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THE ELEMENTS OF NEGOTIATION MANAGEMENT

J. D. Nyhart & Dhanesh K. Samarasan*

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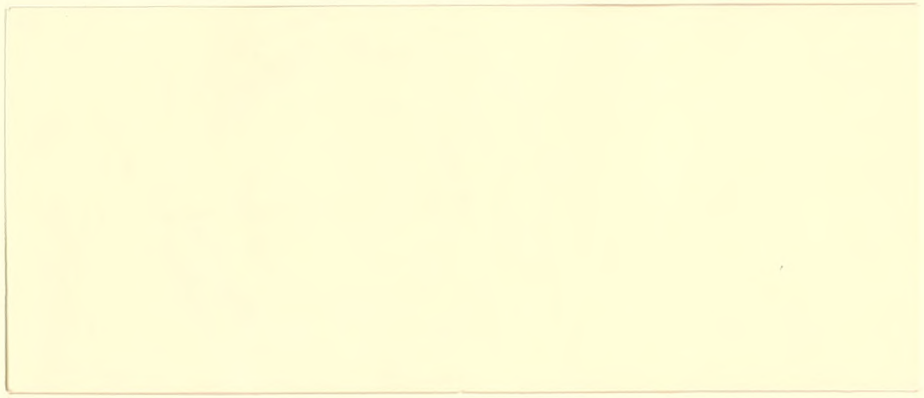
MASSACHUSETTS
INSTITUTE OF TECHNOLOGY
50 MEMORIAL DRIVE
CAMBRIDGE, MASSACHUSETTS 02139



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J. D. Nyhart & Dhanesh K. Samarasan*

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*The authors are, respectively, Professor of Management and Ocean Engineering, Sloan School of Management and Department of Ocean Engineering, and doctoral candidate, Department of Ocean Engineering, MIT. The work described in this paper is part of a multi-disciplinary effort underway at the MIT Project on Modeling for Negotiation Management.

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CONTENTS

I. THE OPPORTUNITY AND THE NEED

Negotiating, or treating with others in order to reach an agreement, is ubiquitous. Everyone negotiates. Bankers engage in arbitrage over percentage points. Engineers reluctantly make design trade-offs with clients. Attorneys plea-bargain to speed up a trial. And managers negotiate daily, both inside and outside the firm. The verb "to negotiate" comes from the Latin *negotiari*, meaning "to transact business," underlining the universal character of the process. Governments, public officials, special interest groups, private individuals, and just about anyone with any business to transact, all negotiate regularly.

As the idea of negotiation gains widened favor as a means of managing differences and resolving disputes [see, for example: Lindblom, 1965; Kochan & Verma, 1983; Reich, 1987], a new generation of ideas, skills and tools is needed. This paper describes work being undertaken at the MIT Project on Modeling for Negotiation Management to develop these ideas, skills, and tools, and to put the power of the computer directly in the hands of negotiators and their third-party facilitators.

There are many contemporary problems where the concept of *negotiation management* as elaborated here can play a major role. Some involve the implementation of large engineering systems, and are characterized by technical complexity, a diffusion of decision-making authority, and the recognized need for a quick settlement. Others involve major public issues, share many of the same characteristics, and are often heated by policy considerations. Still others require the efficient and uniform handling of large numbers of similar conflicts or the effective use of the negotiating experiences of others. Unfortunately, not a great deal of work has been done to alleviate the difficulty of dealing with negotiation in a rapidly changing and technologically oriented world.

In many negotiations, the interactions between parties are complex. Even a meager understanding of the issues is contingent on acquiring a depth of arcane and technical knowledge that is beyond the reach of all but the specialist. When decisions have to be made in these cases, parties nominate

and depend on technical experts who require a wide variety of information on which to base their calculations. Often, such information is hard to define, and harder to collect. A greater part of the decision-making must then deal with the management of risk and uncertainty. And even in the best of circumstances, when all parties to the negotiation have sufficient data and confidence in that data to come to an agreement, Nature does not always cooperate or conform to expectations: agreements that are politically feasible often fail for technical reasons. With the large problems that are today faced almost routinely, the consequences of a negotiation that fails in this way can be disastrous. When irreparable and widespread damage occurs or threatens to occur, as when an arms control agreement is undermined by new technology, or when the construction of a nuclear plant has to be delayed because emergency evacuation plans are unacceptable, further negotiation is generated.

Another difficulty arises when a conflict is prolonged, with no particular end in sight. Traditionally, violence or the threat of violence has caused the more threatened side to feel a desperate longing for an end to the conflict. But nowadays, even in purely commercial disputes no protagonist has the time or the resources for an extended stint in the trenches. With change already endemic and ever accelerating, settlements that can be reached quickly have more value to the parties. And often, the prompt resumption of stable, if not friendly, relations is also important to all sides. Unfortunately, the courts, the traditional means of resolution in such cases, are jam-packed with litigants, and the queues are lengthening as more are granted access. The high cost of litigation, and the sometimes higher cost of waiting around for litigation, have given a shot in the arm to the alternate dispute resolution movement. Still, there remains a deep concern that due process be maintained when a dispute is taken out of court to be settled. Such concern underscores the need for a consistent and principled framework for the ordering of negotiations.

The problems are only exacerbated when there is no acknowledged authority to whom the conflicting parties defer. The co-existence of multiple 'final' decision-makers tends to slow a negotiation down until it is perceived as being less than efficient. Yet even with this multiplicity of participants and

decision-makers, frequently not all parties who will be affected by an agreement are effectively at the negotiating table. The perennial tensions between equity in participation, efficiency in execution, and effectiveness in resolution clearly present a difficult problem, but one that must be addressed nevertheless.

In short, these three features – technical complexity, a need for quick and careful disposition, and the absence of unquestioned decision-making authority – are common to many of today's conflicts, and emphasize the need for a new approach toward negotiation. But even in simpler cases, where two parties seek a quick resolution of their differences, new ideas and tools would be welcome.

The framework we are developing is meant to be a systematic guide to the management of negotiations. The investigators intend to provide practitioners in the field of negotiation management with new ideas and tools, and with a clear vision of how these ideas and tools can be used. The synthesis is supplemented by a collection of software, the different parts of which share the following primary functions:

i) the simulation of the problem through joint model-building;
ii) the calculation of risk and uncertainty;
iii) the selection of decision-making procedures and norms; and
iv) the optimization of settlements by a third party computer.

Starting out with these primary functions for the computer, the concept of negotiation management is aimed at the synthesis of various theoretical constructs that relate to negotiation. The investigators have developed out of these constructs a set of working hypotheses about the role of models and modeling in negotiation and conflict management. This paper is designed to be a reasoned argument in support of that set of hypotheses; it is not based on research findings or the analysis of a newly created database. It comprises much of the thinking underlying the efforts underway at the MIT Project on Modeling for Negotiation Management and is a first statement of experimental intent.

II. THE ELEMENTS OF NEGOTIATION MANAGEMENT

Negotiation management, as described in this paper, has several essential elements:

i) the use of computers, modeling, and communication technology as an integral part of negotiation and other forms of dispute resolution and conflict management;

ii) the joint use of models and modeling by negotiating parties, by third-party neutrals, and by students of negotiation;

iii) the use of models and modeling to serve better the introduction of integrative bargaining or joint problem-solving in negotiation;

iv) the combination of a synthetical process and various computer-based analytical tools to develop a coherent outcome;

v) the use of these tools in different stages of dispute management, from the construction of a consensual database, through reaching agreement on the critical issues, to monitoring implementation of the agreement and settling subsequent disagreements;

vi) the application of these ideas in a variety of substantive contexts;

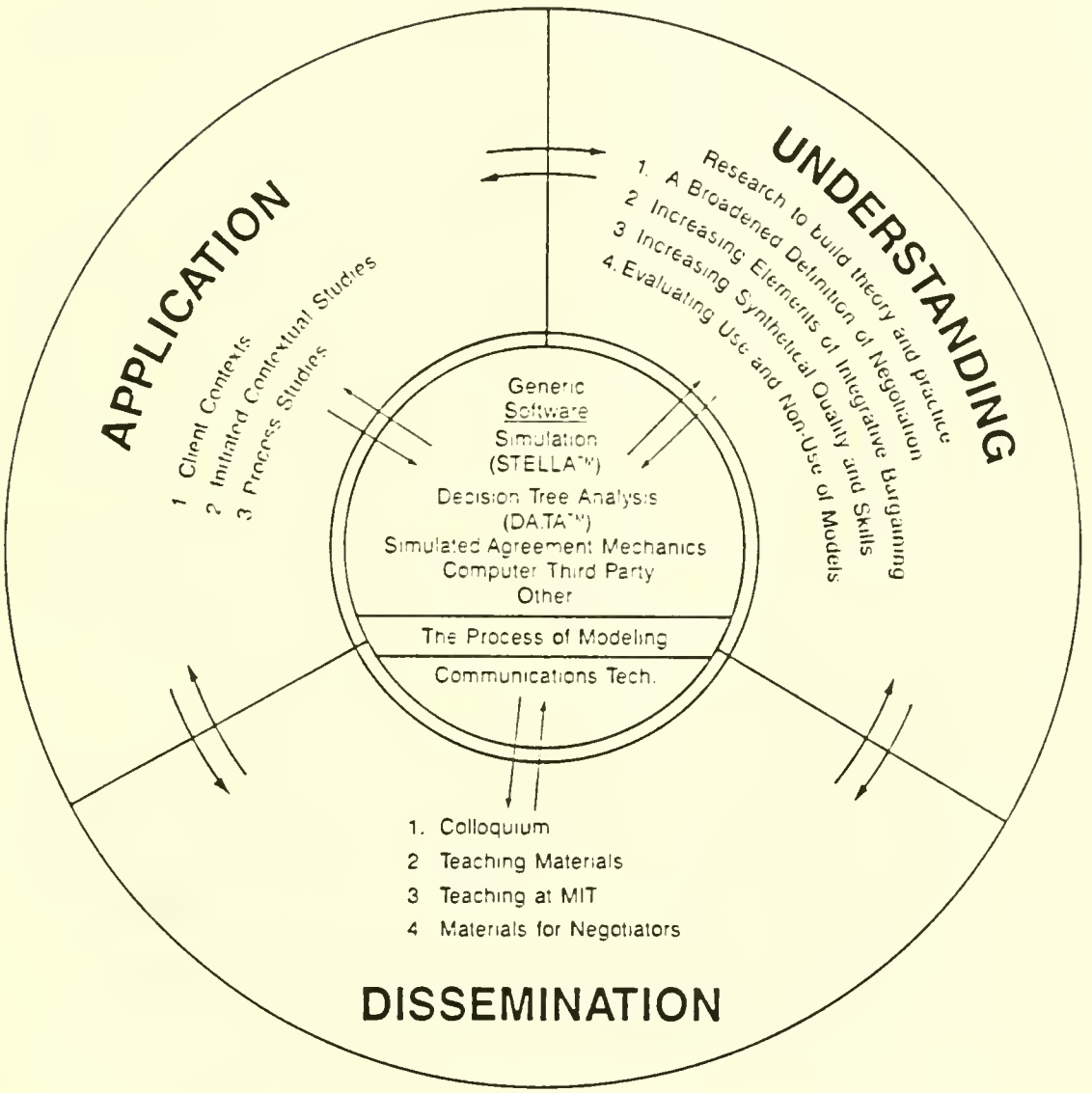
viii) understanding through research the impacts on negotiation of the use of models and modeling, thereby contributing to both theory and practice; and

ix) the dissemination of the knowledge so gained through writing, teaching, and the development of teaching materials.

The further development of these elements will incorporate current theory and empirical knowledge from several fields. The underlying ideas from dispute resolution include the theoretical concepts of synthetic and integrative thinking, a differences orientation towards negotiation, and the maximization of joint utility through collaborative problem-solving and integrative bargaining. Similarly, from the modeling sciences, the effort draws upon systems dynamics, game theory, optimization, statistical and retrospective pattern analysis, and various ideas from artificial intelligence.

Figure 1 summarizes the elements of negotiation management in graphic form. The remainder of this paper elaborates on these elements.

Figure 1 – The Elements of Negotiation Management



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III. MODELS AND MODELING FOR NEGOTIATION MANAGEMENT

Although it is largely unfamiliar, the idea of using models in negotiation is not a new one. In the late 1970's, for example, one of us (Nyhart) led an effort at MIT through which a computer simulation of the technology and economics of deep-ocean mining helped to bring consensus in the negotiations of the Third United Nations Convention on the Law of the Sea [Nyhart, 1984; Straus *et al.*, 1984; Antrim, 1985]. Since then, there have been several discussions and examples of the use of computer methods in negotiation [Sebenius, 1981; Kraemer, 1985; Nyhart and Goeltner, 1987]. These methods can be divided into five major categories: (i) pattern-seeking models; (ii) simulation models; (iii) agreement-seeking models; (iv) teaching models; and (v) syntheses of the above. Although this categorization is not necessarily comprehensive or free from overlap, it does serve to point out the breadth of potential for computer applications in this area. The concept of negotiation management, as laid out in this paper, is not meant to be a substitute for the use of these and other existing paradigms. Instead, the approach taken is to build on what has gone before.

Simultaneously adaptive and developmental, the work at the MIT Project combines in an integrated package of software as many different tools and methods as are necessary for the management and resolution of a wide range of disputes and controversies. The different parts of the software share the following primary functions:

i) the simulation of the problem through joint model-building;
ii) the calculation of risk and uncertainty;
iii) the selection of decision-making procedures and norms; and
iv) the optimization of settlements by a third-party computer.

Each of these components is described in detail below. There are, in addition, three other functions being explored: the provision of expert advice to a negotiator, the analysis of large numbers of similar problem cases, and the

facilitation of the overall process of negotiation. In this paper, however, only the four primary functions are discussed at any great length.

In the description of each of these four functions, the roles which models and the process of modeling can play in aiding negotiators and facilitators are illustrated. Although these roles are discussed in greater detail in Section IV below, Figure 2 summarizes them here as a preview.

Negotiators and facilitators can use models and modeling to help them:

1) Establish a consensual database as a foundation for agreement;
2) Assess the impact of uncertainty and change in the database;
3) Set a common research agenda to collect useful additional data;
4) Probe inequalities of power, influence, and access to data;
5) Track the formation of coalitions and clusters;
6) Formulate new procedures for making collective decisions;
7) Practice cross-cultural negotiating styles and tactics;
8) Provide communication links for bargaining and discussion;
9) Communicate effectively while protecting secret information;
10) Discover the areas of potential agreement among sub-groups;
11) Suggest settlements that minimize the need for compromise;
12) Evaluate the substantive impact of proposed settlements;
13) Enhance initial agreements through Pareto-optimization;
14) Monitor the implementation of the final agreement; and
15) Reach an amicable solution should disputes arise anew.

Figure 2 – Models and Modeling in Negotiation Management: A Summary

The Simulation of the Problem

An important part of negotiation management is the use of computer methods to simulate the relationships between substantive variables of interest. To date, the work has focused on the application of systems dynamics. Speaking now in general terms, the more complex the substantive system, the less intuitive will be its behavior. Forrester and others have shown that this failure of intuition can be discovered in a group setting through the process of jointly building a simulation model, and including within it the policy goals and structure of the group [see Forrester, 1969, for example]. The usefulness of the process is enhanced if the members of the group can take an active role in the modeling effort [Senge, 1985]. The more participation and surfacing of assumptions that take place, the more there is a deepened understanding of the substantive realities. In addition, the personal and active involvement of the participants reinforces their sense of ownership of the process. Therefore, a very high premium is placed on easy-access simulation in the context of negotiation management: those with the authority to negotiate most frequently do not have the time to master very complex modeling techniques. In any case, a transparent technology/interface is preferable so that the parties can concentrate on the conceptual issues in controversy, rather than on the intricacies of modeling.

As long as the stipulation of easy access is observed, the essential features of many real systems can be clearly and effectively modeled with the tools of systems dynamics in such a way that negotiating parties can identify their interests with the various attributes of the model. Kreutzer, for instance, has used such a modeling process as an eye-opener in the context of arms races [Kreutzer, 1985]. No doubt, there is a subtle shift in this process of joint model-building when a group is *negotiating*, as opposed to when it is jointly making decisions or policy choices. To a lesser extent, the same shift can be detected between intra- and inter-organizational negotiations. In the language of negotiation, as explained in a later section, the shift relates to the difference between integrative and distributive bargaining.

Irrespective of the extent to which negotiators are bargaining integratively or distributively, when negotiations focus on convoluted

technical issues, or are complicated by a need to preserve long-term relationships between parties, the joint development of a model holds at least three important advantages [Samarasan, 1987]. It allows the parties to focus on the issues and inter-relationships rather than on their positions. It exposes unrealistic private assumptions. And it fosters a good working relationship among the negotiators. By asking what-if questions, by performing comprehensive sensitivity analyses, and by conjuring up relevant scenarios and pursuing them through simulation, negotiators can enhance considerably the level of understanding with which they approach substantive questions. We are designing a new process – one we have called *Meta-Modeling* – which will create a negotiating environment in which collaboration through the use of the computer will be not only possible but natural [Samarasan, 1987].

Dealing with Risk and Uncertainty

A different substantive issue that often arises in a negotiation is the degree of certainty with which information is held by the various parties. In many cases, there is incomplete information about variables that are deterministic in nature. In other cases, the variables themselves are only probabilistically defined. When the eventual outcome of a particular gain or concession is not immediately obvious, the management of risk and uncertainty becomes an important part of the negotiator's role. To this end, software for decision tree analysis is included as one of the tools available for negotiation management.

Since decision tree analysis is well-known, only a brief explanation is presented here in the context of negotiation management. A decision tree is a graphical representation of the various options open to decision-makers, and the various outcomes that might befall them by chance. By taking into account the expected rewards and costs associated with each option, and the multiple probabilities or probability distributions associated with each random variable, the method allows a negotiator to calculate the expected value of each possible combination of options and outcomes [Raker, 1986].

Generally speaking, a tree flows from left to right, representing the issues under discussion in logical or chronological order. Nodes in the tree can be either decision nodes or chance nodes. From decision nodes emanate specific options that are available to the negotiators. From chance nodes, branches emerge that represent specific alternative states of nature not within the control of the negotiators. Each terminal node in the tree corresponds to the combination of all decisions and events encountered along the path from the root to that node. The probabilities that are used with a given node are selected from the set of prior, posterior and marginal probabilities, according to the position of that node in the tree. The optimal set of decisions is then calculated through backward induction.

Especially useful for those involved in a negotiation is the subsequent ability to analyze quickly the sensitivity of the optimal set of decisions to changes in assumptions about probability and expected value. Bargaining positions that are favorable under some assumptions may actually be irrelevanr or even have a negative effect on the satisfaction of the negotiators and their constituents under other assumptions. Information, interests, or positions that might seem crucial at first may be found to be dominated by other information, interests, or positions. Decision tree analysis, therefore, can be used in negotiation management to scope the discussion and to focus it on the details that really matter.

The use of decision trees may be new to negotiation, but it is obviously not new to decision analysis. Raiffa, for example, illustrates with a detailed case study [1982] how the method might be used by an attorney in deciding whether or not to settle litigation out of court. The premise underlying the research described in this paper is that the *joint* use of the method by those involved in a negotiation is a valuable extension, and a special case of its use by any single decision-maker. A decision tree that includes explicitly *all* the options available to one party in a negotiation will also include those options that are available to that one party in cooperation with the others. Later discussion of the relationship between integrative bargaining and the joint use of models in negotiation management elaborates on this point.

Selecting Norms and Procedures

The discussion now leaves the substance of negotiation and turns to questions of process. Two of the four components of the software being developed by the Project on Modeling for Negotiation Management deal explicitly with process. The first one is called Simulated Agreement Mechanics (SAM), and is a descriptive model of the negotiation process [Samarasan, 1987]. Since there is clearly no single 'negotiation process' to model, SAM actually implements a library of algorithms that represent different ground rules for negotiation and group interaction. Insofar as game theory deals with the logic of multi-lateral decision making, SAM is a game-theoretic simulation of the dynamics of a negotiation. On the other hand, insofar as game theory has traditionally dealt with a mathematical search for equilibrium, SAM is an outcast to this tradition.

As many observers have pointed out, there is great difficulty in predicting analytically and narrowly the outcome of a negotiation [see, for example, Lax & Sebenius, 1983]. In a sense, both Myerson and Axelrod surmount the difficulty elegantly and extract some interesting conclusions by modeling only very simple or highly abstracted interactions [Myerson, 1979; Axelrod, 1984]. But in general, there are simply too many variables, and too many ways in which they can vary.

SAM, therefore, does not function as an analytical predictor of stable outcomes. When decision-making authority is shared among the members of a group, whether they be managers distributing assignments, contract administrators negotiating compensation, or Senators seeking consensus, the types of agreements that emerge are defined qualitatively in large part by the ground rules, or norms of fairness, that are in effect [Gulliver, 1979]. Many of these group norms can be coded in SAM algorithms. Negotiators and facilitators can then use SAM to investigate different conceptions of fairness, to formulate new procedures for making collective decisions, and to track the formation and disbanding of coalitions and clusters in the course of a negotiation under different conditions [Samarasan, 1987]. The conditions which can be varied in the simulation include, among other things, the distribution of influence among the parties, the control of the agenda, and the

availability of substantive data as well as confidential tactical information. SAM is primarily meant to be used jointly by the parties to understand the local dynamics of their negotiation, and not to predict its global outcome given some *a priori* evaluation of utility.

The Computer as a Third-Party Neutral

The fourth component of the software under development for negotiation management, which we have called ONDINE (for "ONe-DImensional NEgotiation"), is an unobtrusive computer environment that allows negotiators to communicate and bargain without the intervention of a human facilitator, and therefore without revealing to each other basic information about their preferences [Goeltner, 1987].

If there is only one issue being negotiated, ONDINE I, the first version of this software, is appropriate. It deals primarily with the concept of the computer as a third party in the process of negotiation. It is designed to support a two-party, single-issue negotiation, and sets up an environment in which the computer functions as a neutral advisor to both sides, guiding the parties towards agreement. The two sides communicate with each other and with the program separately. ONDINE I channels the bargaining and the ordinary communication separately but simultaneously. In addition, where actual bargaining takes place but is stalemated, ONDINE I offers several rules that the parties can agree on beforehand for the allocation of benefits [see Goeltner, 1987]. Because of the unobtrusiveness of the ONDINE environment, the negotiation can proceed in a natural fashion without the distraction of the computer getting in the way.

ONDINE II, the second version of this software, retains the role of the computer as a third party in the process but is expanded to cover negotiations between two parties over more than one issue (paradoxically but naturally, its name has not changed much). Once the parties have agreed on the identity and number of issues to be negotiated, they give ONDINE II information about their positions on the issues, but do not divulge to the other side information about their reservation prices or alternatives to agreement.

After considering the offers and the reservation prices of both sides, ONDINE II informs them if there is any room for negotiation. If there is none, the solution is trivial: either they have reservation prices that are incompatible, or they have misrepresented their reservation prices, or they have not made their most generous offers, or some combination of the above. In any case, ONDINE II simply requests new information. If there is genuinely no room for compromise on a particular issue, no amount of negotiation will solve the problem. Given this information, the parties are freed to focus their efforts in more fruitful areas, perhaps on the substance of the dispute rather than on the bargaining.

If, however, there is indeed room for negotiation, ONDINE II begins to play a more active role. Using the utility functions that both sides have specified to it in confidence, ONDINE II calculates, while the two sides negotiate, the set of Pareto-optimal agreements, *i.e.*, each agreement in this set has two related qualities that distinguish it from those not in the set: (i) the sum total of the satisfaction derived by both parties is the highest that it could ever be, according to the specified utility functions; and (ii) neither party could improve its position except at the expense of the other. If shown these optimal agreements, the parties can compare their negotiated outcome with the ones on the Pareto-optimal frontier, and perhaps select an improved agreement from the optimal set. Or, if they so choose, they can simply elect to be informed that their agreement is not on the Pareto frontier, and then continue their negotiation.

There are undoubtedly problems with the use of all these pieces of software. With simulation, the model may not always advance understanding, especially if it provides either no simplification or over-simplification. With decision tree analysis, possible outcomes may be overlooked or probabilities may be impossible to estimate meaningfully. With SAM, the cultural and organizational differences between the parties may be so great that a common concept of fairness cannot be achieved rationally. And, finally, with ONDINE, second-guessing and the attempt to manipulate the process may be inevitable. Research designed to provide a better understanding of these problems is outlined below in Section IV.

The Model in the Middle

The paragraphs above will reveal a marked emphasis on the joint use of the computer in negotiation management. Straus and Bazerman [1985] call attention to "the battle of the print-out" in which computers and computer models can, and indeed have, been used to persuade, to dissuade, to confuse, and even to bully. These motivations for the use of the computer fail to address one of the basic reasons people negotiate rather than fight or bury their heads in the sand – namely, to achieve a cost-effective solution. Because it focuses on joint problem-solving rather than sophisticated argument, negotiation management is predicated on the assumption that the model is in the middle. Especially where objective information is required to deal with the scientific or technical complexity of the issues, a joint and open modeling effort may be to the advantage of all parties.

Collaborative Model-Building

But the concept of negotiation management includes more than joint modeling. If instead of using a model that comes pre-built, negotiators actually engage in joint model-building, the benefits of using models are compounded. To use earlier language, the use of *ordained* models is good, but a collaborative effort is even better [Nyhart & Dauer, 1984]. Even if the technical experts and advisers understand all the issues completely, there is good reason for the negotiators themselves to jointly conceive, build, and experiment with simple models of reality so that they can better appreciate the strengths and weaknesses of other parties' positions and arguments. A joint model-building effort could precede actual bargaining, or it could run in parallel, the two concurrent processes informing each other [Sebenius, 1981; Samarasan, 1987].

Zooming and Bridging

The practical need to minimize the additional knowledge and skills that are required for for the use of computer models and related technologies in negotiation management points out again the logic behind the early stipulation of simple and easy-access modeling. But simplicity comes at a price, if at all.

In many cases, the substantive issues in a negotiation are not sufficiently understood and cannot simultaneously be modeled simply and accurately. The natural or perceived hierarchy in a particular substantive area may be intimidating. In other cases, several separate models might exist that each describe some of the issues, but cannot be used together to form a comprehensive picture, because of vastly different underlying assumptions or motivations [Samarasan, 1987].

In the language of negotiation management, these problems may be amenable to simplification through *zooming* and *bridging*. Zooming refers to a vertical movement through the hierarchy of complexity, whereas bridging refers to a horizontal link between hierarchies dealing with parallel complexities in different substantive contexts [Straus, 1986]. The ability to zoom is important because it would allow modelers and model-users to specify their requirements in convenient levels of detail. And the ability to bridge effectively between different substantive models, whether ordained or built by the negotiators, is useful because it would allow facilitators, negotiators, and their expert advisors to relate issues to each other, thus compensating for their narrow specializations. A cautious note: it is possible to make too much of these ideas, since they are tied so closely to semantic definitions and categories.

The ability to zoom and bridge effectively implies the prior ability to abstract and synthesize in order to grasp the structure of complex relationships. As noted in Section IV below, these topics are among the research questions being studied by the Project.

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Other Issues

A few brief comments on the development of the software are in order. Consistent with the objective of providing software that is at once powerful and easily accessed by non-experts, the effort described in this paper uses STELLA™ (a product of High Performance Systems, Inc., Lyme, NH) for a systems dynamics simulation environment, and DA:TA™ (a product of TreeAge Software, Brookline, MA) for decision tree analysis [see Samarasan, 1987; and Raker, 1987]. The two versions of ONDINE were developed largely by the investigators, but the second incorporates a Pareto-optimization routine conceived by Blass and Raiffa [see Goeltner, 1987]. SAM was written by the investigators from scratch.

In addition to the development and application of these primary pieces, the MIT Project on Modeling for Negotiation Management will investigate and possibly put to work in an integrated negotiation support system [see Antrim, 1987] a wide variety of other technologies and generic 'productivity' tools. Included in this last category are such software items as outliners, idea processors, and spreadsheets. Expert systems have also been examined for applicability to negotiation [see Boose, 1984; Loofburrow, 1986]. More work has been done under the rubric of CSCW (Computer-Supported Collaborative Work). This work includes such topics as small group communication [Shimanoff, 1984], the 'decision room' [Konsynski, 1987], and electronic brainstorming *(Colab)* [Stefik *et al.*, 1987]. These areas and others are being examined. The rationale and impetus for this aspect of the investigators' efforts stem from the simple rule to avoid reinventing the wheel.

With regard to hardware, the Project currently operates on two distinct species of computer. STELLA™, DA:TA™, and SAM are designed specially for the Apple Macintosh™ personal computer (a product of Apple Computer, Inc., Cupertino, CA). The Macintosh interface is ideal for the purposes described in this paper. ONDINE takes advantage of MIT's X Window system and is designed for use with a VAXStation II™ workstation (a product of Digital Equipment Corporation, Marlboro, MA). As used by the investigators, this workstation runs the UNIX™ operating system (a product of AT&T Bell

Laboratories, Murray Hill, NJ). This combination of computer environments sounds more complicated than it really is, and gives the software both power and flexibility.

IV. UNDERSTANDING THE IMPACT OF MODELS AND MODELING

Among the intellectual goals of the MIT Project on Modeling for Negotiation Management are the following:

i) understanding how models and modeling might enhance synthetical skills and qualities in negotiation management;
ii) understanding how models and modeling might relate to the applicability and application of integrative bargaining;
iii) understanding the potential usefulness of models and modeling in a broadened definition of negotiation; and
iv) understanding where and why models and modeling may or may not be used in negotiation.

These research topics are elaborated upon in this section.

Enhancing Synthetical Skills and Qualities

Successful negotiation must be both synthetical and analytical. The value of analysis in negotiation has been pointed out by Lax and Sebenius [1986]. It has also implicitly been taken into account in the concept of negotiation management, by the discussion on the uses of computer models in Section III above.

On the other hand, synthesis, or the combining of elements to form a coherent whole, is largely an unexplicated concept, especially in the context of negotiation. When an adjective is needed, the word "synthetical" is used in

this paper, to draw attention towards the idea of creative and coherent innovation, and away from the alternative "synthetic" which connotes an inferior artificiality.

The intellectual challenge in the area of synthesis is essentially one of discovery. A negotiation process that arrives at an outcome by integrating, combining, composing, creating, or unifying must somewhere along the way include a significant synthetical component. Perhaps this component is located in the intuitive skills of an experienced and imaginative facilitator who, having accompanied the parties through the negotiation, can draw the interests, stakes, and issues together into one multi-faceted agreement. Or, possibly, it is to be found among the negotiating parties themselves, in the tension between collaboration and competition as they "create and claim." Or it could conceivably grace the mind of the rare 'Renaissance' individual who can rally data and knowledge from a wide variety of fields or disciplines to fashion a creative and original solution to the problems being negotiated. The answer is not obvious.

It could also turn out to be no more than coincidence that the use of the computer is a highly synthetical activity. The computer allows the user to hold, arrange, sort, analyze, combine, and present large quantities of data. But on another level, the concept of negotiation management is itself synthetical, in that it attempts to integrate a coherent set of ideas and tools, each of which can be used flexibly according to the dictates of the substantive context or process problem. And in the enunciation and development of its conceptual foundations, negotiation management seeks to draw eclectically but synthetically from a number of different fields – the art of design, the social and behavioral sciences, including law, as well as the more quantitative fields of decision analysis, game theory, and artificial intelligence – all of which have individually contributed to a better understanding of human interaction. The hope is that further research in this project will delve deeper into the 'how' and 'why' of synthesis to reveal new or improved ways of combining elements to form a coherent whole. Although it is not expected that anything in the nature of rigid rules for efficient synthesis will be found, some intuitive progress may be possible.

The Relationship to Integrative Bargaining

Integrative bargaining forms a major part of what is widely recognized as the dominant paradigm in negotiation. In the words of Lewicki, Weiss, and Lewin [1987], it is the process:

> ... by which parties attempt to explore options to increase the size of the joint gain without respect to the division of payoffs. The key to this process is openness of communication in order to maximize information about one's own and the other's needs and perspectives, to facilitate discovery of joint gain options.

Walton and McKersie, identifying integrative bargaining in their seminal work [1965], contrasted it with the process of distributive bargaining, in which each party tries to maximize its share of a fixed sum of available payoffs, with the result that what one party wins, the others lose.

Several scholars have pointed out that the integrative approach may offer significant advantages over the distributive. Lax and Sebenius [1986] note, for example, that:

> ... integrative bargains : (1) lead to speedier settlements; (2) have higher agreement probabilities; (3) reduce the danger that one or more parties will repudiate the agreement; (4) tend to strengthen the relationship between the parties thus facilitating later agreements, and (5) contribute to organizational effectiveness where subunits ... with distinct needs and values engage in intra-organizational bargaining. ...

If parties value different aspects of the settlement differently, and if their thinking style predisposes them towards the visualization of trade-offs and joint gains, then integrative bargaining can be used to maximize joint utility [Fisher and Ury, 1981].

Beyond their usefulness in negotiation, the ideas captured in integrative bargaining appear to be responsive to problems on several societal levels. In assessing the present and future place of the United States in the global order, Reich writes [1987]:

> ... The most complex questions about our place in a changing world, as they are processed by the conceptual filter of political mythology, are reduced to a blunt and binary choice between toughness and charity toward 'them.' ... This narrow spectrum of choice – assertiveness versus accommodation, discipline versus conciliation – bounds our political debates, limits how problems are defined and solutions weighed, and blinds us to a subtler set of options. ... The common error of both variants is the rigid delineation of 'us' and 'them.' ... The tension between a basic stance of accommodation or one of confrontation excludes

> the middle ground of negotiations and collaborations that both assert 'our' interests and comprehend 'theirs.' ...

Freely interpreted, Reich might have been describing a social orientation towards the bargaining styles associated with distributive situations, which a widened use of integrative bargaining concepts might ameliorate.

Especially in those social problems characterized by technical complexity, a need for early and decisive resolution, and a diffused decision-making authority, a focused application of the principles underlying integrative bargaining might be useful. This assertion is particularly apt if such problems are viewed as a cluster of activities over time, and therefore as a series of negotiations. And since the problems are so complex, reaching agreement requires a combining of disparate parts and activities into a whole solution – a step which is highly synthetical and integrative. Collaboration, or joint problem-solving, therefore, may be an effective approach for these problems.

In the field of law, a growing emphasis on preventive law [Brown & Dauer, 1978; Sciamanda, 1986] with its link to alternate dispute resolution [Nyhart & Dauer, 1987] provides another conceptual underpinning for the attempt to expand integrative bargaining. The structural options in preventive law of dealing with the prospects of future disputes by "presentiating" and resolving, deferring, or avoiding them (the latter in the sense of making agreements that leave minimal possibility of future disputes) would seem to call forth objectives closely akin to those associated with integrative bargaining – the effort to expand the number and nature of possible outcomes while treating issues as common problems to be resolved jointly, rather than battled to resolution through litigation.

These are among the considerations informing the premise that the attempt to increase the integrative quality of negotiations is a worthwhile effort. Fortunately, it would appear that the use of models and modeling might help in that effort.

To a certain extent, the joint use of models implies a commitment to the tenets of integrative bargaining. As Lax and Sebenius point out [1983], bargaining for competitive advantage often co-exists with a less explicit bargaining for knowledge. Because knowledge and information are the essential ingredients in the evaluation of utility, irrespective of negotiating

style, there is a natural link between integrative or synthetic negotiation, which requires access to a great deal of knowledge and information, and the modeling sciences, which can provide that access, or an approximation of it.

The software created for use in negotiation management provides, among other things, the capability to model different styles of negotiation, and different concepts of fairness. Using these models, negotiators can compare the various conceptual frameworks and test the applicability of integrative techniques to their situation. And academic use of this software might allow researchers to further explicate the principles of integrative bargaining.

The establishment of consensual databases, from which all parties can draw data, and to which all parties contribute data, is the natural starting point for a collaborative problem-solving process. In the kinds of conflicts under discussion, the collaborative process is greatly aided by a parallel model-building effort. Even if the technical issues are completely understood by each party's expert, there is good reason for the negotiators themselves to build the models, so they can more rationally separate good arguments and offers from bad ones.

A Broader Definition of Negotiation

As illustrated in Figure 2 above, it is believed that in at least fifteen activities, models and modeling can potentially assist in negotiation management. One way to understand these activities is to view them as a tentative version of a descriptive framework for negotiation management, built around the use of computers, models and modeling. Another way to interpret them, given that differences and disputes can and do occur in all of them, is to see the framework as extending the idea of negotiation far beyond actual bargaining.

The recognition that the process of negotiation extends beyond explicit bargaining – beyond the 'actual negotiation' – is not unfamiliar in the literature. Susskind and Cruikshank [1986] set out a model of the process that divides it into three main phases: pre-negotiation, negotiation, and post-

negotiation. The basic trichotomy made by Lax and Sebenius [1986] – create, claim, and reconfigure – further reflects these ideas. Raiffa's post-settlement-settlement follows what is normally considered negotiation [Raiffa, 1985]. Straus and Bazerman [1984] have also recognized the basic difference between the consensus-building and bargaining phases of negotiation. From the legal standpoint, Brown and Dauer, in their concept of preventive law, recognised these general ideas earlier [1978]. Nyhart and Dauer linked the activities of preventive law and alternate dispute resolution to suggest a spectrum of activities that foreshadow those expressed here [1984].

At this point, it may be worth returning to the fifteen activities, to analyze them in some detail. In reality, these activities may form several parallel streams, a series of cycles, or even a converging spiral iteration. For simplicity, the activities are presented below in a simple and linear list:

1) *Establish a consensual database as a foundation for agreement*

   Gaining consensual agreement on the basic facts underlying a large problem is an early task, and one which, when achieved, quickly identifies areas of disagreement on the fundamental technical uncertainties, points to areas of disagreement over fact, and indicates the extent to which consensus is already achieved. In doing so, many issues may systematically be removed as potential points of subsequent adversary confrontation. The use of modeling in establishing databases is fundamental – many technical databases are models, and *vice versa*. The process of joint modeling requires specificity as to values and assumptions held by the parties. At this early stage of the negotiation, it also provides an opportunity for the parties to improve their communication and relational skills vis-à-vis each other. Lax and Sebenius, in referring to "knowledge bargaining" [1983], attest to the importance of this stage of negotiations.

2) *Assess the impact of uncertainty and change in the database*

   As explained in the discussion of decision tree analysis in Section III above, information, interests, or positions that might seem crucial at first blush may be found after some analysis and comparison to be dominated by other information, interests, or

positions. DA:TA™ decision tree models, for example, can therefore be used in evaluating the database to scope the discussion and to focus it on those details that really make a significant difference.

3) *Set a common research agenda to collect useful additional data*

Once the initial consensual databases are evaluated, and the significant deficiencies in data identified with the use of models, the parties can use this information to establish a commonly acceptable research agenda on what new data need to be collected. In particular, substantive STELLA™ simulation models can play an instrumental role here: dominated possibilities may not need to be fully investigated if, as is usually the case, there are only limited resources for information-gathering.

4) *Probe inequalities of power, influence, and access to data*

Referring now to the prior discussion of SAM, it is likely that parties will not agree *a priori* on what constitutes a fair process. Especially if there are many parties to the negotiation, joint use of SAM might help in the formulation of decision-making procedures and norms of fairness that are acceptable to all parties.

5) *Track the formation of coalitions and clusters*

As indicated earlier, SAM can be used by negotiators to examine jointly the impacts of unequal distributions of power, influence, and information on the course of the negotiation; the approach is less abstractly mathematical than similar approaches taken by other modelers [see Myerson, 1979, for example]. Details of the tracking methods and motivations are elaborated in a parallel paper [Samarasan, 1987].

6) *Formulate new procedures for making collective decisions*

The suggestion here is that negotiators can use the results of the process simulations that SAM provides and the substantive simulations that STELLA™ provides to understand the practical effects of the norms that they hold, and to begin to relate and contrast political agreeability and technical effectiveness. A better understanding of these relationships, it is suggested, may lead to a

desire or willingness to institute a more useful collective decision-making rule.

7) *Practice cross-cultural negotiating styles and tactics*

Other researchers have concentrated an effort in this area. A specific example is the use of an expert system that captures effective negotiation rules in its knowledge base and combines them with a knowledge base about negotiators from a different organization or culture [Susskind & Gercik, 1986]. Using such a system in a training mode, a negotiator can begin to understand inter-cultural differences in tactics, negotiating style, and communication, and become familiar in dealing with them. To a certain extent, SAM performs the same function. The difference is that SAM makes no attempt to act as an automated negotiator.

8) *Provide communication links for bargaining and discussion*

Face-to-face communication between the parties to a negotiation adds one more dimension to the interaction. Clearly, there are many instances when face-to-face communication is either expensive or inconvenient. In large groups, or when negotiators are geographically far apart, it may often be more practical to negotiate remotely through electronic messaging and teleconferencing. There are also times when remote communication may facilitate the emotional interaction: for instance, it may allow tempers to cool down or encourage admissions and retractions to be made without embarrassment. ONDINE is intended to deal with these issues.

9) *Communicate effectively while protecting secret information*

The obvious and critical importance of effective and trusted channels of communication has been illustrated in many examples by writers from such diverse fields as international diplomacy, arms control, and industrial relations [see, for example: Allison, 1971; Kettelle, 1986; Walton & McKersie, 1965]. Of the software currently developed for negotiation management, ONDINE addresses the issue of communication most literally

and directly. It allows the parties to communicate effectively without revealing their basic negotiating positions.

10) *Discover the areas of potential agreement among sub-groups*

Both ONDINE and SAM allow the parties to discover all areas of potential agreement among sub-groups. They accept from the parties information that allows the models to determine the range of solutions for each issue that is acceptable to all parties. However, what the parties do with this information is not prescribed automatically.

11) *Suggest settlements that minimize the need for compromise*

One of the norms included in SAM's algorithm library is the simple idea that the best settlement is the one that requires the least compromising on the part of all the parties. If the parties choose this norm, SAM computes the settlement that results in the least total movement of all parties away from their respective ideal settling points on the issues. The goal here is not so much to locate that particular settlement, but to illustrate the effect of the norm on the quality and course of the negotiations. There are other norms in the library that SAM can suggest, or the parties can design their own.

12) *Evaluate the substantive impact of proposed settlements*

This is perhaps the most obvious of the roles that a computer model can play in a negotiation. Countless examples of the adversarial use of models can be found. The suggestion here is that joint substantive modeling, with DA:TA™ and STELLA™, for instance, allows all parties to see the impacts of proposals, both theirs and others'. There are often times when such information, if shared, can precipitate agreement very quickly.

13) *Enhance initial agreements through Pareto-optimization*

If the parties reach an agreement, simple techniques can assist them in enhancing its value [Raiffa, 1985]. ONDINE uses a Pareto optimization routine to point out to the parties potential agreements where at least one party could do better without any other party doing any worse. Especially when the issues are easily

valued in a common currency, this technique can highlight significant joint gains [see Goeltner, 1987].

14) *Monitor the implementation of the final agreement*

A critical yet often overlooked aspect of negotiation is the monitoring of the implementation of the agreement and of the overall system or set of issues of which the negotiated agreement was the core. In this activity, models can be used to provide parties a dynamic picture of the implementation. In the ideal case, substantive models that were built during the negotiation, either as self-standing ones or as front-ends to more rigorous models, would be used [Samarasan, 1987]. This double duty would help reduce the effective cost of the initial modeling effort. It would also minimize the unacceptability of the monitoring models.

15) *Reach an amicable solution should disputes arise anew*

Inevitably, differences will arise over the subject matter of the negotiation. Some of these differences may develop into vigorous disputes. Anticipating these developments, parties may agree in advance to use the models that have been validated as bases for objective criteria in resolving the new disputes in a non-adversarial setting. Or, where appropriate, adjudicators could make use of such models: there is precedent for the use of models in adjudication [McGovern, 1986]. Of course, in some contexts these early models might have to be updated before they can serve a sensible function.

The Use and Non-Use of Models

Although the uses of models discussed in this paper are, for the most part, not revolutionary in the world of computer science, they are relatively new to the world of negotiation. Therefore, their use can be expected to meet with resistance and rejection. Much of what is said above, in Section III and in this section, is concerned with ways to make models and modeling more

useful and widely acceptable. Enough is now known or suspected, however, about perceptions that lead instead to their non-use, so much so that an understanding of the obstacles to the increased use of models in negotiation is essential.

The kinds of criticisms made by the authors in Section III can, to some extent, be met by the observation that the computer is not a panacea. But in many of the types of disputes for which the concepts of systems simulation and decision tree analysis are most appropriate, *i.e.*, where the substance of the dispute is beyond the intuition of the unaided human mind, or where the settlement (or lack of settlement) of the dispute has far-reaching consequences, to fail to attempt a model may prove to be far more costly than to fail in an attempt to model.

And with regard to the role of SAM and ONDINE as agents, they offer essentially the chance for an improved process. Many writers on alternate dispute resolution have urged the *caveat* that certain kinds of problems are simply not amenable to decisive resolution through negotiation [Lewicki & Litterer, 1985; Ozawa & Susskind, 1985; Raiffa, 1982; Fisher and Ury, 1981]. These problems commonly end up either in the courts or in 'extended negotiation.' At least in these cases, an improved process through negotiation management may turn out to be the best alternative to stalemate.

Some other apparently legitimate bases of resistance have also been anticipated. Lax, for example, has speculated [1987] that the usefulness of Pareto-optimization software will be a lot less significant than one might expect on initial consideration.

From the perspective of Negotiation Analysis as elaborated by Lax and Sebenius [1986], a critical element is the interplay between competition and cooperation in such bargaining. Parties to a negotiation, if they are creating joint gains at all, are simultaneously creating these gains and dividing them up amongst themselves – an intertwined process. Naturally, parties can be expected to advance their self-interests. And they may do attempt to do so by distorting the statement of their preferences and utilities when using a Pareto-optimization routine, providing biased information to skew the 'optimal' outcomes towards their true preferences. Lax and Sebenius note that

this problem is essentially one form of the Negotiator's Dilemma [Lax and Sebenius, 1986]:

> ... An abstract version of a similar dilemma is currently being investigated by game theorists studying bargaining with incomplete information. One major result, due to Myerson (1979), is that in highly simplified situations that are analogous to the ones we discuss, fully honest revelation of private information by individual bargainers and Pareto efficiency cannot simultaneously be achieved. This is a starkly abstracted analogue of the result we describe that tends to result from the tension between cooperative moves to create value and competitive moves to claim it individually. ...

Lax believes that when using models, negotiators will shift their immediate efforts from negotiating into trying to understand the 'black box' of the optimization model in order to claim more of the joint gains. Extending this argument, he argues that negotiators may often be unwilling to commit the dispensation of their negotiation to an optimization routine whose role it is to find agreements that maximize joint gains.

Be that as it may, there remain times when the uses of optimizing models may provide advantages that outweigh the objections raised above. One example is the case of very complex negotiations with many issues, parties, possibilities, and unknowns. The capacity of an optimization model may in that case aid the analysis because analysis would be impossible without it. It could flag those situations where – at least according to stated utilities – no solution space exists. And if a basic agreement is eventually reached, a Pareto-optimizing model might then be used to enhance the agreement [Raiffa, 1985].

In a sense, the concerns expressed above may in essence turn on a different issue than the use of computer models. The underlying doubts may be about the degree to which the negotiation at hand is perceived and treated according to the principles of integrative or distributive bargaining. Nonetheless, they do point out the importance of understanding the theoretical as well as practical obstacles to the use of computers and information-based modeling.

Different reservations about the use of models may arise in technically complex or science-laden negotiations. In a recent study Clements and Sossen [1987] interviewed persons who had in one way or another been involved in the recent negotiation and implementation of a monitoring plan for

proposed oil and gas exploration of the Georges Bank area offshore New England under the Department of the Interior. At the outset of the study, it was anticipated that some of the several existing computer models used to study oil and gas productivity, oil pollution, and interaction with fisheries might have been useful to the negotiators. In fact, the study concluded that essentially no computer models were used. The reasons given by the interviewees for steering clear of modeling obviously informs the work of the Project. From among them, Clements and Sossen summarized the following:

> ... Over the course of the interviews, we discovered three reasons for the non-use of models. First, at the time, models for these sorts of negotiations were underdeveloped. Better models have appeared, however, subsequent to the *Lease-Sale 42* debate. Second, there was distrust of the models that were then extant. Scientists and negotiators alike expressed reservations about the adequacy of the input data, the scientific knowledge embodied in the models, and the implicit assumptions. Finally, the perception of the role of the computer at that time limited the willingness of negotiators to employ models.

Whether these concerns reflect objective questions, or the subjective perceptions of those interviewed is less important at this point than the fact that they exist at all. Further research will adapt the Clements and Sossens protocol to a general format for inquiry that can be used for investigation in other contexts.

V. POTENTIAL APPLICATIONS IN SUBSTANTIVE CONTEXTS

Use of the software and processes described here is a major element of negotiation management. Use initially provides an opportunity to test and ultimately evaluates the efficacy of the generic software in a range of substantive contexts.

At the time of writing, the investigators are creating contexts from fact situations for use in teaching materials. One case, for example, the *Kherov Joint Venture,* focuses on a U.S.-U.S.S.R business negotiation. Another examines the potential exploitation of krill resources in the context of

prospective Antarctic Treaty negotiations. Still other modeling efforts underway include a strategic analysis of the submarine nuclear deterrent in an arms control context, the simulated enforcement of new international garbage disposal rules applying to offshore waters, and the management of disputes arising in shipbuilding. Earlier applied modeling efforts concerned deep ocean mining [Nyhart *et al.*, 1978] and oil spill clean-up [Psaraftis, 1985].

The next research phase will be to work directly with parties in negotiations. Substantive contexts are being sought for this purpose in which the quality and the course of the negotiation are a central part of the problem. It is hoped that multi-party and multi-issue situations can be found for collaborative work using the tools at hand.

VI. DISSEMINATION

At the heart of the MIT Project on Modeling for Negotiation Management is the objective of making the integrated set of models and modeling tools described in this paper available to negotiating parties and third-party facilitators, for general use and under appropriate distribution arrangements.

The methods of negotiation management can and should be taught in a systematic way before conflicts arise, and the software developed at the Project encompasses this purpose. Therefore, another part of the Project is the preparation, testing, and packaging of teaching materials for use at MIT and in law, management, engineering, and public service professional schools. Software and written teaching materials providing fact scenarios and instructions will enable students to create their own models based on the simulated facts. Negotiation exercises, comprising materials for simulating the process of joint model-building will be provided along with appropriate textual material. The intent is to provide a complete set of materials for the use of students, negotiators, and third-party neutrals.

Another means of dissemination, the MIT Research Colloquium on Modeling for Negotiation Management, has been established to discuss and critique current project work and to hear scholars' and practitioners' presentations of the current state of the art. The Colloquium, which functions as a research and teaching seminar, serves as a focal point for such interchange and for the development of graduate, undergraduate, and faculty research. One of the goals of the project is to educate Ph. D students in the uses of modeling in negotiation management, in the context of an integrated approach. In this regard, the Colloquium will continue to be an element of that effort.

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The long term goals of the MIT Project in Modeling for Negotiation Management include the development of principled guidelines for the use of models in negotiation, the creation of computer software and supporting materials, the design of formal methods of instruction in negotiation management, and the assessment of the implications of the use of computers in negotiation and decision-making.

The experience gained so far suggests that the use of the computer in the practice and teaching of negotiation is crucial. The computer makes possible a deeper understanding of complex and technical issues in negotiation. But more generally, the computer will help in organization and optimization, so that negotiations are more efficient, and agreements more robust.

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