Control and Cybernetics

VOL. 21 (1992) No. 1

Simulating Process and Outcome for Two-party Contract Negotiations[1]

by

Thomas A. Darling

Jeryl L. Mumpower

University Center for Policy Research,
and Department of Public Administration and Policy
Rockefeller College of Public Affairs and Policy
University at Albany, State University of New York
Albany, New York 12222, USA

In contract negotiations, disputants' interests are ordinarily fundamentally opposed. For such negotiations, the problem structure is determined by the joint distribution of negotiators' potential payoffs, across all feasible settlements. The attractiveness of common settlements, such as issue-by-issue compromise and logrolling, is largely dependent on problem structure. Likewise, various social welfare criteria sometimes favor the same and sometimes favor different settlements, depending on problem structure. The dynamics and outcomes of contract negotiations not only are influenced by problem structure, but also by negotiators' appraisals of the strategic merits of potential concessions which they might make during the course of

[1] The research reported in this paper was supported in part by the National Science Foundation under Grant No. SES-9010359.

negotiations. Simulation analyses investigated several simple strategic rules for making concessions. Results indicated that an individualistic rule, which placed no weight either positive or negative on the welfare of the other, did best (or nearly so) for a self-interested negotiator, no matter what the structure of the problem or what the other negotiator's strategic rule. The other negotiator's rule had as much or more of an effect on payoff as did one's own rule. The analyses demonstrated that a Prisoner's Dilemma game is often embedded in contract negotiations.
Keywords: negotiation, judgment.

1. Introduction

Two different types of negotiator judgment in bargaining can be distinguished – evaluative and strategic. Evaluative judgments are negotiators' appraisals of the desirability of potential (feasible) settlements. Such judgments determine the structure of the negotiation problem. Strategic judgments are negotiators' appraisals of the relative merits of potential concessions which they might make during the course of negotiations. These judgments influence the dynamics and outcomes of negotiations.

This paper consists of four sections. The first section discusses the manner in which negotiators' evaluative judgments determine the structure of the negotiation problem. In the second section, computer simulations are used to investigate the negotiation process that would result if each negotiator followed a simple strategic rule; i.e., at each move, make the concession that minimizes the marginal loss in payoff. The third section examines the effects on negotiation process and outcome of other strategic rules that negotiators might use for making concessions. In the concluding section, lessons from the simulations are reviewed.

2. The Structure of Contract Negotiation Problems

In contract negotiations, disputants' interests are ordinarily fundamentally opposed. On issues for which Negotiator 1 wants higher levels, Negotiator 2 wants lower levels, and *vice versa*. For example, labor typically prefers higher levels of wages and health benefits, whereas management prefers lower levels. Because negotiators' interests are opposed on each issue, the feasible settlement that is most preferred by one is least preferred by the other. Between these two extremes, the negotiators' interests need not be strictly opposed – the negotiation problem is not necessarily a fixed-sum game. Differences between negotiators in the relative importances of issues, as well as differences in value curves, sometimes create opportunities to improve on a fixed-sum outcome.

Negotiators are interdependent – neither can unilaterally impose a settlement. The structure of the negotiation problem depends jointly on the two negotiators; it is determined by the joint distribution of negotiators' payoffs across all possible settlements. The resulting feasible settlement space and efficient frontier defines both the opportunities the problem affords and the constraints it imposes on negotiators.

Modeling Negotiators' Evaluations of Potential Settlements

A number of approaches can be used to develop judgment models that describe negotiators' evaluations of potential settlements (Mumpower, 1988; 1991). In the Social Judgment Theory (SJT) approach (Hammond et al., 1975; Stewart, 1988), regression–based judgment policies are constructed that describe a negotiator's evaluation of the overall desirability of a potential settlement in terms of three key components: (1) *weights*, or the relative importance placed on each disputed issue; (2) *function forms*, or the functional relations between levels within an issue and desirability for that issue (the concept of *function form* in SJT is equivalent to *value curve* in multi–attribute utility theories); and, (3) the *organizing principle*, or the way judgments of individual issues are combined into an evaluation of overall desirability.

In the present analysis, it is assumed each negotiator's payoff (his or her evaluation of the desirability of a particular settlement) can be represented by a weighted averaging model of the following form:

$$P = \sum w_i f_i(x_i) \qquad (1)$$

where P is a negotiator's payoff for a potential settlement;
x_i is the level of issue i in the potential settlement, such that $0 \leq x_i \leq 100$;
f_i is the negotiator's function form for issue i, reflecting (unweighted) changes in payoff as a function of the levels of issue i; and,
w_i is the relative weight a negotiator associates with issue i, where $\sum w_i = 1$.

For the contract negotiation simulations reported in this paper, it is assumed that all issues can be scaled so that function forms are monotonically increasing for one negotiator and monotonically decreasing for the other. Function forms, f_i, are arbitrarily scaled from 0 to 100; for minimum and maximum levels of each issue, the (unweighted) payoff is 0 for one negotiator and 100 for the other. Because relative weights sum to one, negotiators' overall payoffs range from 0 to 100.

Linear function forms reflect a constant marginal change in value between issue levels. Since issue levels, x_i, are scaled from 0 to 100, at the median level, $f_i(50) = 50$. Two classes of monotonic, non-linear function forms are also considered. *Concave* function forms "bow out," reflecting decreasing changes in marginal value as the negotiator approaches the ideal; $f_i(50) > 50$. *Convex* function forms "bow in," reflecting increasing changes in marginal value as the negotiator approaches the ideal; $f_i(50) < 50$.

Function forms for Negotiator 1 are always positively sloped, whereas Negotiator 2's forms are always negatively sloped. Function forms are calculated as: positive slope:

$$f_i(x_i) = x_i + \delta[x_i - (x_i^2//100)], \quad -1 \leq \delta \leq +1; \tag{2a}$$

and, negative slope:

$$f_i(x_i) = (100 - x_i) + \delta[(100 - x_i) - ((100 - x_i)^2//100)], \ -1 \leq \delta \leq +1. \tag{2b}$$

When $\delta = 0$, the function form is linear $[f_i(50) = 50]$. When $\delta > 0$, the function form is concave [e.g., if $\delta = +1$, $f_i(50) = 75$]. When $\delta < 0$, the function form is convex [e.g., if $\delta = -1$, $f_i(50) = 25$]. The second derivatives of these function forms are fixed for a given value of δ, reflecting a constant rate of change in the marginal values along the issue scale.

Feasible settlements for negotiation problems

The feasible settlement spaces for four prototypical two-party, two-issue negotiation problems are summarized in Figure 1. In Problems I and III, both negotiators have concave function forms ($\delta = +0.5$) for both issues; in Problems II and IV, both negotiators have convex function forms ($\delta = -0.5$) for both issues. In Problems I and II, the negotiators believe different issues are more important; Issue B is more important for Negotiator 1 ($w_A = .35$; $w_B = .65$), and Issue A is more important for Negotiator 2 ($w_A = .65$; $w_B = .35$). In

Problems III and IV, the same issue is more important to each one – for both negotiators, $w_A = .35$ and $w_B = .65$.

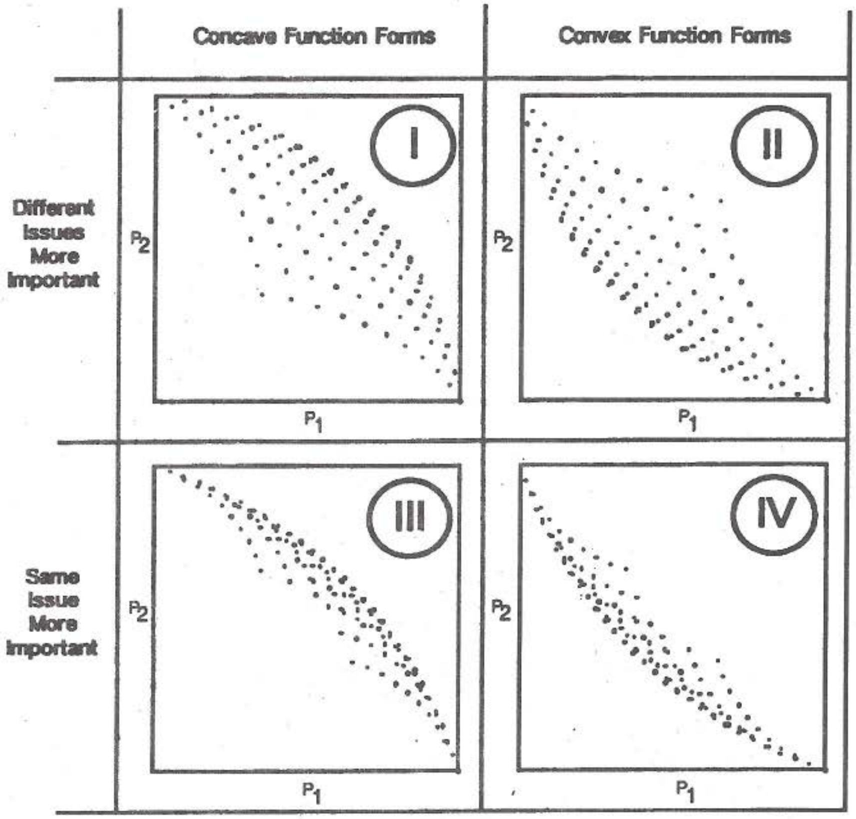

Figure 1. Feasible settlement spaces for four negotiation problems.

For each problem, the settlement that maximizes one negotiator's payoff also minimizes the other's payoff. In between these two extremes are other possible settlements. For those on the efficient frontier, no other settlement exists that both negotiators simultaneously prefer; all others are dominated. Even though both negotiators' function forms are nonlinear and both place a non–trivial relative weight on each issue in all four problems, the resulting feasible settlement spaces and efficient frontiers are distinctly different.

Problems I, II, and III all have efficient settlements that give both negotiators significantly more than half of their maximum payoff. In these three problems, the settlement that maximizes joint payoff ($P_J = P_1 + P_2$) also provides the negotiators with equal payoffs ($P_1 = P_2$). The efficient frontier in Problem IV has a scallop–like shape, bowed inward. None of the feasible settlements in this problem allow both negotiators to simultaneously achieve even half of their maximum payoff. The two fixed–sum settlements that maximize the negotiators' joint payoff ($P_J = P_1 + P_2 = 100$) provide unequal payoffs of 65 for one and 35 for the other. The maximum equal payoff settlement in Problem IV provides each negotiator a payoff of ≈ 44.

As these four problems show, depending on the structure of the negotiation problem, settlements that are simultaneously efficient, maximize joint payoff, and minimize inequality are sometimes possible, sometimes not. Settlements on the efficient frontier that yield equal payoffs to both negotiators will sometimes leave both relatively well–satisfied, sometimes not (Mumpower, 1991).

Compromise and logrolling: two common settlements to negotiation problems

Negotiators prefer, *ceteris paribus*, to maximize their own payoff. To reach an agreement in contract negotiations, however, concessions must be made, usually by both negotiators. Compromise and logrolling are two particularly salient feasible settlements (Milter, Darling, & Mumpower, 1991; Roth, 1985; Schelling, 1960). Compromise settlements set each issue at its median level; for a two–issue problem, both negotiators concede exactly half–way on each issue, $[x_A = 50,\ x_B = 50]$. Logrolling settlements set each issue at extreme levels; one negotiator concedes entirely on Issue A, the other concedes entirely on Issue B. (There are two logrolling settlements in a two–issue negotiation problem, $[x_A = 0,\ x_B = 100]$ and $[x_A = 100,\ x_B = 0]$; these usually do not lead to the same value of P_J. We use the term logrolling to refer to the settlement(s) that maximizes P_J.)

Table 1 gives the negotiators' payoffs for the compromise and logrolling settlements for the four problems presented in Figure 1. The relative attractiveness of compromise and logrolling settlements is largely dependent on the problem structure. Compromise settlements tend to yield good payoffs to both negotiators when the function forms are concave (Problems I and III). Logrolling settlements tend to yield good payoffs to both negotiators when different issues are more important (Problems I and II). When the function forms are convex and the same issue is more important (Problem IV), compromise settlements tend to yield low payoffs for both negotiators, whereas logrolling settlements tend to yield unequal payoffs.

	COMPROMISE (P_1, P_2)	LOGROLLING (P_1, P_2)
Problem I	(63, 63)	(65, 65)
Problem II	(38, 38)	(65, 65)
Problem III	(63, 63)	(65, 35) or (35, 65)
Problem IV	(38, 38)	(65, 35) or (35, 65)

Table 1. Negotiators' payoffs for compromise and logrolling settlements.

Three social welfare criteria for evaluating the quality of settlements

A number of criteria have been proposed to evaluate the quality of actual or potential negotiated settlements. Three such criteria are (a) the *utilitarian* criterion (Bentham, 1948), which selects the settlement that maximizes the sum of the negotiators' payoffs, P_J; (b) the *Nash* criterion (1950; 1953), which selects the settlement that maximizes the product of the negotiators' payoffs, $(P_1 * P_2)$; and, (c) the *Rawls* criterion (1971), which selects the settlement that maximizes the minimum negotiator's payoff.

For each criterion, Figure 2 shows the indifference curve that passes through the point $P_1 = P_2 = 50$. Each has an infinite number of indifference curves parallel to the one shown, and each prefers indifference curves to the northeast. The three criteria always will select efficient settlements (provided the frontier is continuous and monotonic), but they will not always select the same settlement.

	UTILITARIAN (P_1, P_2)	NASH (P_1, P_2)	RAWLS (P_1, P_2)
Problem I	(67, 67)	(67, 67)	(67, 67)
Problem II	(65, 65)	(65, 65)	(65, 65)
Problem III	(63, 63)	(63, 63)	(63, 63)
Problem IV	(65, 35) or (35, 65)	(65, 35) or (35, 65)	(≈44, ≈44)

Table 2. Negotiators' payoffs for settlements regarded as optimal by three different criteria for evaluating settlement quality.

For each of the four problems in Figure 1, both negotiators' payoffs were calculated for the 121 combinations of issue levels $x_i = 0, 10, 20, \ldots, 100$, $i = A, B$. Table 2 gives the payoffs for the settlement preferred by each criterion. For

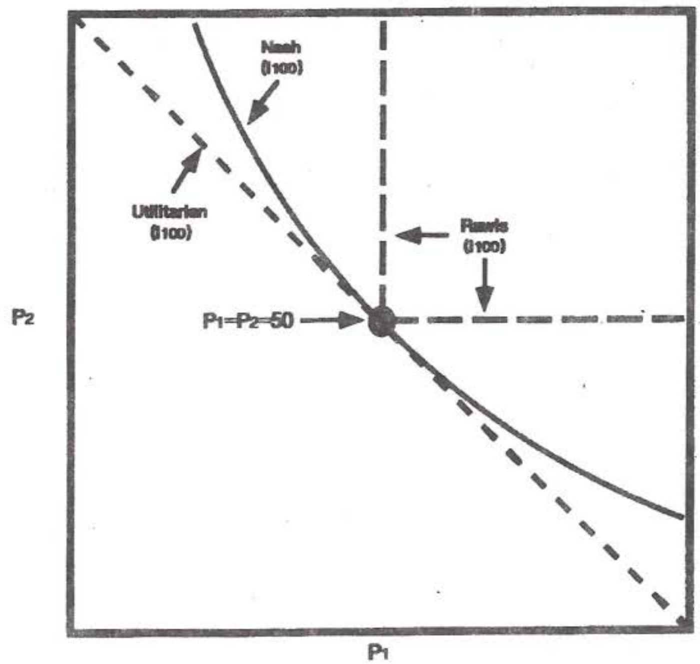

Figure 2. Indifference curves (I_{100}) for three social welfare criteria.

Problems I, II, and III, all three social welfare criteria agree on a settlement – they each select the feasible settlement that simultaneously maximizes P_J and provides negotiators equal payoffs ($P_1 = P_2$). In Problem I, the preferred settlement, [$x_A = 20$, $x_B = 80$], is a hybrid between compromise and logrolling; Negotiator 1 concedes most, but not all, of his or her less important issue, Issue A, and Negotiator 2 concedes most, but not all, of his or her less important issue, Issue B. This type of settlement has been described as "proportional compromise" (Mumpower, 1991). In Problem I, it (slightly) dominates both the logrolling and compromise settlements. For Problems II and III, the settlements most preferred by the social welfare criteria correspond to logrolling and compromise, respectively.

In Problem IV, the three criteria select different efficient settlements. Both the utilitarian and Nash criteria are indifferent between the two logrolling settlements. The Rawls criterion selects the settlement that provides the maximum equal payoff, $P_1 = P_2 \approx 44$, which may be reached by either [$x_A = 0$, $x_B = 77$] or [$x_A = 100$, $x_B = 23$].

Simulation results: comparing settlements from compromise, logrolling, and the three social welfare criteria

How do compromise and logrolling settlements compare to one another? How do they compare to the settlements that the three social welfare criteria suggest as optimal? How do the settlements identified as optimal by the three criteria differ? A stochastic simulation was used to address these questions across a broader sample of conditions than represented by Problems I–IV. Five sets of negotiation problems were randomly drawn, assuming different distributions of negotiator judgment policies. Each set consisted of 100 problems (i.e., 100 pairs of simulated negotiators).

In the first set, Case F(ull), function forms for both negotiators were randomly drawn from a uniform distribution ranging from highly concave [$\delta = +1.0$, $f_i(50) = 75$] to highly convex [$\delta = -1.0$, $f_i(50) = 25$]. (Recall that the slopes of function forms are positive for Negotiator 1 and negative for Negotiator 2.) For both negotiators, the relative weights on Issue A were randomly drawn from a uniform distribution between +.20 and +.80 ($w_B = 1 - w_A$).

Problems I–IV (see Figure 1) served as prototypes for the negotiation problems in the remaining four sets, Cases I–IV. In order to investigate a broader range of negotiation problems, (a) the relative weights and the degree of non–linearity of function forms were allowed to vary, and, (b) the two negotiators were not constrained to be mirror images of one another. (All five cases were linear scalings of the same randomly drawn set of parameters.)

For Cases I and II, different issues were more important to each negotiator; the range of relative weights was $+.20 \leq w_A \leq +.50$ for Negotiator 1, and $+.50 \leq w_A \leq +.80$ for Negotiator 2. For Cases III and IV, the same issue was more important to both negotiators; the range of relative weights was $+.20 \leq w_A \leq +.50$ for each negotiator. For Cases I and III, both negotiators' function forms were concave; $0.0 \leq \delta \leq +1.0$. For Cases II and IV, both negotiators' function forms were convex, $-1.0 \leq \delta \leq 0.0$.

For each of the 100 pairs of negotiators simulated in each case, the settlements yielded by compromise, logrolling, and the three social welfare criteria were identified from among the 121 feasible settlements consisting of combinations of issue levels $x_i = 0, 10, 20, \ldots, 100$, $i = A, B$. Figure 3 shows (a) the negotiators' average payoff, $(P_1 + P_2)//2$, and (b) the average absolute difference in their payoffs, $|P_1 - P_2|$, for the 100 problems in each case.

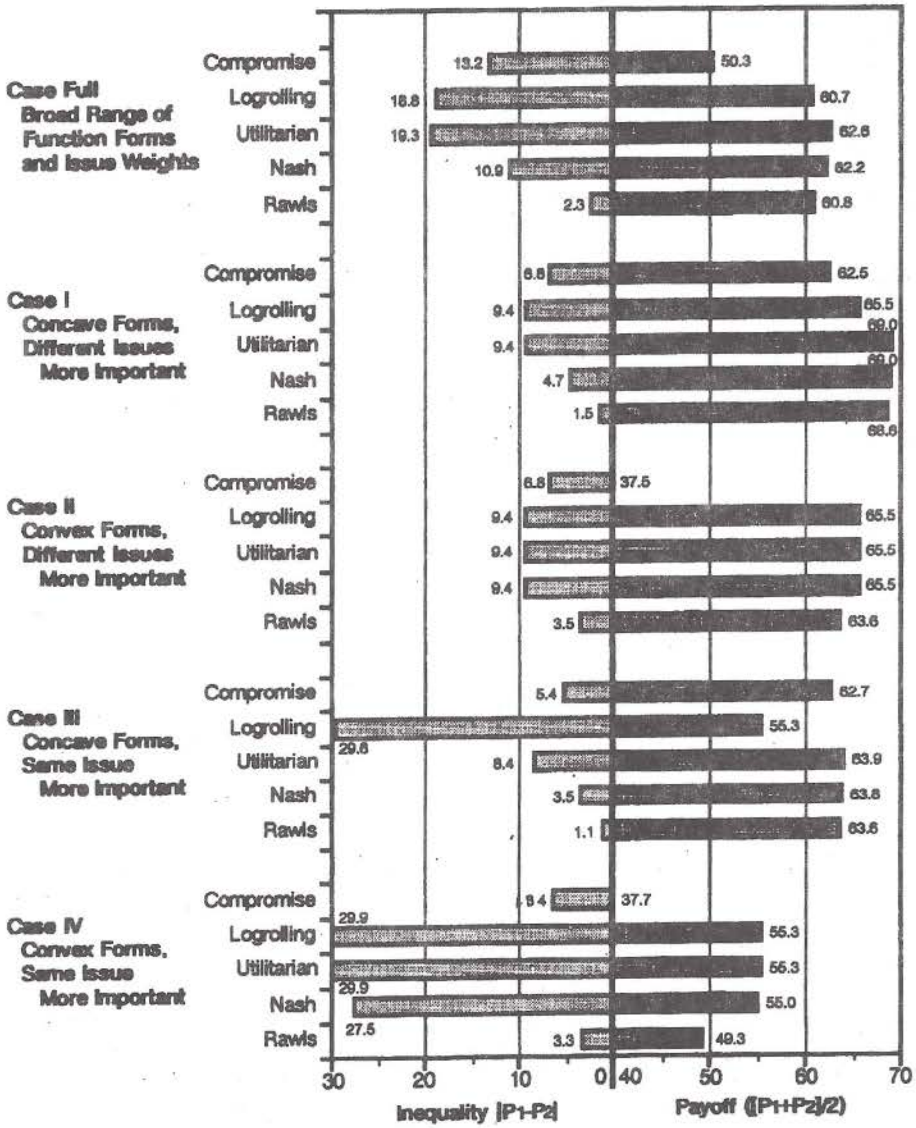

Figure 3. Average payoff and inequality for five types of settlements.

The results for compromise and logrolling are generally consistent with those from the previous analyses of the four prototypical problems. Logrolling provided negotiators with higher average payoffs than compromise except when function forms were concave and the same issue was more important (Case III). Payoffs from logrolling were higher than compromise when function forms were convex (Cases II and IV). In all cases, compromise resulted in less inequality in payoffs than logrolling – dramatically so when the same issue was more important (Cases III and IV).

Real negotiators are unlikely to know precisely the judgment policy of the other negotiator. Even their own evaluations may be somewhat uncertain. Negotiators sometimes may be able to make reasonable estimates about whether function forms are concave or convex both for themselves and for the other negotiator. Likewise, they may be able to estimate the relative importance of issues both for themselves and for the other negotiator. If so, they will be able to evaluate the probable merits of logrolling versus compromise.

Figure 3 indicates that if function forms are concave, and different issues are more important (Case I), it ordinarily makes little difference whether negotiators compromise or logroll. If function forms are convex, and different issues are more important to each negotiator (Case II), it would be to their mutual advantage to logroll. If function forms are concave, and the same issue is more important (Case III), both negotiators would be better off to compromise than to logroll. When function forms are convex, and the same issue is more important to both (Case IV), their best hope might be to find a new negotiation problem – no feasible settlement exists that will leave them both relatively well satisfied. Fisher and Ury (1981), Lax and Sebenius (1986), Pruitt and Rubin (1986), Raiffa (1982), and Walton and McKersie (1965), among others, have written eloquently on the importance of redefining issues or adding new ones, when negotiators confront "hard" problems such as this one.

Neither compromise nor logrolling will necessarily lead to the same settlements as those preferred by the three social welfare criteria. This is because neither compromise nor logrolling always lead to efficient settlements, whereas the three social welfare criteria always do.

Although all three criteria select efficient settlements, they do not necessarily prefer the same one. The utilitarian criterion always provides negotiators with equal or higher average payoffs than either the Nash or Rawls criteria (as it must, by definition). The Rawls criterion always minimizes inequality (as it must, by definition). (The Rawls criterion will always select a perfectly equal settlement ($|P_1 - P_2| = 0$) when the efficient frontier is continuous and monotonic; the slight inequalities in the present analyses are the result of limited sample sizes.) The Nash criterion is intermediate between the other two in terms of the trade–off between maximizing average payoff and minimizing inequality.

Figure 3 shows that differences in problem structure constrain the average payoffs that negotiators can achieve. For instance, the joint payoff of the settlements selected by the three social welfare criteria is substantially lower in Case IV than in Cases I-III. Figure 3 also shows that differences in problem structure affect the degree of similarity among the settlements preferred by the three criteria. For instance, in Case IV, the differences (in terms of average payoff and inequality) between the settlements preferred by the three criteria are much greater than in Cases I–III. In order to minimize inequality, the Rawls criterion selects settlements that yield lower joint payoffs than the ones preferred by the utilitarian or Nash criteria.

The simulations demonstrate that differences in problem structure may accentuate or suppress differences between the three social welfare criteria in the trade–off required between average payoff and inequality. Whether or not the three criteria yield similar answers depends on the negotiation problem structure, which, in turn, depends on the evaluative judgment policies of the negotiators themselves.

3. Modeling the Dynamics of Negotiation Processes for Individualistic Negotiators

Analyses of negotiations from a judgmental perspective should focus on process as well as structure (see Darling & Mumpower, 1990; Mumpower & Darling, 1991). Negotiators rarely leap to joint agreement on their first move. Rather, they proceed incrementally and cautiously, attempting to "feel their way along" to a settlement, unsure of when the level of concessions they offer will meet the other's minimum reservation price, and hoping not to be taken advantage of. Encumbered by limited, imperfect information about the other negotiator's (and perhaps their own) payoffs and hampered by the limits of their cognitive capacity, negotiators are likely to look ahead only a move or two. In choosing among the many possible offers and counter–offers to make, negotiators are likely to rely on relatively simple rules–of–thumb (for example, always make the smallest possible concession) that they hope will lead eventually to a settlement that is satisfactory to themselves and acceptable to their counterpart.

The bargaining game

In this and the following section, simulations of a simple two–party, two–issue bargaining game are used to investigate the manner in which negotiators' strategic judgments affect the dynamics of the negotiation process and its outcome. The rules of the game are simple. Communication between the players is not allowed, except for the interchange of incremental offers and counter–offers expressed solely in terms of levels of the two issues.

Each player starts the negotiation with an initial offer that reflects his or her most preferred level for each issue. The players take turns making concessions, giving up 10 x_i units on either one issue or the other. When the players' offers on an issue coincide, no further concessions on that issue are allowed. When their offers on both issues coincide, an agreement is reached. At each move, a concession is always required, and once a concession is made on an issue, it may not be retracted. Given these rules, negotiators inevitably reach an agreement and make an equal number of concessions in doing so.

Examples using the individualistic strategy

Until agreement is reached on one of the issues, a negotiator is faced at each move with a choice of conceding on Issue A or Issue B. In this section, the simulated negotiators use the *individualistic* strategy – they concede on Issue A if the result leaves them with a higher payoff than if they had conceded on Issue B, and *vice versa.* They do not look ahead, or consider what concessions the other has made.

Real negotiators might act similarly for several reasons. Limits on attention, cognitive capacity, or information about the other's prior moves may prevent them from planning far ahead (Morecroft, 1985; Simon, 1976; Sterman, 1989). Or, real negotiators may simply hope the other will accept their next offer, in which case it is in their best interest to make as small a concession on the current move as possible.

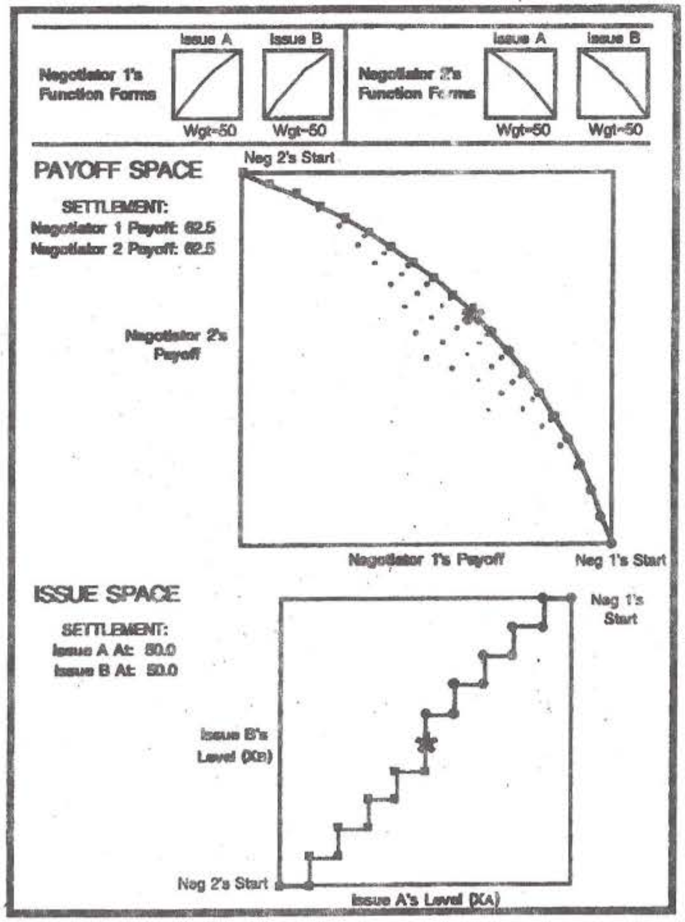

Figure 4. Individualistic negotiation dance for Problem E(qual) – concave function forms, both issues equally important.

Figure 4 shows the negotiation dance of two individualistic negotiators for Problem E(qual). Function forms for both negotiators are moderately concave ($\delta = +.5$), and each places equal weight on both issues ($w_A = w_B = 50$). The negotiation dance is superimposed on the payoff space. Both negotiators start with their most preferred offer, and dance along the efficient frontier until their offers coincide.

The bottom of Figure 4 shows the negotiators' offers and counter–offers in issue space, i.e., in terms of issue levels, x_i ($i = A, B$). Since function forms are concave, each concession on an issue results in a larger loss in payoff than a negotiator's prior concession on that issue. Because the relative weights of the issues are the same, each negotiator alternately concedes on Issue A and Issue B, arriving at the final, compromise settlement, $[x_A = 50, x_B = 50]$, that maximizes P_J and provides them with equal payoffs.

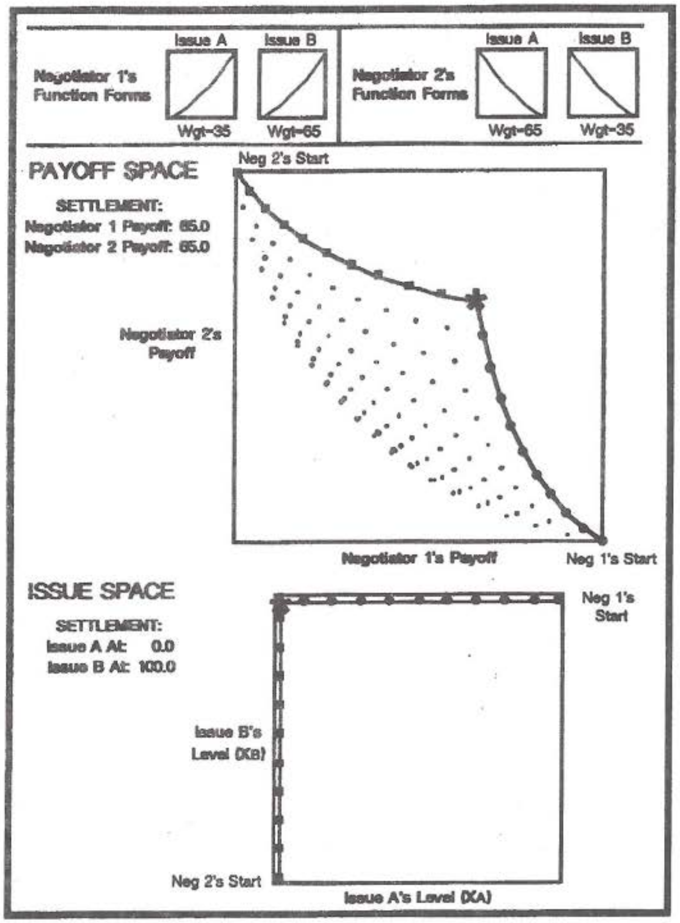

Figure 5. Individualistic negotiation dance for Problem II – convex function forms, different issues more important.

In Figure 5, negotiators confront Problem II (convex function forms and different issues more important). In terms of the payoff space, the negotiators again dance along the frontier. Since function forms are convex, each new concession on an issue results in a smaller loss in payoff than prior concessions on that issue. Once an individualistic negotiator begins to concede on an issue, he or she continues to make concessions on that issue for as long as possible. In terms of issue space, the disputants arrive at a logrolling settlement, $[x_A = 0, x_B = 100]$, that maximizes P_J and provides them with equal payoffs.

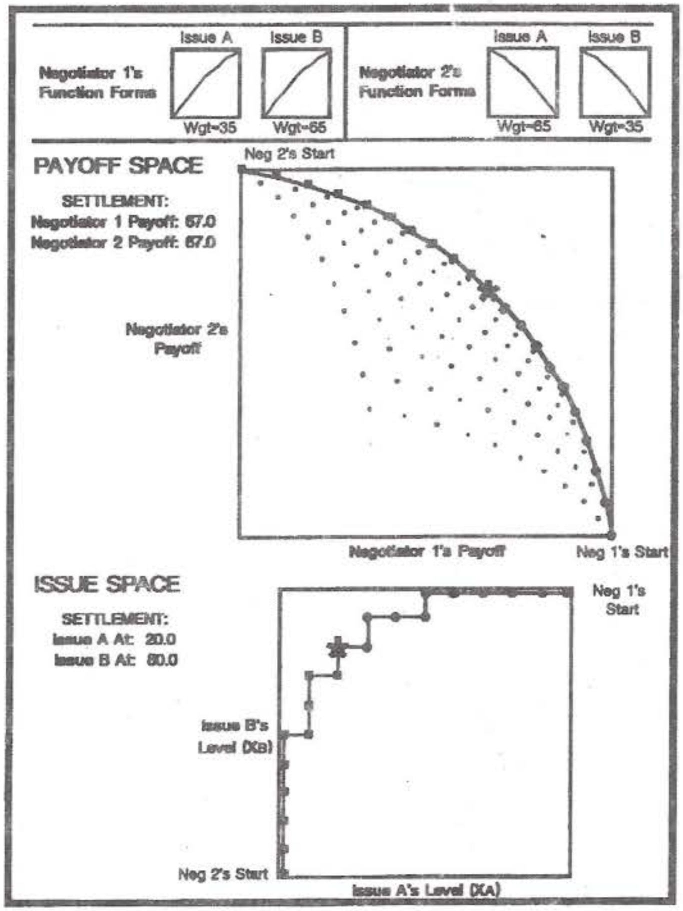

Figure 6. Individualistic negotiation dance for Problem I – concave function forms, different issues more important.

In Figure 6, the simulated negotiators confront Problem I (concave function forms and different issues more important). Again the negotiators dance along the efficient frontier of the settlement space, but their sequence of offers in issue space is less straightforward. One issue is nearly twice as important as the other, so negotiators initially concede on the other, less important issue. Because concessions on concave issues become progressively more costly, twice during the dance each negotiator discovers that it is marginally less costly to concede on their more important issue. The final agreement maximizes P_J and gives the negotiators equal payoffs, this time via a proportional compromise, $[x_A = 20,\ x_B = 80]$.

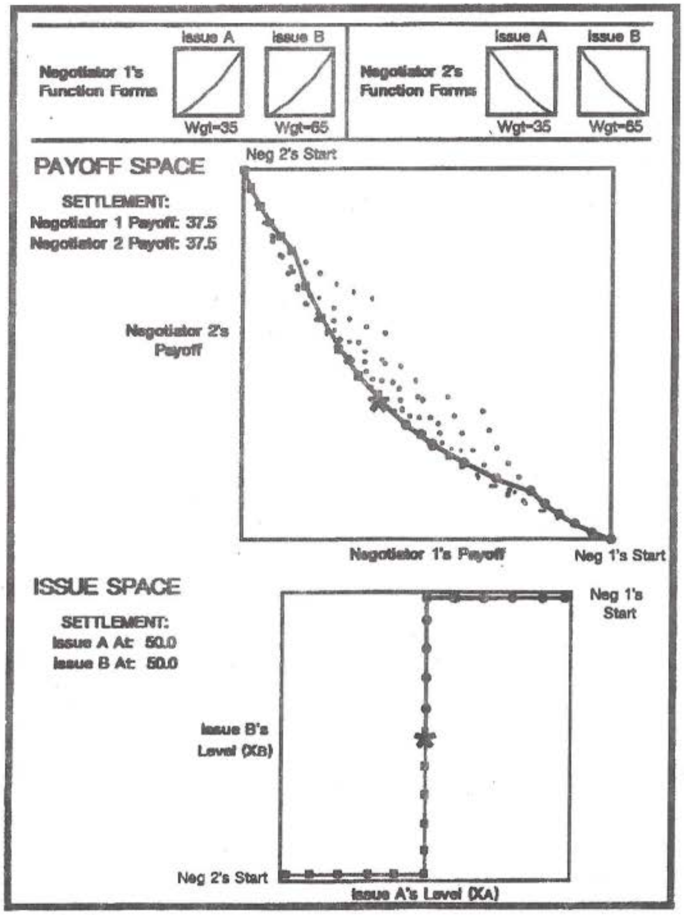

Figure 7. Individualistic negotiation dance for Problem IV – convex function forms, same issue more important.

As shown in Figure 7, in which the negotiators confront Problem IV (convex forms, same issue more important), the simulated negotiation dance does not always lead to efficient outcomes. Negotiators may dance away from the efficient frontier, into the interior of the feasible settlement space, and agree to a dominated alternative. The offers in issue space demonstrate one way this can happen. In their first five moves, both negotiators make all their concessions on their less important issue, just as they did in Problem II (Figure 5). After five rounds of offers, Issue A is settled at its mid-level ($x_A = 50$). In accordance with the rules of the game, the negotiators then make the remainder of their concessions on Issue B. Although for certain problems (e.g., Problem III), this same pattern of offers would result in a compromise settlement that maximized P_J and provided negotiators with equal payoffs, in the present example, negotiators arrive at an inefficient compromise.

Compromise, logrolling, and the individualistic strategy

Much of the literature on negotiation draws a strong distinction between compromise and logrolling. Compromise is portrayed as a distributive approach to bargaining that neglects potential "win–win," integrative logrolling solutions. The preceding simulations demonstrate that efficient agreements sometimes require compromise, sometimes logrolling, and sometimes other approaches (Darling & Mumpower, 1990; Mumpower, 1991).

The present analysis underscores a second important point. The same individualistic strategy may sometimes lead to compromise and sometimes to logrolling (and sometimes to other solutions), depending on the structure of the negotiation problem. Through the incremental dynamics of the negotiation dance, the individualistic rule can lead at various times to final outcomes that *appear* to reflect quite different approaches to the bargaining problem. Moreover, these outcomes may be efficient for some negotiation problem structures, and inefficient for others.

4. The Effect of Different Strategic Rules on Negotiation Outcomes

This section investigates the effects that different strategic rules for guiding concessionary behavior might have on contract negotiation process and outcome. Computer simulations are used to suggest answers to two general questions:

(1) What types of rules are most likely to maximize a negotiator's individual payoff?; and,

(2) What combinations of rules are most likely to maximize the joint payoff for the two negotiators?

Two sûb–issues are addressed: (a) Are different rules appropriate for different types of problem structures?; and, (b) What difference does the other negotiator's strategic rule make?

Strategic concessionary rules

MacCrimmon and Messick (1976) proposed a graphical model for representing social motives. The two axes of their model, concern for self and concern for other, allowed for the possibility that individuals might place either a positive or a negative weight on the other's welfare, as well as their own. Figure 8 shows an extension of this model (Darling, 1990; Darling & Mumpower, 1990) that identifies eight primary strategic negotiating orientations (starting at the right and proceeding counterclockwise): (1) individualistic; (2) cooperative; (3) altruistic; (4) sacrificing; (5) self–destructive; (6) nihilistic; (7) punitive; and, (8) competitive.

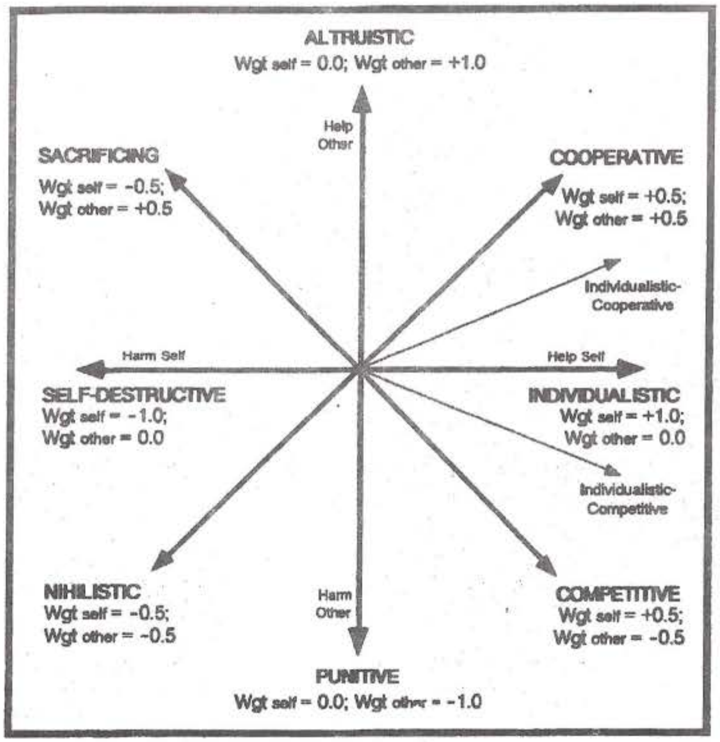

Figure 8. Eight strategic negotiating orientations based on weights on Self and Other.

In this section, we are concerned with five common rules. Three of these – cooperative, individualistic, and competitive – correspond to strategic orientations in Figure 8. The other two strategic rules – individualistic–cooperative and individualistic–competitive – are intermediate; in terms of Figure 8, they bisect the angles between the three primary strategies. In the simulation, negotiators use one of these five rules to make concessions during the negotiation dance. They make the concessionary offer that maximizes the weighted sum of the negotiator's own payoff and the other's payoff, in accordance with the weights appearing in Table 3.

	Self	Other
Cooperative	+0.50	+0.50
Individualistic-Cooperative	≈+0.72	≈+0.28
Individualistic	+1.00	0.00
Individualistic-Competitive	≈+0.72	≈-0.28
Competitive	+0.50	-0.50

Table 3. Strategic weights on self and other.

The present simulation assumes that negotiators focus their attention solely on the implications of their next concession. It also assumes they have perfect information about the marginal changes in their own and the other's payoffs that would result from possible concessions. Both of these are somewhat unrealistic assumptions, especially the latter. It seems reasonable, however, to assume that negotiators generally would have better insight into the payoffs associated with small incremental changes rather than larger ones, and could contemplate more easily the implications of their next concession, rather than contingent, multi–move sequences of offers and counter–offers.

Simulating negotiations between disputants using the five strategic concessionary rules

The present simulation relies on the same five cases used in the previous section. The negotiation process was simulated fifty times for each of the 100 problems that comprised each case – once with Negotiator 1 making the first move, and once with Negotiator 2 making the first move, for each of the 25 possible combinations of Negotiator 1 and Negotiator 2 strategic rules. Each simulation provided two sets of data, one that treated Negotiator 1 as "Self" and Negotiator 2 as "Other," and *vice versa*.

Negotiators are assumed to be egoists – they seek to maximize their own payoff. Why would such negotiators ever adopt a rule other than the individualistic one? As the following results will show, sometimes negotiators' self-interest may be served by considering the payoffs received by the other. Since the simulated concessionary rules focus on short-run considerations, their long-run impacts are not always readily predictable. Being competitive in the short-run is often not congruent with a negotiator's long-run self-interest; however, for certain problems, denying value to the other in the short run may be equivalent to claiming it for oneself in the long run. For other problems, cooperatively creating value for the other may be equivalent to creating value for oneself.

The long-run implications of negotiating rules depend on a number of factors about which the negotiators usually have incomplete and imperfect information: their own preferences; those of the other; and, the duration of the negotiation dance. When considering his or her next concession, a negotiator who places positive (or negative) weight on the other's welfare cannot be sure whether this will prove advantageous or disadvantageous in the longer run. The following analyses suggest some general conclusions about the impacts of different strategic concessionary rules.

Case Full.

Maximizing An Individual Negotiator's Payoff. Across all 100 problems, which of the five possible rules maximized the Self negotiator's average payoff? As shown in the top of Figure 9, assuming that the Other was equally likely to use any of the 5 possible concessionary rules, Self did best by adopting the individualistic rule.

What happens if Self is not individualistic? Figure 9 shows that Self's average payoff decreased when he or she used a rule that reduced the weight on self and increased the weight on the other negotiator. This was true whether Self placed a positive or a negative weight on the Other's payoff.

Would information about the Other's strategy have helped Self choose a better rule? Table 4 gives Self's average payoff from each of the 25 possible combinations of self/other rules. The payoffs in bold typeface show Self's *best reply* to each of the Other's rules. No matter what concessionary rule Other used, Self maximized his or her average payoff by adopting the individualistic rule.

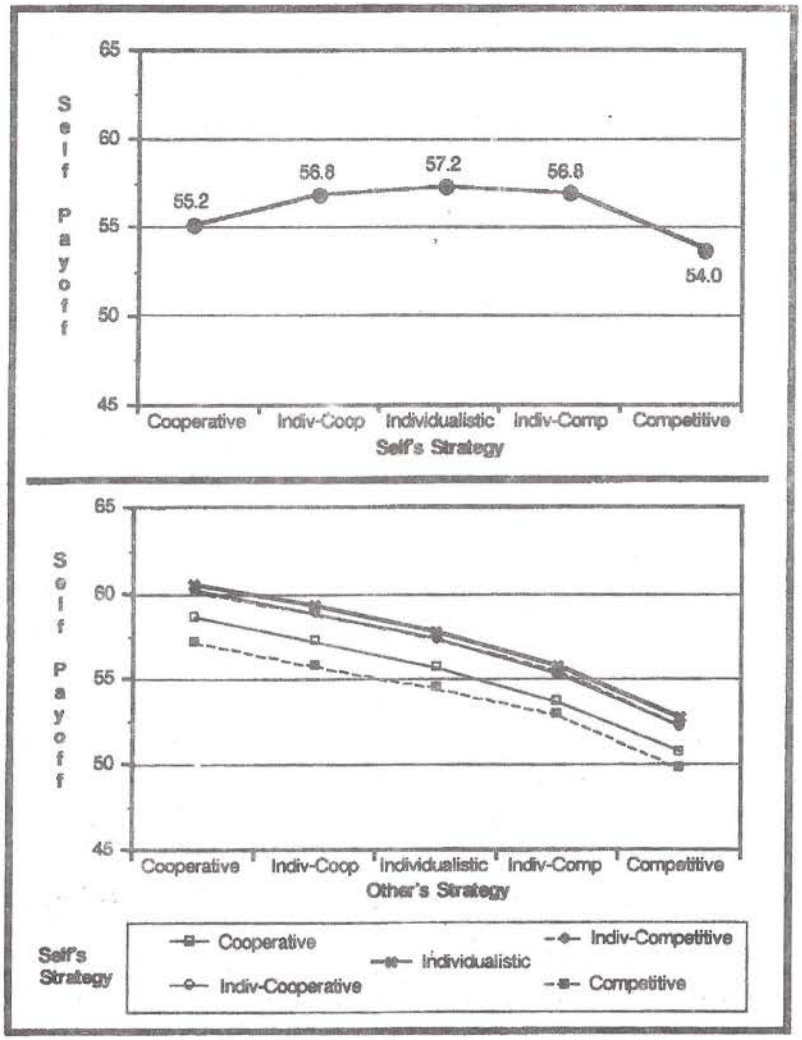

Figure 9. Case F(ull): Self's average payoff from his or her own strategy (top); Self's average payoff from interaction of Self and Other strategies (bottom).

Because the simulation used each negotiator twice, once as Self and once as Other, the self/other average payoff matrices are symmetric. Thus, the individualistic rule was the dominant concessionary rule for both negotiators. The settlements that resulted when both negotiators adopted the individualistic rule were in equilibrium; neither could improve his or her average payoff by unilaterally changing to another rule.

	OTHER'S RULE				
SELF'S RULE	Cooperative	Individualistic-cooperative	Individualistic	Individualistic-competitive	Competitive
Cooperative	58.7	57.2	55.7	53.6	50.7
Individualistic-cooperative	60.2	58.9	57.4	55.3	52.2
Individualistic	**60.6**	**59.3**	**57.8**	**55.7**	**52.6**
Individualistic-competitive	60.2	58.9	57.4	55.5	52.2
Competitive	57.2	55.8	54.4	52.9	49.7

Table 4. Self's average payoff for combinations of Self and Other strategic rules for Case F(ull).

The bottom of Figure 9 shows the interaction plot for the payoff information in Table 4. The Y–axis is the average payoff to Self. Each line plots one of Self's possible rules against all five rules that the Other might use. Against each of the Other's possible rules, the individualistic rule always was best for Self. If Self used either the individualistic–cooperative or the individualistic–competitive rule, he or she obtained essentially the same payoff as by adopting the individualistic rule. A Self who used either the cooperative or competitive rule, however, substantially reduced his or her average payoff. The simulations in Cases I–IV help to explain why this was so.

Figure 9 also shows the effect of the Other's concessionary rule on Self's payoff. As the Other's strategy moved from cooperative to competitive, Self's payoff decreased, regardless of the strategy Self used.

The Self negotiator's strategy had a larger effect on the Other's average payoff than on Self's own payoff. If pre–negotiation discussions were allowed, Self could, perhaps, try to intimidate the Other by threatening to adopt a competitive concessionary rule unless the Other were cooperative. Since the threat, if carried out, also would reduce Self's payoff (and since the Other could make the same threat), the effectiveness of this approach is questionable (Luce and Raiffa, 1957; Schelling, 1960:124–125).

Maximizing the Negotiators' Joint Payoff. Which combination of Self/Other negotiator rules maximized their average joint payoff? The maximum average joint payoff (58.9) was achieved when both negotiators adopted the individualistic–cooperative rule. The lowest average joint payoff (49.7) occurred when both negotiators were competitive.

Notice that both negotiators preferred their average payoff from the individualistic–cooperative/individualistic–cooperative combination to their payoff from the individualistic/individualistic equilibrium. The individualistic–cooperative/individualistic–cooperative combination was not stable, however. If one negotiator adopted the rule that led to the preferred result, the other negotiator could take advantage of the first by using the individualistic rule to maximize his or her own average payoff.

	OTHER'S RULE	
SELF'S RULE	Individualistic-cooperative (P_S, P_O)	Individualistic (P_S, P_O)
Individualistic-cooperative	(58.9, 58.9)	(57.3, 59.3)
Individualistic	(59.3, 57.3)	(57.8, 57.8)

Table 5. Prisoner's dilemma matrix for Case F(ull).

A variant of the prisoner's dilemma problem emerged from this simple bargaining game, revealing the tension between creating and claiming value emphasized by Lax and Sebenius (1985). As shown in Table 5, each negotiator preferred his or her average payoff from using the individualistic rule, whether the other negotiator adopted the individualistic–cooperative or the individualistic rule.

Cases I & II: Different Issues More Important; Concave and Convex Function Forms

Maximizing An Individual Negotiator's Payoff. Which of the five possible rules maximized a negotiator's average payoff? As shown in Figure 10, in Case I the negotiator should be individualistic, and in Case II he or she should use the individualistic–cooperative rule. In Cases I and II, there was little difference in average payoff between the individualistic rule and either the cooperative or individualistic–cooperative rules, both of which place some positive weight on the other negotiator. In these cases, a negotiator should not be competitive. As a

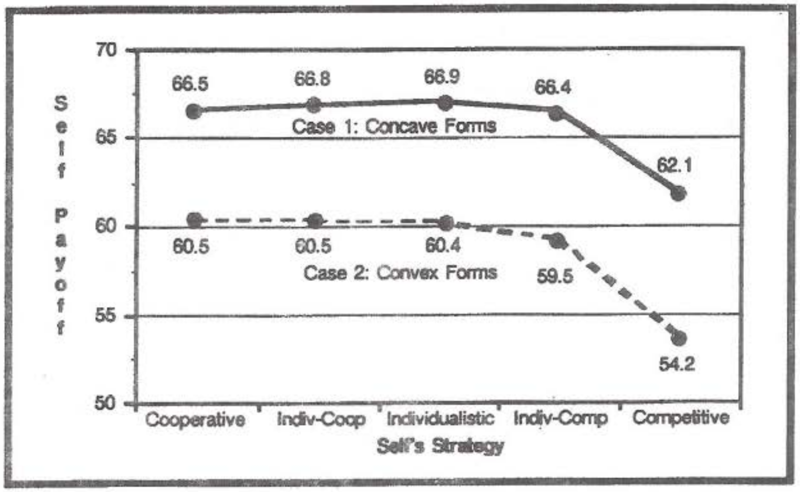

Figure 10. Cases I and II: Self's average payoff from his or her own strategy.

negotiator's rule moves from individualistic toward competitive, the negotiation process will lead to a settlement that yields a lower average payoff to him or her.

Why is there so little difference between the individualistic rule and those that place some positive weight on the Other's payoff? Since different issues were more important and the game required equal concessions, conceding to give value to the Other was consistent with claiming value for Self. When Issue B was more important to Self and less important to Other, to claim value Self conceded on Issue A, his or her less important issue. To give value to the Other, Self also conceded on Issue A, the Other's more important issue.

The interaction plot for Case II is shown in Figure 11; the interaction plot for Case I (not shown) was similar. In these cases, the rule adopted by the Other could have as great or greater effect on Self's payoff than Self's own strategic choice. Regardless of Self's strategic rule, his or her average payoff was comparatively high as long as the Other used individualistic or cooperative rules. A competitive Other could dramatically reduce Self's payoff, although only at the price of also reducing his or her own.

Maximizing the Negotiators' Joint Payoff. Average joint payoff was maximized by cooperative/cooperative negotiator pairs – in Case I, $P_J/2 = 68.6$, in Case II, $P_J/2 = 63.0$. The minimum average joint payoff occurred for competitive/competitive pairs – in Case I, $P_J/2 = 54.7$, in Case II, $P_J/2 = 47.1$. The prisoner's dilemma also occurred in these cases, but to a lesser degree than in

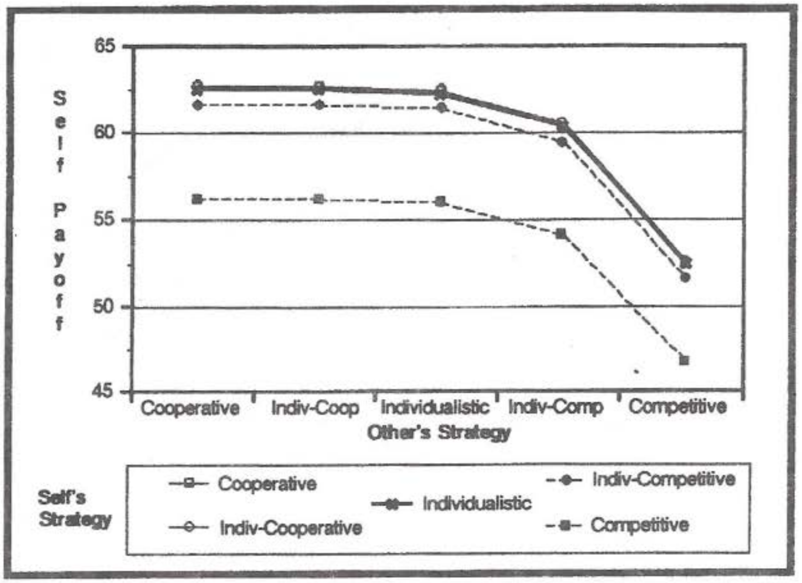

Figure 11. Case II: Self's average payoff from interaction of Self and Other strategies.

Case F.

Case III: Same Issue More Important; Concave Function Forms

Maximizing An Individual Negotiator's Payoff. As shown in Figure 12, either the competitive or individualistic–competitive rule maximizes a negotiator's average payoff. There was little difference in average payoff between these competitive rules, both of which place some negative weight on the other negotiator, and the individualistic rule. In Case III, a negotiator should not be cooperative. As a negotiator's rule moves from individualistic toward cooperative, the negotiation process will lead to a settlement that yields a lower payoff to him or her.

Why was it in the negotiator's self–interest to be competitive in Case III, rather than cooperative, which worked well in Cases I and II? Since the same issue (Issue B) was more important to both negotiators, in this case, claiming value for Self and giving value to the Other were not consistent with one another. A negotiator who cooperated by conceding on Issue B, would have acted counter to his or her own best interest.

Why was it better for a negotiator to be somewhat competitive, rather than purely individualistic? In most instances, it made no difference whether negotiators adopted the individualistic rule or one of the competitive ones. For a few simulated problems, however, being competitive helped a negotiator to avoid inferior settlements that would have been reached if he or she had used the individualistic rule.

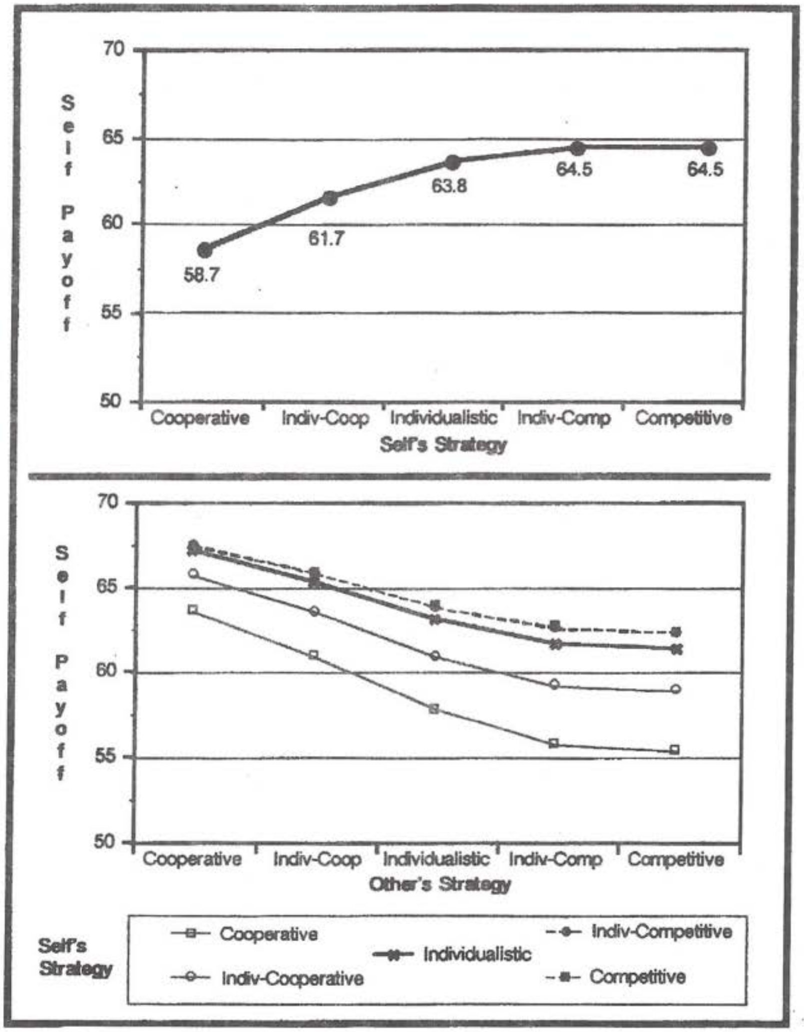

Figure 12. Case III: Self's average payoff from his or her own strategy (top); Self's average payoff from interaction of Self and Other strategies (bottom).

Typically, this occurred when Issue B was comparatively much more important to one negotiator than the other. (Recall that Issue B is more important than Issue A for both negotiators.) For instance, assume that the relative weight for Issue B was greater for Self than for the Other (e.g., $w_{SB} > w_{OB} \geq .5$). If negotiators are individualistic, at the beginning of the negotiations both will make more concessions on their less important issue, Issue A, but because function forms are concave, they also will make a few concessions on Issue B. Focussing solely on the marginal costs of the next move, the Other will more frequently make an occasional concession on Issue B. For certain of the simulated pairs, this proves unwise for the Other in the long-run. Later in the negotiation dance, when the Other would prefer to concede on Issue A, agreement has already been reached about its level, and he or she has no choice but to make still more concessions on Issue B. If the Other is somewhat competitive, however, these ultimately undesirable early concessions on Issue B are avoided, and he or she receives a higher payoff.

This illustrates an important point. The type of myopic rules simulated here, which focus on the marginal costs of the next move, have no capacity for foresight. For the present negotiation problem structure, the competitive rules lead a negotiator ultimately to superior payoffs, even though other strategic rules would have generated more desirable offers at intermediate points during the negotiation dance. A short-run focus may or may not prove congruent with a negotiator's long-term interests, and patterns of negotiation that appear to reflect some long-term strategy may sometimes be produced by simple heuristic rules.

The interaction plot for Case III is shown in the bottom of Figure 12. As in previous cases, the rule adopted by the Other has a significant effect on Self's payoff; Self's payoff increases as the Other becomes more cooperative.

Maximizing the Negotiators' Joint Payoff. As in Cases I and II, cooperative/cooperative negotiators maximized average joint payoff – $P_J/2 = 63.7$. The prisoner's dilemma that occurred in this case is shown in Table 6. There is a strong temptation to defect from cooperation. The payoff value gained by defecting to the individualistic–competitive rule is substantial. The payoff value lost if the Other defects while Self remains cooperative is large. And, if both negotiators defect, the difference between average payoffs for cooperative pairs and individualistic–competitive negotiators is small.

Case IV: Same Issue More Important; Convex Function Forms

Maximizing An Individual Negotiator's Payoff. Nothing a negotiator does in this case has much of an effect on his or her payoff, as shown in the top of Figure 13. The individualistic–cooperative rule is always a negotiator's best reply to whatever rule the other adopted, but there is little decrement in average payoff if any of the other rules are used. Instead, as shown in the bottom of Figure 13, a negotiator's payoff depends almost entirely on the strategy chosen by the Other.

	OTHER'S RULE	
SELF'S RULE	Cooperative (P_S, P_O)	Individualistic competitive (P_S, P_O)
Cooperative	(63.7, 63.7)	(55.7, 67.6)
Individualistic competitive	(67.6, 55.7)	(62.6, 62.6)

Table 6. Prisoner's dilemma matrix for Case III.

Maximizing the Negotiators' Joint Payoff. Cooperative/cooperative negotiators maximized average joint payoff – $P_J/2 = 45.2$, although in comparison to the previous cases the average is small. Pairs of competitive negotiators provided the lowest average joint payoff, 38.0. A mild prisoner's dilemma occurred.

The effects of strategic concessionary rules on negotiators' individual and joint payoffs

Across the five cases examined in this simulation game, what type of rule is most likely to maximize a negotiator's own payoff? Are different rules appropriate for different types of problem structures? The average payoff from using the individualistic rule was always the best result, or nearly the best result, a negotiator could achieve, regardless of the problem structure. Although the simulated negotiators had perfect information about the effect of their concessionary alternatives on the other's welfare, given the rules of the bargaining game, this information was not particularly helpful.

What difference does it make what the other negotiator's rules are? As far as a negotiator's optimal strategic choice, almost none. The individualistic rule is a strong reply to whatever rule the other is using. In another respect, however, the other negotiator's strategic choices are critical – the other's rule has as much or more of an effect on the negotiator's payoff than his or her own rule. The present simulations emphasize the interdependence of the negotiators – the simulated negotiators can help (or harm) each other more than they can help themselves.

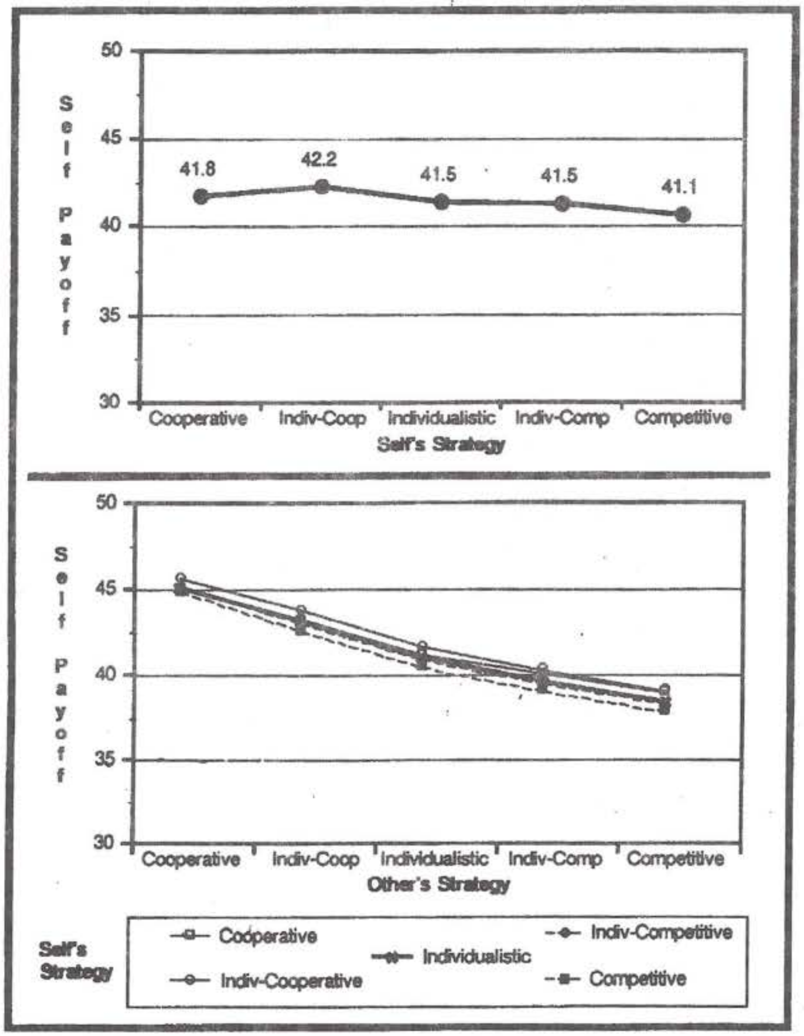

Figure 13. Case IV: Self's average payoff from his or her own strategy (top); Self's average payoff from interaction of Self and Other strategies (bottom).

What types of rules are most likely to maximize the joint payoff for the two negotiators? The average joint payoff was maximized by pairs of negotiators with rules that gave some positive weight to the other's welfare. Cooperative pairs of negotiators did better across all five cases than did individualistic pairs. Instances of the prisoner's dilemma were found in all the cases. If negotiators could somehow have ensured that neither would defect from cooperation, they would both have been better off than in the stable equilibrium (generally, individualistic//individualistic).

CONCLUSIONS

The simulation results demonstrated that in order to understand the process and outcome of contract negotiations it is important first to understand the structure of the negotiation problem. The joint distribution of potential payoffs, across all feasible settlements, defines the structure of the problem. The structure is determined by the interaction of the negotiators' evaluative judgment policies; it reflects the interdependence of negotiators.

The analyses demonstrated the manner in which the relative attractiveness of compromise and logrolling, two common solutions to negotiation problems, is largely dependent on problem structure. For some problems, one solution yields good payoffs to both negotiators while the other does not, sometimes both lead to attractive outcomes, and sometimes neither does. The analyses also showed that different social welfare criteria sometimes prefer the same negotiation settlements, and sometimes different ones, depending on the structure of the problem.

The outcome of negotiations is not determined by problem structure alone. The process of reaching agreement also is critical. The negotiation dance, in which disputants incrementally proceed toward a final settlement, is influenced by strategic judgments made by negotiators during their exchange of offers and counter–offers.

The analyses investigated the implications of several simple strategic rules for making concessions. These rules focussed solely on short term implications (i.e., the marginal impacts of the next offer). Despite their simplicity, these rules sometimes lead to simulated dances that appear, *post hoc*, to reflect a grand overall strategy.

For a self–interested negotiator, an individualistic rule, which placed no weight either positive or negative on the welfare of the other, did best (or nearly so) no matter what the structure of the problem or what the other negotiator did. The other negotiator's rule had as much or more of an effect on payoff as did one's own rule. Further, the analysis suggested that a prisoner's dilemma problem is often embedded in contract negotiations. A negotiator's payoff could be maximized if both negotiators acted cooperatively, but there is an incentive for each to defect in order to increase his or her own payoff.

Two lines of additional, simulation-based investigation are suggested by these results. The first and most natural expands the range of negotiation problem structures by looking at situations where the weights and function forms for negotiators are not drawn from identical distributions, or where both do not face the same payoff structure. Likewise, it might prove instructive to weaken the assumption that negotiators have perfect information about other disputant's payoffs. Perhaps, it might be assumed that negotiators have some insight into the other negotiator's payoff for potential settlements, but that such impressions are influenced by one's own payoffs (e.g., if a potential settlement gives me a low payoff, then it must necessarily give the other negotiator a correspondingly high payoff).

The second line of investigation would extend the current simulations beyond single meetings to repeated interactions. Repeated plays of matrix games such as the prisoner's dilemma (Axelrod, 1984; Luce and Raiffa, 1957) have provided rich insights into strategic behavior in social situations. Iterative play expands the strategic problem from a one-time choice of a concessionary rule, to how that choice should change based on the results of prior interactions with the other. By simplifying the negotiation problem to a prisoner's dilemma, Axelrod (1984) elegantly demonstrated the importance of being cooperative, provocable, and forgiving. Following this lead, it may prove useful to investigate what happens when the negotiator must select from among a range of rules (rather than just cooperate or defect), as is the case in contract negotiations, across a variety of problem structures.

References

AXELROD, R. (1984). *The Evolution of Cooperation.* New York: Basic Books.

BENTHAM, J. (1948). *An Introduction to the Principles of Morals and Legislation.* New York: Hafner. (Originally published, 1789).

DARLING, T.A. (1990). Computer-Assisted Analysis of Negotiations. In P.M. Mangiameli (ed.), *Proceedings of the Nineteenth Annual Northeast Decision Sciences*

Institute. Madison, Wisc.: Omnipress, 177–179.

DARLING, T.A., AND J.L. MUMPOWER (1990). Modeling Cognitive Influences on the Dynamics of Negotiations. In R.H. Sprague (ed.), *Proceedings of the Twenty-Third Hawaii International Conference on System Sciences, Vol. IV.* Los Alamitos, Calif.: IEEE Computer Society Press, 22–30.

FISHER, R., AND W. URY (1981). *Getting to Yes: Negotiating Agreement Without Giving In.* Boston: Houghton Mifflin.

HAMMOND, K.R., T.R. STEWART, B. BREHMER, AND D.O. STEINMANN (1975). Social Judgment Theory. In M.F. Kaplan and S. Schwartz (eds.), *Human Judgment and Decision Processes:Formal and Mathematical Approaches.* New York: Academic Press.

LAX, D.A., AND J.K. SEBENIUS (1986). *The Manager as Negotiator: Bargaining for Cooperation and Competitive Gain.* New York: Free Press.

LUCE, R.D., AND H. RAIFFA (1957). *Games and Decisions.* New York: Wiley.

MACCRIMMON, K.R. AND D.M. MESSICK (1976). A Framework for Social Motives. *Behavioral Science,* **25**, 86–100.

MILTER, R.G., T.A. DARLING, AND J.L. MUMPOWER (1991). The Effects of Issue Labels on the Ability of Negotiators to Reach Efficient Agreements. Albany, NY: University Center for Policy Research, SUNY.

MORECROFT, J.D.W. (1985). Rationality in the Analysis of Behavioral Simulation Models. *Management Science,* **31** (7), 900–916.

MUMPOWER, J.L. (1988). An Analysis of the Judgmental Components of Negotiation and a Proposed Judgmentally-Oriented Approach to Mediation. In B. Brehmer and C.R.B. Joyce (eds.), *Human Judgment: The SJT Approach.* Amsterdam: North-Holland, 465–502.

MUMPOWER, J.L. (1991). The Judgment Policies of Negotiators and the Structure of Negotiation Problems. *Management Science,* **37** (10), 1304–1324.

MUMPOWER, J.L., AND T.A. DARLING (1991). Modeling Resource Allocation Negotiations. In J.F. Nunamaker, Jr. (ed.), *Proceedings of the Twenty-Fourth Hawaii International Conference on System Sciences, Vol. III.* Los Alamitos, Calif.: IEEE Computer Society Press, 641–649.

NASH, J.F. (1950). The Bargaining Problem. *Econometrica,* **18**, 155–162.

NASH, J.F. (1953). Two Person Cooperative Games. *Econometrica,* **21**, 128–140.

PRUITT, D.G. AND J.Z. RUBIN (1986). *Social Conflict: Escalation, Stalemate, and Settlement.* New York: Random House.

RAIFFA, H. (1982). *The Art & Science of Negotiation.* Cambridge, Mass.: Harvard University Press, Belknap Press.

RAWLS, J.A. (1971). *A Theory of Justice.* Cambridge, Mass.: Harvard University Press, Belknap Press.

ROTH, A.E. (1985). Toward a Focal-Point Theory of Bargaining. In A.E. Roth (ed.), *Game-Theoretic Models of Bargaining.* Cambridge: Cambridge University Press, 259–268.

SCHELLING, T.C. (1960). *The Strategy of Conflict.* Cambridge, Mass.: Harvard University Press.

SIMON, H.A. (1976). *Administrative Behavior,* third edition. New York: The Free Press.

STERMAN, J.D. (1989). Misperceptions of Feedback in Dynamic Decision Making. *Organization Behavior and Human Decision Processes,* **43** (3), 321–339.

STEWART, T.R. (1988). Judgment Analysis: Procedures. In B. Brehmer and C.R.B. Joyce (eds.), *Human Judgment: The SJT Approach.* Amsterdam: North–Holland, 41–74.

WALTON, R.E., AND R.B. MCKERSIE (1965). *A Behavioral Theory of Labor Negotiations.* New York: McGraw–Hill.