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TEMPER

Technological, Economic, Military and Political Evaluation Routine

Volume I

ORIENTATION MANUAL

FR-65-174-1 9 July 1965

TEMPER

VOLUME I

ORIENTATION MANUAL

Contract No. DA49 - 146 - XZ - 110

Prepared under the direction of the

NATIONAL MILITARY COMMAND SYSTEM
SUPPORT CENTER

for the

JOINT WAR GAMES AGENCY

by the

Raytheon Company
Bedford, Massachusetts

FOREWORD

The TEMPER program was initially funded by Raytheon Company and received continued support through Contract No. DA49-146-XZ-110 under the direction of The National Military Command System Support Center (NMCSSC) of The Defense Communication Agency for the Joint War Games Agency. The project was conceived by and initially developed at Raytheon under the direction of Clark C. Abt. The principal contributors to the project were Robert L. Goodrich, Morton Gorden, James C. Hodder, Robert V. Jacobsen, Walter F. Jaros, Joanne Lewis, John J. McDonnell, Robert Nelson, Peter Miller, Anton S. Morton, Thomas C. O'Sullivan, Ernest Rogers, Warren Siemens and Ellen Wax. From the early days of the project, personnel from the Joint War Games Agency and the NMCSSC have lent their encouragement and offered their guidance. Particular mention should be made of Col. W. T. Minor, Col. William Jones (Ret.), Lt. Col. Andrew Keller (Ret.), Lt. Col. James Sherwood, and Captain George Draper.

Volume I gives a broad view of TEMPER to determine if it is applicable to a potential user's problem. Volume II provides details of the simulation and the theory. Volume III describes how to set up, play, and analyze a game. (It is recognized that Volume III falls far short of being a game handbook. The lack of gaming experience, time, and money, prevented development to that point. It is expected that with time and experience the material in Volume III can be developed into a handbook in the full sense of the term.) Volume IV which follows the outline of Volume II gives details of the computer program including numerical examples of each element of the simulation. Volume I is a computer operator's reference for setting up, debugging, and running a game. Volume VI is a reference directory which defines variables and parameters and gives their use. A seventh volume, not a part of the formal documentation, presents raw data collected for a 1960 data base and is available as a guide for collecting future data bases.

Project director has been, in order of their service, Clark C . Abt, James C. Hodder, and Thomas C. O'Sullivan, Jr.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

TABLES

1.0 Introduction

This document describes the TEMPER* Program developed under the direction of the National Military Command System Support Center (NMCSSC) of the Defense Communications Agency for the Joint War Games Agency. The TEMPER model describes global cold war conflict and simulates it with a digital computer program. The computer simulation, has been designed to permit quantitative simulation of a wide range of international conflict situations, and to provide insight into the complex interactions between political, economic, cultural, and military factors which shape national decisions. The basic theory underlying the model** is when a nation detects a difference between the desired and actual values of a condition, it takes rational actions which tend to decrease the difference. For example, if a nation senses that an unfriendly neighbor has too large an advantage in military force, it will spend money to buy more forces of its own or may ask its allies to furnish forces. The simulation describes a simplified world in which the real world nations can be aggregated into a maximum of 39 representatives. Each representative nation may reflect the resources of a single real world nation or a group of nations depending on how the TEMPER world map is drawn. These simulated nations are called Nation-Groups. Each Nation-Group is described by approximately thirty different characteristics. Problems are recognized and corrective actions are taken. These actions lead to inter Nation-Group contacts which can develop into conflict situations, e.g., an arms race, or a limited war, just as in the real world. The value of the TEMPER simulation is in revealing consequences of specific policies or actions, which because of the remoteness of cause and effect might not have been anticipated. The set-up and operation of a new scenario is made simple and straightforward by an automated data management system which uses the computer to generate a series of English language data input forms. The game designer uses these to create a simulation structure which focuses attention on the problem of interest to him.

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* Technological, Economic, Military, and Political Evaluation Routine.

** For a description of the seven theoretical assumptions used in guiding the development of TEMPER, see Appendix A.

This volume provides the reader with a broad view of the TEMPER program and an overview of the theory and its implementation in the computer simulation. Volume II, The Theory of The Model, provides details of the simulation and the underlying theory. The reader requires no knowledge of computers or computer programs to read the volume with understanding. Volume III, Game Handbook, describes how to provide the necessary inputs to set up a particular game, and how to analyze the output. Examples taken from a sample game are included. The key variables are identified and their interactions are discussed in detail. Actual samples of the computer output are given.* Volume IV, Technical Manual, parallels the organization of Volume II, but gives specific details of the computer program used to implement each element of the simulation. The reader of Volume IV is assumed to be familiar with the program language, FORTRAN, but no knowledge of the operation of the computer is required. Volume V, Operations Manual, gives complete and specific details about the process of setting up, de-bugging and running a new TEMPER game. The format of data and control cards is given. Operation of the data management system is described. Volume VI, Reference Manual, contains a dictionary of the variables used by the computer program and other basic data useful to game operators. Volume VII, Data Collection Manual, is not a part of the formal documentation. It lists the real world data as of 1 January 1961 that has been used during the development of the TEMPER simulation, and will be a useful guide to preparing a future Data Base.

1.1 Components of the TEMPER Program

The TEMPER program has five component elements:

a. The basic model of global cold war conflict.

b. The digital computer program which is a simulation of the model.

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* The present form of Volume III falls short of this description,

c. Basic data describing 117 real world nations in the format of the simulation.

d. An automated data management system which assists the user in setting a simulation run.

2.0 The TEMPER World

2.1 Basic Assumptions of the Simulation

The TEMPER model attempts to simulate the cold-war interactions of all the nations of the world (including entering, conducting and terminating limited war) over a period up to 10 years. The simulation uses data about the resources, behavior, and attitudes of 117 real world nations and aggregates these data into a maximum of 39 TEMPER world Nation-Group. The model is based on several basic assumptions about the behavior of nations. Stated briefly these are as follows:

a. There are two basic kinds of Nation-Groups, neutrals and bloc members. All Nation-Groups within one of these kinds have the same basic behavior structure although differences in emphasis may be very great.

b. Each non-neutral bloc member is in one or the other of two blocs and to a degree is responsive to bloc goals and problems. (For the purposes of the computer simulation, the neutral Nation-Groups are lumped into a third "bloc", but they do not interact with one another as do members of the non-neutral blocs).

c. Each Nation-Group has goals and ideals, and its perception of the disparity between the actual state of the world and the ideal state is the motivating force which causes it to modify its behavior.

d. Behavior modifications seek to reduce, during the period ahead, this disparity between actual and ideal.

e. A Nation-Group acts with common purpose (a united population) and internal dissention or subversion is not included in the model.

f. Bloc members may also be the owners of strategic (i.e., nuclear) forces. The simulation makes a provision for a maximum of six strategic owners, two of which are also designated as bloc leaders (one for each non-neutral bloc). The strategic owners differ from the other bloc members only in that they carry the added economic burden of supporting the cost of the strategic forces. They try to use the bloc leader strategic spending behavior as a pattern for their own spending. The bloc leaders bargain with each other in an attempt to bring about a mutual reduction in strategic spending.

g. Finally, TEMPER assumes that the real world can be simulated realistically by the following basic operation. Each Nation-Group is described numerically by a list of characteristics or specifications which include descriptions of such things as its economic and military resources, its international political leanings, its culture, and its geographic location. The sum of these descriptors, called the Data Base, can be thought of as a numerical description of the TEMPER world at a given moment in time. (The Data Base currently in use is a reflection of the real world on 1 January 1961.) These data are stored in the computer's memory at the beginning of a run. A series of subroutines[1], which call upon the Data Base, are then executed in sequence. Each subroutine is concerned with simulating a different functional area of world behavior. For example, the Force Maintenance and Procurement Subroutine, (FORMAP), computes for each Nation-Group in turn the spending of its military budget. To do this for a given Nation-Group, FORMAP first calls from the computer memory (where the data base is stored) the information about that Nation-Group's military forces and its military budget. It computes the cost of operating the current forces. If the budget is inadequate, FORMAP computes the reduction in the force which would result from depreciation and returns the revised data to the data base. If there is an excess after operating cost has been computed, FORMAP computes the additional forces that can be procured from a list of desired additional forces, adds them to the current forces, and returns the revised data to the data base. Other subroutines evaluate threats, conduct trade, strengthen and weaken alliances, and fight limited land and naval conflicts. As each of the subroutines is executed, the Data Base is updated, and represents the TEMPER world after the passing of one week of real world time. Twelve such cycles will simulate a quarter year and 48 cycles a full year.

[1] For ease of operation, the total computer program is broken into a number of functionally integral segments called subroutines.

Because some real world functions do not occur every week, not all subroutines are executed at every cycle. For example, FORMAP is operated quarterly. BUDGET, which computes the amount of taxes and the allocation of revenue to each of several areas of the economy, is operated annually.

In summary, the TEMPER simulation is a computer program which describes the world in simplified form, and which modifies that description week by week to reflect the response each Nation-Group is expected to make to the simplified description in each of several different functional areas, which together describe the behavior of the Nation-Groups.

Volume III, Game Handbook describes how the computer simulation can be used by the player. However, it can be seen that the analyst learns by observing the changing world which the Data Base describes. His task is to relate the effect he observes with its cause. He does this by establishing initial values for the Data Base.

a. He can arrange the 117 nations into a maximum of 39 Nation-Groups so as to emphasize a particular area of the world.

b. He can adjust the initial data to reflect specific real world data.

c. Finally, he can modify the characteristics of a Nation-Group. For example, he can increase or decrease willingness to use military forces to achieve goals. By observing the differences in results as he varies these quantities, he may gain insight into the complex interactions of the real world.

2.2 The Structure of the TEMPER World

The basic data describing the real world is organized in terms of 117 nations.[2] A computer program which stored data on 117 nations, and then operated on it would require a very large memory, and would take a long time to operate. In recognition of these practical considerations, the

[2] Details on data and sources will be found in Volume VII, Data Collection Manual.

TEMPER world has been reduced to a maximum of 13 Conflict Regions[3] which embody the 117 real nations. In addition, the oceans of the real world are represented by seven sea conflict regions. Each conflict region may (but need not) have a neutral Nation-Group, a Western block Nation-Group, and an Eastern bloc Nation-Group. The analyst selects the real world nations which are politically and geographically aggregated to form each of the possible 39 Nation-Groups. He may, if he wishes, place only one or two Nation-Groups in a conflict region, or he may leave it blank. Figure 2-1 shows an aggregation of 117 real world nations into Nation-Groups. Each Nation-Group has a descriptive name which will identify it in computer output statements.

Having defined the 13 land conflict regions, the analyst then defines seven sea conflict regions. He does this by defining which sea conflict regions are contiguous to each other and to the land conflict regions. He also sets the time required for cargo and military forces to be moved from a given conflict region to any other. All cargo and military forces are assumed to move by sea. Logistics subroutines keep account of these moves. Another subroutine computes the consequences of encounters between the naval and transport ships of conflicting Nation-Groups. Figure 2-2 shows the real world divided into the land conflict regions (labeled L.C.R.) listed in Figure 2-1, with sea conflict regions (S.C.R.) added.

Once the constituents of each Nation-Group have been selected most of the clerical work of melding the real world data into TEMPER world data is done automatically by the data management system, a set of auxiliary computer programs. However, values for variables must be established which describe aspects of the relationship each Nation-Group has with

3. A geographic subdivision of the world which may have up to one each of a Nation-Group from East, West, and Neutral blocs. May refer to a sea conflict region. TEMPER permits a maximum of 13 land conflict regions, and seven sea conflict regions.

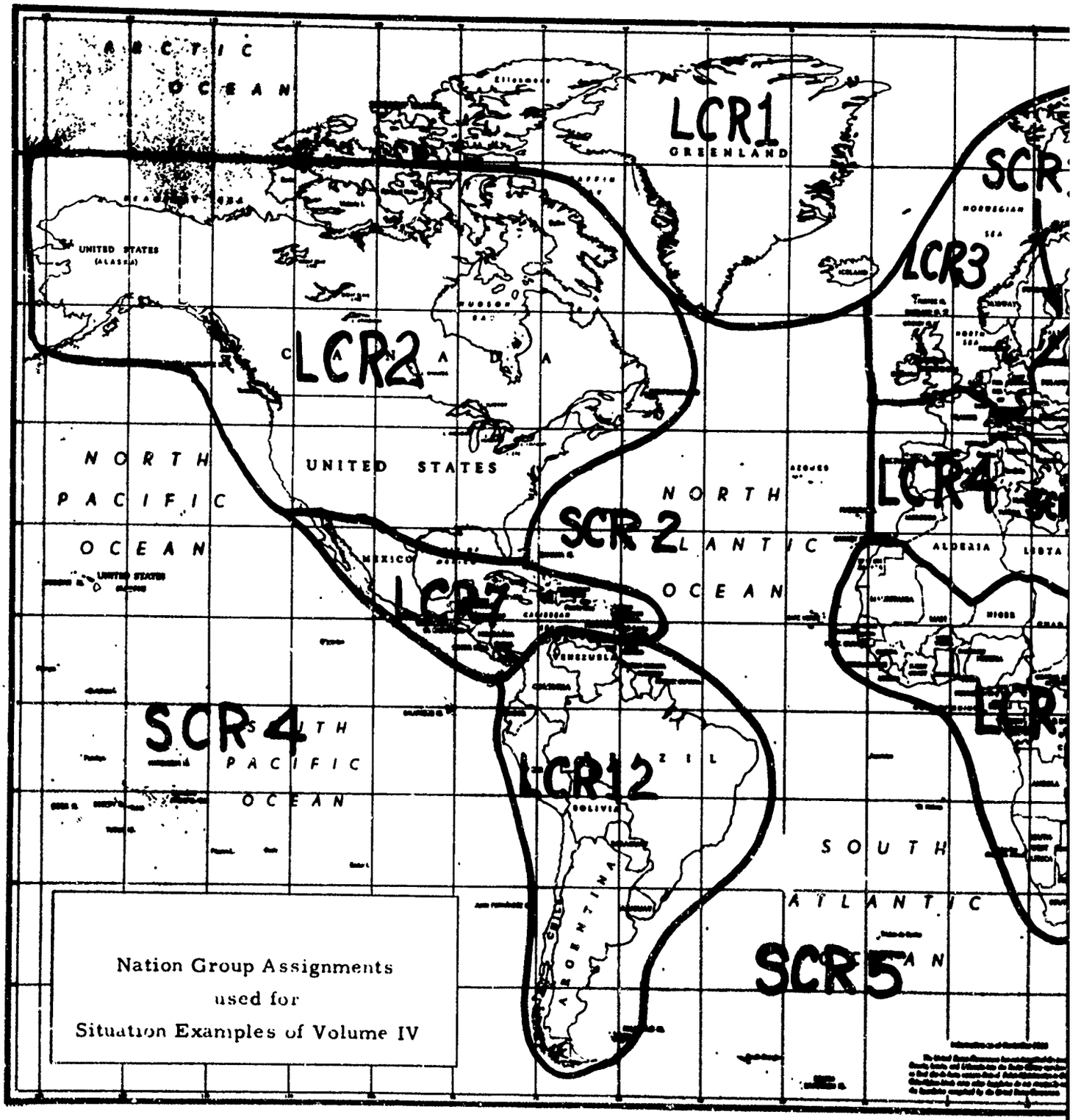
13 Land Regions	L, LL, =1 WESTERN BLOC NATION GROUPS	L, LL, =2 EASTERN BLOC NATION GROUPS	L, LL, =3 NEUTRAL NATION GROUPS
J=1	ICELND ICELAND (1)	(NONE)	(NONE)
J=2	USACAN CANADA (2) UNITED STATES (3)	(NONE)	(NONE)
J=3	UKGFR BELGIUM (5) HOLLAND (16) G. F. R. (12 U. K. (22) LUXEMBOURG (15)	EGERM G. D. R. (11)	SCNDIA DENMARK (8) NORWAY (17) FINLAND (9) SWEDEN (20) IRELAND (14)
J=4	FRANCE FRANCE (10) GREECE (26) ITALY (27) PORTUGAL (29)	POLCHK BULGARIA (6) CZECHOSLOVAKIA (7) HUNGARY (13) POLAND (18) RUMANIA (19) ALBANIA (24)	ALGRIA AUSTRIA (4) MOROCO (28) SWITZERLAND (21) SPAIN (30) YUGOSLAVIA (23) TUNASIA (31) ALGERIA (25) LIBYA (62)
J=5	(NONE)	RUSSIA USSR (32)	(NONE)
J=6	JAPAN JAPAN (33) NEW ZEALAND (73) PHILIPPINES (35) AUSTRALIA (67)	NKOREA NORTH KOREA (34)	SKOREA SOUTH KOREA (36)
J=7	MEXICO MEXICO (58)	CUBA CUBA (38)	PANAMA COSTA RICA (37) HONDURAS (43) DOM. REP. (39) JAMAICA (44) EL SALVADOR (40) NICARAGUA (46) GUATEMALA (41) PANAMA (47) HAITI (42) TRINIDAD (48)
J=8	TAIWAN TAIWAN (51)	C. P. R. CHINA (49)	MACAO MONGOLIA (50)
J=9	ISRAEL ISRAEL (55) TURKEY (60)	(NONE)	EGRAB AFGHANISTAN (52) LEBANON (57) IRAN (53) SAUDIA (58) IRAQ (54) SYRIA (59) JORDAN (56) U. A. R. (61)
J=10	PAKSTN PAKISTAN (66)	TIBET	INDIA CEYLON (63) NEPAL (65) INDIA (64)
J=11	SVETNM LAOS (71) THAILAND (76) SOUTH VIETNAM (75)	NVETNM NORTH VIETNAM (74)	CAMMAY BURMA (68) CAMBODIA (70) CAMBODIA (69) MALAYSIA (72)
J=12	BRAZIL BRAZIL (79)	VENZLA VENZUELA (86)	SAMRC ARGENTINA (77) ECQUADOR (82) BOLIVIA (78) PARAGUAY (83) CHILE (80) PERU (84) COLUMBIA (81) URUGUAY (85)
J=13	SAFR RS AFR	CAFR PCONGO (107)	CAFRC* (88) (93) (98) (103) (109) (114) (89) (94) (99) (104) (110) (115) (90) (95) (100) (105) (111) (116) (91) (96) (101) (106) (112) (117) (92) (97) (102) (108) (113)

Sea Regions: (1) BALTIC (3) MEDTRN (5) S. ATLN (7) BLACK
(2) N. ATLN (4) PACIFC (6) INDIAN

Note: Figures in parentheses are reference numbers assigned to the real world nations, usually identified as K or KK in the TEMPO program.

* The Nations represented by these numbers are listed on Table 2-1.

Figure 2-1 A Representative Arrangement of the 117 Real World Nations into the 13 Conflict Regions of the TEMPER World


ARCTIC OCEAN
LCR1
GREENLAND
SCR
LCR3
UNITED STATES (ALASKA)
LCR2
CANADA
NORTH PACIFIC OCEAN
UNITED STATES
NORTH ATLANTIC OCEAN
SCR 2
LCR4
MEXICO
LCR7
SCR4
SOUTH PACIFIC OCEAN
LCR12
SOUTH ATLANTIC OCEAN
SCR5
Nation Group Assignments
used for
Situation Examples of Volume IV

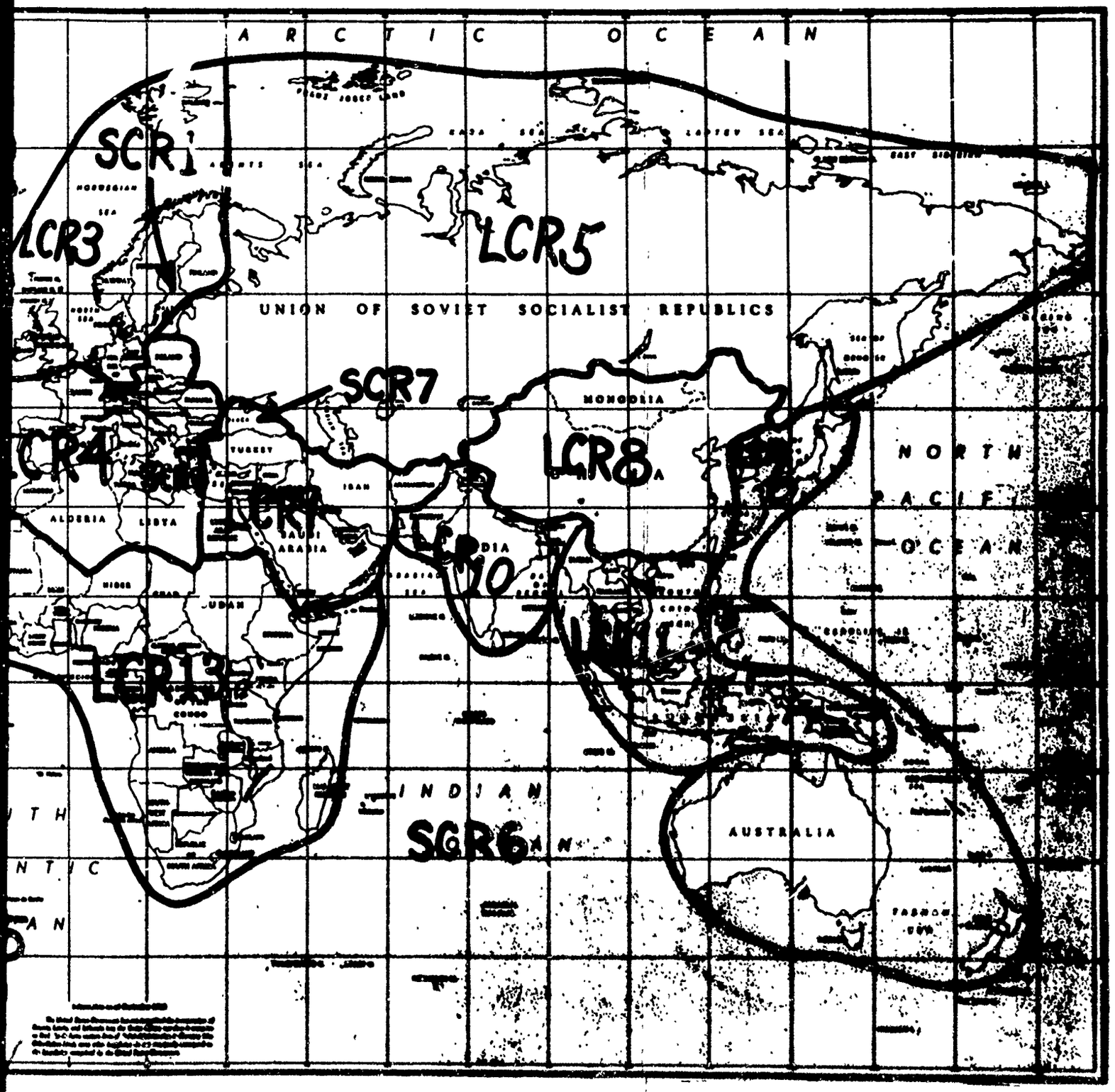


Figure 2-2 A Map of the Real World Showing the TEMPER World of Figure 2-1 Superimposed

its conflict region and with other Nation-Groups. Details of this process are not given here, but it is important to understand that the map and interaction variables must be established not only to represent the situation being studied, but also to respond to the detailed requirements of the computer simulation. Otherwise, meaningless or misleading events begin to occur and the simulation of the real world becomes less and less meaningful with the simulated passage of time.

2.3 Key National Characteristics

As stated above, Nation-Group in the TEMPER world is described by a number of key characteristics. These characteristics are established for a specific Nation-Group in the data management system by an appropriate merging of the data stored on each of the 117 real world nations which the player has selected for membership in the Nation-Group. For example, Nation-Group USACAN (see Figure 2-1) will have a work force which is the sum of the work forces stored for the U.S. and for Canada.

The data stored are as follows:

a. Economic:

- Annual GNP, and GNP growth rate.
- Annual government spending.
- Work force size.
- Total resources or raw materials on land.
- Capital wealth in each of six economic sectors.[4]
- Fraction of demand in each economic sector to be satisfied by importing..

[4] Each nation's total economy is lumped into six sectors: military spending, heavy industry (or capital goods), light industry (or consumer goods), agriculture, natural resources (or mining), and services.

b. Psychological (Cultural)

External dynamism, the zeal with which a nation pursues its international goals.

Military coercion motivation, the willingness of a nation to use military force to achieve its goals.

Reinvestment motivation, the tendency to stress capital growth.

Taxation motivation, the willingness to impose taxes on the population.

Defense spending propensity, the willingness to use [illegible] ment resources for defense.

c. Political:

Alliance relationships for non-neutrals in a bloc

Alignment relationships of neutrals to the other blocs.

Proximity to (or degree of involvement felt) with allies.

d. Military:

Annual military spending.

Tactical forces owned in each of four categories.[5]

Exogenous or overseas deployments of tactical forces.

Naval forces and the sea conflict regions in which they are deployed.

Shipping units available for redeployment of forces.

(In the case of the strategic owners, the following data are also stored)

Strategic forces operation and procurement spending.

Strategic forces R&D spending.

Strategic forces owned in each of four categories.[6]

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[5] Tactical forces are lumped into four categories: Tactical air wings, conventional or ROAD army divisions, nuclear army divisions, and paramilitary army divisions.

[6] The four strategic force types are strategic air wings, located ICBM's, hidden ICBM's, and Polaris Type (SLBM) submarines.

Each real world nation is identified in the basic data as either being in the West, East, or Neutral blocs. Each Nation-Group must consist of real world nations from only one of these groups. Table 2-1 which lists the 117 nations shows the bloc memberships assumed for each nation in the present data base. Belgium and Denmark which are both identified as members of the West bloc may be included in the same Nation-Group, but Sweden which is identified as a neutral may not be in this Nation-Group. The user could change Sweden to a West bloc member if desired and include it in the Nation-Group, but the change would require that certain political relationships be inspected after the aggregation.

The political factor, friendship value, is most significant to the simulation, because it completely defines the communications channels between Nation-Groups. The real world data makes provision for storing a total of 650 friendship values. These values are a measure of the value one nation places on the friendship of another. Military aid, and trade can only flow between two Nation-Groups if one has placed value on the friendship of the other. TEMPER uses two terms for these friendship values. The value one bloc member places on a fellow bloc member is called ally value. The value a neutral places on a bloc member is called an alignment value. There are no ally values awarded between members of opposing blocs. Bloc members do not award alignment value to neutrals, and neutrals do not award alignment value to each other. The first exception is obvious. The remaining two result from a desire to make the simulation concentrate on the vital aspects of cold war conflict, the holding of allies, and the winning of neutrals. All other relationships are of lesser interest. The structure of the TEMPER world can now be seen as 13 triplets of Nation-Groups, with inter-relationships based on the relationships of their real world components. Figure 2-3 shows three of these triplets graphically. Each circle represents a Nation-Group made up of one or more real world nations as selected by the player. The vectors represent the friendship values between the real world nations which become the TEMPER world links. For example, both real world nations of Nation-Group D, have friendship for the two real world nations of Nation-Group B. If these real relationships are both strong, a relatively strong link would be established in the TEMPER world and

TABLE 2-1

ONE-HUNDRED AND SEVENTEEN NATIONS

INCLUDED IN "SEASIA" MAP

W = Member of West bloc, E = Member of East bloc, and N = neutral member

Country Number	Geog. Assoc.	Nation	Country Number	Geog. Assoc.	Nation
1 W	Arctic	Iceland	41 N		Guatemala
2 W		Canada	42 N		Haiti
3 W		USA	43 N		Honduras
4 N	N. Europe	Austria	44 N		Jamaica
5 W		Belgium	45 W		Mexico
6 E		Bulgaria	46 N		Nicaragua
7 E		Czechoslovakia	47 W		Panama
8 W		Denmark	48 N		Trinidad
9 N		Finland	49 E	Asia	Red China
10 W		France	50 E		Mongolia
11 E		East Germany	51 W		Taiwan
12 W		West Germany	52 N	Middle East	Afghanistan
13 E		Hungary	53 W		Iran
14 N		Ireland	54 N		Iraq
15 W		Luxembourg	55 N		Israel
16 W		Netherlands	56 N		Jordan
17 W		Norway	57 N		Lebanon
18 E		Poland	58 N		Saudi Arabia
19 E		Rumania	59 N		Syria
20 N		Sweden	60 W		Turkey
21 N		Switzerland	61 N		UAR (Egypt)
22 W		UK	62 N		Libya
23 N		Yugoslavia	63 N	South Asia	Ceylon
24 E	Europe	Albania	64 N		India
25 N		Algeria	65 N		Nepal
26 W		Greece	66 W		Pakistan
27 W		Italy	67 W	S. E. Asia	Australia
28 N		Morocco	68 N		Burma
29 W		Portugal	69 N		Cambodia
30 W		Spain	70 N		Indonesia
31 N		Tunisia	71 N		Laos
32 E	Eurasia	USSR	72 W		Malaysia
33 W	No. Pacific	Japan	73 W		New Zealand
34 E		North Korea	74 E		N. Vietnam
35 W		Philippines	75 W		S. Vietnam
36 W		South Korea	76 W		Thailand
37 N	Cen. America	Costa Rica	77 N	S. America	Argentina
38 E		Cuba	78 N		Bolivia
39 N		Dom. Republic	79 N		Brazil
40 N		El Salvador	80 N		Chile

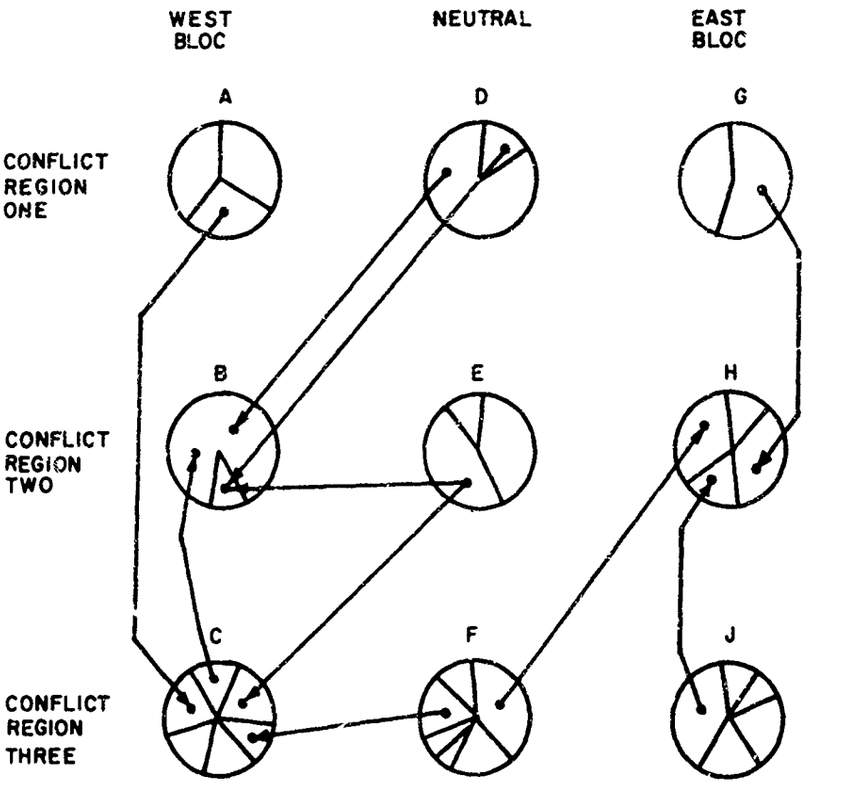
TABLE 2-1 (Cont)

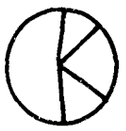
ONE-HUNDRED AND SEVENTEEN NATIONS

INCLUDED IN "SEASIA" MAP

W = Member of West bloc, E = Member of East bloc, and N = neutral member

Country Number	Geog. Assoc.	Nation	Country Number	Geo. Assoc.	Nation
81 N		Columbia	99 N		Kenya
82 N		Ecuador	100 N		Liberia
83 N		Paraguay	101 N		Malagasy
84 N		Peru	102 N		Mali
85 N		Uruguay	103 N		Mauritania
86 W		Venezuela	104 N		Niger
87 W	S.Africa	Rep. S.Africa	105 N		Nigeria
88 N	C.Africa	Burundi	105 N		Nyasaland
89 N		Cameroon	107 N		Rep. Congo
90 N		Cen.African Rep.	108 N		Rwanda
91 N	C.Africa	Chad	109 N		Senegal
92 N		Congo Republic	110 N		Sierra Leone
93 N		Dahomey	111 N		Somalia
94 N		Ethiopia	112 N		Sudan
95 N		Gabon	113 N		Tanganyika
96 N		Ghana	114 N		Togo
97 N		Guinea	115 N		Uganda
98 N		Ivory Coast	116 N		Upper Volta
			117 N		Zanzibar





THIS SYMBOL REPRESENTS A NATION-GROUP, EACH SEGMENT REPRESENTING ITS REAL WORLD NATION COMPONENTS.

ARROWS SHOW REAL WORLD FRIENDSHIPS WHICH ARE MERGED TO FORM TEMPER WORLD FRIENDSHIPS ONLY 9 OF THE 39 NATION-GROUPS ARE SHOWN. IN THIS MERGING PROCESS THE RESOLUTION OF INDIVIDUAL NATIONAL FRIENDSHIPS IS LOST, BUT THE EFFECT IS RETAINED BY AGGREGATING THEM INTO SINGLE LINKS BETWEEN NATION GROUPS.

Figure 2-3 Structure of the TEMPER World

Nation-Group B would be quite willing, within its resources, to aid Nation-Group D except if it were in conflict with Nation-Group A, a fellow bloc member. Nation-Group F could draw support from the West (Nation-Group C) if attacked by the East, and from the East (Nation-Group H) if attacked by the West. The simulation is designed to prohibit a bloc member from supplying aid to both a neutral and a fellow bloc member who are in conflict. For example, Nation-Group C would not support Nation-Group E in a conflict with Nation-Group B.

With the above characteristics aggregated by the data management system for each of the Nation-Groups he has designated, the user is then required to furnish additional information about his simulated world. These are the following:

a. For each conflict region the relative cultural-political proximity each bloc member feels to the opponent on a scale of zero to one.

b. For each conflict region the level at which a problem will be considered as crisis, and a permissive switch which permits or prevents intra-conflict region bargaining between non-neutrals.

c. The fraction of the conflict region which each Nation-Group thinks of itself as once owning, and the fraction it would now like to own.

d. A set of parameters which describe the relationship of each of the sea conflict regions to one another, and to the land conflict regions. These are used in moving naval forces. Also required is the time to move military forces from one conflict region to any other conflict region.

e. An initial level of military operations and deterrent threat for each Nation-Group against each of its two neighbors in the conflict region.

f. The fraction of the military budget of Nation-Groups to be spent on each of the various force types.

g. The belief each bloc member has that he might become involved in a nuclear war with the other bloc.

This group of characteristics called the "situation variables" give the player the opportunity to test the consequences of various policies. For example, he can establish a conflict region made up of North Korea and

South Korea as East and West respectively, and omit the neutral Nation-Group. By letting each think of itself as having once owned all of the conflict region, giving North Korea a relatively high willingness to use military force (military coercion), he can investigate the effect of different levels of military forces on each side, proximity and friendship of allies, and various levels of economic strength on the relationship between the two Nation-Groups.

By a thoughtful choice of his map of the world, and the settings of the situation variables, the user can simulate a wide range of real world problems and establish a qualitative relationship between cause and effect. However, since the simulation will contribute nothing to the thought processes, but simply does as instructed, it is important that the player assure himself that all the characteristics have been carefully set to realistically represent the real world. The friendship links described above are a good example. The data management system will provide the player with the links which have resulted from the map he has drawn. No new links will be created during the operation of the simulation. He must assure himself that these links adequately describe the world for his situation. If they do not, he may insert additional links.

The data management system, described briefly in Volume III, and in some detail in Volume V, may be used in three ways to supply a user with the necessary simulation to test the situation of interest. These are:

a. Redefine the situation using a previously developed map.

b. Rearrange the geo-political aggregation and define the situation.

c. Develop new basic data, aggregate into TEMPER map and define the situation.

If a previously drawn map has geo-political aggregation suitable for the situation of interest, it may be sufficient for the user to redefine the key characteristics of the nations in the world and the situation variables which define the specific political-military environment and strategy to be used (political military containment, roll back etc.). With this information, the supporting staff will use the data management system to build a TEMPER

world with national behavior and response suitable for the player. This may be done in a matter of days.

If no previously used maps seem suitable for the situation of interest (none give geo-political resolution at the desired level in the part of the world of interest), then a new map must be established. However, this task is more substantial and the support group may require several weeks for preparation.

If substantial change is required to the Data Base (start at 1965 or 70 with assumed data, or using classified data), then the number of weeks for preparation may have to be extended to allow extra time to collect the data, prepare it for use in the data management system, aggregate the new map, and test the national behavior and responses. Depending on the extent of the changes, this could take from weeks to months.

3.0 Operation of the TEMPER World

3.1 Introduction

Section Two has described the elements which make up the TEMPER world, 39 Nation-Groups, each with characteristic resources, ideals, and goals. It has discussed how interactions occur between the three Nation-Groups of each of the 13 conflict regions, and between Nation-Groups across conflict regions boundaries when value has been placed on inter Nation-Group friendships, and actions are taken to maintain and enhance these friendships. This section describes how these complex activities are carried out by the simulation. Figure 3-1, which follows this section, is a simplified flow diagram. If the reader will fold it out, he will find it helpful in following the remainder of this section.

The TEMPER simulation is divided into four functional areas: 1) Psychological, 2) Economic, 3) War, and 4) Decision-Making. This section and Volumes II, and IV are all written in this order.

3.2 Operation of the TEMPER World

The simulation's subroutines are sequenced to simulate the flow of real world time. This cycling of the subroutines is what causes the operation of the TEMPER world. Figure 3-1 without making specific reference to these subroutines shows how their functions are performed in sequence by the computer. Having entered the initial TEMPER world description (the Data Base) into the computer memory, the sequencing begins at the point labeled, "START". As indicated by the arrows, the subroutines are linked together so that as each completes its function, it initiates the operation of the next subroutine. Each subroutine has special functions associated with its functional area which it performs at the start of a run to initialize many of the Data Base variables which are themselves functions of other data base variables. These "start up", or "day zero" functions are described in detail in Volumes II and IV, and need not concern us here. Let us consider first the weekly sequencing starting at the point, "Advance Time by One Week".

3.3 Psychological Functions

Assuming simulated time has been advanced to week number one, the amount of political and military threat each Nation-Group perceives as

a result of the actions of other Nation-Groups is computed. These levels of threat replace the values previously stored in memory and control and are passed to the next subroutine. It examines the past history of relationships, the present activities of other Nation-Groups, and computes for each Nation-Group a current measure of hostility for other Nation-Groups. Information about other Nation-Groups used in these computations is delayed and distorted to simulate real world information transmission channels and perception. Control then checks the week being simulated to see if it is a multiple of twelve.[1] If not, control skips down to the War function, otherwise the simulation operates on the key cultural-ideological characteristics and ideals of each Nation-Group. The theory of the TEMPER world is that each Nation-Group, if free from threat, would be guided in its actions by six basic motivations:

a. Propensity to use military force.
b. The energy with which it pursues its international goals.
c. The propensity to invest GNP in capital goods.
d. The propensity to spend for defense.
e. The willingness to impose taxes.
f. Desired power ratios.

Current values are computed for these factors based on the initial values and the current threats, friendships, and hostilities of other Nation-Groups. In this way, gradual changes in national character are simulated.

3.4 Economic Functions

Now assuming that the simulated time is at the end of quarter (i.e., multiple of twelve weeks), control sequences the subroutines of the Economic

[1] The diamonds in Figure 3-1 indicate decision nodes; the branch selected by the simulation in each case depends on the answer to the question asked at the node. It can be seen that some functions occur at a quarterly, semi-annual, or annual rate, rather than weekly.

functions. First, the current state of the economy is computed for each Nation-Group. GNP, growth rate, work force size, and capital worth are updated. GNP is distributed among six sectors of the economy:

a. Military
b. Capital goods (or heavy industry)
c. Consumer goods (or light industry)
d. Agriculture
e. Resources development (or mining)
f. Services

Unsatisfied public and private demand is noted for later use. Public and private demand for the products of the economy is computed on the basis of a theory which states that allocation of demand is primarily a function of per capita income, and not the political-economic system in use. The simulation seeks out opportunities for each Nation-Group to try to regain declining friendship through exports to the Nation-Groups withdrawing the friendship from it. The simulation then tries to arrange imports as available from all friendly Nation-Groups to satisfy consumer demand. In all cases trade only occurs if there is an unsatisfied demand matched by a surplus inventory and a friendship link between the two Nation-Groups. Each Nation-Group satisfies its own demand before offering goods for export. Friendship values are adjusted upward appropriately as a result of each trade agreement. These friendship values are very significant quantities which are used by many of the subroutines in the computation of such things as the amount of military aid to be furnished, the priority on the list of potential trade suppliers, and threat. Indeed, these variables express the basic considerations of TEMPER, the changing alliance and alignment of nations in cold war conflict.

A military budget has been established for each Nation-Group. This money is first used to maintain existing forces. The cost to operate and maintain these forces is a function of the number of each type of force the Nation-Group has in its current inventory. The excess money is used to procure additional forces in response to the needs the Nation-Group has felt during the previous quarter as will be described below. If the budget is insufficient to maintain the current military forces, the size of the forces is

reduced to reflect depreciation.

3.5 WAR Functions

The first WAR function is to keep account of the current limited wars in the TEMPER world. Each conflict region is checked to see if the level of military operations has reached the level of war. If a war has started during the current week, the simulation assigns a serial number, and computes variables having to do with the forces and terrain which are used later to compute the progress of the war. The results of the current week of fighting for each on-going war is then computed. As a function of the terrain type, and size and types of forces engaged, the losses in men, material, and land area for each side is computed, and the appropriate quantities are updated in the Data Base. Reductions in forces due to war losses are computed and noted in the Data Base. The number of transport and naval ships each land war combatant has in each ocean is noted, and the probability of encounters between opposing Nation-Groups and the resulting losses of ships are computed. These losses are noted in the Data Base. Nation-Groups will note the declining inventories and attempt to replace losses within the limits of economic resources.

Having completed the war subroutines, the associated logistic activity is carried out. The simulation seeks to optimize the deployment of land forces. It first compares needed forces with available forces for each Nation-Group and identifies the Nation-Groups with an excess and those with a need. Starting with the Nation-Group with the greatest need, it seeks friendly Nation-Groups with both a willingness to supply military aid and an excess of forces. If transportation is available, the simulation selects for redeployment the nearest source whose least cost-effective force will be at the same time the most cost-effective to the recipient. It continues this process until either the need is fully satisfied, all the proffered aid is exhausted, or no more transportation is available. The process is repeated for the next Nation-Group on the list needing forces and so on, until all possible deployments have been arranged. Forces are subtracted from the shipping Nation-Group when they are being "loaded on the transports" and then added to the receiving Nation-Group when the transports "arrive".

Finally, the naval forces of the world are selectively redeployed to match the military operations (i.e., land wars) of the Nation-Groups who own the naval forces. The process is performed first for the West bloc and then for the East bloc. The desired level of operation in each sea conflict region, as a function of the contiguous land military operations is updated. The sea with the largest differences between desired and actual deployment is identified. The nearest ocean in which an interested Nation-Group (or Groups) has an excess of forces is located, and these forces are shifted toward the sea where the largest need exists. For the sake of simplicity, the simulation assumes that ships take one week to move from one sea to any of the seas that adjoin it.

3.6 Decision Making Functions

It can be seen that the activities of the three preceding functions have set the stage for this final function which is primarily concerned with governmental activities. A number of miscellaneous updating functions are performed first. If there have been no recent trade relations, or offers of military aid friendship values are decreased slightly to simulate the gradually loosening of ties between two countries. If there have been no recent trade relations, or offers of military aid. Characteristics of strategic weapons are updated quarterly to reflect the growth in technology. The strategic owners of a bloc are assumed to share technology so that, for example, all West bloc SLBM submarines will have the same CEP. The value per unit area of the land of each Nation-Group is recomputed to reflect added capital and threat. The desire of each Nation-Group for land in its conflict region is updated as a function of present holdings, historic holdings, values placed on an opponents land, and armed forces.

Every half year the losses on each side, in event of a hypothetical nuclear war between the West and East blocs, are computed. Because the defender will lose some weapons to the attacker, the loss a bloc sustains depends upon which bloc preempts. Therefore, the losses resulting in preemption by both blocs are computed. Results depend upon such factors as numbers, sizes, accuracies, and vulnerabilities of the strategic weapons. Targeting is assumed to be counterforce and can be modified by the analyst.

The problems each Nation-Group has in connection with each of the other two Nation-Groups in the conflict region is computed each week for each conflict region. These problems arise from:

a. Military operations by others despite deterrent threats by the subject Nation-Group.

b. Deterrent threats by others to military operations of the subject Nation-Group.

c. An unsatisfactory perceived tactical force ratio.

d. The discrepancy between land desired and land actually owned by the subject Nation-Group.

After computing these problems for the three Nation-Groups of a conflict region, the simulation attempts to perform bargaining between the Western and Eastern Nation-Groups. This is done weekly. It seeks to find problems which can be reduced in size through mutual actions (quid pro quo). Bargains which only involve two Nation-Groups are accepted immediately. If one Nation-Group offers to effect a reduction in forces by returning forces supplied by its allies as its part of the bargain, the simulation determines if these allies in the sum are less disposed to use force than the bargaining Nation-Group (i.e., would willingly withdraw). If the result is affirmative, the bargain is accepted. Likewise, if the propensities of the allies are mixed, but their forces do not predominate, the bargain will be accepted. Finally, in less clear cases, the simulation will weight the friendship the bargainer has for each of his allies and cause the bargainer to follow the desires of his closest friends.

The simulation then computes for each Nation-Group its <u>perception</u> of the size of the same problems for the other two occupants of the conflict region. At the end of each year, each Nation-Group identifies the discrepancy between actual and desired defense budget and tax rate. In addition, the demand in each sector of the economy to be satisfied by trade is established. These discrepancies are based on the size of the problem at the end of each quarter of the current year. For those Nation-Groups with strategic forces the discrepancies between desired and actual spending reflect the motivations

of the Nation-Group, and the level of spending of its bloc leader and the opponent bloc leader. Finally, the simulation computes for each bloc leader the perceived problem that the other bloc leader has in strategic spending. These functions are extremely important to TEMPER. As mentioned above, TEMPER theory states that nations seek to relieve their problems by rational actions. The simulation uses these problems, together with the cultural motivations, as the driving force behind the actions of each Nation-Group.

Since most countries establish government spending on an annual basis, the establishment of government spending budgets is simulated once each year, based on projections of GNP and previous defense budget, the problems previously identified, and national characteristics. The new year's defense budget, and the portions devoted to R&D and strategic forces are computed for each Nation-Group. The balance is used for tactical forces. These funds will be used as described in Section 3.4 to operate existing forces, and if possible, to procure new forces.

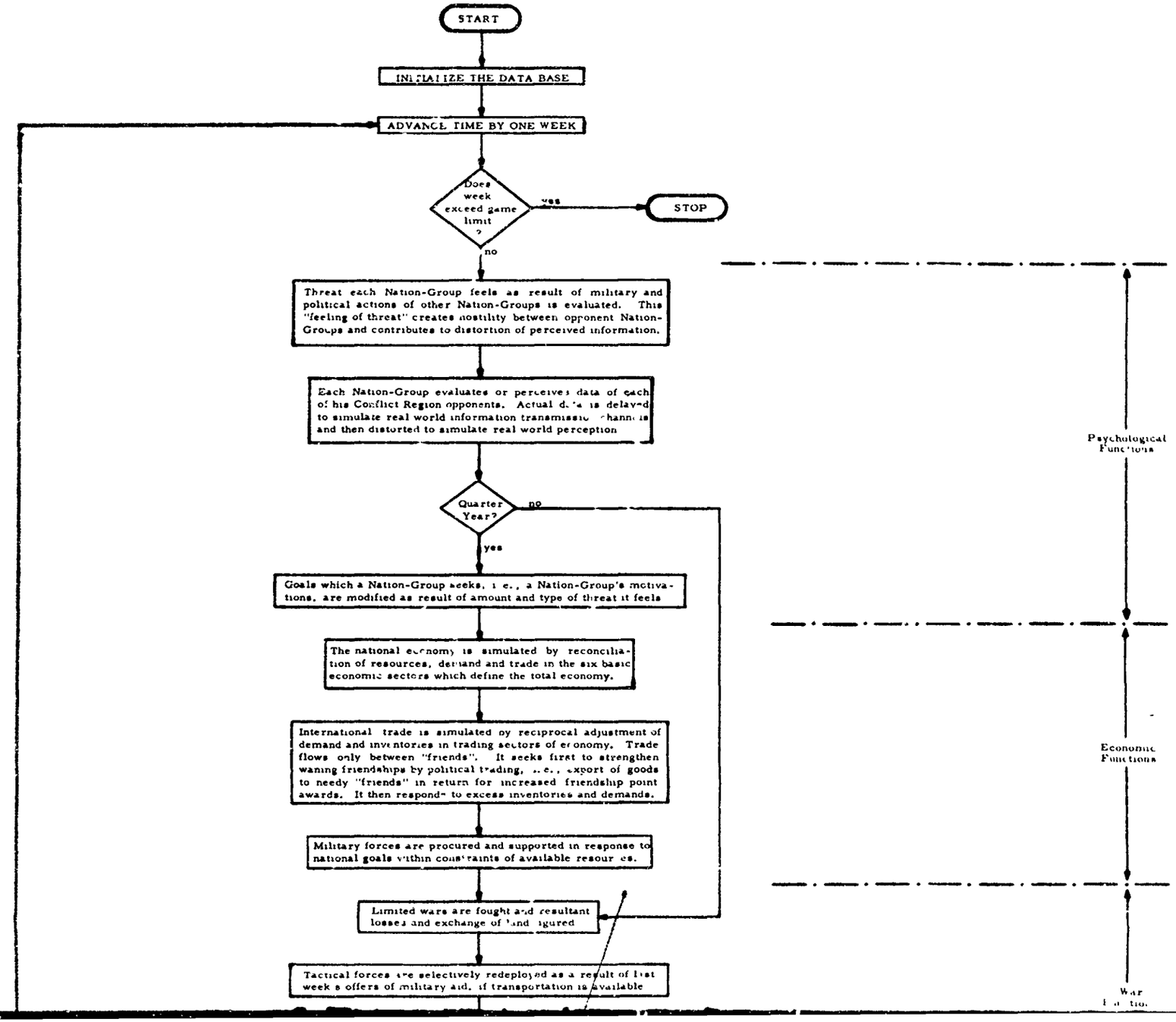
Each week two key decision making functions are simulated, limited war and cold war conduct. The simulation first examines each war from the standpoint of both combatants. If both Nation-Groups find that their losses exceed their gains, the military operations level of both Nation-Groups is set below the level of war, and the war is terminated. On the other hand, if either or both sense impending victory, it raises the level of operations, possibly to the point where nuclear escalation becomes possible. After updating all current wars, the total weekly problem that each Nation-Group has with each of the other Nation-Groups in its conflict region is considered, excluding the war situations already considered. If the problem rate of change exceeds a threshold, the problem is called a crisis. The best course of action (escalation, de-escalation, or status quo) for the Nation-Group is determined. The simulation considers potential gains or losses, probable results from changes in military operations and deterrent threats, and determines for each Nation-Group the levels of military operations and deterrent threat it will apply to each of the other two Nation-Groups in its conflict region.

The simulation next computes the military forces each Nation-Group feels it needs to carry out the change in military operations and deterrent threat decided on above. When the need is compared with existing force, it will be found that some Nation-Groups will need help, and some have excess forces. A table is developed for each needy Nation-Group of other Nation-Groups willing and able to help. The table includes details of the amount, type, location, and owner of the offered forces. This table will be used "next" week to find forces to satisfy the redeployment request generated by the WAR function described in Section 3.5. Each Nation-Group which consigns aid is awarded appropriate additional friendship value.

Referring to Figure 3-1, it can be seen that the week's activities have been completed. In preparing his game, the player has specified the number of real world weeks he wants the simulation to operate (up to a maximum of 480 ten years of TEMPER time). If this time has not been exceeded, the entire process is repeated. Otherwise, the game is terminated.

This iterative process causes the Data Base, or simplified description of the world, to undergo change, and so simulate the flow of events in the real world. Because the computer simulation can perform the enormous bookkeeping task required, the player can study his particular area of interest in the global context, with the simulation supplying the inputs to his problem area for the remainder of the world. For example, the player need not overlook the effect on world trade of a local conflict. He may find that the local conflict upsets normal relationships, and that one of the local conflict nations receives an unexpectedly different level of support from its friends.

The remaining chapter of this volume describes briefly and in non-technical terms, the practical aspects of operating the computer simulation. The reader may skip it without loss of understanding. If he wants more details about the functions described in this chapter, he should turn to Volume II, The Theory of The Model, or for even more detail, Volume IV, Technical Manual. Volume III, Game Handbook, describes in detail the procedure for implementing a new game, and gives samples of the actual computer output.


START
INITIALIZE THE DATA BASE
ADVANCE TIME BY ONE WEEK
Does week exceed game limit ?
yes
STOP
no
Threat each Nation-Group feels as result of military and political actions of other Nation-Groups is evaluated. This "feeling of threat" creates hostility between opponent Nation-Groups and contributes to distortion of perceived information.
Each Nation-Group evaluates or perceives data of each of his Conflict Region opponents. Actual data is delayed to simulate real world information transmission channels and then distorted to simulate real world perception
Quarter Year?
no
yes
Goals which a Nation-Group seeks, i.e., a Nation-Group's motivations, are modified as result of amount and type of threat it feels
The national economy is simulated by reconciliation of resources, demand and trade in the six basic economic sectors which define the total economy.
International trade is simulated by reciprocal adjustment of demand and inventories in trading sectors of economy. Trade flows only between "friends". It seeks first to strengthen waning friendships by political trading, i.e., export of goods to needy "friends" in return for increased friendship point awards. It then responds to excess inventories and demands.
Military forces are procured and supported in response to national goals within constraints of available resources.
Limited wars are fought and resultant losses and exchange of land figured
Tactical forces are selectively redeployed as a result of last week's offers of military aid, if transportation is available
Psychological Functions
Economic Functions
War Fighting

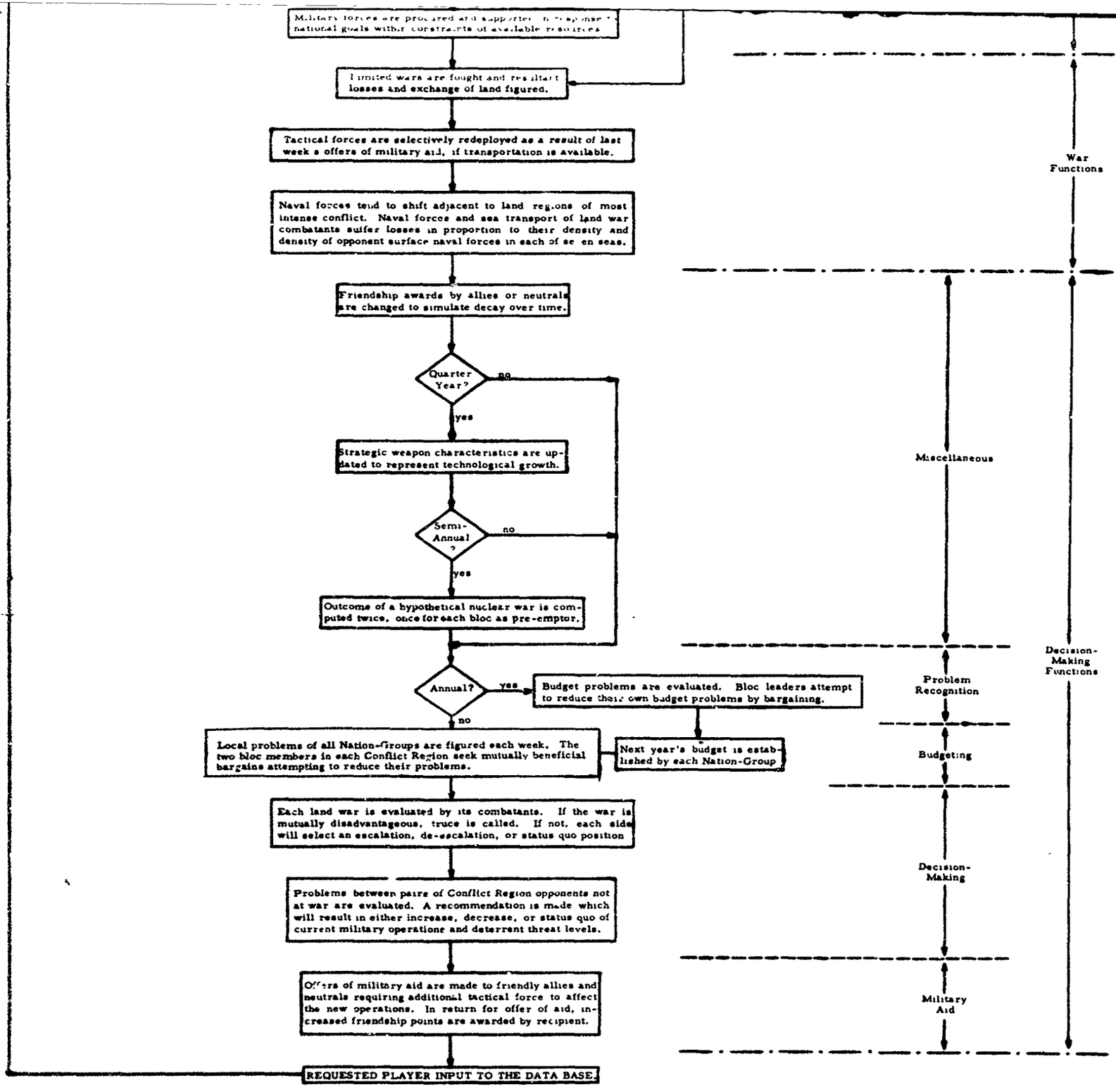


Figure 3-1 Simplified Flow Diagram of the TEMPER Computer Simulation

4.0 Computer Operation of TEMPER

4.1 Introduction

For the reader with no knowledge of computer systems and methods the two following sections trace the conversion of the TEMPER simulation concept into a computer program. These sections can be summarized as follows for those with some familiarity with the area:

a. The TEMPER simulation source program is written in a subset of FORTRAN common to FORTRAN IV, CDC FORTRAN 62, and FORTRAN 63, with the exception of minor differences in library functions, such as sine and cosine, which are easy to adjust.

b. The minimum computer system must have the following:

1. A 32 thousand word memory
2. A card reader
3. Three magnetic tape drives, assuming one of which could handle the computer monitor.
4. An on-line printer
5. A FORTRAN compiler.

c. A more efficient system could use an off-line printer and about six magnetic tape drives.

d. Using all features of the system operational at NMCSSC, eleven magnetic tape drives are required.

The reader is cautioned that the above material, and the sections which follow are not definitive and reference should be made to Volume V, Operations Manual, for specific details. However, it is felt that the overview provided here will be useful to the general reader.

4.2 The Design of the Simulation Program

The model and the simulation concept are transformed into a working computer program by writing a series of instructions for the computer which will cause it to operate on the data supplied to it in a way which meets the objectives of the model. To take a very simple example, if we wanted to simulate the behavior of a mass suspended from a spring, we would instruct the computer to evaluate an expression for the position of the mass. We would give each quantity in the expression a unique name or label. We would tell (i.e., provide as input data to) the computer the size of the mass, the spring constant, and the initial displacement. We might ask it to compute the position at time zero, and for ten times thereafter at one second intervals. These elements are called the instructions and the input data of the computer program. The computer will record its answers on some output device as instructed.

The instructions which make up the TEMPER program have been written in a widely used computer language called FORTRAN (Formula Translation) which is a combination of English words (DO, GO TO, etc.) and common mathematical terms (= , +, etc.). Each individual instruction is encoded on one or more punched cards. When we are ready to use the program on a particular computer, we first must translate the instruction from FORTRAN into the language used by the particular computer, generally referred to as machine language. The computer is supplied with instructions which enable it to translate a FORTRAN instruction such as "C equals A plus B" into something like "Take the quantity stored at location 89 and put it into temporary storage. Take the quantity stored at location 753, add it to the quantity in temporary storage, and put the sum into temporary storage. Take the quantity in temporary storage and store it at location 522". It can be seen that the original instruction which reflects the problem being solved is converted into a set of specific instructions for the computer. Of course, earlier instructions must have placed A at 89 and B at 753, and later instructions will expect to find C at 522. (The important point is that the FORTRAN instructions are directly relatable to the TEMPER theory. For operation on a specific computer, these instructions must be translated into the machine language of that computer.)

FORTRAN can be thought of as having many dialects. The TEMPER program is written in one which can (with minor exceptions) be translated by both the IBM-7044 computer, and by the CDC-1604 computer. The IBM-7044 translates dialects of FORTRAN called FORTRAN II, and FORTRAN IV. The CDC-1604 will translate FORTRAN 62 and FORTRAN 63. The TEMPER program can be translated (converted into machine language) by any computer which can translate FORTRAN IV, FORTRAN 62, or FORTRAN 63. This process is performed by the computer using a program furnished by its manufacturer called a compiler, One of the exceptions mentioned above is the naming of mathematical functions. Computers have auxiliary programs which will accept instructions like A = SIN(B) which means set A equal to the sine of B. Similarly, there are functions to obtain the tangent, logarithm, cosine, etc. These are called library or external functions and the particular form in which they are written in FORTRAN will vary. In addition, the words used to control input-output devices may vary from machine to machine, e.g., WRITE, or WRITE ON TAPE. However, these differences are not difficult to find and rectify so that the modified FORTRAN will be accepted by the translator of a particular machine. In summary, the many operations on the data which make up the TEMPER simulation are written in FORTRAN as instructions which the computer will translate (perhaps with a little help) into instructions expressed in its own language.

These FORTRAN instructions are organized into two main programs so called, one of which embodies the simulation itself, and the other contains the instructions for reading the data into and out of the computer. These programs in turn are broken up into convenient parts called subroutines. For example, the instructions which carry out the simulation of annual governmental budget making are in a separate subroutine, called BUDGET. A third program called the Data Management System contains the instructions which convert the data of the 117 real world nations into the data of the 39 TEMPER world Nation-Groups. These three programs are coded onto punched cards, read into the computer and translated into machine language. The computer can store the machine language instructions on magnetic tape for rapid read-in at a later time, and at the same time punch a deck of cards

with the more compact machine language as a permanent record.

4.3 Operation of the Computer

The preceding section has described briefly how the TEMPER simulation is converted into a set of instructions for a particular kind of computer to do certain things with input data, and to display certain results. To do these things the computer uses three elements, input-output devices, a processor, and a memory. The processor is the part of the computer which adds A to B or moves C to location 522, and similar logical actions.

The memory is the device which stores the numbers being operated on as directed by the processor. Each number to be recalled must be in a designated location in the memory. This is called its address. Thus, all of the location numbers given in the examples above are addresses. The translator which converts the FORTRAN into machine language assigns addresses to all of the quantities which must be remembered. In the case of the TEMPER simulation, there are approximately 10,000 different numbers which make up the description of the TEMPER world, each of which must be assigned its own address in the computer's memory. Secondly, the translator will assign an address to each instruction so that when the processor has completed an instruction, it will know where to find the next instruction. The instructions must be followed in a specific order if the results are to have any meaning. The instructions of the TEMPER simulation require about 20,000 memory locations. Finally, the computer must store the instructions it needs to direct its activities, i.e., to enable it to carry out the instructions of the program being processed. The number of these instructions vary from computer to computer, but might typically occupy 6000 locations. Adding these three requirements we see that about 36,000 locations or addresses would be required.

Since many computer installations have what is called a 32 K memory (2^{15} or 32,768 locations), the TEMPER program has been designed so that after the portion of the instructions which control read-in have been completed, they are moved out of memory and stored on a magnetic tape to make room for the simulation instructions. This process is called overlay or chaining and extends the capability of the computer. However, the technique has limitations and the TEMPER simulation cannot be operated

on a computer with less than a 32 K memory.

The above paragraph mentioned magnetic tapes, one type of input-output device. In addition, a punched card reader, and a line printer are required to operate the TEMPER simulation. The functions of the input-output devices, which are controlled by the processor in accordance with the program instructions, are listed below for a reasonably efficient operation which produces a summary data only:

a.	Card Reader:	Read game control cards.
b.	Magnetic Tape Drive	1: Computer operating system.
c.	Magnetic Tape Drive	2: TEMPER Data Base storage.
d.	Magnetic Tape Drive	3: TEMPER overlay storage.
e.	Magnetic Tape Drive	4: TEMPER simulation storage.
f.	Magnetic Tape Drive	5: TEMPER output storage.
g.	Line Printer:	Converts data from magnetic tape drive 5 into words and numbers printed on paper for study by the analyst.

The tape from tape drive 5 can be processed at a later time by a smaller computer equipped with a line printer to produce the printed output at a lower cost. If the output is printed as it is computed, the processor which is much faster than the line printer, must wait for the printer to complete each print statement before proceeding, and a game would take somewhat longer to run. If detailed output data are desired, one to four additional magnetic tape drives are needed.

The National Military Command System Support Center (NMCSSC) has developed an auxiliary program which can produce output from what is called a history tape. If a sixth magnetic tape drive is available, it can be used for the history tape on which the entire Data Base is recorded at the end of each week of simulated time. This history tape can then be rerun later and the values of selected variables can be printed out for each week of TEMPER time. In addition, NMCSSC has the capability to make X-Y plots of selected variables on a standard form in which time is the abscissa, and to make full color slides with computer generated labels. With these

and other output features in use, as many as eleven magnetic tape drives may be required.

APPENDICES

APPENDIX A

THE THEORETICAL ASSUMPTIONS OF THE TEMPER MODEL

The original and sustained objective of the TEMPER Model is the exploration of global cold war and limited war conflict among the major political power blocs of the post-World War II era. Cold war conflict includes political and economic activities, as well as military preparations and maneuvers threatening various uses of force. Limited war conflict also includes important political and economic aspects, demonstrated in such limited wars as those in Korea, Southeast Asia, the Mid-East, and Africa. The revolutions in the developing post-colonial areas of Africa, Asia, and Latin America are also a form of limited conflict involving political, economic, and military factors.

There were seven theoretical assumptions which guided the development of the TEMPER Model. The fundamental theoretical assumption about world conflict on which the TEMPER Model is based in that the over-all nature of the current world conflict and the national strategies designed for dealing with it are best described in the comprehensive terms of global military, political, and economic interactions. In terms of an engineering analogy, over-all aircraft or communication system design is best accomplished by the systems approach, that considers all the major elements and their interactions, rather than the components approach that refines details in isolation from context. In terms of an operations research analogy, optimization over the major tradeoffs obtains a more efficient result than sub-optimization of each of the elements involved. In terms of a military analogy, a balanced plan taking account of all major operations is superior to one that provides exhaustive detail on one operation and nothing on the others. In sum, a comprehensive examination of the dynamics of global

conflict can profit from identifying the major elements and relating them in proportion to their importance, without regard to such artificial geographic and disciplinary limits as exist in area studies and specifically military, political, and economic studies. The balance of power, the balance of political loyalties, and the balance of trade are very much related, and the theory of global strategy on which TEMPER is based attempts to relate them.

Any "theory" is an attempt to explain phenomena, usually in a way sufficiently simplified to permit experimentation by manipulation of the variables to achieve specific results. A theory of cold and limited war global conflict should "explain" at least some of the major events that occur, in the sense of identifying combinations of factors that under specified conditions result in these events. The "events" we are most concerned with "explaining" are international conflicts such as ideological disagreement, political warefare (threats), economic warefare (embargos), and Shooting war; and international agreements such as military alliances, trade, aid, and military intervention in support of an ally.

The specific results we would like to achieve experimentally by manipulating the variables are enhancements of the military security and economic standards of first the free nations of the West, and eventually all nations, by an avoidance or limitation of wars, technological advancement, and economic growth. The variables to be manipulated to these ends include technological factors such as productivity, economic factors such as invertment, military factors such as the balance of power, and political factors such as a nation's ideological propensity toward expansionism.

Each of the technological, economic, military, and political factors is itself the product of some aspect of some or all of the other factors. For example, the technological factor of unit productivity is the result of the economic factor of investment in research and development, as well as that

of previous technology. The economic factor of investment is determined in part by the results of the competition among domestic consumption, government spending (including military procurement and operations), and foreign aid and trade for the gross national product, which is itself the result of the previous GNP plus growth resulting from investment. The military factor of the balance of strategic power is determined in part by the political factors of potential enemy intentions, the economic factor of government spending, and the technological factor of the relative combat effectiveness of weapons. The political factor of a nation's propensity to expand is also the result in part of technological advancement, economic productivity, relatively strong military capabilities, and how these factors interact with the same factors of other nations, as well as those of ideology. Because of these functional inter-relations, no purely economic, military, or political theory or model can explain comprehensively the nature of international conflicts.

A second fundamental assumption of the theory is that all nations possess sufficient set of variables. Thus all nations have some degree of technology; an economy consisting of investment, production, and consumption; some actual or potential military force; and political loyalties and aversions. The relative weight of these variables may differ from nation to nation, as for example the state of technology of the degree of political unity may vary from nation of nation, but the variables will be the same. In other words, it is possible to identify standard characteristics shared by all nations, the different values of which will identify their differences.

This is really not such a novel idea, being commonly applied to the comparison of national population, area, wealth, and military power. What is perhaps somewhat new is that a standard set of variables should also be used to describe the ideological, political, and decision-making aspects of different nations. This is made possible because of the theory is intended to describe realistically only the external behavior of nations toward each

other, and perhaps the most gross level of internal operation. It is not intended necessarily to describe realistically how the behavior is determined by detail domestic interactions. In terms of an engineering analogy, the theory is intended to be an "equivalent circuit" to international reality that will produce certain outputs from certain inputs, much like a real nation will, but not necessarily by means of the same internal structure.

A third fundamental assumption of the theory is that each nation acts like a homeostatic device that seeks equilibrium among pre-set concepts of an ideal state of itself in relation to the world, and the discrepancies from this ideal produced by real world constraints. The nation will behave in such a way as to correct the discrepancies it preceives between its ideals and the real state of the world, allocating its resources to the tasks of doing so.

A fourth fundamental assumption of the theory is that nations do not perceive the real world exactly as it exists, but rather in a way that is incomplete and distorted by their own preconceptions, values, and experience. Thus, for example, they tend to be sensitive (amplify) external threats that have done them damage in the past.

A fifth fundamental assumption of the theory is that nations will attempt to reduce the discrepancies between their ideals and reality in the most cost-effective way, again assuming that the cost and the effectiveness of a given "solution" is that which is perceived. Thus if a discrepancy can be reduced only by means that introduce other and greater discrepancies between equally important ideal and real values, no action will be taken.

A sixth fundamental assumption of the theory is an instrumental necessity to the realization of cost-effective decision-making. This is that all costs and all degrees of discrepancy-reducing effectiveness can be reduced to common, commensurate units, respectively.

Finally, a seventh basic assumption or set of assumptions is that nations can reduce economic, military, and political discrepancies between ideal and reality by the following six types of behavior.

1. Ideal Modification
   (sour grapes response - since it wasn't feasible, it couldn't have been desirable.)
2. Resource Allocation
3. Political Action
4. Military Maneuver
5. Military (Combat) Action
6. International Bargaining
   (including formal negotiation and tacit bargaining)

In summary, the seven basic assumptions of this theory of cold and limited war conflict are (1) geographic and functional comprehensiveness and integration, (2) formalistic similarity (identical variables) among substantively different nations, (3) homeostatic national behavior that attempts to reduce discrepancies between ideals and reality, (4) imperfect national perception of intentions and actualities, (5) reduction of discrepancies between ideals and reality by the most efficient, cost-effective means, (6) availability of commensurate units of measurement for previously incommensurate costs and degrees of effectiveness, and (7) reduction of discrepancies between ideals and reality by the most effecient of at least the six alternative means of ideal modification, resource allocation, political action, military maneuver, military action, and international bargaining.

Given these seven assumptions, most of the major cold and limited war events and national behavior in the contemporary era can be described in a way permitting experimentation with alternative policies.

SUPPLEMENTARY

INFORMATION

THE JOINT CHIEFS OF STAFF
WASHINGTON, D. C. 20301

JOINT WAR GAMES AGENCY

JWGA- 180?-67
8 MAY 1967

MEMORANDUM FOR USERS OF TEMPER MODEL DOCUMENTATION

Subject: TEMPER

Users of this material are advised that the TEMPER model is an experimental and rudimentary effort to apply computer technology to the simulation of international relationships. The current JWGA goal in follow-on activities to TEMPER is to develop a broad base of international affairs theory and salient factors relevant to conflict relationships, elements of which might be computerized to reinforce interagency activities in the field of simulation and gaming. There is no expectation that TEMPER will be developed into a practical tool either for analyzing international affairs problems per se or providing insights into crisis management. The TEMPER model, as now constituted, can best be used as a reference to assist in future development thru examination of its deficiencies.

JAMES D. KEMP
Brigadier General, USAF
Chief, Joint War Games Agency

JOINT WAR GAMES AGENCY

JWGA-180A67

8 May 1967

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JAMES D. KEMP
Brigadier General, USAF
Chief, Joint War Games Agency

JOINT WAR GAMES AGENCY

JWGA- 180-67

8 MAY 1967

CHIEF | DEP CH | ADMIN | CWD | GWD | LWD | OTHER

MEMORANDUM FOR THE ADMINISTRATOR, DEFENSE DOCUMENTATION CENTER, CAMERON STATION, ALEXANDRIA, VIRGINIA 22314

Subject: Preface for TEMPER Documentation Volumes

1. The Joint War Games Agency, Organization of the Joint Chiefs of Staff, has release authority over the below-listed TEMPER model documentation volumes:

Volume	DDC AD Number
I	470375
II	471458
III	470241
IV	473050
V	470069
VI	470070
VII	470071

2. It is requested that the attached memorandum be included with each order for this material from DDC users.

JAMES D. KEMP
Brigadier General, USAF
Chief, Joint War Games Agency

Attachment
a/s

JOINT WAR GAMES AGENCY

JWGA- 180367

8 NOV 1967

MEMORANDUM FOR USERS OF TEMPER MODEL DOCUMENTATION

Subject: TEMPER

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JAMES D. KEMP
Brigadier General, USAF
Chief, Joint War Games Agency

AD-470 375

THE JOINT CHIEFS OF STAFF
WASHINGTON, D. C. 20301
JOINT WAR GAMES AGENCY

JWGA- 389-67
3 NOV 67

MEMORANDUM FOR THE ADMINISTRATOR, DEFENSE DOCUMENTATION CENTER, CAMERON STATION, ALEXANDRIA, VIRGINIA 22314

Subject: Preface for TEMPER Documentation Volumes

1. Reference is made to JWGA memorandum 180-67, dated 8 May 1967 with attachment.

2. By reference memorandum, it was requested that a statement concerning the nature and status of the TEMPER model be made a part of the seven volumes of TEMPER documentation listed below.

3. It is requested that the attached statement be substituted for the statement of reference memorandum in order that users of this material may have the benefit of two excellent evaluation reports on the model.

VOLUME	DDC AD #
I	470375
II	471458
III	470241
IV	473050
V	470069
VI	470070
VII	470071

James D. Kemp

JAMES D. KEMP
Brigadier General, USAF
Chief, Joint War Games Agency

Attachment
a/s

THE JOINT CHIEFS OF STAFF
WASHINGTON, D. C. 20301
JOINT WAR GAMES AGENCY

JWGA- 390 -67

6 NOV 1967

MEMORANDUM FOR USERS OF TEMPER MODEL DOCUMENTATION

Subject: TEMPER

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2. In order that users of this material obtain a balanced and comprehensive view regarding the capabilities and limitations of the model, it is recommended that the following two independent evaluation reports be carefully considered:

a. MATHEMATICA Corporation, Review of the TEMPER Model, September 30, 1966; DDC AD # 816457.

b. SIMULMATICS Corporation, TEMPER as a Model of International Relations, December 1966; DDC AD # 653606.

JAMES D. KEMP
Brigadier General, USAF
Chief, Joint War Games Agency