The Hostage Crisis Simulation

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The HOSTAGE CRISIS SIMULATION

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The HOSTAGE CRISIS SIMULATION was developed as part of a simulated real-world situation in which negotiators can be trained and experiments conducted. The work consists of a strategic model of negotiation and a sophisticated computer-based decision support system. Three central dimensions of negotiation are incorporated into this model: the role of time; the formation by the parties of preference orderings for different negotiated agreements and outcomes; and the availability of information to the parties. An additional feature of this project will be the design of an automated negotiation agent. This article presents the elements of the HOSTAGE CRISIS SIMULATION, based on the hijacking by Palestinians of a passenger plane bound from Europe to Israel and its forced landing at Cairo. It presents preliminary findings based on experimental runs of the model with undergraduate international relations students. Among the reported findings is confirmation that the performance of participants in simulated crisis negotiations improves with their exposure to decision support tools.

KEYWORDS: *crisis; decision support system; hostage crisis; ICONS; negotiations.*

The HOSTAGE CRISIS SIMULATION to be described in this article was developed in conjunction with the work of Project ICONS at the University of Maryland. ICONS places participants in the roles of foreign policy decision makers for various countries, interacting on the basis of a scenario that deals with such issues as arms control, human rights, environmental concerns, nuclear proliferation, and economic issues such as trade and debt. Computer networks such as Sprintnet and NSFNET/Internet are used to link as many as 20 country-teams in joint exercises lasting up to 4 weeks.

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Development of THE HOSTAGE CRISIS SIMULATION was envisaged as a training exercise for persons who would eventually participate in an ICONS simulation. It involves both human and computer simulation. An ultimate objective of the Hostage Crisis portion of the project is the creation of a prototype automated negotiator, based on a strategic model of negotiations. This work is undertaken as part of the development of a simulation environment of a real-world situation, in which negotiators can be trained and experiments conducted. Ongoing theoretical work forms the basis for the development of the automated negotiator, and current work on the creation of a user interface will facilitate the employment of the model for training and experimental purposes. Further, experimental work conducted with the prototype automated negotiator, based on the hypothetical international crisis outlined below, will form the basis for modification and refinement of the theory.

Our theoretical work to date has focused on three central dimensions of strategic negotiations: the role of time, the formation by the parties of preference orderings for different negotiated agreements and outcomes, and the availability of information to the parties (Kraus & Wilkenfeld, 1991a, and 1991b). A preliminary model has been constructed, based on the differential impact of time on the parties, agreement preferences in a restricted two-party environment, and full information (see Kraus & Wilkenfeld, 1990a). Theoretical extensions of this model are now underway to incorporate the impact of changes in preferences resulting from the involvement of third parties, attitudes of the players toward risk (risk averse, risk neutral, risk prone), and uncertainty resulting from imperfect information. With these theoretical extensions in place, the design for the automated negotiator will be developed and an initial prototype created. This latter work will be undertaken using artificial intelligence techniques.

Work in distributed artificial intelligence has dealt with negotiation strategies that can be used in building agents that are able to communicate to reach mutually beneficial agreements (see, for example, Davis & Smith, 1983; Durfee, 1988; Malone, Fikes, & Howard, 1988; Sathi & Fox, 1989; Sathi, Morton, & Roth, 1986). Sycara (1987), using case-based reasoning, and Kraus, Ephrati, & Lehmann (1989) modeled negotiations from a cognitive standpoint, and Matwin, Szpakowicz, Koperczak, Kersten, and Michalowski (1989) developed an expert system shell to support negotiators. Rosenschein and Genesereth (1985), Genesereth, Ginsberg, and Rosenschein (1986), and Zlotkin and Rosenschein (1989) used certain game-theoretic techniques to model communication in multi-agent interaction.

A variety of approaches to crisis phenomena have been explored by political scientists and other students of decision making: the Stanford studies

of the link between perceptions and decisions in the 1914 crises (Zinnes, North, & Koch, 1961; Holsti, 1965), McClelland's (1972) use of macrolevel quantitative data to examine a sequence of crises in the Berlin and Taiwan Straits crises, Paige (1968) on U.S. decision making in the Korean War Crisis and Allison's (1971) models of decision making in the Cuban missile crisis. Also of note are George and Smoke's (1974) study of deterrence processes in 11 U.S. crises, Snyder and Diesing's (1977) analysis of the bargaining process in 16 international crises from 1898 to 1973, Stein and Tanter's (1980) model of Israeli decision making in the 1967 Middle East War, Lebow's (1981) analysis of cognitive closure and crisis management, Leng's (1988) quantitative analysis of bargaining in 20th-century crises, and George's (1983) studies of crisis prevention. Most recently, the International Crisis Behavior Project has focused on the behavior of actors in all crises in the last half century (Brecher & Wilkenfeld, 1989; Brecher, Wilkenfeld, and Moser, 1988; Wilkenfeld, Brecher, & Moser, 1988).

Studies of a closely related phenomenon, "militarized international disputes," have also made considerable contributions to theory development (Gochman & Maoz, 1984; Leng & Singer, 1988), as have several analyses of deterrence and crisis management (Huth & Russett, 1988; Jervis, Lebow & Stein, 1985; Winham, 1988). Finally, the systematic study of war itself, as a manifestation of failed crisis management, has received considerable systematic attention in this literature (Singer & Small, 1972; Singer, Bremer, & Stuckey, 1972; Small & Singer, 1982).

The Hostage Crisis

The Hostage Crisis, to be outlined below as seen from the perspective of individual decision makers, is a special case of foreign policy decision making. For definitional purposes, a foreign policy crisis, that is, a crisis viewed from the perspective of an individual state, is a situation with three necessary and sufficient conditions deriving from a change in a state's external or internal environment. All three are perceptions held by the highest level decision makers of the actor concerned: a threat to basic values, along with the awareness of finite time for response to the external value threat, and a high probability of involvement in military hostilities (Wilkenfeld, Brecher, & Moser, 1988).

This article presents a detailed discussion of the substantive background of the HOSTAGE CRISIS SIMULATION. In the process of developing a strategic model of negotiations, we began with a hypothetical case of an international crisis involving three real-world parties (see Kraus & Wilkenfeld,

1990b). In working through the details of the hypothetical crisis, we were able to formalize the general process of negotiation under crisis conditions. This latter formalization in turn provides the basis for the development of a decision support system called the Hostage Crisis Interface (to be discussed below), and an automated negotiation agent, which will be used in experimental work involving simulation of the negotiation process in general.

The Setting

A commercial airliner en route from Europe to Israel is hijacked and forced to land at Cairo International Airport. The passengers are predominantly Israeli, but there are a number of Americans and other nationals aboard.

The hijackers are known to be Palestinian, although their affiliation is not clear at the outset. They are demanding the release from Israeli security prisons of an undetermined number of Arab prisoners, and safe passage for the hijackers to an undisclosed destination.

The three parties to the HOSTAGE CRISIS SIMULATION are Israel, the terrorists (hijackers), and Egypt. Each party must consider six possible outcomes of the crisis:

1. Israel launches a military operation in an attempt to rescue the hostages.
2. Egypt launches a military operation in an attempt to rescue the hostages.
3. The terrorists blow up the plane with the hostages and themselves aboard.
4. Israel and the terrorists negotiate an agreement.
5. Egypt and the terrorists negotiate an agreement.
6. The terrorists give up without harming the hostages.

The hostage crisis was chosen as a typical case of multiparty negotiation. Although this hypothetical case is quite specific in detail, the intention is to build a general model of negotiation. The choice of a real historical case would have increased the complexity of the model, at the same time reducing its potential generalizability.

Once the case was chosen, it was reduced to its essential characteristics. For example, this model consists of only three players: the terrorists, Israel, and Egypt. Additional actors such as the United States or Syria could have been added, but it was felt that these three adequately represent the most important types of actors and their interests in such a negotiation. Similarly, the number of options available to each player could have been increased—for example, Israel could have had the option of kidnapping a prominent Palestinian leader, in addition to its two options of agreement with the

TABLE 1: Israeli Objectives

1A.	Safe return of the passengers	180 points
1B.	Acceptable level of casualties among military	45 points
2A.	Maintenance of status quo in relations with Egypt	50 points
2B.	Maintenance of status quo in relations with United States	80 points
3.	No concessions to terrorists	100 points
4.	No negative effect on Israeli public opinion	100 points
5A.	Restrict publicity for terrorist cause	80 points
5B.	No damage to Israel's external image	50 points
6A.	Credibility of Israel's deterrence against terrorism is maintained	140 points
6B.	Israel's overall strategic interests are unchanged	140 points
6C.	Experience in counterterrorism operations augmented	35 points
	Total	1,000 points

terrorists or launching a military operation. Here again, we assume that the added complexity that additional options would have entailed would not have added appreciably to the reliability or generalizability of the model.

Each party to the negotiation has a set of objectives, and a certain number of utility points is associated with each (see Kraus & Wilkenfeld, 1990a). Utility points were assigned in order to express a complex set of preferences in such a way that subtle distinctions can be made among them. Short-term objectives pertain to the resolution or management of the immediate crisis, and long-term objectives have to do with the consequences of the policy chosen by that actor once the immediate situation has been resolved. Tables 1 to 3 present listings of the objectives of each of the three parties, and the utility points associated with each.

For Israel, short-term objectives involve the safe return of the passengers and an acceptable level of casualties among Israeli military personnel in the event of military action. For the terrorists, short-term objectives include the release of prisoners held in Israeli jails, release of the hostages, and safe passage for the terrorists. Egypt is cast in the role of mediator or facilitator, and has no exclusively short-term goals.

Among Israel's major long-term goals is a cluster of factors relating to the credibility of its deterrence against terrorism, its overall strategic interests, and experience in counterterrorism. For the terrorists, long-term objectives include damage to Israel's internal and external image, damage to Israel's deterrence against terrorism, and damage to Israel's relations with the United States and Egypt. For both Israel and the terrorists, the long-term consequences are considerably more important than the resolution of the immediate situation.

TABLE 2: Terrorist Objectives

1.	Release of prisoners held in Israel	180 points
2.	Safe passage for terrorists	100 points
3.	Message of terrorists—publicity	320 points
4.	Damage to Israeli deterrence against terrorism	75 points
5A.	Damage to Israeli relations with Egypt	25 points
5B.	Damage to U.S.-Israeli relations	50 points
6.	Damage to Israeli external image	100 points
7.	Damage to Israeli internal image	75 points
8.	Enhanced position of terrorist group in Palestinian movement	75 points
	Total	1,000 points

TABLE 3: Egyptian Objectives

1A.	Egyptian demonstration of control	375 points
1B.	Egyptian internal image	100 points
2A.	Israel is not strengthened	50 points
2B.	Israel is not weakened	25 points
3.	No strengthening of terrorists	50 points
4.	Maintenance of status quo with United States	50 points
5.	Maintenance of status quo with Arabs	225 points
6.	Maintenance of status quo with others	50 points
7.	Maintenance of status quo with Israel	25 points
8.	Maintenance of status quo with Palestinians	50 points
	Total	1,000 points

As we have indicated, all of Egypt's objectives are long-term in nature. By far the most important Egyptian objective is its ability to demonstrate its control of the situation, and the maintenance of its internal image. Also of critical importance is Egypt's ability to emerge from the crisis with its relations with other Arab countries intact.

In combining the range of utility points associated with each objective with the six possible outcomes listed above, a matrix is generated that yields a point output total for the various outcomes. In the case of three of these outcomes—an Israeli or Egyptian military operation, and a terrorist decision to blow up the plane—probabilities are attached to the success or failure of such actions (see the separate discussion of probabilities below).

The specific issues to be negotiated during the course of the crisis include the following:

Israel-terrorists

— Number of prisoners to be released by Israel in exchange for release of all hostages

Israel-Egypt

— Israel request for logistical information from Egypt on location and condition of plane, number and affiliation of hijackers and types of arms possessed by hijackers
— Israel request for Egyptian assistance during an Israeli operation
— Israel request that Egypt deny the terrorists access to the media in order to publicize their message
— Egypt request for Israeli assistance during an Egyptian operation
— Egypt request that Israel accept a terrorist offer

Terrorists-Egypt

— Terrorist request for access to the media to publicize their message
— Egypt request that terrorist give up or reach an agreement for safe passage
— Egypt request that the terrorists accept an Israeli offer.

Rules of the Simulation

The following rules govern the play of the participants in the simulation.

1. Possible actions are an Israeli military operation, an Egyptian military operation, and the terrorists blowing up the plane. These actions are put into motion when the action's initiator sends a message to that effect to the manager (control).
2. Actions take effect at the end of a period. In the event that two or all three parties take action in the same period, the results will be as follows:
   - If Israel and/or Egypt launch operations, and the terrorists blow up the plane: Action = terrorists blow up plane
   - If Israel and Egypt launch operations: Action = Egyptian operation.
3. Actions are irreversible.
4. The outcome of an action—success, failure, or partial in the case of a military operation, success or failure in the case of the terrorists blowing up the plane—will be announced by the manager. This determination will be made in accordance with a random number drawn and the probabilities associated with these outcomes for the player undertaking the action (see discussion of probabilities below).
5. The following interim agreements will become final and irreversible once they are communicated to the manager:
   - Egypt agrees to provide Israel with information—quantity in terms of percentile must be specified. The quantity of information provided by Egypt

can be increased during the course of the simulation. This Egyptian-Israeli agreement is secret.

- Egypt agrees to allow the terrorists direct access to the press—the period in which this is to go into effect must be specified. This Egyptian-terrorist agreement is made public.

6. An Egyptian decision to help Israel, fight Israel, or remain neutral—in the event of an Israeli operation—can be changed at any time, provided such a message has been received by the manager prior to the launching of the operation. Similarly, an Israeli decision to help Egypt or remain neutral—in the event of an Egyptian operation—can be changed at any time, provided the manager has been notified. These decisions will remain secret until the end of the simulation.
7. If agreement to end the crisis is reached, both parties must send a message to the manager with identical details of the agreement. If this occurs, the simulation is over and the manager will announce the outcomes. Otherwise, the simulation continues.
8. The manager will determine the end of the simulation and calculate the results.

Time

The concept of the passage of time is incorporated into the model in two ways. First, it provides a reference point for the calculation of utilities and probabilities. Second, time is a factor for the three parties, because the passage of time impacts on them differently. In general, time works in favor of the terrorists, and against Israel and Egypt. This latter aspect of time sets up a complex negotiation dynamic for the crisis.

Time impacts on the following aspects of the model: (a) the probability of success of an Israeli or Egyptian military operation (having to do with whether the operation is launched in daylight or at night, time available for preparation of troops, deteriorating weather conditions, and condition of terrorists and hostages); (b) the extent of publicity for the terrorists' message; and (c) the utility points associated with Israel and Egypt's internal and external images, and for Egypt, demonstration of control.

Probabilities

Each of the parties in the HOSTAGE CRISIS SIMULATION has one option available to it, the success of which is subject to probability. For Israel and Egypt, there are probabilities associated with the success or failure of a military operation. For the terrorists, there are probabilities associated with their ability to successfully execute a decision to blow up the plane. A number of factors contribute to these probabilities; they will be discussed for each of the actors in turn.

Israel

Among the options available to Israel is the launching of a military operation to free the hostages being held aboard the hijacked plane at Cairo International Airport. A successful operation is one in which virtually all of the hostages are freed unharmed, there is an acceptable number of casualties among the members of the raiding party, and the terrorists are either captured or killed. An unsuccessful operation is one in which there are heavy casualties among the hostages and there is an unacceptably large number of casualties among the members of the raiding party. Finally, a partial success is a case in which there are some casualties among the hostages and the raiding party sustains heavy but marginally acceptable casualties.

The probabilities associated with each of these outcomes (success, failure, partial) depend on whether a number of conditions are favorable or unfavorable for purposes of carrying out such an operation. Table 4 summarizes the ranges of probabilities.

There are seven specific conditions that together determine the probability of a particular outcome for Israel. When all conditions are unfavorable, the lowest of the two probabilities is assigned. When all conditions are favorable, the highest probability figure is assigned. Thus, as we note in Table 4, when conditions are favorable, an Israeli operation has a .30 probability of success, a .25 probability of failure, and a .45 probability of partial success (summing to 1.00). The specific conditions which contribute to the calculation of these probabilities are discussed below, and are based on a total of 1.00.

Information: .26 points. It will be recalled that one of the issues that Israel and Egypt will negotiate in the simulation is the amount of information that Egypt will provide Israel. Israel can use whatever information it receives from Egypt both to enhance its negotiating position with the terrorists and to increase the chances of a successful military operation. Thus Israel would like to get as much information as possible. Egypt, on the other hand, would like to give Israel as little information as possible, so as to avoid an Israeli military operation. However, it wants to give Israel enough information so that Israel will be able to reach a satisfactory agreement to resolve the crisis, and thus will choose such an agreement over a military operation.

There are four components to the information category: (a) affiliation of the terrorists (what group), (b) number of terrorists involved, (c) location of the plane at the airport, its type, and other relevant logistical data, and (d) types of weapons and explosives the terrorists possess. Each component is worth .065 points.

TABLE 4: Probabilities Associated With an Israeli Military Operation

Success		*Failure*		*Partial*	
Favorable Conditions	*Unfavorable Conditions*	*Favorable Conditions*	*Unfavorable Conditions*	*Favorable Conditions*	*Unfavorable Conditions*
.30	.02	.25	.78	.45	.20

Egyptian cooperation: .24 points. This factor relates to Egyptian cooperation with Israel during an Israeli military operation. Egypt must communicate its intentions to the manager of the simulation prior to the launching of an operation. If Egypt cooperates with Israel, then Israel receives all .24 points. If, on the other hand, Egypt's message to the manager indicates that Egypt will fight Israel, then Israel will receive no points. If Egypt remains neutral, Israel receives .10 points.

Night and day: .10 points. Each day is divided into four periods, two of daylight and two of nighttime. It is assumed that for Israel, the operation has a greater chance of success if it is carried out at night. Hence, during the two nighttime periods, Israel will get the full .10 points, while during the daylight periods, Israel will receive none of these points.

Training/preparation of assault team: .20 points. No matter how much advanced training the Israeli counterterrorism unit has had, the particulars of the specific situation will necessitate some additional training, preparation, and planning. The longer the crisis lasts before an operation is launched, the better training and preparation will be. Israel can gain .01 point each period, up to .20 points.

Weather: .08 points. A weather report is issued at the beginning of the hostage incident, indicating that the parties should expect deteriorating conditions over the next few days. Israel will begin with .08 points in the first period, and lose .02 points at the end of each day (4 periods) that the crisis remains unresolved, up to a maximum of .08 points.

Condition of hostages: .06 points. The longer the crisis drags on, the more likely it is that some of the hostages will experience a deterioration in their physical conditions. Others may have been wounded in the initial attack. It is assumed that the worse their condition, the more difficult it will be to launch a successful military operation for their rescue. Israel will have all .06

points in the first four periods, with a decrease of .02 each day thereafter (until .00 is reached).

Condition of terrorists: .06 points. The condition of the terrorists may also deteriorate during the course of the crisis. As fatigue sets in, they may become more edgy, less inclined to negotiate, and generally less rational. Israel will have all .06 points in the first period, with a decrease of .01 each period (until .00 is reached).

Total = 1.00 points. It should be noted that only the first two conditions are subject to negotiation in the simulation. For any period, the user can obtain the relevant probabilities of success, failure and partial. In order to compute the exact probability of a particular outcome (success, failure, or partial) when the value of all seven conditions is given by x, the following formula may be used: (Favorable – Unfavorable) $\times x$ + Unfavorable.

Egypt

Egypt also has the option of launching a military operation in order to free the hostages. A successful Egyptian operation is defined as release of the hostages and few casualties among the raiding party. An unsuccessful operation is one in which a large number of hostages are killed, along with large casualties among the raiding party. A partial success means that some hostages were killed and there were moderate casualties among the raiding party members.

The probabilities associated with each of these outcomes (success, failure, partial) depend on a number of conditions. Table 5 summarizes the ranges of probabilities.

There are six conditions that contribute to the probability of a particular outcome for an Egyptian operation. These conditions follow.

Israeli cooperation: .24 points. Egypt will get all .24 points when Israel agrees to cooperate in an Egyptian operation in terms of logistical support and expertise. Egypt will receive zero points for this condition when there is no agreement with Israel for its cooperation.

Day and night: .10 points. Like Israel, Egypt will also benefit from the launching of the operation in darkness. Thus, during the two nighttime periods per day, Egypt will receive the full .10 points, and will lose all .10 points if it launches an operation in daylight.

TABLE 5: Probabilities Associated With an Egyptian Military Operation

Success		*Failure*		*Partial*	
Favorable Conditions	*Unfavorable Conditions*	*Favorable Conditions*	*Unfavorable Conditions*	*Favorable Conditions*	*Unfavorable Conditions*
.10	.01	.70	.89	.20	.10

Training/preparation of Assault Team: .41 points. Our assumption is that the level of preparation of the Egyptian assault team will be lower in the beginning than an Israeli team. And as time passes and training and preparation takes place, Egypt gains considerably more than Israel. With the passage of each period, Egypt will gain .01 training point.

Weather: .07 points. Weather is also a factor, and as in the case of Israel, its deterioration during the course of the crisis adversely affects the probability of a successful Egyptian operation. Egypt will lose .02 points for each day that the crisis remains unresolved.

Condition of hostages: .09 points. See Israel for discussion of this condition.

Condition of terrorists: .09 points. See Israel for discussion of this condition.

Only the first condition is the subject of negotiation. For any period, the user can obtain information on the relevant probabilities. Computation of the probabilities for success, failure, and partial success is done in a similar manner to that described for Israel.

Terrorists

Among the options available to the terrorists is to blow up the plane, resulting in their deaths as well as the deaths of the hostages. This model assumes that although such a decision on the part of the terrorists has a very high probability of success, that probability is not 1.00. The terrorists begin in period 1 with a probability of .99 of successfully blowing up the plane, the .01 loss due to the possibility of faulty equipment.

In each succeeding period, the terrorists lose an additional .01 in probability of successfully blowing up the plane. This is due to the deteriorating

condition of the terrorists, who are experiencing fatigue and anxiety. Because it will be assumed that to blow up the plane requires the coordinated effort of all the terrorists, fatigue and anxiety will cause a loss in group cohesion, such that there will be a certain probability of failure to actually blow up the plane. Failure of an attempt to blow up the plane will result in the terrorists giving up (being captured).

Preliminary Experimental Results

We have developed a menu-driven decision support system that enables players in the HOSTAGE CRISIS SIMULATION to interact with other human players, with the simulation manager, and, eventually, with the automated negotiator. The Hostage Crisis Interface facilitates decision making by the human players by enabling them to create and examine hypothetical future situations, based on alternative negotiation strategies. For example, a player can hypothesize that events 1, 2, and 3 will occur and then see how these occurrences will be reflected in his or her utility point score. Interplayer and player-manager communication is handled by the POLNET II software, a UNIX-based system written in C, which is in general use in Project ICONS simulations at the University of Maryland. The Hostage Crisis Interface runs under IBM DOS. It is written in Turbo C 2.0 and uses the C-Scape Interface Management System and the MetaWindow Plus graphics toolkit (for detailed discussion of the Hostage Crisis Interface, see Harris, Kraus, Wilkenfeld, & Blake, 1991).

The all-human version of the HOSTAGE CRISIS SIMULATION was tested with undergraduate international relations students at the University of Maryland in the spring of 1991. A total of 32 simulations were run, each beginning with the same scenario. Each participant, representing one of the three parties to the crisis, was seated before a networked IBM PS/2, and was able to move back and forth from the Hostage Crisis Interface (where they were able to make projections about the utility points associated with various outcomes) to the POLNET II software (which they could use to communicate with the other parties). The POLNET II software stored all messages exchanged, and these were then available to the authors for postsimulation analysis.

Although we did not have an ideal controlled environment in which to run these experiments, some of the preliminary results are nonetheless quite revealing. At the very least, they are encouraging enough to warrant further work with the HOSTAGE CRISIS SIMULATION, both in its all-human version and in the version that will incorporate the automated negotiator. In

TABLE 6: Average Utility Points at Conclusion of Run

	India	*Pakistan*	*Sikhs*
Interface	479	529	498
Noninterface	438	444	431

TABLE 7: Outcomes

	Agreement	*India Act*	*Pakistan Act*	*Sikh Act*
Interface	4	2	1	0
Noninterface	2	2	2	0

the tables below, we summarize some of the patterns we have observed based on some of these initial runs. It should be noted that preliminary runs indicated that the students had preconceived notions of how Israelis and terrorists typically behave in such situations and that this interfered with their proper evaluation of strategies and outcomes. Therefore, the scenario for these experiments was altered for these experimental runs, with the Israelis becoming Indians, the Egyptians becoming Pakistanis, and the Palestinians becoming Sikh separatists.

In this brief discussion, we will deal with two questions from among many that we have begun investigating.

1. Does use of a sophisticated decision support system such as the Hostage Crisis Interface increase the likelihood of higher payoffs to the participants?
2. Do the communications patterns exhibited by participants in a simulation that ended in a negotiated agreement differ from those exhibited by players in simulations that ended in nonagreements (i.e., one of the players opted out)?

Let us turn first to the question of whether use of the Hostage Crisis Interface had an impact on performance, as measured by utility points received by the participants. In one set of parallel simulation runs, seven triads (India, Pakistan, Sikhs) were trained in the use of the interface and allowed access to it during the course of the simulation, and six triads were not informed of the existence of this decision support system. Tables 6 and 7 compare these two sets of simulation runs.

It will be noted that for all three types of simulation participants, the average utility scores at the conclusion of the runs were higher for the interface users than for the noninterface users. In addition, we note that agreement was a more prevalent outcome for the interface users than it was

for the noninterface users. Here, then, is preliminary evidence of the positive impact of use of a decision aid such as the Hostage Crisis Interface on the performance of participants in a crisis simulation. It is worth noting that proofs of the theorems on which the model is based lead to the conclusion that rational actors with full information should reach a negotiated agreement in an early period.

Table 8 provides information relevant to the question of whether the communications patterns among the three parties in each simulation run differed for simulations that ended in agreement from those which did not. A second set of six simulation runs was undertaken in which we closely monitored various aspects of the communication patterns among participants, taking advantage of the storage and retrieval capabilities of the POLNET II simulation software. In all six of these runs, the participants had access to the Hostage Crisis Interface. Three of these runs ended in agreement, and three ended in nonagreement outcomes.

We note first that for the Indian players, there was virtually no difference between their communication patterns in agreement and nonagreement simulations. That is, these players directed between 70% and 73% of their messages during the crisis to Pakistan, and between 20% and 27% to the Sikhs. Between 3% and 7% were directed to both simultaneously. Finally, the total number of Indian messages did not differ a great deal across these two types of outcomes—59 Indian messages in the case of agreements, 67 in the case of nonagreements.

The Sikhs, on the other hand, exhibited two widely different patterns. Although the proportion of messages they exchanged with India closely resembled the Indian pattern for communications with the Sikhs, their communications with Pakistan showed markedly different patterns. That is, the proportion of communications with Pakistan in agreement cases was double that for nonagreement cases. And the proportion of communications addressed to India and Pakistan simultaneously was twice as large in the nonagreement cases as it was in the agreement cases. Overall, the Sikhs sent 76 messages in agreement cases, and only 61 in nonagreement cases.

The key to understanding these patterns lies with the data on Pakistan. Among the agreement cases, Pakistan sent exactly half of its messages to India, and half to the Sikhs (only one message was sent to both simultaneously). Among the nonagreement cases, Pakistan sent three times as many messages to India as it did to the Sikhs, with another 17% sent to both simultaneously. Overall, Pakistan sent 88 messages in the agreement cases, and only 48 in the nonagreement cases.

Clearly, then, Pakistan plays a pivotal role in the way these crises are concluded. By maintaining open communications channels with each of the

TABLE 8: Communication Patterns

Simulation ID	*India (I) Communications*			*Pakistan (P) Communications*			*Sikh (S) Communications*		
	I - P	*I - S*	*I - All*	*P - I*	*P - S*	*P - All*	*S - I*	*S - P*	*S - All*
Agreement cases									
Number 43[a]	13	4	1	11	14	1	5	12	3
Number 44	27	6	0	22	19	0	7	19	3
Number 46	3	2	3	11	10	0	4	6	17
Total	43	12	4	44	43	1	16	37	23
Percentage	73	20	7	50	49	1	21	49	30
Nonagreement cases									
Number 41	27	11	1	16	4	4	4	4	26
Number 42	9	2	1	6	5	3	1	5	8
Number 45	11	5	0	8	1	1	4	6	3
Total	47	18	2	30	10	8	9	15	37
Percentage	70	27	3	62	21	17	15	25	60

a. These refer to case identification numbers.

other parties, it can serve in the role of third party mediator to bring the negotiations to a successful conclusion. Open channels does not, however, imply public: We observed that agreements tended to result when Pakistan exchanged virtually no public messages to both India and the Sikhs simultaneously. A more detailed analysis of the actual content of these messages will be necessary before we can say more about this dynamic (a task well beyond the scope of this article), but we have some preliminary evidence of some of the factors associated with success versus failure in such negotiations.

Conclusion

This article reports on the development of the HOSTAGE CRISIS SIMULATION that serves as the basis for the creation and implementation of an automated negotiator. We have reviewed some of the underlying assumptions of the model, and have reported preliminary experimental results generated by simulation runs with human players, based on use of the decision support system called the Hostage Crisis Interface, and the ICONS-related POLNET II simulation environment. These preliminary results appear to provide support for the notion that the play of participants with access to such a decision support system is superior to that of players with no such access. They also show that the patterns of communication among the participants in the HOSTAGE CRISIS SIMULATION provide insights into the negotiation process itself.

It is our expectation to continue this developmental work, with the ultimate goal of creating a simulation environment in which negotiators can be trained and experiments conducted. This work will be based on the development and testing of an automated negotiation agent.

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