A RECONSTRUCTION OF OLIVER BENSON'S 'SIMPLE DIPLOMATIC GAME'

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With advances in hardware and software, it has become possible to reconstruct previously uncirculated computer simulation programs for the purpose of examining the advantages and disadvantages inherent in these simulations and which might be expected of computer simulation methodology in general. Advantages which are sometimes claimed for computer simulations include the extent to which the simulation (1) requires unambiguous statement of hypotheses; (2) elaborates the consequences of implicit and explicit assumptions; and (3) facilitates the compounding of propositions, thereby permitting consideration of interactive effects among variables.

Oliver Benson's "Simple Diplomatic Game" (Benson, 1961) is treated as an early case study of an all-computer simulation of international relations. A working version of this simulation, implemented on time-sharing equipment, is presented for examination. Technical differences between the original and the present versions are discussed, together with the operational characteristics of the present model and various aspects of its implementation. Advantages and disadvantages of all-computer simulation are discussed on the basis of the author's experience in reconstructing the Benson simulation from published accounts.

Conclusions: The inter-relationships between method and substantive theory-building are found to be particularly crucial for those model-building tasks related to the actual translation of verbal international relations theory into an operating computer simulation. These tasks are seen to include: (1) choosing algebraic terms which "adequately" represent the verbal propositions involved; (2) aggregating the terms thus decided upon; (3) translating the algebra into computer instructions (algorithms); and (4) aggregating these algorithms when the simulation is run.

The present simulation is viewed as supportive of advantages (1) and (2) above. Advantage (3), the utility of computer simulation for the compounding of propositions is confirmed in this case, but a general limitation--the simulator's ability to maintain control over what in fact is being simulated in the face of increasingly complex theoretical additions to a given model--is suggested.

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I. INTRODUCTION

General. Oliver Benson's "Simple Diplomatic Game," developed at the University of Oklahoma in 1959,[2] represents a pioneering attempt to articulate a number of "loose" assumptions about international behavior into a set of computer instructions such that high speed computing equipment can be used to "simulate"[3] a variety of international crisis situations. The uniqueness of this effort derives from Benson's use of the computer as simulator, in contradistinction to "all-man" simulations, in which human participants introduce the major variables as well as attitudes and personal values with respect to international decision-

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2. See Oliver Benson, "A Simple Diplomatic Game," in James N. Rosenau, International Politics and Foreign Policy (New York: The Free Press, 1961), pp. 504-511. Additional information regarding the original computer routines can be found in H. Borko (ed.), Computer Applications in the Behavioral Sciences (Englewood Cliffs, N.J.; Prentice-Hall, 1962), especially pp. 580-593. The present version was constructed from information contained in the above two articles.

3. The present paper adopts the definition of "simulation" in Guetzkow, H., C. Alger, R. Brody, R. Noel, and R. Snyder, Simulations in International Relations: Developments for Research and Teaching (Englewood Cliffs, N. J.; Prentice-Hall, 1963), p. 27: "(A) simulation is an operating representation in reduced and/or simplified form of relations among social units by means of symbolic and/or replicate parts."

making, and "man machine" simulations involving a mix of men and computers, in which certain aspects of the simulation, equations representing relationships between variables, for example, are highly programmed by the researcher. With developments in hardware and software, it has become possible to liberate the original all-computer simulation from technical limitations imposed by early equipment, thereby obtaining a clearer picture of the operating model.

Other objectives underly the reconstruction of this early simulation, however. The development of an all-computer simulation to the point where it may be readily examined by interested persons is one such concern. Neither the original version, nor the TEMPER international simulation,[4] is presently available for use by interested scholars in the field. The lack of examples suggests that examination of the variety of potential advantages being claimed for computer modeling of international behavior may be impeded. The advantages of such modeling are said to include the extent to which the use of all-computer simulation (1) requires unambiguous statement of hypotheses; (2) elaborates the consequences of both implicit and explicit assumptions; and (3) facilitates the compounding of propositions, permitting consideration of interactive effects among variables. In addition to making the Benson model available to interested scholars, the present paper explores the advantages and disadvantages of computer modeling of international behavior using the

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4. TEMPER is an acronym for Technological, Economic, Military, Political Evaluation Routine, an all-computer simulation of international relations developed by Clark C. Abt, James C. Hodder, and Morton Gorden. See Abt, C. C. and M. Gorden, "Report on Project TEMPER" in Snyder, R. and D. Pruitt (eds.) Theory and Research on the Causes of War (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1969), pp. 245-262, and M. Gorden, "Burdens for the Designer of a Computer Simulation of International Relations: The Case of TEMPER," in Bobrow, D. B., and J. L. Schwartz (eds.), Computers and the Policy-Making Community (Englewood Cliffs, N. J., Prentice-Hall, Inc., 1968), pp. 222-245.

reconstructed Benson model as a case study.

Overview of the simulation. The present model simulates a world of 25 mutually interactive states, any one of which can initiate increasingly severe diplomatic or military action against any other, for the purpose of increasing or regaining war potential. "War potential," a percentage measure, is used to define each nation's share of the total "power" in the world. The war potential index is initially derived from nine categories of data (population, military-age manpower, miles of track and highways, GNP, GNP per capita, energy and steel output, literacy, and atomic capability). An option has been provided such that the user may modify the war potential of any nation(s) at the beginning of any round except the first round to suit specific investigative needs.

An interest index, computed from data on geographic locations, coalition membership, the extent of mutual trade between all states and the state designated as "target," and the presence of military bases in the "target state" is also generated for each nation-state in the simulation. At the beginning of a round, the user designates one state as the initiator of action, a second state as the target of action, and specifies the intensity of action. The intensity of action is a continuous scale from 1 to 9 and is interpreted as ranging from "diplomatic protest" at level 1 to "all-out war" at level 9. The computer calculates the product of the war potential, the interest index, and the intensity of action (scales which range between 0.0 and 1.0 at the point of computation) for each state in the simulation. The product thus determined represents the gain awarded initially to the initiator of the action, and the loss given to each of the remaining states.

But the gain awarded to the initiator is by no means a certain

one. Counteractions are then computed for each state except the initiator of action on the assumption that states act to recover lost power (Benson, p. 506). Counteractions thus selected are modified under specific conditions: for example, war against an ally is ruled out; nuclear war is ruled out if the actor state involved is not a nuclear power, and the intensity of counteraction is lowered if the state's "propensity-to-act index" (a measure of aggressiveness) is low. New war potentials are calculated in view of the counteractions finally implemented. Three successive losses suffered by an ally as a result of initiative by the leader of his coalition causes that ally to become a neutral; three successive losses suffered by a neutral as a result of action by Coalition Leader A will cause him to join rival Coalition B. A more detailed description of the simulation follows in the next section.

II. DESCRIPTION OF THE SIMULATION

General. Written in BASIC computer language for use in an on-line, time-sharing environment, the simulation is implemented by a source program consisting of approximately 1130 BASIC-language statements, including a large number of comment statements which assist the user in evaluation and modification of the program. Of this total, approximately 400 statements contain the data set by which the simulation variables are given their initial values. A small, separate program of about 60 statements provides instructions for using the main program and is utilized at the option of the user. The source program occupies 6,300 words of storage (about 28,300 alphanumeric and special characters), and requires roughly 11,000 words of core memory when running. The general structure of the program is depicted in the flow chart, Figures 1 and 2.

/Figures 1 and 2 go about here./

Figure 1.

Basic Flow Chart for Reconstructed Simple Diplomatic Game: Adapted from Oliver Benson, "A Simple Diplomatic Game," in James N. Rosenau, International Politics and Foreign Policy, 1961, p. 508.

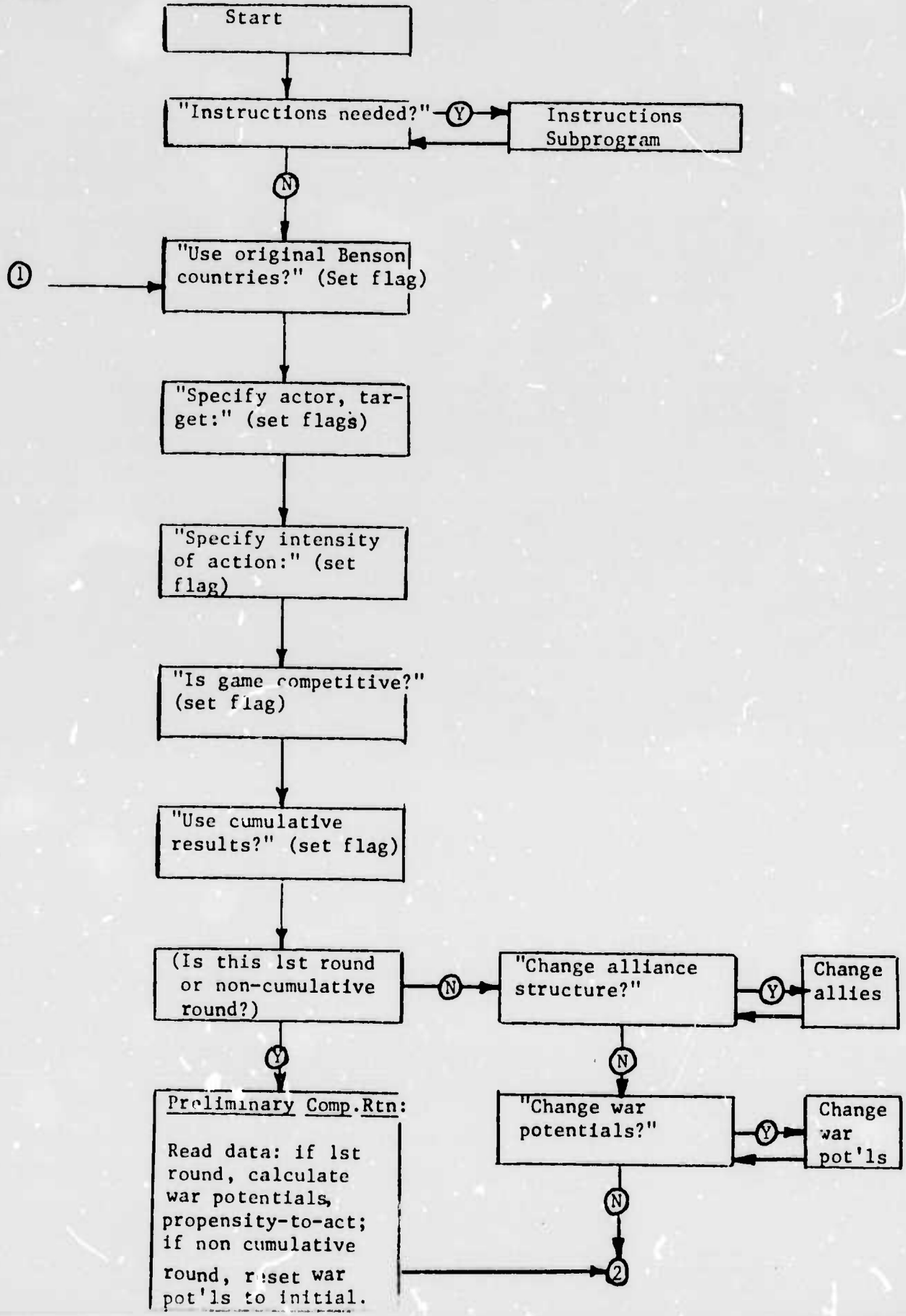
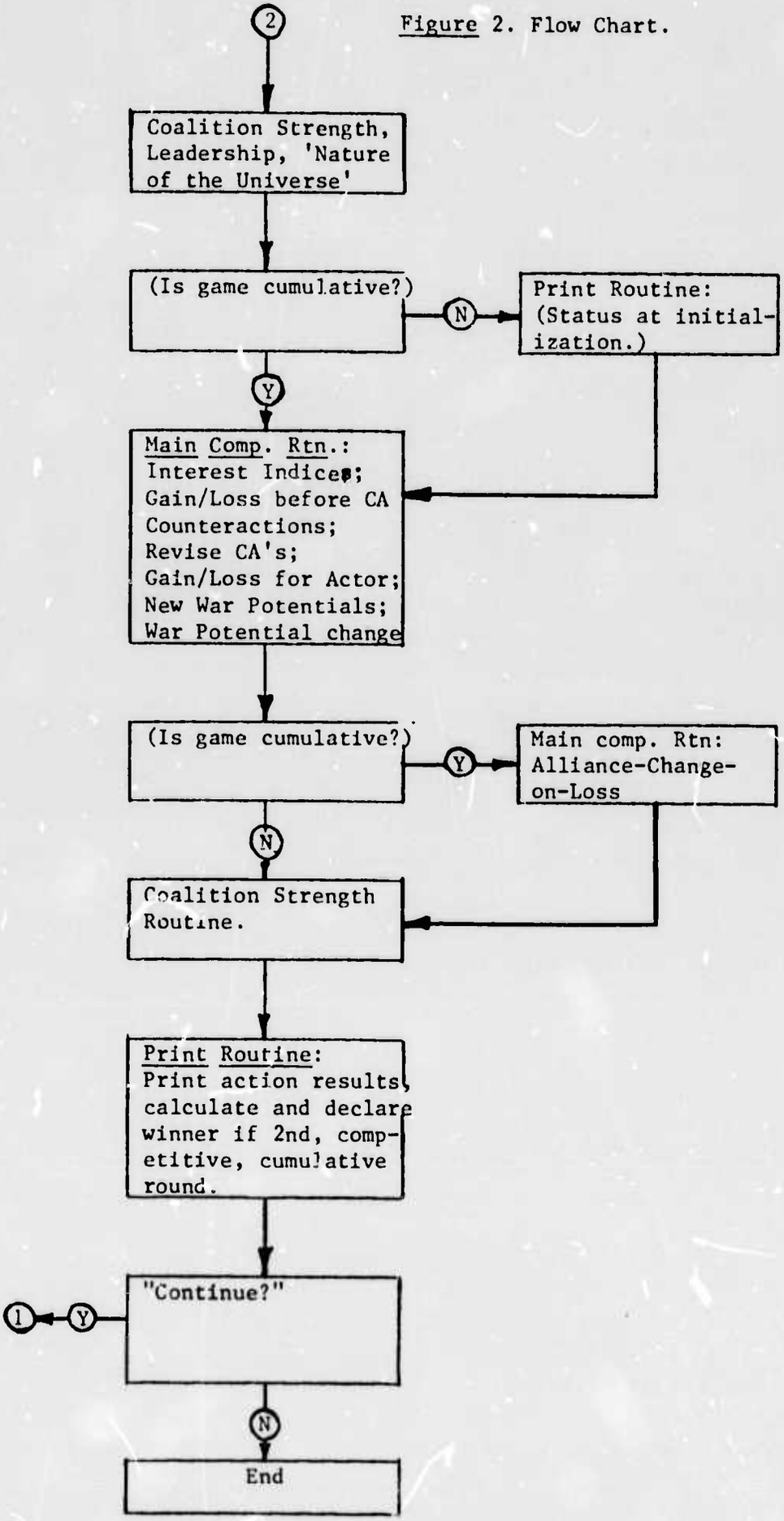


Figure 2. Flow Chart.



User Options. When the program is run, the user indicates whether an instructional print-out is desired. If so, the sub-program which contains a brief description of the game is called from storage by the main program and the instructions are printed out at the teletype. At the conclusion of the print-out, the main program is called by the sub-program and retrieved from storage. Execution of the main program begins again. If the user indicates that no instructions are desired, the program continues to the next option: the user is asked whether the simulation is to be based on the full 25-country configuration, or whether it is to be reduced to the original 18-nation design used by Benson. The user decision for this and every other option in the simulation is communicated to the program by entering one or more numbers at the teletype. For this option, a "1" is understood to mean a "yes" response, while a "2" designates a "no" response. The storage of responses from the teletype is referred to as "setting flags" in the flow chart.

Next, the user is asked to specify the initiator of action, the target state, and the intensity of action. Intensity of action is represented for the user[6] on a scale of one to nine; Table 1 is meant to be suggestive of the activities being simulated at each point on the scale.

[Table 1 goes about here.]

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[6]In order to enhance the readability of the print-outs and to simplify the entry of scale values at the teletype, the various scales used in the program are multiplied by factors of 10 or 100 before they are printed. The intensity of action scale in Table 1 ranges from 1 to 9 on the print-out, but is treated as ranging from 0.0 to 0.900 in terms of machine computations. War potential indices range from 0.1 to 100.0 externally, but from .001 to 1.000 internally. The interest indices are scaled from 0.0 to 100.0 on the print-out, but from 0.0 to 1.0 internally. Counteractions range from 1 to 10 on printing but vary between 0.0 to 1.0 in computations. Finally, the propensity-to-act index varies from -100 to +100 on the display but is computed in the range of -1.0 to +1.0.

Intensity	Action Simulated
1	Diplomatic Protest
2	United Nations Action
3	Sever Diplomatic Relations
4	Boycott, Blockade, or Seizure
5	Trcop Movements
6	Guerrilla Warfare
7	Limited Conventional War
8	Large-Scale War
9	All-Out War

TABLE 1

Sample Interpretation of Levels of Intensity of Action Adapted from Oliver Benson, "A Simple Diplomatic Game", in James N. Rosenau, International Politics and Foreign Policy (New York: The Free Press, 1961), p. 505.

For present purposes, the intensity of action can be thought of as representing the portion of national power being exercised in a given situation. The conceptual mapping of action to intensity level, it should be noted, is intended only as an intuitive guidepost to the severity of actions being simulated (Benson, p. 505), and to the nature of counteractions produced (this scale is also used to interpret the counteractions produced in each round). In both cases, however, the mapping is easily modified and interpolated to include or exclude specific categories of action.

The user is then asked if the action is to be treated as one of two successive competitive plays. If the game is competitive--that is, if the proportional gain or loss of Actor Nation A in the first round is to be compared with the proportional gain or loss of Actor B in the next round, the program saves the results of the first round and compares them with the results of the second round. This comparison can be made independently of the state designated as the "target state" in either round: the relative gains of A's attack against C can be measured against the relative gains of B's attack against A, C, or D; in the case where A acts against B in the first round and B acts against A, the program inspects both the gains of A and B and the losses of A and B for each round. In either case, a "winner" is declared at the end of the second, sequential competitive round. If the game is not competitive, the program calculates gains and losses for each actor and shows the net change in war potential from the previous round (or from war potential at initialization) for each state, but no special comparison is made of the relative gains or losses of the actor state in Round 1 vis à vis the actor state in Round 2. According to Benson (Benson, p. 509), this competitive game feature permits "human

interaction" in the simulation in the form of competition between two opposing users or teams of users.

On rounds other than the first round (where there is no history of previous actions), the program asks the user if computations are to be made using the initial war potentials or using modified war potentials carried over from previous round(s). For the first round, the program generates the initial war potentials from nine categories of data stored in the program. The propensity-to-act index for each country is also calculated on the first round (see below). Data for these computations is "read" only on the first round, as a matter of efficiency: likewise, the initial war potential indices and the propensity-to-act indices are calculated only once. The program saves the results of these computations and stores them in such a way that if the use of initial war potential settings is requested in subsequent rounds, the program is able to reset the appropriate variables very quickly. On rounds other than the first round, two additional options are presented (1) for changing the alliance structure, and (2) for changing the war potential of one or more nations. These options may be used to create imaginary universes, imaginary coalitions, or to alter the overall distribution of power in the simulation for specific experimental purposes.

In addition to the user options discussed to this point, a number of minor options for abbreviating the print-out displays have been inserted at appropriate places in the print routine. The function of these options is to by-pass or abbreviate redundant information.

The Data Base. Data for each of the 25 countries used in the present version was gathered for 1965 rather than 1955 on the grounds that more recent data was necessary to accommodate the seven countries added to

the simulation. Program runs with a "dummy" data set and with 1965 referent data indicated that the choice of data base does not affect the operating characteristics of the model, but does affect the model's initialization, as well as percentage gains and losses resulting from various actions. Findings related to the interchangeability of data bases are reported below.

In the original version, the data base was separated from the main program to permit easy modification. In the present version, data and instructions are combined in one file for programming simplicity with no significant loss of data flexibility, since the space available to each user on the particular time-sharing system used is sufficient to accommodate the data and source program in one large file.[7] The data may be easily separated from the main file with standard BASIC editing commands to facilitate use of the program and data base on systems where less than 50K characters of core are available to each user. In either case, new or more suitable data may be added to the data base, categories can be refined, and imaginary data sets employed with little difficulty.

The data file (lines 7140-11170 in the program listing) is "read" into memory by commands (lines 2000-2200) in the program's Preliminary Computation Routine (see flow chart). The structure of the

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[7] The present program was written and debugged using the General Electric MARK II Time Sharing System (Cleveland) which permits approximately 50K characters for each BASIC user program (source plus temporary memory for execution). Testing and evaluation of the model was carried out on Applied Logic Corporation's Dual PDP-10 system (Princeton), which allows approximately 33,000 words, or about 164K characters per user.

data base is as follows:

(1) Ten haversines are included for computing the geographic location of one major industrial area within each country relative to the location of one major industrial center in each other country. This calculation is included in a "proximity index" which in turn is incorporated into the interest index (see discussion of interest index, below). The "proximity index" represents the logistic cost of moving materiél from one area to another and in this way contributes to the overall "interest" of one nation relative to the target state.

(2) The main data matrix (25 nations by 25 variables) contains (a) nine categories of indicators of natural and technical resources, used in computing the "war potential" of each nation; (b) values for nine indicators of aggressiveness, used for computing the propensity-to-act index; (c) a numerical code (0-4) indicating alliance membership; (d) a "one" or "zero" indicating the nuclear or non-nuclear status of each country; (e) a tally of losses suffered by a coalition member as a result of an unsuccessful initiative on the part of the coalition leader; (f) a statistic for total exports and imports for each country, expressed in millions of U.S. dollars; (g) degrees of longitude for a major industrial area in each country; and (h) degrees of latitude for these industrial areas.

(3) Eighteen weights for the nine resource categories and for the nine indicators of aggressiveness follow the main data matrix. These weights serve to scale the separate categories before the categories are added linearly; they also serve to establish the relative importance of each category with respect to the others.

In the absence of theoretical guidelines, these weights were

developed on an intuitive basis in the original version.[8] The same method was attempted and evaluated in the present simulation. The use of these weights is discussed below in the subsections on the war potential index and the propensity-to-act index; the significance of the weights and the consequences of an intuitive approach are treated in the concluding section.

(4) A matrix indicating the presence or absence of Country A's military bases in Country B follows next. This matrix contains 625 entries.

(5) A final 25 by 25 matrix containing statistics on mutual trade between all possible pairs of countries, if such trade exists, concludes that data set.[9]

A "dummy" data set, constructed for debugging purposes using estimated data values, but structured in exactly the same manner as the data base currently in use, was subjected to various mathematical transformations in order to observe the effect of changes in magnitude on the operation of the simulation. The numbers produced by the simulation under these conditions varied, but the operating characteristics (Figure 3) remained stable.

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[8]Oliver Benson, personal correspondence with the author, March 5, 1970.

[9]Traditional sources were used in the development of the 1955 data base (O. Benson, personal correspondence with the author, July 10, 1969); a similar practice was adopted for this version. Sources are cited in the bibliography.

Action in the simulation. As mentioned in the overview, the present version defines a world of 25 mutually interactive states,[10] any one of which can initiate increasingly severe diplomatic and military action against any other. In the original version, only nine "big-power" actor states could initiate action against any one of nine smaller "target states." Moreover, a major power could take no direct action against another major power, and the nine countries designated as targets could take no action at all. Underlying these restrictions was the premise that trouble among major powers tends to result from disputes involving small powers (e.g., World War I resulting from Austria attacking Serbia; World War II developing from Germany's attack upon Poland; post world war crises involving Taiwan, Korea, Cuba, Vietnam, etc.)[11] In the original program, big-power "confrontations" were possible only in the counteraction cycle. In the present version, such "confrontations" can be controlled directly by the user through appropriate specification of actor state, target state, and the level of intensity of action. Disputes between two small powers are likewise more easily programmed, since small states can be specified as initiators of action as readily as larger powers.

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[10]The current version incorporates the following states: USA, USSR, U.K., France, Italy, West Cermany, India, Communist China, and Japan (the original nine actor states); also included are North Korea, Guatemala, UAR, Lebanon, Hungary, South Vietnam, Taiwan, Cuba, and the Congo (Brazzaville), which comprised the nine original target states. Seven countries have been added: East Germany, Pakistan, South Korea, Czechoslovakia, Yogoslavia, Isreal, and North Vietnam. These additions were chosen on the basis of the author's intuitive judgment of prominence in contemporary international affairs. The program is constructed such that countries may be deleted or added, within the limitations of available program space to suit user-specific requirements. In addition to data base flexibility, an option has been provided for reducing the 25-country data set to the 18-country configuration used by Benson for comparison purposes.

[11]O. Benson, personal correspondence, July 10, 1969.

War Potential Index. Each nation in the simulation is defined in terms of its "war making potential," which is expressed as a percentage of the total war potential or "power" in the world. Action within the simulation is intended to increase or recover each nation's share of "power." The war potential index for each nation is initially computed from nine categories of data (population, military-age manpower, transportation, G.N.P., G.N.P. per capita, electrical energy production, steel production, literacy, and atomic capability).[12] Each category is first multiplied by a weighting factor which serves the dual purpose of establishing the relative importance of each category, and providing decimal point scaling. The nine weighted terms are then added linearly, yielding a subtotal for each country and a grand total for all countries. By expressing the subtotal for each country as a percentage of the grand total, the war potential index, each nation's share of the total power in the world, is obtained (a discussion of the limitations of this index and the importance of the weights appears below):

$$W_i = T_i/S, \text{ where } S = \sum T_i, \text{ and where} \qquad (1)$$
$$T_i = \sum D_{ij} G_j.$$

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[12]Benson, p. 506. Electrical energy production (millions of KWH) was used in the present version. In personal correspondence (March 5, 1970), Benson indicates that total energy production from all sources, translated into millions of kilowatt-hours, was the measure used in the original version.

The term D_{ij} is a discrete item of data in capability category j for state i, and G_j is the weight assigned to that category. W_i, the war potential index for state i, has an acceptable internal range of 0.001 (since no state can be eliminated) to 1.0 (since no state can have more than 100 per cent of the total power in the world). If the equation produces a value less than or equal to 0.0, the value 0.001 is substituted. The computations are implemented in lines 2270-2400 of the program. Restrictions are implemented in lines 6200-6230 and 6300-6350. W_i has an external range from 0.1 to 100 (per cent).

Propensity-to-Act-Index. After computing the war potential index, a "propensity-to-act index" is calculated which represents each nation's overall tendency toward aggressiveness. This index was derived by Benson using Quincy Wright's capability and analytical fields (cited in Rose..., 1961, p. 507). The scales used include energy-lethargy, flexibility-rigidity, cooperation-isolation, strength-weakness, resource abundance-poverty, technological advancement-backwardness, objectivity-subjectivity, liberality-restrictiveness, and affirmation-negation. A value ranging from -5 for "civilized" characteristics to +5 for "aggressive" traits is assigned to each nation for each of the nine scales. Each value is then weighted (in the Benson version, each of the nine terms is weighted equally pending further development of the index); the products of weights and scale values are then added together. Dividing the subtotal for each country by the sum of the weights yields the propensity index for each country. A high score on this index represents a greater propensity to act; a low score represents passivity. As in the original program, the influence of

this index on the level of counteractions is relatively small as partial compensation for the conceptual difficulties encountered by both simulators in mapping the simulation countries onto each scale. These scales are used during the calculation of counteractions to lower the intensity of counteraction for less "aggressive" countries. If the propensity index for a given country is less than the mean propensity value, the counteraction for that country is lowered .100 on an internal scale ranging from zero to 1.0. If the index is less than one-half the average value, the intensity of counteraction is lowered a second time by the same amount. Both versions use the following formula:

$$X_i = \sum D_{ij} G_j / \sum G_j, \qquad (2)$$

where D_{ij} is a discrete item of data in propensity category j for state i, and G_j is the weight assigned to that category. The internal range of X_i, the propensity-to-act index for state i, is -1.0 to +1.0. It is represented as ranging from -100.0 to +100.0 on the print-out. This computation is made in lines 2520-2630 of the program.

Coalition Strength, 'Nature of the Universe' Routine. As in the Benson version, the distribution of power in the world results in its description as "balance of power," "loose bipolar," or "tight bipolar," depending on whether the two largest coalitions in combination control (1) less than 75 per cent of the total power in the world, (2) more than 75 but less than 90 per cent, or (3) 90 per cent or more, respectively (Benson, p. 506). This subroutine also determines coalition membership, selects the most powerful nation in the coalition as the leader of the coalition, rank orders each of the five coalitions in order of relative

strength, and codes these findings for use in the alliance-change-on-loss subroutine described below. On the first round in the simulation, this subroutine is called after the initial war potentials and propensity-to-act indices are calculated. If modifications from previous rounds are to be used, the determination of coalition strength, leadership, and the "nature of the universe" occurs immediately after the option for using cumulative results.

Print Routine. After the Coalition Strength Routine is executed, the program checks to see if (1) the simulation is in its first round; or (2) if the game is using cumulative results. If cumulative results are being used, the program has already offered the "status at initialization" print-out, and control proceeds to the main computation routine for further work. If it is the first round, or if the game is not cumulative, the Print Routine is entered.

The Print Routine asks the user if the values of the simulation variables at initialization are to be printed. If so, a print-out begins (it may be abbreviated at the user's request). If a print-out of initial values is not desired, control is transferred to the Main Computation Routine. An initial print-out contains information on coalition membership, war potential, nuclear capability, and propensity-to-act for each nation. Table 2 indicates the initial alliance structure (each number is merely a label, 0 - 4, for designating coalitions and coalition membership), the initial war potentials (0.1 to 100.0 per cent), whether a country is a nuclear power or not ("1" means nuclear; "0" means non-nuclear), and the propensity-to-act index for each country (-100 to +100).

/Table 2 goes about here./

WORLD STATUS REPORT -- ROUND 1

LATEST STATUS INDICATORS ARE AS FOLLOWS:

(War Potentials from data base.)

COUNTRY	ALLIANCE	WAR POT'L	NUCAP	PROPENSITY
			(Nuclear capability.)	
U.S.	1	16	1	38.7
USSR	2	18.8	1	43
U.K.	1	7.6	1	6.1
FRANCE	4	7.4	1	47.6
ITALY	4	3.8	0	12.3
GERM-FDR	1	5.3	0	23
INDIA	0	4	0	-7.7
CHINA	3	8.6	1	52.3
JAPAN	1	5.2	0	4.6
N.KOR.	3	0.8	0	95.3
GUATEMALA	0	1.1	0	3
U.A.R.	2	1.4	0	55.3
LEBANON	0	1.1	0	33.8
HUNGARY	2	3.1	0	-1.6
S.VIET	1	1.1	0	78.4
TAIWAN	1	1.7	0	48
CUBA	2	2.3	0	49.2
CONGO(K)	0	0.6	0	21.5
GERM-DDR	2	3.2	0	52.3
PAKSTN	0	1.2	0	53.8
S.KOR.	1	2.1	0	33.8
CZECH.	2	3.5	0	29.2
YUGO.	2	2.4	0	-7.7
ISRAEL	1	2.6	0	9.2
N.VIET	2	1.9	0	76.9

(Propensity-to-Act indices for each nation.)

(Mean Propensity = 33.4) If Index is less than 33.4, Counter-action is lowered 1.0.)

THIS IS A BALANCE OF POWER WORLD.

TABLE 2

Print-Out of Initialization Values, Reconstructed Simple Diplomatic Game. Values are given for (1) alliance membership (allies have same number); (2) War Potential Indices (scale is 0.1 to 100.0 per cent); (3) nuclear capability ("1" means nuclear, "0" means non-nuclear); and (4) Propensity-to-Act Indices (scale is -100.0 to +100.0).

The main computation routine is then entered. This routine determines each state's interest in the target state, the gain or loss accruing to each state before counteractions are taken, the counteraction ultimately selected for each state, new war potentials after counteractions are effected, and any alliance changes resulting from a simulated loss of confidence in coalition leadership.

Interest Index. The "interest index" is computed from data on geographic proximity, coalition membership, the extent of mutual trade between each state and the target state, and the presence or absence of military bases in the target state. According to Benson (p. 506), the index is based on the following assumptions: "that the degree of interest of one state in another varies directly with the ratio of mutual trade to total trade and inversely with distance, and is heightened by alliance and by possession of military bases in the second state." The following computations were used in both versions to determine the interest index:

$$Y_i = (A_i + B_i + U_i + P_i)/R_i \quad , \qquad (3)$$

where Y_i represents the interest index of state i with respect to the target state, where

$$A_i = ((M_{iQ2}/D_{ij}) + (M_{iQ2}/D_{Q2j}))/2 \quad , \qquad (4)$$

where A_i represents the average percentage which mutual trade constitutes of total trade for the two states: M_{iQ2} is the mutual trade between state i and the target state; D_{ij} is the total trade of state i, and D_{Q2j} is the total trade of the target state Q2. The factors B_i and U_i are set at either 100 or 0.0, depending on the presence of state

i's bases in target state Q2 and on whether state i is a member of the same coalition as target state Q2.

P_i is the proximity index of state i to target state j:

$$P'_i = (SIN(V1))^2 + (SIN(V2)*SIN(V3)*(SIN(V4))^2), \quad (5)$$

where $V1 = (Latitude_i - Latitude_j)/2$; (5.1)

$V2 = 90.0 - Latitude_i$; (5.2)

$V3 = 90.0 - Latitude_j$; and (5.3)

$V4 = (Longitude_i - Longitude_j)/2$. (5.4)

The value thus obtained for P'_i is then multiplied by 100,000 such that $0 \leq P'_i < 999,999$. This can be compared directly with the ten haversines (H_i) in the data base. The comparison is implemented such that P_i, the proximity index, increases from 0.0 to 100.0 as the haversine of the great circle distance between major industrial centers decreases.

Finally, R_i, the number of factors constant, is set either to 300 or to 400 to adjust the interest index, Y_i, for the number of factors, either 3 or 4, which are relevant in computing Y_i: Three factors are used for neutrals without bases; four factors for other states. Y_i ranges internally from 0.00 to 1.00, and, for purposes of readability, is represented as 0.0 to 100.0 in the print-out.

Y_i is calculated at lines 5620-5640; A_i is found between lines 4940 and 5010. Calculation of B_i occurs at lines 5040-5100; R_i and U_i are computed at lines 5130-5260; and P_i is determined from lines 5360-5540 in the program.

Gain-Loss Before Counteractions. The product of the war potential index, the interest index, and the intensity level of the action

represents the gain temporarily awarded to the initiator, and the loss sustained by the other countries. Modified war potentials are also produced at this point, to be further modified after counteractions are effected. Counteractions for each state other than the initiator are then chosen on the assumption that states act to recover lost power, and that an appropriate level of counteraction will bring this about.

A number of constraints attend the selection of counteractions, however, which reduce the intensity of the counteraction which would otherwise occur: (1) the counteraction is lowered .100 if the propensity index is less than average; it is lowered again by the same amount if the index is less than one-half average; (2) should the logic lead to a response of .900 (the threshold of nuclear war) for a non-nuclear power, the intensity of counteraction is lowered to .800 (large-scale war); and (3) war (a counteraction greater than or equal to .700) against an ally is ruled out in any but a balance of power world. New war potentials are then calculated for each state based on counteractions thus selected. In the case of the initiator, the gain in war potential initially awarded is reduced by a factor representing the logistical cost of action. This factor takes into account both the distance between the initiator and the target and the intensity of action specified. Hence the initial gain is not at all a certain one: an actor may lose if he acts with strong intensity against a target in which his interest is low and where logistic cost is high.

Initial gains and losses before counteractions are calculated as follows:

$$R_i = (W_i * Y_1 * Q3) \quad , \qquad (6)$$

where R_i is the loss accruing initially to all states except the initiator of action, and the gain awarded initially to the actor state. W_i is the war potential index from Formula (1); Y_i is the interest index from Formula (2); and Q3 is the level of intensity of the action. R_i also has an internal range from 0.00 to 1.00. It is calculated at lines 5690-5710 in the program.

Modified War Potentials Before Counteractions. Modified war potentials as measured after the actor state has "acted" but before counteractions are selected and implemented are calculated as follows:

$$T'_i = W_i - R_i \quad , \qquad (7)$$

where T'_i is the temporary war potential, W_i is the old war potential as calculated in Formula (1), and R_i is the loss awarded to each non-actor state as calculated in Formula (6). The temporary war potential of the actor state, Q1, is simply

$$T'_{Q1} = W_{Q1} + R_{Q1} \quad . \qquad (8)$$

Since war potential is a percentage measure, it is necessary to normalize the modified war potentials on the basis of 100 per cent:

$$T_i = T'_i/T \quad , \qquad (9)$$

where

$$T = \sum T'_i \quad . \qquad (10)$$

These calculations occur in lines 5730-5830 in the program.

Counteractions. Counteractions, A_i, for each state except the actor state (for which there is no counteraction) are calculated as follows:

$$A_i = \left|((W_i - T_i)/T_i)\right| \quad . \quad (11)$$

A_i for each state except the initiator of action is calculated at line 5940; counteractions are revised at lines 5900-6460.[13]

Gain-Loss for Initiator of Action. For the initiator of action, modified war potential is calculated as follows:

$$W'_{Q1} = T_{Q1} - ((100.0 - P_{Q1})*.001458*Q3), \quad (12)$$

where W'_{Q1} is the modified war potential of the initiator of action;

$$T_{Q1} = T'_{Q1}/T \quad , \quad (13)$$

T_{Q1} is the normalized war potential of the initiator determined by adding the old war potential and the gain from Formula (8), but before deducting logistic cost. P_{Q1} is the proximity index for the initiator calculated in Formulas (5) through (5.4) and in lines 5040-5100. Q3 is the level of intensity of action. A cost factor constant, k = .001458, is included in this formula to represent logistic cost for transporting one U.S. division per unit distance. A more thorough treatment of this constant and its derivation appears in Section III, below.

Modified War Potentials. Modified war potentials for all states except the initiator of action are computed at line 6200 from the following formula:

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[13]The Benson formulas for computing modified war potentials (Benson, p. 510, Equations (14) and (15))and counteractions (Equations (16), (17)) were used in deriving Formula (11). Personal correspondence (March 16, 1970) confirms the use of a normalized war potential in the present equations, mentioned only implicitly by Benson in a verbal description following Equation (17), p. 510.

$$W'_i = \left| (W_i - R_i) + ((W_i - R_i) * A_i) \right| . \qquad (14)$$

Alliance-Change-on-Loss. If the game is cumulative, alliance structure will change as follows: three successive losses for an ally resulting from coalition leader A's initiative will place this ally in a neutral category; three losses sustained by a neutral as a consequence of leader A's action will cause the neutral to join rival coalition B. The codes for coalition membership and leadership, developed in the Coalition Strength subroutine, are utilized in this determination. This completes the main computational segment of the program.

The program branches to the subroutine which calculates coalition membership, strength, and leadership for the second time in the cycle. The "nature of the universe" is re-calculated for the purpose of detecting important changes in the distribution of power in the world.

Program control is then transferred to the print subroutine which displays the results of the round at the teletype. Alliance changes, if any, new war potentials, changes in war potential from the previous round (or differences from values at initialization), counteractions taken, interest indices used in the determination of gains and losses, and a description of the "nature of the universe" are given. A winner is declared in the second round of a competitive game.

The formula for determining the winner is as follows:

$$(W_{a2}/W_{a1}) - (W_{b2}/W_{b1}) = y \qquad (15)$$

is computed for y: if y=0, both players a and b lost or gained equally; if y is positive, player a gained more or lost less; if y is negative, player b was the relative winner. The notation a1, b1, represent the

war potentials of the same states at the end of the action cycles resulting from the two respective choices. Differences in notation excepted, this is the general formulation implemented at lines 4490-4710. This formula, and all others appearing in this section are in Benson, p. 510.

The Value of the International Situation. This index, initially included but subsequently deleted from the Benson model, has not been incorporated into the present simulation. This index was deleted by Benson in early runs of the program on the grounds that it provided no information which other indices in the program did not supply.[14]

Typical Run. A typical action status report appears in Table 3.

/Table 3 goes about here/

The simulation reported in Table 3 encompasses the following interactions: The United States, at the option of the user, has acted against the USSR at intensity level 3, corresponding to an effort of 30 per cent of U.S. capability. This action level is conceptually approximated above as "severing diplomatic relations." The USSR responded with a counteraction of 3.01, a roughly equivalent response in this case. The US. suffered a net loss of 1.3 per cent of total war potential in the world in this instance, while the USSR gained four-tenths of one percent. A high "logistic cost" in this run (see section on findings, below) in combination with a relatively low interest index for the U.S. vis a vis the USSR (10 on a scale ranging from 0 to 100), made the action unprofitable from the standpoint of the country initiating the action. The

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[14] O. Benson, personal correspondence, July 14, 1969.

W O R L D S T A T U S R E P O R T -- R O U N D 1

MOST RECENT ACTION WAS INITIATED BY U.S. AGAINST USSR WITH AN INTENSITY OF 3

(Cost factor constant for this round only: k=.002187. See discussion, Section III. Other examples: Appendix A.)

LATEST STATUS INDICATORS ARE AS FOLLOWS:

COUNTRY	ALLIANCE	WAR POT'L	WP-CHANGE	C-ACTION	INTEREST
		(War potential after action; change from previous round.)			
U.S.	1	14.8	-1.3		10
USSR	2	11.3	0.4	3.01	100
U.K.	1	7.4	-0.3	0	25.5
FRANCE	4	7.7	0.3	0.13	25.2
ITALY	4	3.8	0	0	7.9
GERM-FDR	1	5.5	0.2	0.7	20.4
INDIA	0	3.8	-0.2	0	25
CHINA	3	9	0.3	0.13	25.3
JAPAN	1	5	-0.2	0	23.1
N.KOR.	3	0.9	0	0.61	9.5
GUATEMALA	0	1.1	0	0	13.3
U.A.R.	2	1.4	0	0.24	36.9
LEBANON	0	1.1	0	0.29	20.2
HUNGARY	2	2.7	-0.5	0	59.6
S.VIET	1	1.1	0	0.14	25
TAIWAN	1	1.7	0	0.3	20
CUBA	2	2.4	0.1	0.38	40.8
CONGO(K)	0	0.6	0	0.49	13.4
GERM-DDR	2	3.3	0.1	0.39	41.1
PAKSTN	0	1.3	0	0.29	20.2
S.KOR.	1	2.2	0	0.22	22.5
CZECH.	2	3.6	0.1	8.000000E-2	59.3
YUGO.	2	2.2	-0.3	0 (.08)	44.3
ISRAEL	1	2.7	0	0	5
N.VIET	2	2	0	0.23	36.4

(Counter-actions.)

(Interest Indices)

THIS IS A BALANCE OF POWER WORLD.

TABLE 3

Typical Action Print-out, Reconstructed Simple Diplomatic Game: United States acts with an Intensity of "3" (30 per cent effort) against the USSR.

percentage distribution of gains, losses, and zero net change in war potential for each alliance is shown in Table 4.

/Table 4 goes about here./

In this round then, the U.S. and its allies generally lost or incurred no net change in war potential, the USSR and its allies generally increased war potential by small amounts, while the war potential of other coalition members generally remained unchanged. Since no two coalitions in combination controlled 75 per cent of the total power in the world at the conclusion of the round, a polar condition did not exist, and hence the world was described as a "balance of power" type. Since the round was not designated as competitive by the user, the gains or losses of the initiator of action in the previous round (not shown) were not compared with the losses of the initiator of action in the round reported in Table 3, and thus no winner was declared.

At this point, the round is over, and the program asks if the simulation is to continue for another round; if not, the program is terminated. On any round except the first round, where coalition structure and war potentials are determined from the data base, options are provided for the modification of coalition structure and war potentials to suit user-specific investigations.

III. OBSERVATIONS AND CONCLUSIONS

While an assessment of the validity of the substantive assumptions embedded in the simulation is beyond the scope of the present paper, the steps involved in the reconstruction of the model

	U. S. and Allies	USSR and Allies	Other Coalitions
Net Gains	12.5%	50.0%	22.2%
Net Losses	37.5%	25.0%	11.1%
No Change	50.0%	25.0%	66.7%
	(n = 8)	(n = 8)	(n = 9)

N = 25 Countries

TABLE 4

Percentage Change in War Potential Among Coalitions as a Result of U. S. Action (intensity = "3") Against the USSR, from TABLE 3.

from published accounts, in determining its major operating characteristics, and in attempting to assess the "fit" between advantages of the reconstructed simulation and advantages claimed for computer simulation in general nevertheless suggest a strong interdependence between technique and substance. Execution of the techniques involved is not without important consequences for the fidelity with which substantive assumptions are in fact incorporated into the model. "Adequate" computer modeling in no way assures the validity of the substantive propositions, of course, but "inadequate" application of technique might reasonably be expected to jeopardize the simulator's control of what in fact is being simulated, thus precluding questions of validity altogether. Fidelity of the translation from verbal theory to computer instructions in turn affects the extent to which the advantages claimed for computer simulation can be realized: reductions in substantive ambiguity, successful elaboration of consequences, the compounding of propositions such that interrelationships between variables may be observed and tested.

Morton Gorden (1968) explicates another aspect of the intimacy between method and substance when he cites the "need to be highly selective in the computer environment where time for running the machine and space for machine instructions are limited and costly (Gorden, p. 224)." Tuning, "the process of following through the calculations to make sure that decisions are not an artifact of incompatible numbers but a matter of design," (Gorden, p. 238), is likewise an aspect of the relationship between method and substance.

With respect to the cost of developing the present simulation and "tuning," an activity to be examined in greater detail below, nearly one-half the cost of machine time was incurred through testing, evaluation, "tuning," and re-evaluation of the model, while initial programming

debugging, and construction of the data base accounted for remaining machine expenses. A second observation with respect to cost involves theoretical complexity: while machine costs in general appear to be directly related to program size, although small programs can also be costly to develop and operate, the relationship between machine cost and the complexity of the theory being modeled is by no means a direct one. Present experience provides the example: the original implementation of the "Simple Diplomatic Game" in FORTRAN language required the nearly the full, 2,000-character core memory of the IBM 650 Digital Computer used for the purpose (Benson, p. 505). While the present time-sharing implementation is no more complicated in terms of the international relations theory imbedded in it, a relatively large amount of machine memory (approximately 50,000 characters) is required for its implementation. The discrepancy is due to differences in hardware and software, to the larger matrices in the present version for initializing the model (data for 25, rather than for nine, actor nations), and to the inclusion of a substantial number of comment lines (non-executable program statements) in the body of the program as documentation. The complex implementation of relatively uncomplicated theory is thus an artifact of factors not related to theoretical simplicity or complexity. The burden of selectivity with respect to what is being modeled thus seems to entail selection of propositions or theories to be simulated not only on the basis of theoretical simplicity or complexity (as dictated by research objectives), but also with a view to estimating <u>implementational</u> simplicity or complexity and, from this, <u>operational</u> costs.

Total machine costs incurred in the development, debugging,

"tuning," and evaluation of the present version were less than $1,000. While the program is relatively large in size, its operating costs for present purposes are considered acceptable: the first cycle of the program, in which the data is read in and manipulated more extensively than in subsequent rounds, requires approximately 10 seconds of central processor time. This costs about $1.00-$2.00. Subsequent rounds are executed in roughly 3 seconds of central processor time.

In addition to the selectivity imposed by the cost of machine time and by space limitations, Gorden further elaborates the relation between method and substance in describing "the constraints which operate on the programmer who implements the designer's idea" (Gorden, p. 239):

> The designer must live within these constraints or the programmer will . . . unwittingly fall into the role of designer. Instead of implementing what that designer wants, the programmer may implement only what is possible. The designer is faced with the burden of making the desirable possible. He cannot leave it exclusively to the programmer; not because the programmer is by nature a different being from a substantive analyst, but because a programmer operates under rather different constraints from designers. These constraints have to be recognized to take into account what a programmer's probable behavior will be when faced with designer ambitions for a simulation.

It seems plausible that such difficulties would be minimized in cases where one or more individuals, trained in the substantive theory being simulated and in programming and implementation, applied a combination of skills to what, it has been argued, is a combination of tasks.

The most crucial aspects of the method-substance relationship, however, might reasonably be regarded as those tasks related to the actual translation from verbal theory to computer simulation: (1) choosing algebraic terms which "adequately" represent the verbal prospositions involved; (2) aggregating the algebraic terms thus decided upon, a problem with implicit assumptions about the ability to aggregate concepts, if not

phenomena, in ways which are at least theoretically consistent and which in principle can be empirically falsified; (3) translating the algebra to computer instructions (algorithms); and (4) aggregating the algorithms when the simulation is run. The operating characteristics of the present simulation will be examined with the preceding aspects of the method-substance relationship in mind.

As implied in Section II, the simulation serves as a vehicle for combining a number of indices in a way which produces simulated gains and losses in war potential as a result of actions and counteractions among the nations being simulated. Since the gains and losses in war potential are the primary outputs of the present simulation, the calculations for arriving at gain and loss statistics for each nation will be treated as the main substantive and methodological foci of this discussion.

Relative gain or loss accruing to the initiator of action was designed and programmed as a function of four factors: (1) the actor's war potential, (2) the intensity of action, (3) the interest index of the actor with respect to the target, and (4) a logistical cost factor. Gains and losses for other nations in the same round are derived from the first three factors: each nation's war potential, the intensity of action, and each nation's interest index with respect to the target state. The product of these three scales, each represented internally as having a value from zero to 1.00, is initially treated as the loss accruing to each nation and forms the basis for the counteraction selected for that nation as it "attempts to recover lost power."

The War Potential Index as a Determinant of Gain/Loss. Since distribution of power in the simulation is derived initially from distribution of resources, it is safe to assume that changes in the distribution of these

resources since 1955, as reflected in the data collected for 1965, resulted in a somewhat different initial power distribution. (Under conditions where cumulative play is specified, the distribution changes in the next round and each cumulative round thereafter in keeping with the specific actions and counteractions which occur.) Where operating characteristics of the simulation are concerned, however, these differences were not considered to be crucial. Experiments with a "dummy" data set supported this view. The percentage gain and losses produced by the model varied systematically with the data set, as expected in a simulation in which "more powerful" nations tend to have higher percentage gains than "less powerful" nations. Resources as reflected by the data initially define the "strong" and "weak" nations: this partially determines initial gains and losses. Options provided for modifying war potential and alliance structure provide ready confirmation that percentage gains and losses change as war potential increases or decreases (see example, Appendix A, pp. A6-A8). But while the numbers change, the characteristics of the model which produced these numbers do not.

The variation in percentage loss and gain accounted for by different resource data is quite small, however, in relation to the effect of the weights used (1) to establish the importance of one war potential category relative to the eight other categories, and (2) to scale the categories such that meaningful linear combination is possible. While considerable effort was expended on the development of an accurate data set, no guidelines were available for assigning the weights by which each item of data was scaled. Several sets of weights were developed to observe the effect of the weights in greater detail. It was found, for example, that a high weight for the population category

would make China appear to be the most powerful nation in the simulation. Strong emphasis on the transportation categories (railroad and highway mileage) and/or GNP made the United States appear roughly twice as powerful as any other country in the simulation, including the USSR. The imprecision of the method of determining these weights significantly reduced the precision of the data. It became readily apparent that seemingly minor technical adjustments of this nature, which in general might be required frequently in an all-machine simulation, are as much in need of theoretical justification as the computational formulas at the heart of the program: "tuning is also designing, and must be done with the same care as selecting the elements of an equation" (Gorden, p. 238).

Benson frankly points out that, in the absence of appropriate International Relations theory from which to proceed, his weights were estimated by intuitive means.[15] More than ten years after the development of the original version, it is not surprising that more rigorous methods are available for such estimates nor that more accurate initialization seems possible. R. J. Rummel, for example (Rummel, 1969), provides a set of indicators for national "attributes" and "behavior," having determined the relative salience of each indicator by means of factor analysis. Modification of data weights and incorporation of indicators on the basis of Rummel's findings seem plausible as ways to link the present simulation to its data more directly and with less experimenter bias.

Additional research also seems appropriate with respect to the suitability of adding the weighted terms together in order to derive the war potential index. Additivity seems to require (1) a demonstration that a set of indicators are part of a unitary trait; (2) the elimination

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[15] Personal correspondence with the author, March 5, 1970.

of differences in units of measurement (e.g., kilowatt hours v. transportation mileage), and (3) a demonstration that the indicators chosen for the index in fact tap the same concept, rather than two or more different concepts.

Another difficulty encountered in modeling with continuous scales and linear equations is that the values computed for such scales may exceed the lower-and upper- bound desired by the simulator. On these occasions, the scale values must be analyzed to determine whether the results play havoc with equations further along in the program which are designed to accept values which can differ by orders of magnitude from those produced. The intensity scale and the war potential indices were hardest to control in this respect: having determined that off-scale results were not attributable to programming errors, instructions were inserted into the program at appropriate points to ensure that upper and lower bounds were not exceeded before the results were passed to the next point in the program. Where a particular result goes off-scale, the value of the lower or upper bound is substituted. The use of a lower-bound for the war potential index is not inconsistent with Benson's original design in which war potentials are always greater than zero. The theoretical consequence of this decision is that participants cannot be eliminated from the simulation through a depletion of war potential.

While the war potential indices of individual states are significant components of the gain-loss calculation taken separately (Formula 6), the author was unable to confirm Benson's assertion that aggregate war potentials--the "balance of power," "loose bipolar" and "tight bipolar" configurations--are important as determinants of action within the simulation.

Benson describes the nature of the universe feature as a

"determinant of action," since in a tight bipolar world, "only the bipolar leaders act, with other coalition members merely in supporting roles" (Benson, p. 506). But at the same time, he states that "since no particular gain or loss factor is attached to the counteraction 'support,' the program must assume one." In the present version, then, following Benson, the nature of the universe branch does little more from a programming standpoint than cause only the actions and counteractions of the leaders to be printed out under tight bipolar conditions, as if counteractions on the part of other countries had not taken place. The "costs" of supporting the coalition leader's initiative are the same for coalition members regardless of the distribution of power; this appears to be the case in the original simulation. The behavior of allies under bipolar conditions would thus appear to be in need of further articulation.

With respect to changes in the distribution of power ("nature of the universe"), Benson reports that "the nature of the universe seldom changes, and when it does, the change is generally toward the more polar condition" (Benson, p. 507). The same effect was observed in the present version, if only as a result of (1) specification of one of the major coalition leaders as initiator of action, or (2) the inherent tendency in the simulation for "more powerful" nations to enjoy larger percentage gains than "less powerful" nations.

Benson also reports a steady shifting of alliance ties as a consequence of losses in war potential sustained by coalition members or neutrals from initiatives on the part of coalition leaders. In the present version, major shifts in alliance structure occur predictably, given that (1) the leader of Coalition A (2) is repeatedly designated as the initiator of action (3) for three <u>successive</u> rounds in which (4) cumulative results are used.

Intensity of Action as a Determinant of Gain/Loss. Benson's design requires that intensity of action be represented on a continuous scale, ranging from 0.1 to 0.9 internally, but depicted as ranging from 1 to 9 externally for convenience of entry at the teletype. Possible lines of development for this scale might include: (1) The inclusion of a step jump for the scale at level 9 to, say, 1000 to simulate qualitative differences between conventional and nuclear warfare; (2) Since at present the intensity scale is not programmed to simulate threats of additonal damage to come, a supplemental option for the user, and suitable modification of the program to convey threat to the nation acted against and simulate that nation's response to threat situations might prove useful (cf., Schelling, 1966); (3) The intensity scale represents, and the system responds, in terms of acts which are conceptualized as being hostile and destructive; hence, the incorporation of cooperative acts and response mechanisms is another possible area for development.

Interest Index as a Determinant of Gain/Loss. Examination of the interest index, a composite of four separate measures of trade, geographic proximity, alliance membership, and bases abroad (supra, pp. 16-17) discloses some unrealistically low interest indices when the following pairs of countries are considered: Egypt-Isreal, India-Pakistan, USSR-Red China, Red China-Taiwan, North Korea-South Korea, North Vietnam-South Vietnam, and USSR-United States. The reasons for the low interest indices produced are consequences of the definition of the index: trade between each pair of countries is sparce or non-existent; each pair of countries involves two different alliances; neither country in a pair possesses military bases in the other, with the exception of North Vietnam's military presence in South Vietnam. The interest index produced therefore depends on the

proximity of one country with respect to the other, and thus declines as distance increases. It would seem reasonable to add at least one additional component to the index to simulate ideological compatibility-incompatibility, the effect of which might be to increase interest as incompatibility increases. Other modifications based on travel data, communication data, and news media content analysis have already been suggested (Benson, p. 507).

Cost Factor Constant as a Determinant of Actor's Gain/Loss. The initial gain awarded to the initiator of action is reduced by a logistic cost which increases in direct proportion (1) to a proximity factor, derived from the haversine of the great circle distance between a major industrial area in both the actor and the target state, multiplied by (2) a cost factor constant, k, which "represents a constant percentage of total power required to carry out an action of one intensity level at one-tenth the maximum possible distance (Benson, p. 510)," and by (3) the intensity level (Formula 12, p. 20). The value reported by Benson for this constant is .0007286, based on the cost of transporting one U.S. division for specified distances. In the present version, the use of this value for k resulted in uniformly increasing gains for the initiator of action, such that the criteria of uncertainty with respect to actor gains was not met. Tuning in the direction of this criteria, it was found that a value of .001458, roughly twice the value reported by Benson, was required to produce uncertainty of outcome for the largest nation in the simulation (the U.S.) under conditions where the interest index was low. The most probable source of the discrepancy was the scale and manner of computation used to determine the haversine values for each actor nation. Gain/loss curves for U.S. action against the USSR for three values of k are plotted in Figure 3. This figure is the key to understanding the performance

characteristics of the model and the consequences which the model elaborates.

/Figure 3 goes about here./

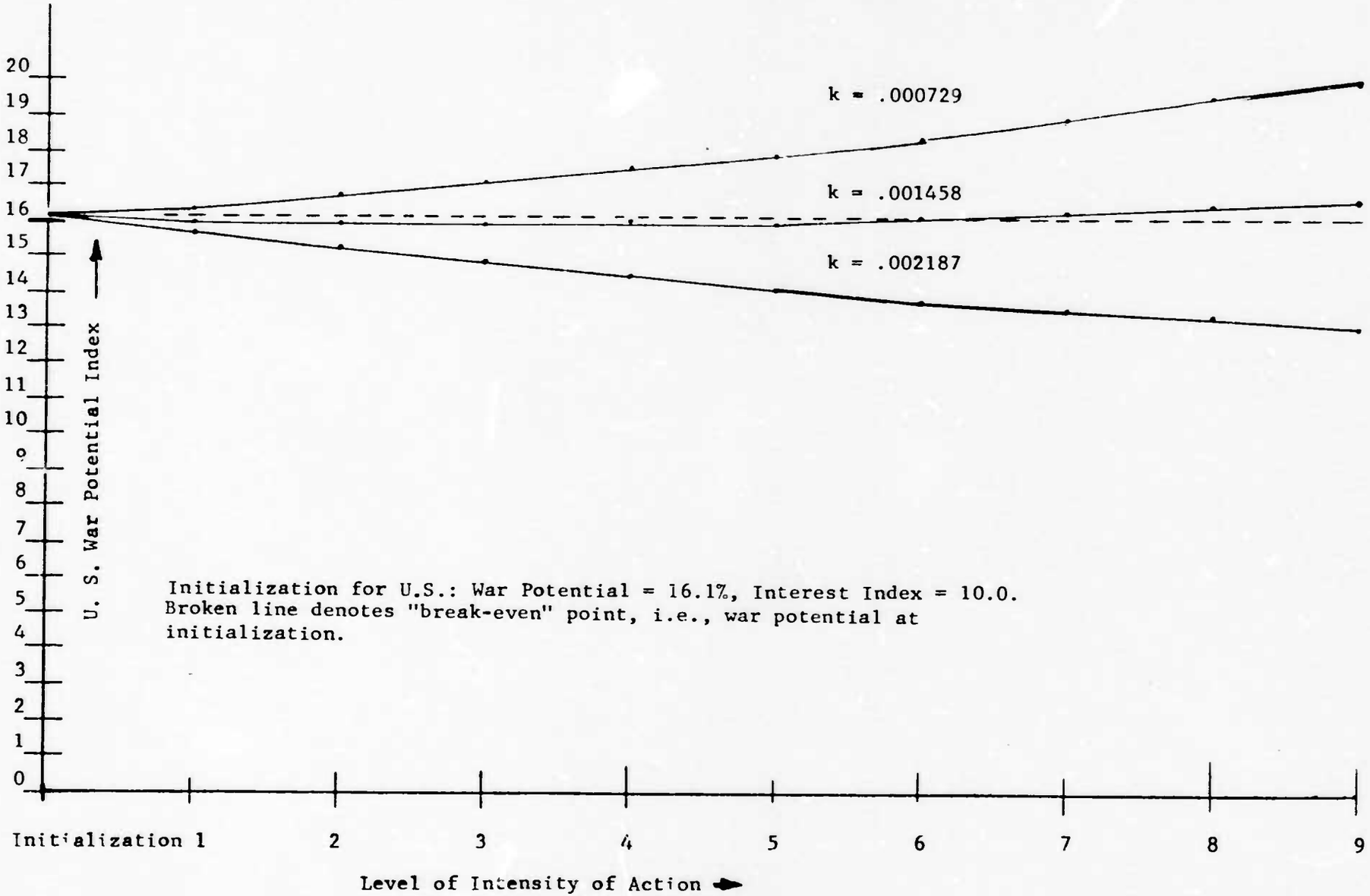
Performance Characteristics. The program was run for nine non-cumulative, non-competitive rounds for each of three values of k: .000729, .001458, and .002187 (refer to Figure 3). In each of the 23 experiments, the initial war potential for the U.S. based on the data set was 16.1%, and the interest index (for U.S. interest in the USSR) was 10.0 on scale of 0.0 to 100.0. This comparatively low value was expected to produce only modest gains, no net change, or varying degrees of loss. A value of k = .001458 was approximately the lowest value which seemed to satisfy the design criteria. Other observations with respect to the gain/loss characteristics of the model are as follows:

(1) A relatively powerful nation (war potential $\geq$ 10%) initiating action with respect to countries for which it has relatively higher interest tends to increase its gains systematically (revising the slopes of the gain/loss curves upward for each value of k);

(2) A relatively powerful nation initiating action with respect to countries for which it has relatively low interest tends to decrease its gains systematically (revising the slopes of the gain/loss curves downward for each value of k);

(3) A less powerful nation (war potential $<$ 10%) initiating action against countries for which it has relatively high interest tends to produce moderate gains (revising slopes gradually downward as war potential of initiator decreases, given that interest is relatively high);

(4) A less powerful nation initiating action against countries for which it has a relatively low interest index tends to produce losses (slopes revised downward as war potential decreases, given that interest



Initialization for U.S.: War Potential = 16.1%, Interest Index = 10.0.
Broken line denotes "break-even" point, i.e., war potential at initialization.

Figure 3

Gain-Loss Curves for U.S. action against USSR, Varying Cost Factor Constant k

is relatively low);

(5) As the interest index increases, the net gain accruing to a nation increases for most values of war potential and intensity of action, given that the cost of action over distance does not exceed the gain which would otherwise be realized;

(6) Counteractions are insensitive to changes in the cost factor constant k, but vary directly with the war potential of the non-initiating states, interest with respect to the target state, and the intensity of action;

(7) As gains decrease for the initiator of action, the counteractions of target states produce generally increasing gains for the target state;

(8) As gains increase for the initiator of action, counteractions of target states produce generally decreasing gains for the target states;

(9) In general, the gains or losses of coalition members vary directly with the gains or losses of the coalititon leaders;

(10) The propensity-to-act index, which is used only in the revision of counteractions and hence is unrelated to activities of any nation designated as an initiator of action, reduces the percentage gain accruing to a particular nation when a gain has been realized, and tends to increase losses when losses are produced, since a nation with a propensity index either (a) below the mean propensity value or (b) less than one-half the mean propensity value cannot redress its losses as fully as would otherwise be the case. These, then, are the major consequence elaborated by the model.

Advantages and Disadvantages. (1) That the present simulation requires unambiguous statement of hypotheses is true almost by definition. What

is less obvious is that the hard choices demanded by the machine with respect to algebra, and in the translation of algebra to machine instructions, as well as the aggregation of terms (and then algorithms, when the simulation is run) exacts costs in terms of arbitrariness. Nevertheless, this arbitrariness is less a disadvantage than a guidepost to relationships left unexplicated in the process of consolidating international relations theory, and as such may be viewed as a helpful, temporary, and in principle reducible characteristic.

While the rigor and complexity of programming languages can obscure theoretical limitations as well as reveal them (another way of saying that theory places tremendous demands on computer instructions with respect to the fidelity of translation) it is also reasonable to expect that the rigor of the instructions places a reciprocal burden on theory as regards the extent to which that theory is unambiguous, explicit, and thorough in its abstraction of phenomena. For example, the oversimplification which results from the decision to treat power (war potential) as a function of natural and technical resources can be viewed in part as indicative of the limitations of the "power" concept itself. In this sense, it might be argued that the need for unambiguous definition constitutes a continuous demand for the explication of theory.

(2) Having provisionally accepted the arbitrary and highly stylized character of the technique and having attempted to observe the constraints of translation and implementation discussed above, the author observed a rapid and systematic elaboration of consequences inherent in the relationships thus programmed. The operating characteristics of the model were observed and interpreted in terms of component variables interacting in a pre-specified way; it was not dificult to make definitive statements about the effects of variable x, or to predict the effect the alteration of variable x would have under various experimental conditions.

The successful elaboration of consequences is thus seen to presume some ability to disaggregate the variables and relationships in order to test the model's consistency, determine its operations, and so forth. Control over what is being simulated appears to be the limiting factor for the third advantage being claimed for computer simulation: compounding propositions and the addition of complexity.

(3) The compounding of propositions and the consideration of interactive effects among variables implies a progression in the direction of steadily increasing complexity. Campbell (1966, p. 1) suggests that

> whatever epistemology we may choose interpreting the laws of science--even if as realists we regard science as iteratively asymptoting on truth--we recognize that the science we have today is only approximate. Further, we know something of the nature of the disparity between the approximation and the ultimate: Our present approximation almost certainly involves a neglect of many principles affecting the phenomenon under examination, principles which must be added before our understanding of the phenomenon is complete.

With respect to simulation as an approximation to a reality perceived as complex rather than simple, Campbell argues that "a complex simulation is a better base for generalizing to a specific natural situation than a simple experiment if the greater complexity provides greater similarity to the natural situation in question (1966, p. 5)."

Provisionally accepting the notion that complexity is in some way "better" for the purpose of approximating referent system complexity, how might complexity be added? On this question, Blalock (1969, p. 3-4 ff.) writes

> in order to develop deductive theories, one must ordinarily begin with very simple models that are totally inadequate to mirror the real world. By adding new variables and complications a few at a time, one can then construct more realistic theories by what amounts to an inductive process....Complexity

> can be introduced in a number of different ways. First, one can add more and more variables. Second, he may allow for relatively more complex forms of relationships such as non-linearity or non-additive joint effects. Third, he can construct dynamic theories that deal with time paths, feedbacks, cycles, and so on. Fourth, he may use increasingly complex but more realistic assumptions about the omission of variables from the system producting measurement errors and unexplained variation.

One practical limit to the amount of complexity which can be adduced would thus seem to be the point at which it is no longer possible to make definitive statements about which variables are producing specific effects. The present implementation did not exceed this limit: temporary "print" commands, inserted at appropriate points in the program, were sufficient to detect errors during the de-bugging phase of the project, and to determine that specific program segments were in fact producing the anticipated range of results. From this point of view, the elaboration of the model's theoretical implications was not without success.

Given control over what in fact is being simulated, and thus having some confidence in the translation from design to implementation, the simulator can turn to an evaluation of simulation outputs, including, for example, an assessment of whether the choice of mathematics led to an extension of theory or to its violation, an examination of the "fit" between simulation results and the performance characteristics of external referent systems, and other important validity issues which exceed the dimensions of this paper. But confidence in translation, and the ability to deal persuasively with validity issues, are in no way "given" to the simulator. On the contrary, they require a continuation of the inquiry into the methodology of all-computer simulation which the early Benson simulation has begun.

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APPENDIX A

Sample Simulation: A Reconstructed "Simple Diplomatic Game" March, 1970

W O R L D S T A T U S R E P O R T -- R O U N D 1

MOST RECENT ACTION WAS INITIATED BY U.S.
AGAINST USSR WITH AN INTENSITY OF 3 ← (SAME ACTION AS IN TABLE 3,) BUT HERE COST FACTOR, k, IS SET AT .001458.

LATEST STATUS INDICATORS ARE AS FOLLOWS:

COUNTRY	ALLIANCE	WAR POT'L	WP-CHANGE	C-ACTION (Counteractions same as in Table 3)	INTEREST (Interest Indices same as in Table 3.)
U.S.	1	15.9	-0.1	3.01	100
USSR	2	11.1	0.3	0	25.5
U.K.	1	7.3	-0.4	0.13	25.2
FRANCE	4	7.6	0.2	0	7.9
ITALY	4	3.8	0	0.7	20.4
GERM-FDR	1	5.4	0.1	0	25
INDIA	0	3.8	-0.2	0.13	25.3
CHINA	3	8.9	0.2	0	23.1
JAPAN	1	4.9	-0.3	0.61	9.5
N.KOR.	3	0.9	0	0	13.3
GUATEMALA	0	1.1	-0.1	0.24	36.9
U.A.R.	2	1.4	0	0.29	20.2
LEBANON	0	1.1	0	0	59.6
HUNGARY	2	2.6	-0.5	0.14	25
S.VIET	1	1.1	0	0.3	20
TAIWAN	1	1.7	0	0.38	40.8
CUBA	2	2.4	0	0.49	13.4
CONGO(K)	0	0.6	0	0.39	41.1
GERM-DDR	2	3.3	0	0.29	20.2
PAKSTN	0	1.3	0	0.22	22.5
S.KOR.	1	2.2	0	8.000000E-2	59.3
CZECH.	2	3.6	0.1	0	44.3
YUGO.	2	2.2	-0.3	0 (.08)	5
ISRAEL	1	2.7	0	0.23	36.4
N.VIET	2	2	0		

THIS IS A BALANCE OF POWER WORLD.

SPECIFY ACTOR, THEN TARGET....?12,24 ← (U.A.R AGAINST ISRAEL)

SPECIFY INTENSITY OF ACTION (SCALE 1 TO 9)....?6 ← (Guerrilla warfare.)

COMPETITIVE PLAY (1=YES; 2=NO)....?1 ← (Competitive play is specified.)

SHOULD THE ACTION INCORPORATE MODIFICATIONS FROM ANY
PREVIOUS PLAYS IN THIS SERIES (1=YES; 2=NO)?2 ← (Use data to set inital war potentials as in Table 2.)

DO YOU WISH TO CHANGE COALITION STRUCTURE (1=YES; 2=NO)....?2

DO YOU WISH TO CHANGE WAR POTENTIALS (1=YES; 2=NO)....?2

PRINT STATUS AT INITIALIZATION (1=YES; 2=NO)....?2 ← (By-pass the first print-out, since it is the same as the print-out in Table 2.)

QUICK PRINT-OUT OF ACTION RESULTS (1=YES; 2=NO)....?2

W O R L D S T A T U S R E P O R T -- R O U N D 2

MOST RECENT ACTION WAS INITIATED BY U.A.R.
AGAINST ISRAEL WITH AN INTENSITY OF 6

LATEST STATUS INDICATORS ARE AS FOLLOWS:

COUNTRY	ALLIANCE	WAR POT'L	WP-CHANGE	C-ACTION	INTEREST
U.S.	1	16.9	0.8	0.52	50.3
USSR	2	11.4	0.6	0.18	30
U.K.	1	6.4	-1.3	0	34.7
FRANCE	4	7.8	0.4	1.54	0
ITALY	4	3.4	-0.5	0	25.4
GERM-FDR	1	5.6	0.2	0.52	38.7
INDIA	0	3.7	-0.3	0	20
CHINA	3	9.1	0.4	1.7	5
JAPAN	1	4.3	-0.9	0	35.4
N.KOR.	3	0.9	0	0.53	25
GUATEMALA	0	1	-0.2	0	30
U.A.R.	2	1.4	0		47.5
LEBANON	0	1.1	0	0.42	26.6
HUNGARY	2	2.5	-0.6	0	37.6
S.VIET	1	1.1	0	0	32.5
TAIWAN	1	1.7	0	0.38	37.5
CUBA	2	2.4	0.1	0.79	42.5
CONGO(K)	0	0.6	0	0.81	30
GERM-DDR	2	3.4	0.1	1.25	47.5
PAKSTN	0	1.3	0	0.64	23.3
S.KOR.	1	2.3	0.1	0.18	35
CZECH.	2	3.7	0.1	0.81	30
YUGO.	2	2	-0.5	0	37.7
ISRAEL	1	2.8	0.1	6.99	100
N.VIET	2	2	0.1	1.49	50

THIS IS A BALANCE OF POWER WORLD.

SPECIFY ACTOR, THEN TARGET....?24,12 ← (ACTION IS SECOND, COMPETITIVE ROUND: ISRAEL AGAINST U.A.R.)

SPECIFY INTENSITY OF ACTION (SCALE 1 TO 9)....?6

COMPETITIVE PLAY (1=YES; 2=NO)....?1 ← (Competitive option exercised again.)

CUMULATIVE RESULTS (1=YES; 2=NO)....?2 (Use initial values for war potentials.)

DO YOU WISH TO CHANGE COALITION STRUCTURE (1=YES; 2=NO)....?2

DO YOU WISH TO CHANGE WAR POTENTIALS (1=YES; 2=NO)....?2

PRINT STATUS AT INITIALIZATION (1=YES; 2=NO)....?2

QUICK PRINT-OUT OF ACTION RESULTS (1=YES; 2=NO)....?2

W O R L D S T A T U S R E P O R T -- R O U N D 3

MOST RECENT ACTION WAS INITIATED BY ISRAEL
AGAINST U.A.R. WITH AN INTENSITY OF 6

LATEST STATUS INDICATORS ARE AS FOLLOWS:

COUNTRY	ALLIANCE	WAR POT'L	WP-CHANGE	C-ACTION	INTEREST
U.S.	1	16.8	0.7	0.14	46.6
USSR	2	11.3	0.5	0.31	36.9
U.K.	1	6.2	-1.5	0	38
FRANCE	4	7.7	0.3	1.14	15.5
ITALY	4	3.5	-0.4	0	20.8
GERM-FDR	1	5.5	0.2	0.13	43.5
INDIA	0	3.6	-0.4	0	21.2
CHINA	3	9.1	0.4	1.27	13.3
JAPAN	1	4.2	-1	0	35.3
N.KOR.	3	0.9	0	0.55	25
GUATEMALA	0	1	-0.2	0	26.6
U.A.R.	2	1.4	0	6	100
LEBANON	0	1.1	0	0.18	30.3
HUNGARY	2	2.4	-0.6	0	42.7
S.VIET	1	1.1	0	2.000000E-2	32.5
TAIWAN	1	1.7	0	0.77	42.5
CUBA	2	2.4	0.1	1.24	47.7
CONGO(K)	0	0.6	0	0.78 (.02)	30
GERM-DDR	2	3.4	0.1	1.03	45.4
PAKSTN	0	1.3	0	0.2	30.1
S.KOR.	1	2.2	0.1	2.000000E-2	32.5
CZECH.	2	3.7	0.1	0.76	35.9
YUGO.	2	2	-0.4	0	33
ISRAEL	1	3.5	0.9		47.5
N.VIET	2	2	0	1.22	47.5

THIS IS A BALANCE OF POWER WORLD.

WINNER OF COMPETITIVE ROUNDS 2 AND 3 IS ISRAEL (Winner declared at end of second, competitive rn

SPECIFY ACTOR, THEN TARGET....?3,2 ← (CHINA AGAINST USSR.)

SPECIFY INTENSITY OF ACTION (SCALE 1 TO 9)....?6 (Guerrilla warfare.)

COMPETITIVE PLAY (1=YES; 2=NO)....?1 ← (Competitive play.)

CUMULATIVE RESULTS (1=YES; 2=NO)....?2

DO YOU WISH TO CHANGE COALITION STRUCTURE (1=YES; 2=NO)....?2

DO YOU WISH TO CHANGE WAR POTENTIALS (1=YES; 2=NO)....?2

PRINT STATUS AT INITIALIZATION (1=YES; 2=NO)....?2

QUICK PRINT-OUT OF ACTION RESULTS (1=YES; 2=NO)....?2

W O R L D S T A T U S R E P O R T -- R O U N D 4

MOST RECENT ACTION WAS INITIATED BY CHINA
AGAINST USSR WITH AN INTENSITY OF 6

LATEST STATUS INDICATORS ARE AS FOLLOWS:

COUNTRY	ALLIANCE	WAR POT'L	WP-CHANGE	C-ACTION	INTEREST
U.S.	1	16.4	0.4	0.71	35
USSR	2	11.1	0.2	0.16	100
U.K.	1	5.5	-2.2	0	50.5
FRANCE	4	7.6	0.1	0.96	25.2
ITALY	4	3.7	-0.1	0	7.9
GERM-FDR	1	5.4	0.1	0.45	45.4
INDIA	0	3.5	-0.6	0	25
CHINA	3	13.4	.7		25.3
JAPAN	1	3.8	-1.5	0	48.1
N.KOR.	3	0.9	0	1.86	9.5
GUATEMALA	0	1.1	-0.1	0	13.3
U.A.R.	2	1.4	0	0.14	36.9
LEBANON	0	1.1	0	1.27	20.2
HUNGARY	2	2	-1.1	0	39.6
S.VIET	1	1.1	0	0.95	50
TAIWAN	1	1.7	0	0.5	45
CUBA	2	2.4	0	0.15	40.8
CONGO(K)	0	0.6	0	0.66	13.4
GERM-DDR	2	3.3	0	0.18	41.1
PAKSTN	0	1.2	0	1.27	20.2
S.KOR.	1	2.2	0	0.72	47.5
CZECH.	2	3.6	0	0.9	59.3
YUGO.	2	1.8	-0.7	0	44.3
ISRAEL	1	2.2	-0.5	0	30
N.VIET	2	1.9	0	0.18	36.4

THIS IS A BALANCE OF POWER WORLD.

SPECIFY ACTOR, THEN TARGET....?2,8 ← (ACTION IS SECOND, COMPETITIVE RND.) USSR V. CHINA.

SPECIFY INTENSITY OF ACTION (SCALE 1 TO 9)....?6

COMPETITIVE PLAY (1=YES; 2=NO)....?1

CUMULATIVE RESULTS (1=YES; 2=NO)....?2

DO YOU WISH TO CHANGE COALITION STRUCTURE (1=YES; 2=NO)....?2

DO YOU WISH TO CHANGE WAR POTENTIALS (1=YES; 2=NO)....?2

PRINT STATUS AT INITIALIZATION (1=YES; 2=NO)....?2

QUICK PRINT-OUT OF ACTION RESULTS (1=YES; 2=NO)....?1 ← (Quick- print-out option

W O R L D S T A T U S R E P O R T -- R O U N D 5

MOST RECENT ACTION WAS INITIATED BY USSR
AGAINST CHINA WITH AN INTENSITY OF 6

LATEST STATUS INDICATORS ARE AS FOLLOWS:

COUNTRY	ALLIANCE	WAR POT'L	WP-CHANGE	C-ACTION	INTEREST
USSR	2	17.5	6.7		50.3
CHINA	3	8.7	0	10	100

THIS IS A BALANCE OF POWER WORLD.

WINNER OF COMPETITIVE ROUNDS 4 AND 5 IS USSR ← (Winner declared.)

```
SPECIFY ACTOR, THEN TARGET....?1,2
SPECIFY INTENSITY OF ACTION (SCALE 1 TO 9)....?3
COMPETITIVE PLAY (1=YES; 2=NO)....?1

CUMULATIVE RESULTS (1=YES; 2=NO)....?2

DO YOU WISH TO CHANGE COALITION STRUCTURE (1=YES; 2=NO)....?2

DO YOU WISH TO CHANGE WAR POTENTIALS (1=YES; 2=NO)....?1
TYPE COUNTRY NO., NEW W.P.....?1,33
MORE CHANGES (1=YES; 2=NO)....?1
TYPE COUNTRY NO., NEW W.P.....?2,27
MORE CHANGES (1=YES; 2=NO)....?2

PRINT STATUS AT INITIALIZATION (1=YES; 2=NO)....?1
QUICK PRINT-OUT OF INITIAL VALUES (1=YES; 2=NO)....?2

W O R L D   S T A T U S   R E P O R T  --  R O U N D   6

LATEST STATUS INDICATORS ARE AS FOLLOWS:

COUNTRY    ALLIANCE   WAR POT'L   NUCAP    PROPENSITY

U.S.           1          33         1         38.7
USSR           2          27         1         43
U.K.           1          5.7        1         6.1
FRANCE         4          5.5        1         47.6
ITALY          4          2.8        0         12.3
GERM-FDR       1          4          0         23
INDIA          0          3          0         -7.7
CHINA          3          6.5        1         52.3
JAPAN          1          3.9        0         4.6
N.KOR.         3          0.6        0         95.3
GUATEMALA      0          0.8        0         3
U.A.R.         2          1          0         55.3
LEBANON        0          0.8        0         33.8
HUNGARY        2          2.3        0         -1.6
S.VIET         1          0.8        0         78.4
TAIWAN         1          1.2        0         40
CUBA           2          1.7        0         49.2
CONGO(K)       0          0.4        0         21.5
GERM-DDR       2          2.4        0         52.3
PAKSTN         0          0.9        0         53.8
S.KOR.         1          1.6        0         33.8
CZECH.         2          2.6        0         29.2
YUGO.          2          1.8        0         -7.7
ISRAEL         1          2          0         9.2
N.VIET         2          1.4        0         76.9

THIS IS A TIGHT BIPOLAR WORLD.
QUICK PRINT-OUT OF ACTION RESULTS (1=YES; 2=NO)....?2
```

(SAME ACTION AS IN TABLE 3, US V. USSR. k = .001458. War potentials have been modified by the user.)

(Initial values as modified by user. Program normalizes remaining war potentials in view of user changes.)

(Propensity-to-act index is invariant for changes in war potential.)

W O R L D S T A T U S R E P O R T -- R O U N D 6

MOST RECENT ACTION WAS INITIATED BY U.S. ← (ACTION IS FIRST , COMPETITIVE RND
AGAINST USSR WITH AN INTENSITY OF 3

LATEST STATUS INDICATORS ARE AS FOLLOWS:

COUNTRY	ALLIANCE	WAR POT'L	WP-CHANGE	C-ACTION	INTEREST
U.S.	1	28.6	-4.4		35
USSR	2	23.7	-3.3	4.81	100
U.K.	1	5	-0.7	0.22	58.5
FRANCE	4	4.8	-0.7	1.22	25.2
ITALY	4	2.4	-0.5	0	7.9
GERM-FDR	1	3.5	-0.5	1	45.4
INDIA	0	2.4	-0.6	0	25
CHINA	3	5.7	-0.8	2.21	50.3
JAPAN	1	3.4	-0.5	0.12	48.1
N.KOR.	3	0.5	-0.1	1.57	34.5
GUATEMALA	0	0.7	-0.2	0	13.3
U.A.R.	2	0.9	-0.2	1.66	36.9
LEBANON	0	0.7	-0.2	1.04	20.2
HUNGARY	2	2	-0.3	0.63	59.6
S.VIET	1	0.7	-0.2	2.2	50
TAIWAN	1	1.1	-0.2	1.98	45
CUBA	2	1.5	-0.3	1.82	40.8
CONGO(K)	0	0.4	-0.1	0.19	13.4
GERM-DDR	2	2.1	-0.3	1.83	41.1
PAKSTN	0	0.8	-0.2	1.04	20.2
S.KOR.	1	1.4	-0.2	2.09	47.5
CZECH.	2	2.3	-0.4	1.61	59.3
YUGO.	2	1.4	-0.5	0	44.3
ISRAEL	1	1.6	-0.5	0	30
N.VIET	2	1.2	-0.2	1.64	36.4

THIS IS A LOOSE BIPOLAR WORLD.

```
SPECIFY ACTOR, THEN TARGET....?2,1
SPECIFY INTENSITY OF ACTION (SCALE 1 TO 9)....?3
COMPETITIVE PLAY (1=YES; 2=NO)....?1

CUMULATIVE RESULTS (1=YES; 2=NO)....?2
DO YOU WISH TO CHANGE COALITION STRUCTURE (1=YES; 2=NO)....?2

DO YOU WISH TO CHANGE WAR POTENTIALS (1=YES; 2=NO)....?1
TYPE COUNTRY NO., NEW W.P.............?1,33
MORE CHANGES (1=YES; 2=NO)....?1
TYPE COUNTRY NO., NEW W.P.............?2,27
MORE CHANGES (1=YES; 2=NO)....?2

PRINT STATUS AT INITIALIZATION (1=YES; 2=NO)....?2

QUICK PRINT-OUT OF ACTION RESULTS (1=YES; 2=NO)....?1
```

(ACTION IS SECOND, COMPETITIVE RND

(This returns war potentials to original values in Table 2.)

(War potentials are modified to the same settings as the previous round.)

(See beginning of previous round for this report.)

W O R L D S T A T U S R E P O R T -- R O U N D 7

MOST RECENT ACTION WAS INITIATED BY USSR
AGAINST U.S. WITH AN INTENSITY OF 3

LATEST STATUS INDICATORS ARE AS FOLLOWS:

COUNTRY	ALLIANCE	WAR POT'L	WP-CHANGE	C-ACTION	INTEREST
U.S.	1	29.3	-3.7	3.6	100
USSR	2	23.6	-3.4		35

THIS IS A LOOSE BIPOLAR WORLD.

WINNER OF COMPETITIVE ROUNDS 6 AND 7 IS U.S.

(Winner declared.)
Simulation terminate

APPENDIX B

Program Listing: A Reconstructed

"Simple Diplomatic Game"

March, 1970

```
100 REM
120 REM.....REM
130 REM BEGIN INTRODUCTORY REMARKS ROUTINE
140 REM
150 REM
160 PRINT
170 PRINT
180 PRINT"        THE S.I.P. VERSION OF BENSON'S SIMPLE DIPLOMATIC"
190 PRINT"GAME DEFINES A WORLD OF 'N' MUTUALLY INTERACTIVE STATES, ANY"
200 PRINT"OF WHICH CAN INITIATE INCREASINGLY SEVERE DIPLOMATIC OR MIL-"
210PRINT"ITARY ACTION AGAINST ANY OTHER, FOR THE PURPOSE OF INCREASING"
220 PRINT"OR REGAINING 'WAR POTENTIAL', THAT IS, THE PER CENT OF"
230 PRINT"TOTAL 'POWER' HELD BY A GIVEN ACTOR."
240 PRINT
250 PRINT
260 PRINT"        THE WAR POTENTIAL INDEX, COMPUTED INITIALLY FROM"
270 PRINT"NINE CATEGORIES OF DATA (POPULATION, MILITARY-AGE MANPOWER,"
280 PRINT"MILES OF TRACK AND HIGHWAYS, GNP, GNP PER CAPITA, ENERGY AND"
290 PRINT"STEEL OUTPUT, LITERACY, AND ATOMIC CAPABILITY) REPRESENTS A"
300 PRINT"GIVEN NATION'S SHARE OF POWER IN THE WORLD. DISTRIBUTION OF"
310 PRINT"POWER ALSO AFFECTS INTERACTION, AND RESULTS IN THE WORLD'S"
320 PRINT"DESCRIPTION AS 'BALANCE OF POWER,' 'LOOSE BIPOLAR,' OR"
330 PRINT"'TIGHT BIPOLAR."
340 PRINT
350 PRINT
360PRINT"        AN INTEREST INDEX, COMPUTED FROM DATA ON GEOGRAPHIC"
370 PRINT"LOCATIONS, COALITION MEMBERSHIP, THE EXTENT OF MUTUAL TRADE"
380 PRINT"BETWEEN ALL STATES AND THE 'TARGET STATE,' AND THE PRESENCE"
390 PRINT"OR ABSENCE OF MILITARY BASES IN THE 'TARGET STATE' IS ALSO"
400PRINT"GENERATED FOR EACH STATE. THE PRODUCT OF WAR POTENTIAL,"
410 PRINT"INTEREST, AND THE INTENSITY OF ACTION CHOSEN (SCALES WHICH"
420PRINT"RANGE FROM 0.00 TO 1.00), COMPUTED FOR EACH STATE, REPRESENTS"
430PRINT"THE GAIN AWARDED TO THE INITIATOR STATE, AND THE LOSS GIVEN"
440PRINT"TO THE OTHERS. AFTER DEDUCTING THE 'COST OF ACTION' FROM THE"
450PRINT"NEW WAR POTENTIAL OF THE INITIATOR, NEW WAR POTENTIAL INDICES"
460PRINT"ARE COMPUTED FOR EACH STATE."
470 PRINT
480 PRINT
490PRINT"        NEXT, COUNTER-ACTIONS FOR EACH STATE ARE COMPUTED"
500 PRINT"ON THE ASSUMPTION THAT STATES ACT TO RECOVER LOST POWER."
510PRINT"COUNTER-ACTIONS ARE THEN MODIFIED: WAR AGAINST AN ALLY IS"
520PRINT"RULED OUT, INTENSITY OF ACTION IS LOWERED IF THE STATE'S"
530PRINT"'PROPENSITY INDEX' (A SUBJECTIVE MEASURE OF AGGRESSIVENESS)"
540PRINT"IS LOW; AND ALLIES SUPPORT ACTION OF COALITION LEADERS."
550PRINT"WAR POTENTIAL INDICES ARE RE-CALCULATED IN VIEW OF THE"
560PRINT"COUNTER-ACTIONS FINALLY DECIDED UPON. IN A POLAR WORLD,"
570PRINT"THREE SUCCESSIVE LOSSES FOR AN ALLY WILL PLACE HIM IN A"
580PRINT"NEUTRAL CATEGORY; THREE LOSSES FOR A NEUTRAL RESULTING FROM"
590PRINT"LEADER 'A'S INITIATIVE WILL CAUSE HIM TO JOIN RIVAL COALITION"
600 PRINT"'B'."
610PRINT
620PRINT
630PRINT"        OPTIONS HAVE BEEN INCLUDED TO ENABLE THE USER TO"
640 PRINT"CHANGE THE COALITION STRUCTURE AND/OR THE DISTRIBUTION OF"
650 PRINT"POWER (WAR POTENTIALS) AFTER THE FIRST ROUND."
660 PRINT
670PRINT
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680PRINT"          RETURNING TO MAIN PROGRAM....."
690 PRINT
700 PRINT
710 CHAIN "DIPLO.BAS"
720 END
```

```
10 REM
20 REM
30 REM.....REM
40 REM BEGIN MAIN PROGRAM
50 REM
60 REM
70 PRINT"         THIS PROGRAM IS A BASIC LANGUAGE VERSION OF OLIVER"
80 PRINT"BENSON'S 'SIMPLE DIPLOMATIC GAME' (UNCLASSIFIED), REVISED"
90 PRINT"3/70 FOR THE NU/ARPA SIMULATED INTERNATIONAL PROCESSES"
100 PRINT"(SIP) PROJECT (S.D. 260), J. KREND, PROGRAMMER."
110 PRINT
120 PRINT
130 PRINT"HAVE YOU PLAYED BEFORE (1=YES; 2=NO)....";
140 INPUT Q(0)
150 IF Q(0)=1 THEN 200
160 PRINT"THEN HAVE YOU 'READ THE DIRECTIONS' (1=YES; 2=NO)....";
170 INPUT Q(0)
180 IF Q(0)=1 THEN 200
190 CHAIN "INTRO.BAS"
200 READ M,N
210 DATA 25,25
220 DIM A(25), B(25), D(25,25), F(25,25), G(13), J(25)
230 DIM H$(25), M(25,25), P(25), Q(60), R(25)
240 DIM T(25), U(25), W(25), X(25), Y(25)
250 FOR I = 1 TO M
260 READ H$(I)
270 NEXT I
280 DATA U.S., USSR, U.K., FRANCE, ITALY, GERM-FDR
290 DATA INDIA, CHINA, JAPAN, N.KOR., GUATEMALA, U.A.R.
300 DATA LEBANON, HUNGARY, S.VIET, TAIWAN, CUBA, CONGO(K), GERM-DDR
310 DATA PAKSTN, S.KOR., CZECH., YUGO., ISRAEL, N.VIET
320 PRINT
330 PRINT
340 PRINT"-------------------------------------------------------"
350 PRINT
360 PRINT
365 IF Q(17)<>0 THEN 390
370 PRINT "USE ORIGINAL BENSON COUNTRIES (1=YES; 2=NO)....";
380 INPUT Q(17)
390 IF Q(17)=2 THEN 420
400 LET O = 18
410 GO TO 430
420 LET O=M
430 LET Z=Z+1
440 IF Z>1 THEN 560
470 PRINT "SPECIFY ACTOR, THEN SPECIFY TARGET:"
480 PRINT
490 PRINT
500 FOR I = 1 TO O
510 PRINT I;"=";H$(I),
520 NEXT I
525 PRINT
530 GO TO 570
560 PRINT"SPECIFY ACTOR, THEN TARGET....";
570 INPUT Q(1), Q(2)
590 PRINT
600 IF Z>1 THEN 670
```

```
610 PRINT "SPECIFY INTENSITY OF ACTION: (1=DIPLOMATIC PROTEST;"
620 PRINT "2=UNITED NATIONS ACTION; 3=SEVER DIPLOMATIC RELATIONS;"
630 PRINT "4=BOYCOTT, BLOCKADE, OR SEIZURE; 5=TROOP MOVEMENTS;"
640 PRINT "6=GUERRILLA WARFARE; 7=LIMITED CONVENTIONAL WAR; 8=LARGE"
650 PRINT "SCALE WAR; 9=ALL-OUT WAR";
660 GO TO 680
670 PRINT "SPECIFY INTENSITY OF ACTION (SCALE 1 TO 9)....";
680 INPUT Q(3)
690 LET Q(3)=Q(3)/10.000
710 PRINT
720 IF Z>1 THEN 760
730 PRINT "SHOULD THE ACTION BE REGARDED AS ONE OF TWO SUCCESSIVE,"
740 PRINT "COMPETITIVE PLAYS (1=YES; 2=NO)";
750 GO TO 770
760 PRINT "COMPETITIVE PLAY (1=YES; 2=NO)....";
770 INPUT Q(4)
780 PRINT
790 PRINT
795 Q(5)=2
800 IF Z=1 THEN 1030
805 IF Z>2 THEN 840
810 PRINT "SHOULD THE ACTION INCORPORATE MODIFICATIONS FROM ANY"
820 PRINT "PREVIOUS PLAYS IN THIS SERIES (1=YES; 2=NO)";
830 GO TO 850
840 PRINT "CUMULATIVE RESULTS (1=YES; 2=NO)....";
850 INPUT Q(5)
870 REM
880 REM
900 PRINT
910 PRINT "DO YOU WISH TO CHANGE COALITION STRUCTURE (1=YES; 2=NO)....";
920 INPUT W2
930 IF W2=2 THEN 1030
950 PRINT "TYPE COUNTRY NO., NEW COALITION NO....";
960 INPUT I,J
970 LET D(I,19)=J
990 PRINT "MORE CHANGES (1=YES; 2=NO)....";
1000 INPUT W3
1010 IF W3=2 THEN 1230
1020 GO TO 950
1030 REM
1040 REM
1050 REM LAST 14 STMTS CHANGE COALITION STRUCTURE IF DESIRED.
1060 REM
1070 REM
1080 IF Q(4)=2 THEN 1100
1090 LET Q(6)=Q(6)+1
1100 IF Z>1 THEN 1140
1110 GO SUB 2000'   FIRST TIME USE OF PRELIMINARY COMP. RTN.
1120 REM LAST STMT IS EXECUTED ONCE WHEN Z=1.
1130 GO TO 1540
1140 IF Q(5)=1 THEN 1130
1150 GO SUB 2450' RESET INITIAL WAR POT'LS IF GAME IS NON-COMPETITIVE.
1160 REM
1170 REM
1180 PRINT
1200 PRINT "DO YOU WISH TO CHANGE WAR POTENTIALS (1=YES; 2=NO)....";
```

```
1210 INPUT W2
1220 IF W2=2 THEN 1540
1230 LET J=0
1250 PRINT "TYPE COUNTRY NO., NEW W.P.....";
1260 INPUT I,I1
1270 LET W(I)=I1/100.0
1280 LET J(I)=W(I)
1290 LET J=J+J(I)
1300 IF J<=1.00 THEN 1350
1310 PRINT "SUM OF REVISED WAR POTENTIALS CANNOT EXCEED 100.0."
1320 PRINT "WAR POTENTIALS HAVE BEEN RESET TO INITIAL VALUES ;"
1330 GO SUB 2460
1340 GO TO 1180
1350 PRINT"MORE CHANGES (1=YES; 2=NO)....";
1370 INPUT W3
1380 IF W3=2 THEN 1400
1390 GO TO 1250
1400 LET W4=0
1410 FOR I = 1 TO 0
1420 LET W4 = W4 + ABS(W(I))
1430 NEXT I
1440 FOR I = 1 TO 0
1450 IF W(I)=J(I) THEN 1470
1460 LET W(I)=ABS(W(I)/W4)
1470 NEXT I
1480 REM
1490 REM
1500 REM LAST 30 STMTS CHANGE NATION'S SHARE OF POWER TO SUIT USER.
1510 REM ALL WAR POTENTIALS ARE THEN NORMALIZED.
1520 REM
1530 REM
1540 IF Q(4)=1 THEN 1560
1550 GO TO 1530
1560 LET H=H+1
1570 FOR I = 1 TO H
1580 IF H=I THEN 1600
1590 GO TO 1620
1600 LET Q(H+6)=W(Q(1))
1610 LET Q(H+23)=W(Q(2))
1620 NEXT I
1630 GO SUB 2610'          COALITION STRENGTH RTN.
1640 IF Q(15)>=1 THEN 1660
1650 GO SUB 3650'          PRINT RTN.
1660 GO SUB 4390'          SECONDARY COMP. RTN.
1670 IF Q(4)=1 THEN 1690
1680 GO TO 1760
1690 LET H=H+1
1700 FOR I=1 TO H
1710 IF H = I THEN 1730
1720 GO TO 1750
1730 LET Q(H+6)=W(Q(1))
1740 LET Q(H+23)=W(Q(2))
1750 NEXT I
1760 GO SUB 2610'          COALITION STRENGTH RTN.
1770 GO SUB 3650'          PRINT RTN.
1780 PRINT
1790 PRINT
```

```
1800PRINT"------------------------------------------------------------"
1810 PRINT
1820 PRINT
1830 PRINT "CONTINUE (1=YES; 2=NO)....";
1840 INPUT Q(13)
1850 IF Q(13)=2 THEN 11210
1860 REM TERMINATION IF DESIRED.
1870 GO TO 320
1880 REM IF GAME IS TO CONTINUE (Q(13)=1), CONTROL GOES TO BEGINNING.
1890 REM
1900 REM
1910 REM END MAIN PROGRAM
1920 REM.....REM

1930 REM
1940 REM
1950 REM.....REM
1960 REM BEGIN ROUTINE FOR READING IN DATA, PRELIMINARY COMPUTATIONS.
1970 REM
1980 REM
1990 REM
2000 FOR I = 1 TO 13
2010 READ  N(I)
2020 NEXT I
2030 FOR I = 1 TO M
2040 FOR J = 1 TO N
2050 READ  D(I,J)
2060 NEXT J
2070 NEXT I
2080 FOR I = 1 TO M
2090 FOR J = 1 TO M
2100 READ  F(I,J)
2110 NEXT J
2120 NEXT I
2130 FOR I = 1 TO 13
2140 READ  G(I)
2150 NEXT I
2160 FOR I = 1 TO M
2170 FOR J = 1 TO M
2180 READ  M(I,J)
2190 NEXT J
2200 NEXT I
2210 REM
2220 REM
2230 REM LAST 21 STMTS READ IN DATA.
2240 REM
2250 REM
2260 REM NOW WE WANT TO COMPUTE THE INITIAL INDICES.
2270 FOR I = 1 TO 0
2280 FOR J = 1 TO 9
2290 LET A(J)=G(J)*D(I,J)
2300 LET T(I)=T(I)+A(J)
2310 NEXT J
2320 LET S=S+T(I)
2330 NEXT I
2340 REM
2350 REM LAST 7 STMTS FIND SUBTOTALS, T(I), GRAND TOTAL, S, OF WAR
```

```
2360 REM POTENTIAL BY MUTIPLYING WEIGHTS, G(J), BY W.P. DATA, D(I,J).
2370 REM
2380 FOR I = 1 TO 0
2390 LET W(I)=T(I)/S
2400 NEXT I
2410 REM LAST 3 STMTS COMPUTE WAR POTENTIAL INDEX (INITIAL) FOR
2420 REM 'O' STATES.
2430 FOR I = 1 TO 0
2440 LET D(I,22)=W(I)
2450 NEXT I
2460 LET Q(16)=0
2470 IF Z=1 THEN 2520
2480 FOR I = 1 TO 0
2490 LET W(I)=D(I,22)
2500 NEXT I
2510 IF Z>1 THEN 2670
2520 FOR J = (1+9) TO 18
2530 LET G=G+G(J)
2540 NEXT J
2550 REM LAST 5 STMTS FIND SUM OF WEIGHTS FOR PROPENSITY CAT. 10-18.
2560 FOR I = 1 TO 0
2570 FOR J=(1+9) TO 18
2580 LET A(J)=G(J)*D(I,J)
2590 LET P(I)=P(I)+A(J)
2600 NEXT J
2610 LET X(I) = (P(I)/G)/5.0
2620 LET X=X+X(I)
2630 NEXT I
2640 REM LAST 8 STMTS FIND PROPENSITY INDEX, X(I), FOR 'O' STATES;
2650 REM ALSO FIND SIGMA X FOR LATER USE IN COMPUTING AVERAGE X(I).
2660 REM 'A(J)' AND 'P(I)' SERVE AS TEMPORARY WORK AREAS AT THIS POINT.
2670 RETURN
2680 REM
2690 REM
2700 REM
2710 REM END PRELIMINARY COMPUTATION ROUTINE.
2720 REM.....REM
2730 REM
2740 REM
2750 REM.....REM

2760 REM BEGIN ROUTINE FOR DETERMINATION OF COALITION STRENGTH,
2770 REM COALITION LEADERSHIP, AND DETERMINATION OF NATURE OF THE
2780 REM UNIVERSE.
2790 REM
2800 REM
2810 FOR I = 1 TO 5
2820 LET C(I)=0.00
2830 NEXT I
2840 FOR I = 5 TO 1 STEP -1
2850 LET K(I)=I
2860 LET J=0
2870 FOR J = 0 TO 1 STEP -1.0
2880 IF I = D(J,19) THEN 2930
2890 GO TO 2950
2900 LET C(I)=C(I)+W(J)
2910 IF W(J)>B THEN 2930
```

```
2920 GO TO 2950
2930 LET B=W(J)
2940 LET L(I)=J
2950 NEXT J
2960 NEXT I
2970 REM
2980 REM
2990 REM LAST 16 STMTS FIND COMBINED WAR POTENTIAL OF FIVE COALITIONS;
3000 REM ASSIGN A LEADER CODE TO THE MOST POWERFUL MEMBER OF EACH CLTN.
3010 REM
3020 REM
3030 FOR I=4 TO 1 STEP -1.0
3040 LET J=I+1
3050 LET B=J-1
3060 IF C(J)<C(B) THEN 3210
3070 LET E=C(J)
3080 LET C(J)=C(B)
3090 LET C(B)=E
3100 REM LAST 4 STMTS ARRANGE COALITIONS IN ORDER OF DECREASING POT'L.
3110 LET E=K(J)
3120 LET K(J)=K(B)
3130 LET K(B)=E
3140 REM LAST 3 STMTS ASSIGN COALITION CODE NUMBERS (1-5) TO EACH
3150 REM COALITION, MOST POWERFUL=1,...,LEAST POWERFUL=5.
3160 LET E=L(J)
3170 LET L(J)=L(B)
3180 LET L(B)=E
3190 REM LAST 3 STMTS ASSIGN CODE NUMBERS (1-5) TO COALITION LEADERS,
3200 REM WHERE LEADER OF MOST POWERFUL COALITION=1, ETC.
3210 LET B=B-1
3220 IF B=0 THEN 3240
3230 GO TO 3060
3240 NEXT I
3250 REM
3260 REM
3270 LET E=0
3280 IF C(1)+C(2)>=.90 THEN 3320
3290 IF C(1)+C(2)>=.75 THEN 3360
3300 LET E=1
3310 GO TO 3460
3320 IF W(L(1))>=C(1)/2 THEN 3420
3330 IF W(L(2))>=C(2)/2 THEN 3430
3340 LET E=1
3350 GO TO 3460
3360 IF W(L(1))>=C(1)/2 THEN 3390
3370 LET E=1
3380 GO TO 3460
3390 IF W(L(2))>=C(2)/2 THEN 3430
3400 LET E=1
3410 GO TO 3460
3420 IF W(L(2))>=C(2)/2 THEN 3450
3430 LET E=2
3440 GO TO 3460
3450 LET E=3
3460 RETURN
3470 REM
3480 REM LAST 19 STMTS DETERMINE NATURE OF UNIVERSE, WHERE IF E=1,
```

```
3490 REM UNIVERSE IS 'BALANCE OF POWER' TYPE; 2='LOOSE BIPOLAR;
3500 REM 3='TIGHT BIPOLAR'.
3510 REM
3520 REM
3530 RETURN
3540 REM
3550 REM
3560 REM END COALITION STRENGTH ROUTINE
3570 REM.....REM

3580 REM
3590 REM
3600 REM
3610 REM
3620 REM.....REM
3630 REM BEGIN PRINT ROUTINE
3640 REM
3650 LET Q(16)=Q(16)+1
3660 IF Q(16)>1 THEN 3745
3680 PRINT
3690 PRINT"PRINT STATUS AT INITIALIZATION (1=YES; 2=NO)....";
3700 INPUT Q(18)
3710 IF Q(18)=2 THEN 4490
3720 REM SKIPS INITIAL PRINT-OUT IF DESIRED.
3730 PRINT"QUICK PRINT-OUT OF INITIAL VALUES (1=YES; 2=NO)....";
3740 GO TO 3760
3745 PRINT
3750 PRINT"QUICK PRINT-OUT OF ACTION RESULTS (1=YES; 2=NO)....";
3760 INPUT Q(23)
3770 PRINT
3780 PRINT
3790 PRINT"W O R L D  S T A T U S  R E P O R T -- R O U N D ";Z
3800 IF Q(16)=1 THEN 3850
3810 PRINT
3820 PRINT
3830 PRINT "MOST RECENT ACTION WAS INITIATED BY  "; H$(Q(1))
3840 PRINT "AGAINST "; H$(Q(2)); " WITH AN INTENSITY OF "; Q(3)*10
3850 PRINT
3860 PRINT
3870 PRINT "LATEST STATUS INDICATORS ARE AS FOLLOWS:"
3880 PRINT
3890 PRINT
3900 IF Q(16)=1 THEN 4220
3910 PRINT"COUNTRY   ALLIANCE   WAR POT'L  WP-CHANGE";
3920 PRINT"     C-ACTION    INTEREST"
3930 PRINT
3940 PRINT
3950 FOR I = 1 TO 5
3960  LET Y(I)=Y(I)/Y(Q(2))
3970 IF Q(23)=2 THEN 4010
3980 IF I = Q(1) THEN 4010
3990 IF I = Q(2) THEN 4010
4000 GO TO 4200
4010 PRINT H$(I),,D(I,19);"      ";(INT(1000.*W(I)))/10,
4015 PRINT       ;
4020 PRINT (INT(1000.*Q((29+I))))/10,
4030 IF E=3 THEN 4090
```

```
4040 IF I=Q(1) THEN 4070
4050 PRINT (INT(1000.*A(I)))/100,(INT(1000.*Y(I)))/10
4060 GO TO 4200
4070 PRINT "          ",(INT(1000.*Y(I)))/10
4080 GO TO 4200
4090 IF I=L(1) THEN 4130
4100 IF I=L(2) THEN 4170
4110 PRINT "          ",(INT(1000.*Y(I)))/10
4120 GO TO 4200
4130 IF L(1)=Q(1) THEN 4150
4140 GO TO 4200
4150 PRINT (INT(1000.*A(L(2))))/100,(INT(1000.*Y(L(2))))/10
4160 GO TO 4200
4170 IF L(2)=Q(1) THEN 4190
4180 GO TO 4200
4190 PRINT (INT(1000.*A(L(1))))/100,(INT(1000.*Y(L(1))))/10
4200 NEXT I
4210 GO TO 4340
4220 PRINT"COUNTRY   ALLIANCE   WAR POT'L  NUCAP";
4230 PRINT"     PROPENSITY"
4240 PRINT
4250 PRINT
4260 FOR I = 1 TO 0
4270 IF Q(20)=2 THEN 4310
4280 IF I = Q(1) THEN 4310
4290 IF I = Q(2) THEN 4310
4300 GO TO 4330
4310 PRINT NS(I),D(I,19);"      ";INT(1000.*W(I))/10,"    ";D(I,20),
4320 PRINT (INT(1000.*X(I)))/10
4330 NEXT I
4340 PRINT
4350 PRINT
4360 ON E GO TO 4370,4390,4410
4370 PRINT "THIS IS A BALANCE OF POWER WORLD."
4380 GO TO 4420
4390 PRINT "THIS IS A LOOSE BIPOLAR WORLD."
4400 GO TO 4420
4410 PRINT "THIS IS A TIGHT BIPOLAR WORLD."
4420 PRINT
4430 PRINT
4440 REM
4450 REM
4460 REM LAST 67 STMTS CONTROL FORM, SUBSTANCE OF PRINT-OUT.
4470 REM
4480 REM
4490 IF Q(4)=2 THEN 4700
4500 IF H=4 THEN 4540
4510 IF Q(6)=2 THEN 4740
4520 LET Q(12)=Q(1)
4530 GO TO 4740
4540 IF Q(12)=Q(2) THEN 4580
4550 LET Q(14)=Q(8)/Q(7)
4560 LET Q(15)=Q(10)/Q(9)
4570 GO TO 4600
4580 LET Q(14)=((Q(8)-Q(7))/Q(7))+((Q(27)-Q(8))/Q(27))
4590 LET Q(15)=((Q(9)-Q(24))/Q(24))+((Q(10)-Q(9))/Q(9))
4600 IF Q(14)>Q(15) THEN 4630
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```
4610 IF Q(14)<Q(15) THEN 4650
4620 IF Q(14)=Q(15) THEN 4670
4630 PRINT"WINNER OF COMPETITIVE ROUNDS ";Z-1;" AND ";Z;" IS ";H$(Q(12))

4640 GO TO 4680
4650PRINT"WINNER OF COMPETITIVE ROUNDS ";Z-1;" AND ";Z;" IS ";H$(Q(1))
4660 GO TO 4680
4670 PRINT "COMPETITIVE ROUNDS"; Z-1;"AND";  Z; "ARE TIED."
4680 IF H=4 THEN 4700
4690 GO TO 4740
4700 LET H=0
4710 LET Q(5)=0
4720 REM LAST 23 STMTS DECIDE WINNER OF LAST TWO CONSECUTIVE ROUNDS IF
4730 REM GAME IS COMPETITIVE.
4740 RETURN
4750 REM
4760 REM
4770 REM END PRINT ROUTINE
4780 REM.....REM

4790 REM
4800 REM
4810 REM
4820 REM
4830 REM.....REM

4840 REM BEGIN ROUTINE FOR SECONDARY COMPUTATIONS: INTEREST INDICES,
4850 REM GAINS-LOSSES, COUNTERACTIONS, C-A REVISIONS, NEW WAR POTENTIALS

4860 REM WAR POTENTIAL CHANGES, AND ALLIANCE-CHANGE-ON-LOSS.
4870 REM
4880 REM
4890 FOR I = 1 TO 0
4900 LET Q((29+I))=W(I)
4910 NEXT I
4920 REM LAST 3 STMTS SAVE WAR POTENTIAL FROM PRIOR COMPUTATIONS
4930 REM FOR LATER COMPARISONS.
4940 FOR I = 1 TO 0
4950 IF M(I,Q(2))=0 THEN 5000
4960 LET A(I)=((M(I,Q(2))/D(I,23))+(M(I,Q(2))/D(Q(2),23)))/2.000
4970 LET A(I)=A(I)*100.0
4980 REM MAKES 0<=A(I)<=100.0
4990 GO TO 5010
5000 LET A(I)=0
5010 NEXT I
5020 REM LAST 8 STMTS FIND TRADE FACTOR, A(I), FOR USE IN INTEREST
5030 REM INDEX COMPUTATION.
5040 FOR I = 1 TO 0
5050 IF F(I,Q(2))=0 THEN 5090
5060 LET B(I)=100.0
5070 LET R(I)=400.0
5080 GO TO 5100
5090 LET B(I)=0.0
5100 NEXT I
5110 REM LAST 7 STMTS CHECK TO SEE IF ANY OF 'O' STATES HAVE BASES
5120 REM IN THE TARGET STATE. B(I), BASES FACTOR, IS SET TO 0 OR 100.
5130 FOR I = 1 TO 0
```

```
5140 FOR J = 1 TO 5
5150 REM J=5 SINCE THERE ARE 5 COALITIONS.
5160 IF D(I,19)=J THEN 5180
5170 GO TO 5220
5180 LET R(I)=400.0
5190 IF D(Q(2),19)=J THEN 5210
5200 GO TO 5220
5210 LET U(I)=100.0
5220 NEXT J
5230 IF D(I,19)=0 THEN 5250
5240 GO TO 5260
5250 LET R(I)=300.0
5260 NEXT I
5270 REM
5280 REM
5290 REM LAST 14 STMTS ASK IF ANY STATE BELONGS TO THE SAME COALITION
5300 REM AS DOES THE TARGET STATE: U(I) SET TO 0,100.R(I), THE NUMBER
5310 REM OF FACTORS RELEVANT IN COMPUTING INTEREST INDEX FOR A GIVEN
5320 REM STATE IS SET AT 3 OR 4, THEN MULTIPLIED BY 100 TO OBTAIN
5330 REM CORRECT DECIMAL POINT SCALING.
5340 REM
5350 REM
5360 FOR I = 1 TO 0
5370 LET D=10.0
5380 LET V1=(D(I,25)-D(Q(2),25))/2
5390 LET V2=90.0-D(I,25)
5400 LET V3=90.0-D(Q(2),25)
5410 LET V4=(D(I,24)-D(Q(2),24))/2
5420 LET P(I)=(SIN(V1))^2+(SIN(V2)*SIN(V3)*(SIN(V4))^2)
5430 LET P(I)=P(I)*100000.
5440 FOR J = 1 TO 10
5450 IF P(I)>=H(J) THEN 5480
5460 IF P(I)<2447. THEN 5500
5470 GO TO 5520
5480 LET P(I)=D
5490 GO TO 5540
5500 LET P(I)=100.
5510 GO TO 5540
5520 LET D=D+10.0
5530 NEXT J
5540 NEXT I
5550 REM
5560 REM
5570 REM LAST 19 STMTS FIND PROXIMITY FACTOR, P(I), FOR '0' STATES:
5580 REM P(I) INCREASES (0-100) AS HAVERSINE OF GRT CIRCLE DISTANCE
5590 REM BETWEEN MAJOR INDUSTRIAL CENTERS DECREASES (LOGISTIC COST).
5600 REM
5610 REM
5620 FOR I = 1 TO 0
5630 LET Y(I)=(A(I)+B(I)+U(I)+P(I))/R(I)
5640 NEXT I
5650 REM
5660 REM LAST 3 STMTS FIND THE INTEREST INDICES FOR '0' STATES
5670 REM USING THE 5 FACTORS PREVIOUSLY COMPUTED.
5680 REM
5690 FOR I = 1 TO 0
5700 LET R(I)=W(I)*Y(I)*Q(3)
```

```
5710 NEXT I
5720 REM LAST 3 STMTS FIND LOSS OR GAIN, R(I), FOR EACH STATE.
5730 LET T=0
5740 FOR I = 1 TO 0
5750 IF I = Q(I) THEN 5780
5760 LET T(I)=(W(I)-R(I))
5770 LET T=T+T(I)
5780 NEXT I
5790 LET T(Q(I))=W(Q(I))+R(Q(I))
5800 LET T=T+T(Q(I))
5810 FOR I = 1 TO 0
5820 LET T(I)=T(I)/T
5830 NEXT I
5840 REM
5850 REM
5860 REM LAST 11 STMTS FIND NEW WAR POTENTIALS BEFORE COUNTER-
5870 REM ACTIONS GO INTO EFFECT. AN ALTERNATE INTERPRETATION OF
5872 REM THE COUNTERACTION CAN BE EXAMINED BY DELETING LINES
5874 REM 5730, 5770, 5800-5830; THIS ELIMINATES NORMALIZATION
5876 REM OF NEW WAR POTL'S, T(I) BEFORE PROCEEDING. THEN LINE
5878 REM 5940 CAN BE WRITTEN 'LET A(I)=ABS((R(I)/T(I)))'.
5880 REM
5890 REM
5900 FOR I = 1 TO 0
5910 IF  I=Q(I) THEN 6280
5920 GO SUB 5940
5930 GO TO 6280
5940 LET A(I)=ABS((W(I)-T(I))/T(I))
5950 IF A(I)>1.00 THEN 5970
5960 GO TO 5980
5970 LET A(I)=1.00
5980 IF X(I)>=X/0 THEN 6010
5990 LET A(I)=(A(I)-.100)
6000 REM C-A IS LOWERED IF PROPENSITY INDEX IS LESS THAN AVERAGE.
6010 IF A(I)>=.900 THEN 6030
6020 GO TO 6070
6030 IF D(I,20)>0.0 THEN 6070
6040 LET A(I)=.800
6050 REM IF LOGIC LEADS TO RESPONSE OF .900 AND COUNTRY IS NON-
6060 REM NUCLEAR, C-A IS LOWERED TO .800.
6070 IF A(I)>.700 THEN 6090
6080 GO TO 6160
6090 IF E>1 THEN 6130
6100 REM IF WORLD IS POLAR (E>1), AND IF LOGIC LEADS TO C-A>.700
6110 REM AGAINST THE LEADER OF ONE'S OWN COALITION, C-A=.700.
6120 GO TO 6160
6130 IF D(I,19)=D(Q(I),19) THEN 6150
6140 GO TO 6160
6150 LET A(I)=.700
6160 IF X(I) > (X/0)*.50 THEN 6260
6170 LET A(I)=(A(I)-.100)
6180 IF A(I)>=0.00 THEN 6260
6190 LET A(I)=0.00
6200 LET W(I)=ABS((W(I)-R(I))+((W(I)-R(I))*A(I)))
6210 IF W(I)>1.00 THEN 6230
6220 GO TO 6235
6230 LET W(I)=1.0
```

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6231 GO TO 6260
6235 IF W(I)<0.0 THEN 6237
6236 GO TO 6260
6237 LET W(I)=.001
6240 REM LAST 4 STMTS FIND NEW WAR POT'LS AFTER C-A'S ARE REVISED;
6250 REM INSURE THAT 0<=W(I)<=1.0 .
6260 LET A(I)=ABS(A(I))
6270 RETURN
6280 NEXT I
6290 LET W(Q(1))=T(Q(1))-(((100.-P(Q(1)))*.001458*Q(3)))
6300 IF W(Q(1))>1.00 THEN 6350
6310 IF W(Q(1))<0.00 THEN 6330
6320 GO TO 6400
6330 LET W(Q(1))=.001
6340 GO TO 6400
6350 LET W(Q(1))=1.0
6360 REM
6370 REM
6380 REM
6390 REM
6400 LET W=0
6410 FOR I = 1 TO 0
6420 LET W=ABS(W(I))+W
6430 NEXT I
6440 FOR I = 1 TO 0
6450 LET W(I)=W(I)/W
6460 NEXT I
6470 REM LAST 7 STMTS FIND NEW WAR POTENTIALS ON BASIS OF 100 PER CENT.
6480 FOR I = 1 TO 0
6490 LET Q((29+I))=W(I)-Q((29+I))
6500 NEXT I
6510 REM LAST 3 STMTS COMPUTE CHANGE IN WAR POT'L FROM PREVIOUS ROUND.
6520 REM
6530 REM
6540 REM
6550 IF Q(5)=2 THEN 7070
6560 IF L(1)=Q(1) THEN 6590
6570 IF L(2)=Q(1) THEN 6840
6580 GO TO 7070
6590 FOR I = 1 TO 0
6600 IF I=Q(1) THEN 6750
6610 IF D(I,19)=K(1) THEN 6640
6620 IF D(I,19)=0 THEN 6640
6630 GO TO 6750
6640 IF Q((29+I))>=0.00 THEN 6752
6650 LET D(I,21)=(D(I,21)+1)
6660 IF D(I,21)>=3 THEN 6680
6670 GO TO 6750
6680 IF D(I,19)=0 THEN 6700
6690 IF D(I,19)=K(1) THEN 6720
6700 LET D(I,19)=(K(2))
6710 GO TO 6750
6720 LET D(I,19)=0
6730 IF D(I,21)<3 THEN 6750
6740 LET D(I,21)=0
6750 NEXT I
6760 GO TO 7070
```

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6770 REM
6780 REM
6790 REM LAST 21 STMTS COMPUTE ALLIANCE-CHANGE-ON-LOSS, WHEN GAME
6800 REM IS CUMULATIVE (Q(5)=1) AND  L(1)=Q(1). ON 3 LOSSES FROM
6810 REM L(1)'S ACTION, ALLY GOES NEUTRAL; NEUTRAL JOINS RIVAL CLTN.
6820 REM
6830 REM
6840 FOR I = 1 TO 0
6850 IF I=Q(1) THEN 7000
6860 IF D(I,19)=K(2) THEN 6890
6870 IF D(I,19)=0 THEN 6890
6880 GO TO 7000
6890 IF Q((29+I))>=0.00 THEN 7000
6900 LET D(I,21)=(D(I,21)+1)
6910 IF D(I,21)>=3 THEN 6930
6920 GO TO 7000
6930 IF D(I,19)=0 THEN 6950
6940 IF D(I,19)=K(2) THEN 6970
6950 LET D(I,19)=-(K(1))
6960 GO TO 7000
6970 LET D(I,19)=0
6980 IF D(I,21)<3 THEN 7000
6990 LET D(I,21)=0
7000 NEXT I
7010 REM
7020 REM
7030 REM LAST 17 STMTS COMPUTE ALLIANCE-CHANGE-ON-LOSS, WHEN GAME
7040 REM IS CUMULATIVE AND L(2)=Q(1).
7050 REM
7060 REM
7070 RETURN
7080 REM
7090 REM
7100 REM END SECONDARY COMPUTATION ROUTINE
7110 REM.....REM

7120 REM
7130 REM
7140 REM DATA BASE
7150 REM.....REM
7160 REM
7170 REM
7180 REM TABLE OF HAVERSINES, H(I):
7190 REM
7200 REM
7210 DATA 999999,97553,90451,79389,65451,50000,34549,20611,9549,2447
7220 REM
7230 REM
7240 REM MAIN DATA MATRIX, D(I,J):
7250 REM
7260 REM THERE ARE 25 ENTRIES FOR EACH OF THE 25 COUNTRIES IN THE
7270 REM SIMULATION. ENTRIES ARE AS FOLLOWS: (1) POPULATION, IN
7280 REM 10'S OF MILLIONS; (2) MILITARY-AGE MANPOWER, IN MILLIONS;
7290 REM (3) TRANSPORTATION, IN 100-THOUSANDS OF COMBINED RAIL-
7300 REM ROAD AND HIGHWAY MILES; (4)GNP, IN BILLIONS OF U.S.-DOLLARS;
7310 REM (5) GNP-PER-CAPITA, IN U.S. DOLLARS; (6) ELECTRICAL ENERGY
7320 REM PRODUCTION, IN MILLIONS OF KWH; (7) STEEL PRODUCTION, IN
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7330 REM MILLIONS OF TONS; (8) PERCENT LITERATE; (9) NUCLEAR STATUS,
7340 REM 1=NUCLEAR, 0=NON-NUCLEAR; (10-18) SCORES FORS WRIGHT'S
7350 REM ANALYTICAL AND CAPABILITY FIELDS, RANGING FROM -5 TO +5;
7360 REM (19) ALLIANCE CODE, RANGING FROM 0 TO 4; (20) NUCLEAR
7370 REM CAPABILITY (DUPLICATE ENTRY TO ADD CATEGORY WITHOUT
7380 REM RE-DIMENSIONING MATRIX); (21) MEMBER LOSS FROM ALLIANCE
7390 REM LEADER'S INITIATIVE TALLY BOX; (22) EXTRA COLUMN, FILLED
7400 REM WITH ZEROS AS PLACE-HOLDERS; (23) TOTAL TRADE, EXPORTS
7410 REM PLUS IMPORTS IN MILLIONS SU.S.; (24) DEGREES LONGITUDE
7420 REM OF MAJOR INDUSTRIAL CENTER; (25) DEGREES LATITUDE.
7430 REM
7440 REM
7450 REM U.S.A.:
7460 REM
7470 DATA 192120,5.27,3355,580.2,3020,1158,119.3,97.8,1
7480 DATA 5,4,0,-5,-5,-5,5,-3,5,1,1,0,0,48964.3,85,40
7490 REM
7500 REM
7510 REM USSR:
7520 REM
7530 DATA 227687,10.1,1444,127.6,890,507,91,98.5,1
7540 DATA 4,4,2,-4,-4,-5,5,3,5,2,1,0,0,16233,-40,55
7550 REM
7560 REM
7570 REM U.K.:
7580 REM
7590 DATA 54213,1.65,215,81.3,1500,196,27.4,96,1
7600 DATA 2,1,-4,1,2,-3,1,-2,1,1,1,0,0,29848.4,5,55
7610 REM
7620 REM
7630 REM FRANCE:
7640 REM
7650 DATA 43411,1.42,912,74.5,1540,101,19.6,96.4,1
7660 DATA 4,4,1,1,2,-3,3,2,3,4,1,0,0,20400,-5,50
7670 REM
7680 REM
7690 REM ITALY:
7700 REM
7710 DATA 51090,1.96,134,43.4,850,83,12.7,91.6,0
7720 DATA -1,0,-1,2,3,-1,1,3,1,4,0,0,0,14565.2,-10,40
7730 REM
7740 REM
7750 REM WEST GERMANY:
7760 REM
7770 DATA 58290,2.20,258,89.8,1540,168,36.8,98,0
7780 DATA 4,3,-2,-3,-3,-4,4,-3,4,1,0,0,0,35522.3,-10,50
7790 REM
7800 REM
7810 REM INDIA:
7820 REM
7830 DATA 471624,18.2,506,42.4,90,37,5.3,27.8,0
7840 DATA -3,-2,4,4,5,5,-3,-1,-3,0,0,0,0,4504.7,-78,25
7850 REM
7860 REM
7870 REM COMMUNIST CHINA:
7880 REM
7890 DATA 738000,30,20,70.1,95,59,15,25,1
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7900 DATA -4,5,5,2,-4,4,5,5,5,3,1,0,0,4200,-115,30
7910 REM
7920 REM
7930 REM JAPAN:
7940 REM
7950 DATA 96046,4.49,625,63.4,660,192,41.1,97.8,0
7960 DATA 5,-4,-5,-3,4,-4,2,-1,3,1,0,0,0,15624,-140,37
7970 REM
7980 REM
7990 REM NORTH KOREA:
8000 REM
8010 DATA 12000,.5,18,2.5,210,13,1.2,25,0
8020 DATA 4,5,5,5,5,4,5,5,5,3,0,0,0,48.2,-126,40
8030 REM
8040 REM
8050 REM GUATEMALA:
8060 REM
8070 DATA 4304,.2,9,1.2,290,5,.1,37.9,0
8080 DATA -4,-3,0,5,5,5,5,1,-5,0,0,0,0,415.6,91,15
8090 REM
8100 REM
8110 REM U.A.R.:
8120 REM
8130 DATA 28900,.9,33,4.3,150,6,.2,41.4,0
8140 DATA 4,-1,-1,1,4,4,5,4,4,2,0,0,0,1538.5,-32,28
8150 REM
8160 REM
8170 REM LEBANON:
8180 REM
8190 DATA 2439,.1,5,.9,390,1,.1,35,0
8200 DATA -2,0,0,1,4,4,4,3,3,0,0,0,0,593.5,-35,32
8210 REM
8220 REM
8230 REM HUNGARY:
8240 REM
8250 DATA 10120,.4,30,9,890,11,2.5,97.4,0
8260 DATA -2,-1,1,1,4,-1,-2,2,1,2,0,0,0,3031,-19,42
8270 REM
8280 REM
8290 REM SOUTH VIETNAM:
8300 REM
8310 DATA 15715,1,.1,1.7,110,1,.1,35,0
8320 DATA 3,5,-3,5,5,3,5,5,5,1,0,0,0,391.7,-107,12
8330 REM
8340 REM
8350 REM TAIWAN:
8360 REM
8370 DATA 12070,.3,15,7.9,190,12,.2,53.9,0
8380 DATA -4,4,-2,5,5,4,3,-2,5,1,0,0,0,1006.3,-120,23
8390 REM
8400 REM
8410 REM CUBA:
8420 REM
8430 DATA 7434,.3,4,2.7,360,4,.2,77.9,0
8440 DATA 2,2,2,3,4,4,2,3,2,2,0,0,0,1551,80,22
8450 REM
8460 REM
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8470 REM THE CONGO (B):
8480 REM
8490 DATA 3260,.01,9,1.1,140,.04,.01,20,0
8500 DATA -2,2,3,4,4,5,1,0,-2,0,0,0,0,111.4,-15,-4
8510 REM
8520 REM
8530 REM EAST GERMANY:
8540 REM
8550 DATA 17155,.6,168,19.2,1120,54,4.4,91,0
8560 DATA 2,4,-2,2,3,-2,3,5,5,2,0,0,0,5918,-13,52
8570 REM
8580 REM
8590 REM PAKISTAN:
8600 REM
8610 DATA 111760,3.5,31,10.1,90,4,.013,18.8,0
8620 DATA 3,3,1,2,3,3,2,2,4,0,0,0,0,1572.2,-80,26
8630 REM
8640 REM
8650 REM SOUTH KOREA:
8660 REM
8670 DATA 27633,1.1,24,3.3,120,4,.192,70.6,0
8680 DATA -2,3,-1,4,5,3,0,1,4,1,0,0,0,638.3,-127,37
8690 REM
8700 REM
8710 REM CZECHOSLOVAKIA:
8720 REM
8730 DATA 14058,.44,8,16.8,1200,34,8.6,98,0
8740 DATA 2,3,3,1,4,-1,-4,4,3,2,0,0,0,5361,-15,49
8750 REM
8760 REM
8770 REM YUGOSLAVIA:
8780 REM
8790 DATA 19279,.78,59,7.5,390,16,1.8,76.5,0
8800 DATA 3,-4,-3,-1,3,-2,-4,0,4,2,0,0,0,2379.3,-20,44
8810 REM
8820 REM
8830 REM ISRAEL:
8840 REM
8850 DATA 2475,.08,3,2.6,1070,4,.084,84.2,0
8860 DATA 4,-4,-3,-2,3,-3,2,-3,5,1,0,0,0,1265,-34,33
8870 REM
8880 REM
8890 REM NORTH VIETNAM:
8900 REM
8910 DATA 18000,1,51,1.8,100,1,.025,64.5,0
8920 DATA 5,5,-3,4,5,3,3,5,5,2,0,0,0,32,-106,21
8930 REM
8940 REM
8950 REM
8960 REM MILITARY BASES ABROAD MATRIX, F(I,J):
8970 REM
8980 REM THERE ARE 625 ENTRIES IN THIS MATRIX: A 1 INDICATES THE
8990 REM PRESENCE OF COUNTRY A'S INSTALLATION IN COUNTRY B. A
9000 REM ZERO INDICATES NO INSTALLATION.
9010 REM
9020 REM
9030 DATA 1,0,1,0,1,1,0,0,1,0,0,0,0,0,1,1,1,0,0,1,1,0,0,0,0
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9040 DATA 0,1,0,0,0,0,0,0,0,0,0,0,0,!,0,0,1,0,1,0,0,1,0,0,1
9050 DATA 0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
9060 DATA 0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
9070 DATA 0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
9080 DATA 0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
9090 DATA 0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
9100 DATA 0,0,0,0,0,0,0,1,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1
9110 DATA 0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
9120 DATA 0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
9130 DATA 0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0
9140 DATA 0,0,0,0,0,0,0,0,0,0,0,1,1,0,0,0,0,0,0,0,0,0,0,0,0
9150 DATA 0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0
9160 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0
9170 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0
9180 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0
9190 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0
9200 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0
9210 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0
9220 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0
9230 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0
9240 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0
9250 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0
9260 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0
9270 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1
9280 REM
9290 REM
9300 REM
9310 REM WEIGHTING FACTORS, G(I): NINE FOR WAR POTENTIALS;
9320 REM NINE FOR WRIGHT SCALES (PROPENSITY-TO-ACT INDEX).
9330 REM
9340 DATA .002,.5,.01,3,.1,.1,10,10,1000,10,10,5,5,5,5,10,5,10
9350 REM
9360 REM
9370 REM
9380 REM TRADE MATRIX, M(I,J): DENOTES DYADIC TRADE BETWEEN
9390 REM PAIRS OF COUNTRIES; 625 ENTRIES IN MILLIONS OF $U.S.
9400 REM
9410 REM
9420 REM U.S.A:
9430 REM
9440 DATA 48964.3,96.5,3194.4,1635.6,1561,3363.6,1280.8,.0
9450 DATA 4589.6,0,164.2,191,71.7,11.9,178.5,301.4
9460 DATA 0,4.2,19.3,337.2,285.8,45.8,221.9,279.7,0
9470 REM
9480 REM
9490 REM USSR:
9500 REM
9510 DATA 86.5,16233,420.6,214.3,275.3,415.2,354.6,100.0
9520 DATA 404.9,8,0,216.7,7.6,2000,0,.0
9530 DATA 100,.5,3000.18.7,0,3000,301,1,10
9540 REM
9550 REM
9560 REM U.K.:
9570 REM
9580 DATA 3194.4,420.6,29848.4,1031.2,713.9,1515.6,663.8,155.1
9590 DATA 367.3,.2,11.2,67.6,44.3,40.8,11.1,10.3
9600 DATA 58.3,13.4,55.7,223.8,3.6,38.9,82.8,217.1,0
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9610 REM
9620 REM
9630 REM FRANCE:
9640 REM
9650 DATA 1635.6,214.3,1031.2,20400,1459.5,3882.1,70.1,104.7
9660 DATA 108,4.7,5.9,67.5,46.8,36.9,21.4,3.6
9670 DATA 25.1,44.5,87.8,36.4,11.7,62.6,65,51.6,4.
9680 REM
9690 REM
9700 REM ITALY:
9710 REM
9720 DATA 1560,275.3,713.9,1459.5,14565.2,2698.1,61.9,95.7
9730 DATA 88,0,8.7,89.6,44.3,88.4,8.7,7.1
9740 DATA 10.8,3.6,30.8,0,5.7,78.6,285.3,38.4,0
9750 REM
9760 REM
9770 REM WEST GERMANY:
9780 REM
9790 DATA 3363.6,415.2,1515.6,3882.1,2644.1,35522.3,331.2,.3
9800 DATA 427.4,3.7,43.9,125.5,52,149,18.1,46.3
9810 DATA 4.5,17.4,595,179.6,22.9,185.5,235,117.5,.3
9820 REM
9830 REM
9840 REM INDIA:
9850 REM
9860 DATA 1200.3,354.6,663.8,70.1,61.9,331.2,4504.7,.0
9870 DATA 339.3,0,0,84.9,1.6,29,6.7,.0
9880 DATA 4.3,.1,50,46.4,.7,75.1,52.6,0,0
9890 REM
9900 REM
9910 REM COMMUNIST CHINA:
9920 REM
9930 DATA 0,100,155.1,104.7,95.7,0,0,4200.0
9940 DATA 471.6,40,0,72.3,5.1,0,0,.0
9950 DATA 1,1.3,0,63.1,0,0,0,0,22
9960 REM
9970 REM
9980 REM JAPAN:
9990 REM
10000 DATA 4589.6,404.9,367.8,108,88,427.4,345.3,471.6
10010 DATA 16524,31.2,36.9,40.5,23.9,2.9,40,369.5
10020 DATA 31.6,.9,2.4,128.3,216.2,15.8,27.1,40.4,14.
10030 REM
10040 REM
10050 REM NORTH KOREA:
10060 REM
10070 DATA 0,8,.2,4.7,0,3.7,0,40.0
10080 DATA 31.2,48.2,0,0,0,0,0,.0
10090 DATA 0,0,0,0,0,0,0,0,5.
10100 REM
10110 REM
10120 REM GUATEMALA:
10130 REM
10140 DATA 164.2,8,11.2,5.9,8.7,43.9,0,.3
10150 DATA 36.9,0,415.6,0,0,0,0,.0
10160 DATA .9,0,0,0,0,0,0,0,0
10170 REM
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10180 REM
10190 REM U.A.R.:
10200 REM
10210 DATA 191,216.7,57.6,67.5,89.6,125.5,84.9,72.8
10220 DATA 40.5,0,0,1538.5,8.8,21.3,0,.0
10230 DATA 14.8,0,47,7.2,0,95.3,41,0,0
10240 REM
10250 REM
10260 REM LEBANON:
10270 REM
10280 DATA 71.4,7.6,44.3,46.8,44.3,52,1.6,5.1
10290 DATA 15.3,0,0,8.8,593.5,3.7,0,.0
10300 DATA .9,0,4.2,0,0,12.7,2.5,0,0
10310 REM
10320 REM
10330 REM HUNGARY:
10340 REM
10350 DATA 11.9,3000,40.8,36.9,88.4,149,29,.0
10360 DATA 2.9,0,0,21.3,3.7,3031,0,.0
10370 DATA 0,0,50,2.8,0,50,51.5,10.1,5.
10380 REM
10390 REM
10400 REM SOUTH VIETNAM:
10410 REM
10420 DATA 170.5,0,11.1,21.4,8.7,18.1,6.7,.0
10430 DATA 40,0,3,0,0,0,391.7,60.7
10440 DATA 0,0,0,.8,16.6,0,0,0,0
10450 REM
10460 REM
10470 REM TAIWAN:
10480 REM
10490 DATA 301.4,0,10.3,3.6,7.1,46.3,0,.0
10500 DATA 369.5,0,.9,0,0,0,46.2,1006.3
10510 DATA 0,0,0,2.6,8.9,0,0,0,0
10520 REM
10530 REM
10540 REM CUBA:
10550 REM
10560 DATA 0,100,58.3,25.1,10.8,4.5,4.3,1.0
10570 DATA 31.6,0,0,14.8,.9,0,0,.0
10580 DATA 51,0,5,8.6,0,50,10.3,0,5.
10590 REM
10600 REM
10610 REM THE CONGO (B):
10620 REM
10630 DATA 4.2,.5,13.2,44.5,3.6,17.4,.1,1.3
10640 DATA .9,0,0,0,0,0,0,0
10650 DATA 0,111.4,0,0,0,0,0,0,0
10660 REM
10670 REM
10680 REM EAST GERMANY:
10690 REM
10700 DATA 19.3,3000,55.7,87.8,30.8,595,50,.0
10710 DATA 2.4,0,0,47,4.2,50,0,.0
10720 DATA 5,0,5918,3.2,0,100,139,0,5.
10730 REM
10740 REM
```

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10750 REM PAKISTAN:
10760 REM
10770 DATA 387.2,18.7,223.8,36.4,0,179.6,46.4,63.1
10780 DATA 128.3,0,0,7.2,0,2.8,.8,2.6
10790 DATA 8.6,0,3.2,1572.2,0,7.5,13.6,0,0
10800 REM
10810 REM
10820 REM SOUTH KOREA:
10830 REM
10840 DATA 285.8,0,8.6,11.7,5.7,22.9,.7,.0
10850 DATA 216.2,0,0,0,0,0,16.6,8.9
10860 DATA 0,0,0,0,638.3,0,0,1.5,0
10870 REM
10880 REM
10890 REM CZECHOSLOVAKIA:
10900 REM
10910 DATA 45.8,3000,88.9,62.6,78.6,185.5,75.1,.0
10920 DATA 15.8,0,0,95.3,12.7,50,0,.0
10930 DATA 50,0,100,7.5,0,5361,141.4,0,5.
10940 REM
10950 REM
10960 REM YUGOSLAVIA:
10970 REM
10980 DATA 231.9,301,97.8,65,285.3,235,52.6,.0
10990 DATA 27.1,0,0,41,2.5,56.5,0,.0
11000 DATA 10.3,0,139,13.6,0,141.4,2379.3,15.5,0
11010 REM
11020 REM
11030 REM ISRAEL:
11040 REM
11050 DATA 279.7,1,217.1,51.6,33.4,117.5,0,.0
11060 DATA 40.4,0,0,0,0,10.1,0,.0
11070 DATA 0,0,0,0,1.5,0,15.5,1265,0
11080 REM
11090 REM
11100 REM NORTH VIETNAM:
11110 REM
11120 DATA 0,12,0,5.1,0,.3,0,22.0
11130 DATA 14.8,5,0,0,0,5,0,.0
11140 DATA 5,0,5,0,0,5,0,0,32
11150 REM
11160 REM
11170 REM END OF DATA BASE
11180 REM.....REM
11190 REM
11200 REM
11210 END
```