper should make it possible for *individual* decision makers to articulate and enhance their personal understanding of the negotiation position, by structuring their thinking in a much richer framework, using tools from the various areas. Coherence among these tools is then provided partially by the unified model which describes the interactions among different descriptive and prescriptive techniques in terms of the model components and relationships concerned, and partially by the decision maker himself, using the blackboard and knowledge base components of the proposed system as cognitive aids.

This argument carries over to a human mediator or group leader, perceived as a particular case of an individual decision maker. It leads us to believe that the MEDIATOR architecture -- which does include such a human mediator -- should be able to provide more powerful group decision support than a fully automatic GDSS approach, especially when geographical dispersion limits direct communication among decision makers outside the system.

Besides raising a host of interesting design and evaluation questions, the proposed individual negotiation support environment and its integration into the MEDIATOR framework leads to another important observation. Since the individual model (even the part of it that is represented in the system) is so much richer than the "group joint problem representation", the "individual problem representation" component in MEDIATOR (Figure 3) --whose role is to compress the "private problem representation"-- will almost unavoidably lead to loss and distortion of information, even in a cooperative setting. Research in the treatment of incomplete or distorted information will therefore play a crucial role for the success of multiperson DSS.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

REFERENCES

Axelrod, R., 1970. *Conflict of interests*, Markham, Chicago, IL.

Bartos, O.J., 1974. *Process and outcome of negotiations*, Columbia University Press, NY.

Bishop, R.I., 1964. A Zeuthen-Hicks theory of bargaining, *Econometrica*, 32, pp.410-417

Bui, X.T., 1985. Co-oP: a DSS for Cooperative Multiple Criteria Group Decision Making, Ph.D Dissertation, Computer Applications and Information Systems, New York University, New York, NY

Bui, X.T. and Jarke, M., 1984. A DSS for cooperative multiple criteria group decision making, *Proceedings 5th International Conference on Information Systems*, Tucson, AZ, pp.101-113.

Coombs, C.H., Davis, R.M. and Tversky, A., 1970. *Mathematical Psychology*, Prentice-Hall, Englewood Cliffs, NJ.

Cormick, G.W., 1971. Power, Strategy, and the Process of Community Conflict: A Theoretical Framework, Ph.D. dissertation, University of Michigan, Ann Arbor, MI.

Crawford, V.P., 1985. Dynamic games and dynamic contract theory, *Journal of Conflict Resolution* 29(2), pp.195-224.

Cross, J.G., 1969. *The Economics of Bargaining*, Basic Books, New York, NY.

Darkenwald, G.G., 1971. Organizational conflict in colleges and universities, *Administrative Science Quarterly* 16, pp.407-412.

DeSanctis, G. and Gallupe, B., 1985. Group decision support systems: a new frontier, *Data Base* 16:1, pp 3-10.

Deutsch, M., 1973. *The Resolution of Conflict*, Yale University Press, New Haven, CT.

--------, Toward an understanding of conflict, *International Journal of Group Tensions* 1, pp.42-54.

Doyle, J., 1979. A Truth Maintenance System, A.I. Memo 521, Artificial Intelligence Laboratory, Massachussets Institute of Technology, Boston, MA.

Dubin, R., 1960. A theory of power and conflict in union-management relations, *Industrial and Labor Relations Review* 13, pp.501-518.

Elam, J.J., Henderson, J.C., and Miller, L.W., 1980. Model management systems: an approach to decision support in complex organizations, *Proceedings First International Conference on Information Systems*.

Giordano, J.L., Jacquet-Lagreze, E., and Shakun, M.F., 1985. Un SIAD pour la conception de produits nouveaux, aspects multicriteres et multi-acteurs, Note de Recherche, Universite de Paris-Dauphine, Paris.

Goldman, R.M., 1962. Conflict, cooperation and choice: an exploration of conceptual relationships, in N.F. Washburne (ed.), *Decision Values and Groups*, Macmillan, New York, NY, pp. 410-439.

Goncalves, A.S. 1985. Group decision methodology and group decision support systems. *DSS-85 Transactions*, San Francisco, CA, pp. 135-142.

Gray, P., 1981. The SMU Decision Room Project, *Transactions of the First International Conference on Decision Support Systems*, Atlanta, GA, pp. 122-129.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

Harsanyi, J.C., 1956. Approaches to the bargaining problem before and after the theory of games: A critical discussion of Zeuthen's, Hick's, and Nash's theories, *Econometrica* 24, pp.144-157.

--------, 1962. Bargaining in ignorance of the opponent's utility function, *Journal of Conflict Resolution* 6(1), pp.29-38.

--------, 1967-68. Games with incomplete information played by Bayesian players, *Management Science* 14, pp.159-182, pp.320-334, pp.486-502.

--------, 1976. Time, information and incentives in noncooperative games, Working paper CP-381, Center for Research in Management Science, University of California, Berkley, CA.

-------- and Selten, R., 1972. A generalized Nash solution for two person bargaining games with incomplete information, *Management Science* 18(5), pp.80-106.

Henderson, J.C., 1986. A methodology for identifying strategic oppurtunities for DSS, in Jarke, M. (ed.), *Managers, Micros, and Mainframes: Integrating Systems for End Users*, John Wiley and Sons, Chichester, UK.

Hewitt, C., 1976. Viewing control structures as patterns of passing messages, *Artificial Intelligence* 8, pp. 323-364.

Huber, G.P., 1982. Group decision support systems as aids in the use of structured group techniques, *DSS-82 Transactions.*

Huber, G.P. and McDaniel, R.R., 1986. Using information technology to design more effective organizations, in Jarke, M. (ed.), *Managers, Micros, and Mainframes: Integrating Systems for End Users*, John Wiley and Sons, Chichester, UK.

Jacquet-Lagreze, E., and Shakun, M.F., 1984. Decision support systems for semi-structured buying decisions, *European Journal of Operations Research* 16, 1, pp. 48-58.

Jarke, M., 1986. Knowledge sharing and negotiation support in multiperson decision support systems, *Decision Support Systems* 2(1).

------, Jelassi, M.T. and Shakun, M.F., 1986. MEDIATOR: towards a negotiation support system, *European Journal of Operations Research*, to appear.

Kahneman, D. and Tversky, A., 1979. Prospect theory: an analysis of decisions under risk, *Econometrica* 47, pp.263-291.

Keeney, R.L. and Raiffa, H., 1976. *Decisions with Multiple Objectives: Preferences and Value Tradeoffs*, John Wiley & Sons, New York, NY.

Kersten, G.E., 1985. NEGO - a group decision support system, *Information & Management* 8, pp.237-246.

Kochan, T.A., Huber, G.P. and Cummings, L.L., 1975. Determinants of intra-organizational conflict in collective bargaining in the public sector, *Administrative Science Quarterly* 20(1), pp.10-23.

March, J.G. and Simon, H.A., 1958. *Organizations*,John Wiley and Sons, New York, NY.

Nash, J., 1950. The bargaining problem, *Econometrica* 18(1), pp.155-162.

-------, 1953. Two person cooperative games, *Econometrica* 21, pp.128-140.

Nierenberg, R., 1984. The Art of Negotiating computer program, Negotiation Institute, New York, NY, 1984. Product review, *The Arbitration Journal* 40(3), p.70.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30

Nisbett, R. and Ross, L., 1980. *Human Inference: Strategies and shortcomings of Social Judgement*, Prentice-Hall, Englewood Cliffs, NJ.

Perrow, C., 1961. Goals in complex organizations, *American Sociological Review* 32, pp.854-865.

Pondy, L.R., 1967. Organizational conflict: concepts and models, *Administrative Science Quarterly* 12, pp.296-320.

------, 1969. Varieties of organizational conflict, *Administrative Science Quarterly* 14, pp.499-505.

Raiffa, H., 1982. *The Art and Science of Negotiation*, Harvard University Press, Cambridge, MA.

Rao, A.G. and Shakun, M.F., 1974. A normative model for negotiations, *Management Science* 20(10), pp.1364-1375.

Rubin, J.Z. and Brown, B., 1975. *The Social Psychology of Bargaining and Negotiation*, Academic Press, New York, NY.

Savage, L.J., 1954. *The Foundations of Statistics*, John Wiley and Sons, New York, NY.

Schelling, T.C., 1963. *The Strategy of Conflict*, Oxford University Press.

Selten, R. , 1975. Bargaining under incomplete information: a numerical example, in O. Becker and R. Richter (eds.), *Dynamische Wirtschaftsanalyse*, J.C.B. Mohr, Tubingen, Germany.

Shakun, M.F., 1981. Formalizing conflict resolution in policy making, *International Journal of General Systems* 7(3), pp.207-215.

-------, 1985. Decision support systems for negotiations, *Proceedings of the* 1985 *IEEE International Conference on Systems, Man and Cybernetics*, Tucson, AZ.

Siegel, S. and Fouraker, L.E., 1960. *Bargaining and Group Decision Making*, McGraw-Hill, New York, NY.

Simon, H.A., 1947. *Administrative Behavior*, Macmillan, New York, NY.

Spector, Bertram I., 1977. Negotiation as a psychological process, in I.W. Zartman (ed.) *The Negotiation process* Sage Publications, Beverly Hills, CA.

Tietz, R. (ed.)., 1983. *Aspiration Levels in Bargaining and Economic Decision Making*, Springer-Verlag, Berlin.

Tsichritzis, D. (ed.), 1985. *Office Automation*, Springer-Verlag, New York, NY.

Turoff, M. and Hiltz, S.R., 1982. Computer support for group versus individual decisions, *IEEE Transactions on Communications COM-30*, 1, pp. 82-90.

Walton, R.E. and McKersie, R.B., 1965. *A Behavioral Theory of Labor Negotiations*, McGraw-Hill, New York, NY.

-------, Dutton, J.M. and Cafferty, T.C., 1969. Organzational context and interdepartmental conflict, *Administrative Science Quarterly* 14, pp.522-542.

Zartman, I.W., 1977. *The Negotiation Process*, Sage Publications, Beverly Hills, CA.

Zeuthen, F., 1930. *Problems of Monopoly and Economic Warfare*, George Routledge and Sons, London.

Center for Digital Economy Research
Stern School of Business
Working Paper IS-86-30