DECISION-MAKING

The idea embodied in the General Problem Solver is a very simple one.
A problem consists of a difference between a desired state of affairs and an
actual state of affairs; problem-solving consists of specifying the difference
and applying a series of operators to it so as to gradually reduce it to zero.
A variety of subsidiary routines control the reduction process so it does not
go off the track in some fashion. Because of its simplicity, the idea is very
flexible. The difference may lie between a desired and a feasible state of
affairs, and operators may be used to modify desires toward feasibility. Or
the difference may lie between the available set of operators and a needed set,
and various operators may reduce this difference. Or, in Reitman's suggested
modification, it may lie between two descriptions of the goal state: an
actual vague, almost non-existent description and a desired specific description.
Reitman calls this an "ill-defined problem" and specifies six types of relevant
operators.

As Simon and his colleagues have worked it out, this conception of decision-
making differs in the following ways from the maximization-of-expected-utility
idea.

1. The decision-maker does not maximize, he satisfies. That is, he aims
at a rather specific goal state which he feels is good enough. This level of
aspiration is given at any specific time but may rise with success or fall with
failure.

2. The goal state is not a homogeneous utility, but a set of heterogeneous
requirements, each of which acts as a separate constraint on the desired
solution.

3. The decision-maker does not compare all possible alternatives, as
the rationality postulate requires; this is beyond human capability. Instead
he constructs an alternative that is good enough, and then stops. The process

of construction may take the form of testing one alternative after another against the goal set until one alternative passes, or it may take the form of building up a satisficing alternative by taking care of one constraint after another.

4. The chosen alternative, as well as rejected alternatives, are rather limited, short-run affairs. In utility theory an alternative consists of all consequences of an action into the infinite future; in game theory a strategy consists of a predetermined reply to all possible moves by the opponent through the entire game. Such wonders are beyond the limits of human computational ability. In Simon's theory a chosen alternative need deal only with foreseen consequences a short way into the future, and later consequences are taken care of as they are foreseen, bit by bit. In a game a chosen strategy might take account of consequences only two or three moves ahead. This means that it consists of a set of operators programmed to reply to specific expected moves of the opponent, but only a few moves a short distance into the future. Incidentially, in this theory a "move" would be defined as a single application of a single operator to the situation.

5. The initial strategy is modified incrementally as feedback reveals a difference between expected and actual results. The revealed difference is, again, a problem, and operators are selected to reduce the difference. The search for the proper operators is as simple as possible; it is made 1) in the neighborhood of the problem symptom and 2) in the neighborhood of the current alternative (Cyert and March, p. 121). In other words, the initial strategy is modified as little as possible, and the modifications are directed to coping with the specific things that have gone wrong.

6. The search process, that is the process of selecting operators, improves with practice. The simplest assumption is that successful operators are used more often and unsuccessful operators less often. For instance Austrian

success in using the _fait accompli_ operator in 1908 contributed to the decision to use it again in 1914, and Russian failures with the "make concessions" operator must have moved that operator lower on their list. A more effective kind of learning would be to make finer discriminations in the kind of problem situations for which each operator is appropriate, but this unfortunately would complicate the model a good deal.

I now apply these ideas to crisis bargaining. In spite of what I have written in an earlier paper, I find myself thinking in terms of stages, four in fact, with different tactics dominating each stage.

The first stage is the onset of a crisis. I presume that a crisis begins when a sudden opportunity or a new resource induces a country to raise its level of aspiration. Its existing strategy is modified to take advantage of the new opportunity, and answers to possible opponent moves are devised. The modified strategy is then output as a bid, either verbally or by direct action.

1A. After this a period of moves by both sides occurs, with opponent moves countered by previously decided on moves. If the initial strategy performs as expected the opponent finally accepts the bid and the crisis is resolved. The accepted bid need not be identical with the initial bid, which may have been modified by preselected operators such as "make concessions" or "offer compensation to new alliance partners". But it remains within the initially foreseen bidding range.

2. More likely the opponent, or allies, make some unexpected moves which make the initial strategy ineffective. This makes modification necessary, and a search for the appropriate operators is undertaken. Several searches and modifications of strategy by both sides may occur at this stage.

3. If neither side is able to devise a winning strategy, we come to the third state: deadlock, with the stock of operators running out and disaster looming directly ahead. At this point there may be a search for a _joint_

solution, namely one that will be acceptable to both sides. The chief tactic used is to lower the level of aspiration of both sides. This is done by decomposing the goal sets of both sides and dropping one or more elements from each until the two goal sets are compatible.

The bargaining process at this stage involves more, and more honest, communication between the two sides and may even involve joint discussion. If one side constructs the solution it can do so only insofar as feedback at state 2 has revealed the true goal structure of the opponent. However, if one side constructs the solution this is a "leader" game

start	
0,0	1,2
2,1	-1,-1

in which the leader can make the solution somewhat more favorable to himself.

4. If a solution is found, there may still be a post-crisis phase in which minor elements on either or both sides refuse to accept the solution. The University construction dispute is now in this stage; another example occurs in Meyerson and Banfield, 1955. Castro in 1962 was another holdout. Here the lineup is the two original opponents vs. the small holdouts, whose only leverage is the possibility that the whole solution may come unstuck. I can think of three operators that have been used on holdouts: "make a small concession", "make a big threat", and "exclude from final agreement". These operators may be applied by either or both of the original contending parties.

Stage three must not be confused with the familiar deadline negotiations in labor contract disputes. These negotiations are by now foreseen and pre-planned by both sides, so they belong to stage 1A or possibly stage 2 in some cases.

Several components of utility models and game models of bargaining have appeared in the above account in modified form, and I shall now point them out as a way of comparing models. Previously, I have listed six differences, in the discussion of Simon's satisficing theory; now I shall point out similarities.

1. No bargaining space appears in the present model. The idea that is equivalent to the idea of a bargaining space is the idea of an initial strategy composed of a single target and two operators, "make concessions" and "threaten no agreement". The bargaining space is equivalent to the area of effectiveness of these two operators. "Make concessions" will be effective up to one's own minimum point, and "threaten no agreement" will be effective up to the opponent's minimum point. So if the initial target is located in an area where these two operators will be effective, the initial strategy will be successful. If it is located outside the area, the bargaining process will eventually move into stage 2.

Note that neither of the bargainers knows at the start of a crisis whether the intial strategy will be successful, since the bargainers do not know each other's minimum points and perhaps not even their own minimum points. These things become clarified during the sequence of moves, if at all. In this sense there is no known bargaining space throughout the bargaining process, and a model that has a bargaining space in it is only describing with hindsight the way things have turned out. Thus a bargaining space model assumes away a good deal of what happens during the bargaining process. It does this by means of the rationality assumption, which states that each party knows both parties preference schedules, including minima and maxima.

2. The idea of a two-dimensional space is equivalent to a second-phase tactic of searching for cheap concessions. Thus the present theory reverses the order of priorities assumed in traditional bargaining theory. In traditional theory it is assumed, sometimes, that the parties will first move to the bargaining line and then agree on some point on the bargaining line. The present theory assumes the opposite: first a confrontation, and if that does not go as expected, a subsequent search for cheap concessions.

The difference is due to our dropping the rationality postulate. The rationality postulate states that each bargainer knows both his own and the opponent's whole preference schedule; and with perfect knowledge it is obviously desirable to begin with mutually advantageous moves and postpone the difficult unilaterally advantageous moves till later. But if one is doubtful and mistaken about the opponent's preferences and pretty vague even about one's own, it is necessary to include contingency plans for meeting opposition in one's initial strategy. Then the feedback provided by the opponent's counter-moves gradually provides information about the opponent's preferences, and the necessity for reacting to opponent's moves provides opportunity to clarify one's own preferences. After a period of this sort of maneuvering it becomes possible to search for mutually advantageous moves, cheap concessions, or readily acceptable demands.

Note that the phase movement from distributive bargaining to integrative bargaining which characterizes the present theory continues right into phase three. Here the common goal of avoiding catastrophe becomes central and the information about preference schedules developed in phase two makes a joint search for a solution possible.

3. The tactics of creating a bargaining space by changing the opponent's utilities and expectations, which Iklé emphasizes, are clearly phase two operators in the present theory. Only after the initial strategy begins to run into difficulties is it necessary to search for operators to take care of the difficulties. The difficulties are created by the opponent's not acting as expected, so the appropriate operators would be those that will bring him back into line.

4. The difference between maximizing and disaster-avoiding, which became so elusive in our discussion the other week, is a simple one in the present theory and is hereby clarified. It is the difference between stage one and stage three bargaining behavior. Actually there is no such thing as maximizing

in bargaining, since maximizing requires an examination of all possible alternatives far into the future, and this is beyond the limits of human computational ability. But there is something fairly similar to it in phase one, namely the successive applications of the "make concessions" and "threaten no agreement" operators.

Note that in this clarification question 5B in the checklist is misleading and should be eliminated. 5A and 5B are both phase one processes, while 5C refers to phase three.

4. The various manipulations that are central in the critical risk model become additional operators used in stage one or stage two. In particular, the critical risk model provides an important operator that does not occur in utility models and that is undoubtedly central to crisis bargaining. Instead of merely threatening no agreement, this operator threatens various degrees of punishment including war. This operator shifts the focus of attention from "above the line" considerations of relative advantage to "below the line" considerations such as relative cost, resolve, recklessness that are one big difference between domestic and international crisis bargaining.

However, the idea of a simple strategic choice between yielding and holding firm is discarded in the present model as too abstract. When a satisficing decision-maker is confronted by a choice between A and B, he typically decomposes and recombines both into a new strategy C that is better than either A or B. A 2x2 matrix abstracts out one tiny phase of crisis bargaining and in this sense is highly unrealistic.

5. Escalation and de-escalation appear in the present theory, not as a set of alternative strategies in a big matrix, but as components of a single developing strategy. Escalation elements can occur at all three stages of the bargaining process. The initial strategy may include an escalation operator to counteract expected resistance by the opponent. If the initially planned

escalation does not succeed in beating down resistance, further escalation measures may be devised step by step in stage two, and some de-escalation measures may even be attempted, as for instance in Vietnam which is now in stage two. Finally, when escalation threatens to get out of hand the bargainers shift to the stage three attempt to find a way out of the escalation trap.

The expanded game matrix abstracts from time and presents the whole escalation ladder as a timeless chart of "alternatives." These alternatives did not exist at the beginning of a crisis but were devised during it as successive modifications of strategy, and the game matrix is to that extent a simplification. Nevertheless, one can use the matrix to describe the course of the crisis and its dynamics at any given point and thereby bring time into one's account. Consequently, this model is the closest of all the utility and game models to the present theory.

6. Supergame matrices specify an important payoff element, namely relative change of power for each outcome. In this respect they are more realistic than other game or utility models, which deal only with a payoff of general utility. This payoff element appears in a satisficing model as a specific goal constraint. In a satisficing model we substitute specific heterogeneous constraints for a single homogeneous "utility", and supergame matrices take one step in this direction.

On the other hand, a satisficing model will typically not have as much foresight in it as a supergame model. A supergame can have as many component games in it as the historian, with hindsight, can distinguish; I distinguished eight in paper no. 5. However, a satisficing foreign minister will probably calculate only one play at a time into the future. For example, Gray in 1914 calculated only that if England remained neutral it would either face a dominant Germany or be isolated and hated by France and Russia; he looked forward only one play. In a satisficing model it should be possible to reduce supergame elements

to two beliefs: 1) time is on our side and 2) things will be worse if we don't act now. This is one place where a satisficing model is more abstract than a game model.

I now present a suggested sketch of a satisficing model. It consists of five modules, one of which, the level of aspiration changer, appears twice on the chart.

GENERAL CRISIS BARGAINER
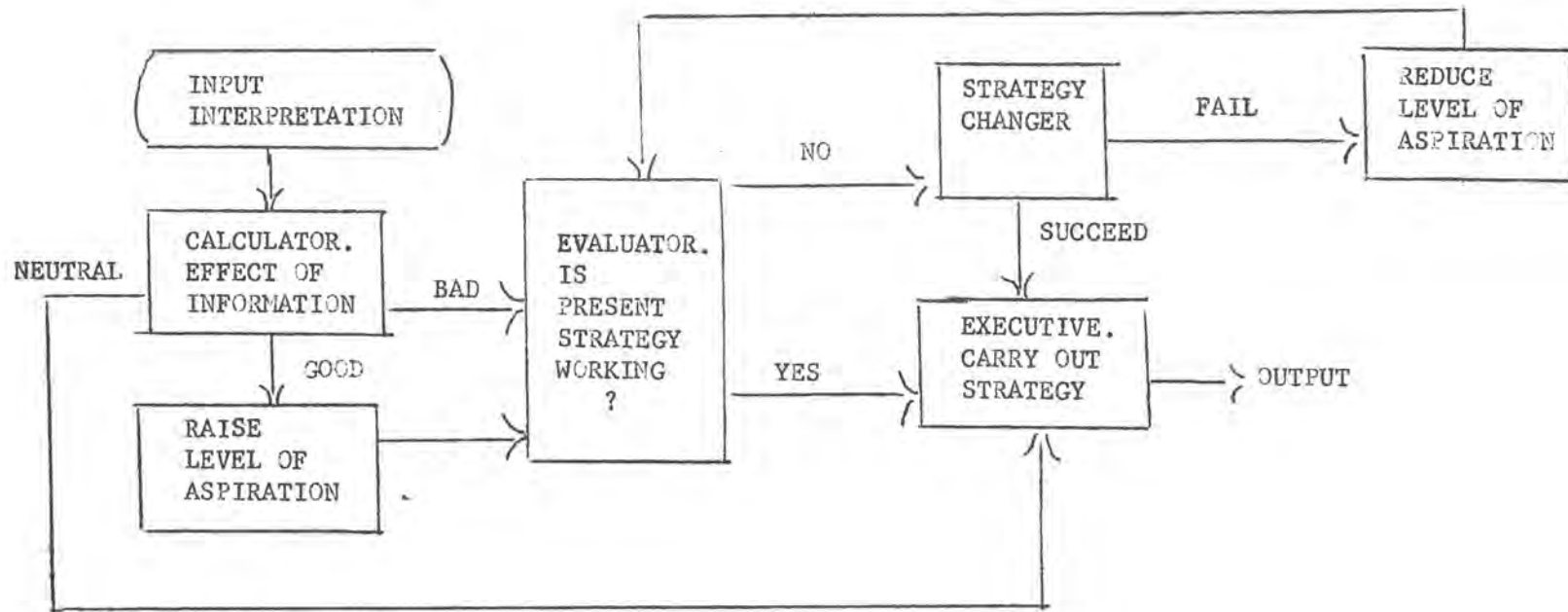
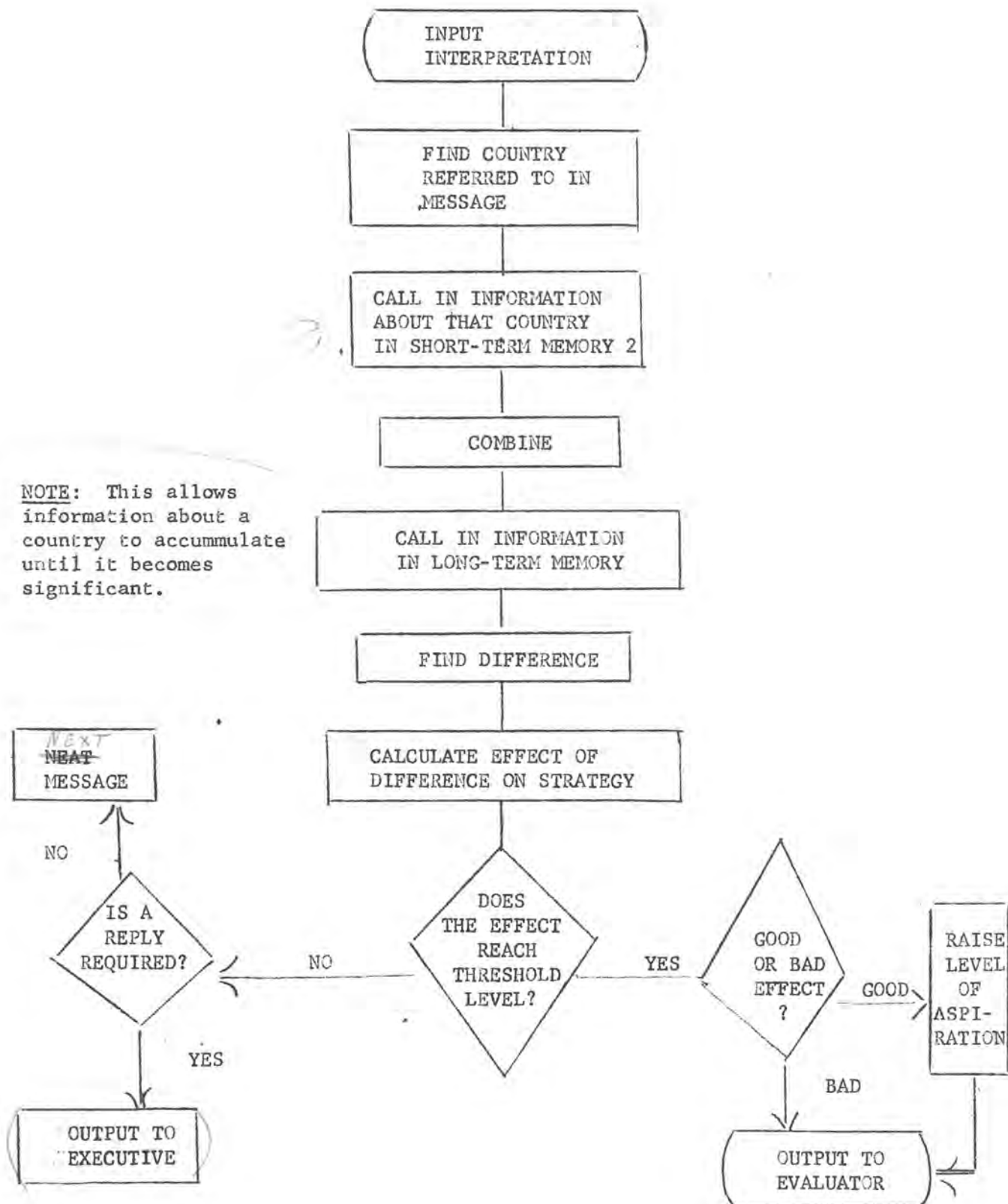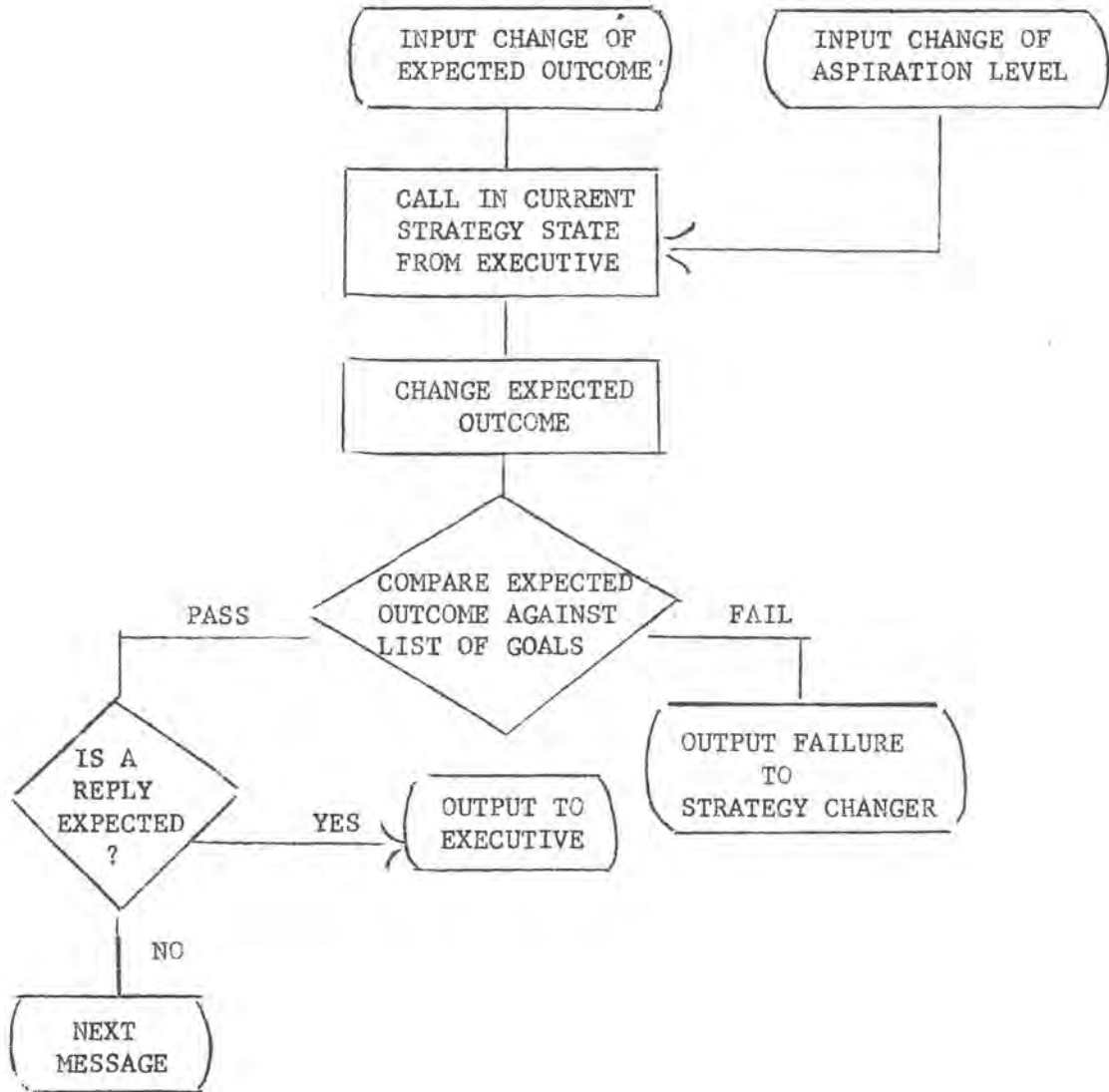This model assumes that every foreign ministry always has a strategy which it is in process of carrying out. It is, however, activated only by interpreted information, namely signals or indices, coming in from the information processor. The implications of the information for current strategy are worked out by the calculator, and as a consequence current strategy is either changed or continued in effect. Finally the executive selects an appropriate reply to the incoming message, if one is needed.

The three stages of crisis bargaining I have previously distinguished appear as alternative paths through the model. Stage one, the onset of a crisis, is initiated by information that the calculator evaluates as very good for the system's goals. This leads to raising the level of aspiration, evaluating current strategy as inadequate by reference to the new level, and changing strategy. In Stage 1A the calculator evaluates information as neutral, and the executive continues to act. In Stage 2 the calculator evaluates information as bad, and the evaluator decides whether a change of strategy is necessary. Late in stage 2 when the available operators have been used up, the level of aspiration is lowered by the aspiration changer, and strategy is re-evaluated against the new level. The stage 3 joint search for a solution is a special operator tucked away in the strategy changer; it is activated by a failure signal of some sort. A few sample details follow:

CALCULATOR

INPUT
INTERPRETATION

FIND COUNTRY
REFERRED TO IN
MESSAGE

CALL IN INFORMATION
ABOUT THAT COUNTRY
IN SHORT-TERM MEMORY 2

COMBINE

NOTE: This allows
information about a
country to accummulate
until it becomes
significant.

CALL IN INFORMATION
IN LONG-TERM MEMORY

FIND DIFFERENCE

NEXT
NEAT
MESSAGE

CALCULATE EFFECT OF
DIFFERENCE ON STRATEGY

NO

IS A
REPLY
REQUIRED?

DOES
THE EFFECT
REACH
THRESHOLD
LEVEL?

NO

YES

GOOD
OR BAD
EFFECT
?

GOOD

RAISE
LEVEL
OF
ASPI-
RATION

YES

BAD

OUTPUT TO
EXECUTIVE

OUTPUT TO
EVALUATOR

EVALUATOR

STRATEGY CHANGER

INPUT DIFFERENCE FROM EVALUATOR
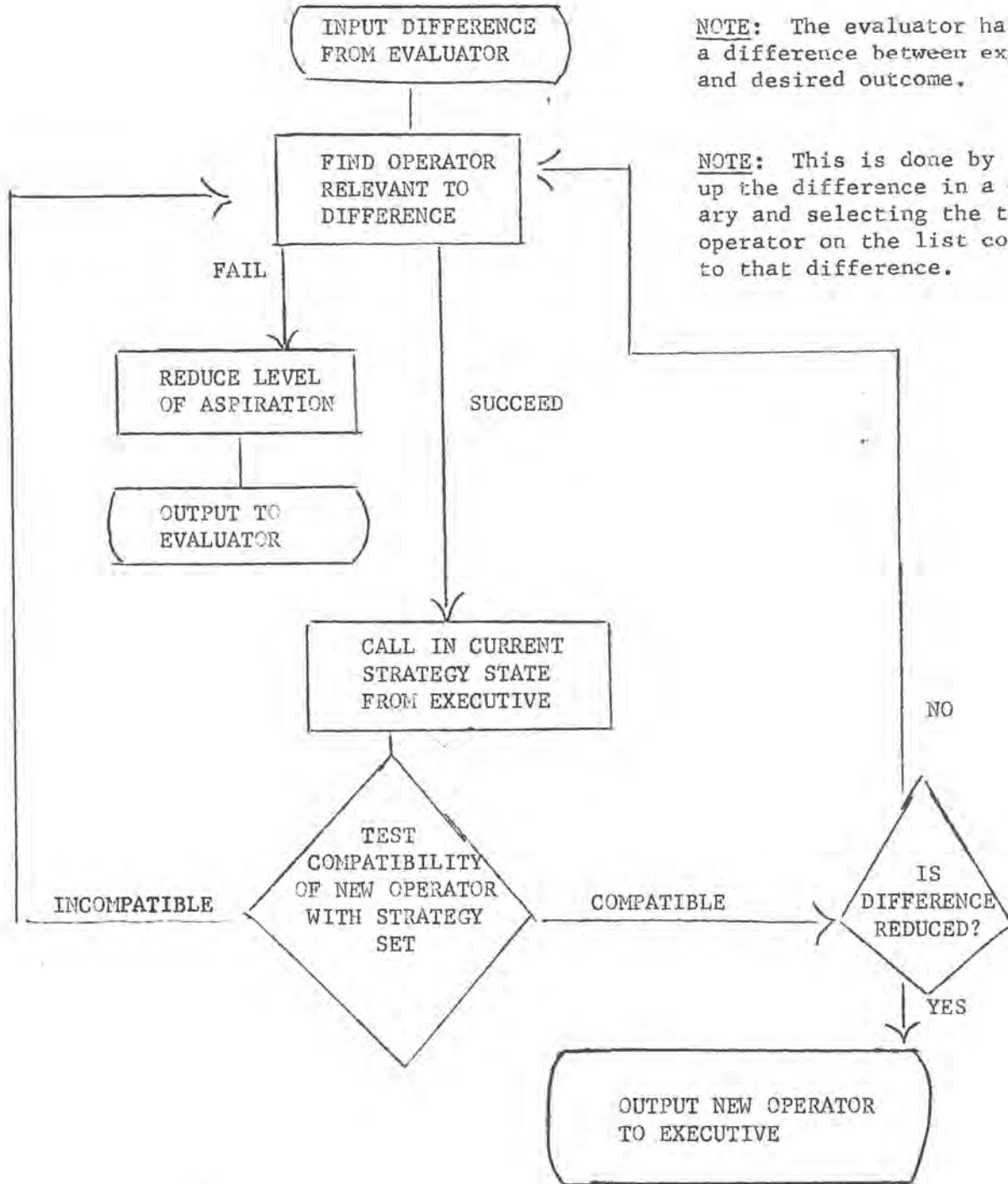
NOTE: The evaluator has found a difference between expected and desired outcome.

FIND OPERATOR RELEVANT TO DIFFERENCE

NOTE: This is done by looking up the difference in a dictionary and selecting the top operator on the list connected to that difference.

FAIL

REDUCE LEVEL OF ASPIRATION

SUCCEED

OUTPUT TO EVALUATOR

CALL IN CURRENT STRATEGY STATE FROM EXECUTIVE

NO

TEST COMPATIBILITY OF NEW OPERATOR WITH STRATEGY SET

INCOMPATIBLE

COMPATIBLE

IS DIFFERENCE REDUCED?

YES

OUTPUT NEW OPERATOR TO EXECUTIVE

EXECUTIVE

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┌─────────────────┐                    ┌──────────────────────┐
│ INPUT MESSAGE   │                    │  INPUT NEW OPERATOR  │
│ WITH REQUEST    │                    └──────────────────────┘
│ FOR REPLY       │                              │
└─────────────────┘                              ▼
         │                            ┌──────────────────────┐
         ▼                            │  ADD NEW OPERATOR    │
┌─────────────────┐                   │  TO STRATEGY SET     │
│  FIND REPLY     │                   └──────────────────────┘
│  IN STRATEGY    │                              │
└─────────────────┘                              │
   │           │                                 │
  FAIL       SUCCEED                             │
   │           │                                 │
   ▼           ▼                                 ▼
┌──────┐    ┌──────────────────────────────────────────┐
│ CALL │    │  OUTPUT REPLY OR OPERATOR TO             │
│ ERROR│    │  SHORT-TERM MEMORY 1                    │
└──────┘    └──────────────────────────────────────────┘
                          │
                          ▼
                ┌──────────────────────┐
                │  OUTPUT MESSAGE OR   │
                │  BASIC MOVE          │
                └──────────────────────┘
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In conclusion, the reader is reminded that this model is highly simplified inasmuch as it assumes away all conflict within a country and government. Yet we know that internal conflict is an important part of a crisis; indeed my main interest when I joined this project was to study the interplay between internal and international conflict. However, I have applied an operator to that interest, and it shall not bother me for some time.