For full detail, print this document on a color printer.

DEXES

Deployable Exercise Support
for Civil Affairs, Peace-Keeping,
and Humanitarian Operations

Scenario Design

Draft of 3 March 1998

A project of
US Southern Command, SCJ5-PAS
3511 NM 91st Avenue
Miami, FL 33172, USA

Primary contact: Dr. Robert Hannan
phone: 305-437-1568
email: hannanr@hq.southcom.smil.mil

Program and Game designed by
Jaime Alfaro, Loren Cobb, & Ted Woodcock

Programming and Model by
Dr. Loren Cobb
phone: 505-897-4024
email: Loren@Rt66.com

Table of Contents

1.1 Concept of the Game

The Deployable Exercise Support system (DEXES) is a simulation program designed to support bilingual international training exercises in military operations other than war for the U.S. Southern Command, Quarry Heights, Panamá.

This manual describes how to design a DEXES scenario. You should have already read the DEXES User's Guide before reading this manual.

At the heart of DEXES there is a dynamic mathematical model of society, encompassing economic, social, political, and public health variables. This model generates the societal reactions to actions taken (or not taken!) by the peacekeeping forces, hostile military and political players, and non-governmental organizations. Understanding in general terms how this model works is absolutely crucial for the scenario designer.

A DEXES scenario typically involves military forces from several nations, operating either under a single military command or a cooperative structure. Each force is a separate player in the game. Other players include the host nation's own government, up to four opposition guerrila forces, forces from neighboring nations, and non-governmental organizations (*e.g.* Red Cross, CARE, OxFam, Doctors without Borders, *etc.*).

Players can perform actions at any time during the game. Each action is chosen from a popup menu by the game's players. If an unanticipated action needs to be performed, it can be created on-the-fly by the player. The database of all anticipated actions (and their consequences) is prepared by the scenario designers.

Events in the game can be scripted in advance, by means of another spreadsheet which gives the event description, its day and time, and its consequences. Special non-scripted events may also be specified. These are events that are triggered whenever a specific combination of conditions is encountered.

As the game unfolds, scripted and triggered events occur, and operational units take actions in response. Each military, governmental, or non-governmental unit follows a plan that is constructed and maintained by the player who controls the unit. All events and actions have direct consequences that are expressed in terms of changes in the state variables of the societal model that underlies DEXES. The model generates the cascade of indirect consequences that ripple out from each event or action. These may take the form of further changes in other state variables, and triggered events caused by these changes.

The current list of societal state variables is divided into four categories: social, economic, political, and public opinion. There are additional state variables that describe the current state (supplies, efficiency, condition, etc) of each unit.

1.2 Preliminary Questions

The first step in designing any scenario for DEXES should be to consider the following preliminary questions:

a. *Are the training objectives written and clearly understood?* Since virtually every design decision should be considered in the context of the training objectives of the exercise, this is a crucial step.

b. *Does all the action take place within one nation?* The current version of DEXES implicitly assumes that all the action takes place in or near a single host nation. DEXES generates separate outcome statistics for each Area of Operation (AO), and aggregates these results together into a single report for the nation. It cannot calculate outcome statistics for separate nations, unless each nation corresponds exactly to an AO.

c. *How many "opposition" factions are involved?* The current version of DEXES can handle zero to four opposition factions. These groups are subpopulations of the host nation that are politically divided along lines based on ethnic, religious, or language differences. The option for zero opposition factions is appropriate for disaster relief operations, where political differences are largely irrelevent. It is unwise to include any factions that represent less than 10% of the population, unless they are absolutely critical to the design of the exercise.

d. *How many separate military forces are involved?* Although the current version of DEXES is not limited in this respect, the simulation becomes cumbersome when more than about 10 separate commands are involved. It is possible to create a DEXES scenario with no military forces at all, in which case it becomes a simulation of purely civilian interactions.

e. *Are military forces expected to attack each other?* DEXES handles attrition due to attack in a simplified way, suitable only for scenarios in which large-scale military conflict never occurs. If attrition is a central feature of the proposed scenario, then a different simulation model should be considered (e.g. Spectrum).

f. *Which NGOs (non-governmental organizations) are playing?* In many cases military script writers do not understand the role of NGOs in operations other than war, or even how they work, what they do, how they do it, and how their work is supposed to interact with the military forces. It is therefore up to the DEXES scenario designers to anticipate which NGOs will be playing, and in what ways.

1.3 Maps

DEXES works best with two maps: an overview map that fits easily within the confines of a typical workstation monitor, and a detailed map that shows a much higher level of detail. These two maps form the background of the DEXES display. All other entities (units, cities, areas of operation) are overlaid on the background by the program.

The final version of the maps must be the Macintosh PICT format, but they may be prepared on any computer and then converted to PICT in the final step. It is generally advisable to use 256 indexed RGB colors for the final version, since maps in this format are most rapidly loaded when the DEXES application is launched. DEXES can read any compressed PICT format, however, including JPEG with maximum compression. Use the latter format only if map file size is much more important than startup speed.

DEXES assumes that its maps are in Cartesian Projection. This is the simplest possible projection, consisting of a rectilinear latitiude-longitude grid in which every 1° by 1° sector is drawn as a square on the map. Note that this is **not** the Mercator projection, despite popular understanding to the contrary. However, the US military's Universal Transverse Mercator (UTM) projection is usually close enough to serve, with only trivial deviations from exactness. The ADRG (ARC Digitized Raster Graphics) maps that are generated by Defense Mapping Agency computer programs are in UTM projection, and can be expected to work without severe problems.

The best maps for use in DEXES are not cluttered with excess detail, and have terrain features color-coded with muted pastel colors. It is almost always necessary to devote several man-days of effort to cleaning up a map, using a graphics editor such as **Adobe Photoshop**. For example, the names of provinces, nations, and bodies of water are almost always changed by the exercise designers, so the original names will have to be erased from the map. When making new features, such as fictional national boundaries or bodies of water, it is advisable to draw these features in a separate drawing layer, so they can be easily re-edited without altering the underlying map. Experience shows that these fictional features are frequently changed, sometimes within days or even hours of the start of an exercise.

The **Maps** spreadsheet shoudl be created at the same time that the detail and overview maps are prepared. DEXES reads this spreadsheet at startup time, in order to obtain the parameters that it uses to calculate the positions of all objects displayed on the map. An example of this spreadsheet is shown in Figure 1, below.

For each map, enter the latitude of the top and bottom, in decimal degrees, and the longitude of the right and left sides, also in decimal degrees.

Next enter the threshold for the display of cities in the overview map. Cities below this population size will not be drawn by DEXES when the overview map is displayed. DEXES draws and labels cities, so it is neither necessary nor desirable to have bold city names on the background map.

Last, enter the UTM8 code and latitude-longitude for the location of four points, each located at or near a corner of the map. The UTM8 code is also known as the Military Grid Reference System code. It consists of a two-letter grid zone designator, followed by 8 digits. These locations are required by DEXES so that it can translate between MGRS and the traditional latititude-longitude system. The four points entered here can be chosen at your convenience — they do not have to be at the exact corners of the map.

Map	Top	Right	Bottom	Left
Overview	-8.00	-36.00	-16.00	-48.00
Detail	-8.00	-36.00	-16.00	-48.00

City Population Display Threshold	10000

Map Corners	UTM4, 6, OR 8 (MGRS) code	Latitude	Longitude
Northwest	JM69251449	-8.00	-48.00
Northeast	AM69251449	-8.00	-36.00
Southeast	AC78902874	-16.00	-36.00
Southwest	JC78902874	-16.00	-48.00
	^^ The UTM8 Code requires a 2-letter grid zone designator.	^^ Use negative numbers for south latitude and west longitude	^^ Use Decimal degrees

Figure 1: The **Map** spreadsheet.

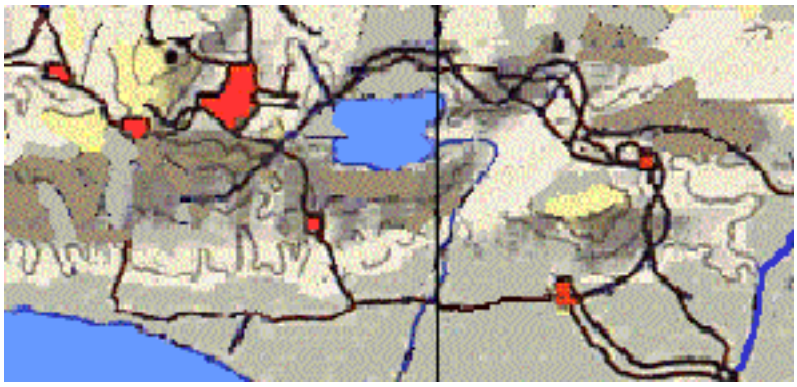

Figure 2: A portion of a DEXES overview map, based on a scanned and edited commercial map.

Figure 3: A portion of the corresponding DEXES detail map, obtained from Defense Mapping Agency files.

1.4 Factions

Most peacekeeping exercises use a scenario in which a conflict (or actual civil war) between several factions has recently ended. International peacekeeping forces are invited into the country in order to stabilize the nation and prevent the conflict from restarting. DEXES reads the number and names of the factions in conflict from the **Factions** spreadsheet, as shown in Figure 4 below.

ID	Faction Name	Military Arm
0	Bosnia	Bosnian Army
1	Serbs	Serb Militia
2	Croats	Croat Militia
3	Muslims	Muslim Militia
4	*	-

Figure 4: The **Factions** Spreadsheet, showing three factions.

Up to four factions can be identified in this spreadsheet. Zero is a valid number: use zero factions for Disaster Relief scenarios in which there is no political conflict. Figure 5 shows an example with no factions:

ID	Faction Name	Military Arm
0	Guatemala	Guatemalan Army
1	*	-
2		-
3		-
4		-

Figure 5: The **Factions** Spreadsheet, showing zero factions.

In addition to naming the factions, there is also a column in this spreadsheet for the names of each faction's military organization (if any). DEXES uses these names to label units and areas of operation. The name be anything that is appropriate for labeling purposes. The name of the faction and the name of its military arm may be the same.

Factions may differentiate themselves by politics (e.g. Democrats and Republicans), by ethnic identification (e.g. Serbs, Croats, and Muslims), by religion (e.g. Catholics and Protestants), by language (e.g. Basque, Spanish, and Catalan), or by any characteristic whatsoever. The basis for the differentiation is not important to DEXES, only the fact that they are indeed divided, and that the potential for armed conflict exists.

Important: place an asterisk in the row that follows the last faction name. This marker is used by DEXES to determine the length of the list of factions.

1.5 Time

The command-post exercises that DEXES normally supports are typically spread out over four or five days of a week. Each day is played in real time (i.e. one minute of simulated time per minute of actual time), and there is a simulation time jump of many days (or even months) overnight between exercise days. The correspondence between simulation time and actual time is described in the **Time** spreadsheet.

In the example shown in Figure 6 below, there are four exercise days, which correspond to days D+61, D+103, D+151, and D+170 of simulation time, where D+0 is the D-day, the day of first deployment of the peacekeeping forces. The simulated deployment day in this example is taken to be June 16, 1997. Simulation day D+61 (which is August 18, 1997), was actually played on Monday, August 25, 1997, beginning at 1330 hours.

Transition	Year	Month	Day	Hour	Sim Date	D+X	Date Played	Day of the Week
Start	1997	6	16	0000	6/16/97	0	n/a	n/a
Real	1997	8	16	1330	8/16/97	61	8/25/97	Monday
Real	1997	9	27	0900	9/27/97	103	8/26/97	Tuesday
Real	1997	11	14	0900	11/14/97	151	8/27/97	Wednesday
Real	1997	12	3	0900	12/3/97	170	8/28/97	Thursday
Stop	1998	1	2	1200	1/2/98	200	8/29/97	Friday

Figure 6: The **Time** Spreadsheet, showing four exercise days.

In this example, the scenario designer enters the simulation date of day D+0 in the first row of the column labeled "Sim Date". All simulation dates are calculated by the spreadsheet from this date forward. For each actual day (or fraction of a day) or real-time play, the scenario designer enters "Real" in the first column, the time of day that the exercise begins in the "Hour" column, the deployment day in the column labeled "D+X", and the actual calendar date when this play occurs in the column labeled "Date Played." All other fields are calculated by the spreadsheet.

The first column of this spreadsheet shows the type of temporal transition that each line describes. The first line must be "Start," indicating the start of the simulation, and the last line must be "Stop," for the termination of the simulation. The start day is usually the deployment day, not the first played day. The stop day is usually the day of an important terminal event, e.g. an election, and is not necessarily the last played day.

Perhaps the single most important use for DEXES in a command-post exercise is to simulate the events and developments that occur during the jump times of the exercise. The Time spreadsheet is crucial, because it provides DEXES with the length of each jump episode. At the end of each day of real time, the DEXES operator shifts DEXES into accelerated time, and simulates the entire jump episode. The graphs and charts that DEXES generates are then used to brief the players as to the situation on the ground at the beginning of the next day of real time play.

1.6 Cities

The command-post exercises that DEXES normally supports are typically multinational peacekeeping or disaster-relief missions to a single country. During the course of the exercise DEXES is continuously used to monitor public opinion and the health status of the population of the country and its refugees. In order to perform this function, DEXES must have an adequate representation of the population. The primary source for this information is the **Cities** spreadsheet, which is used to define the initial characteristics of every simulated city, town, village, and rural district. A small part of this spreadsheet is shown in the figure below.

Name	Lat Long	Population		MNL CRA	REN ACR A	*	*
		Resident	Displaced	%Group1	%Group2	%Group3	%Group4
ARGBAT	**Region**	200000	0	30	70	0	0
BOLBAT	**Region**	200000	0	30	70	0	0
BRABAT	**Region**	200000	0	70	30	0	0
PARBAT	**Region**	200000	0	30	70	0	0
URUBAT	**Region**	200000	0	70	30	0	0
USABAT	**Region**	200000	0	30	70	0	0
Exterior	**Region**	0	0	50	50	0	0
IDP Chorrochó	(8:54'00"S 39:06'00"W)	0	10000	70	30	0	0
IDP Gaviâo	(11:23'00"S 39:47'00"W)	0	15000	90	10	0	0
IDP Ilhéus	(14:41'00"S 39:05'00"W)	0	60000	90	10	0	0
QA Alagoinhas	(12:02'00"S 38:26'00"W)	0	5000	0	100	0	0
QA Barra	(11:00'00"S 43:10'00"W)	0	5000	0	100	0	0
QA Canapolis	(12:09'00"S 44:13'00"W)	0	400	0	100	0	0
Ref Camp Arvonia	(11:20'00"S 44:00'00"W)	0	120000	50	50	0	0
Ref Camp Górvia	(15:45'00"S 45:30'00"W)	0	200000	50	50	0	0
Abaré	(8:49'00"S 39:11'00"W)	55000	0	80	20	0	0
Alagoinhas	(12:07'00"S 38:26'00"W)	180000	0	90	10	0	0
América Dourada	(11:28'00"S 41:26'00"W)	25000	0	10	90	0	0
Aracatu	(14:25'00"S 41:27'00"W)	45000	0	40	60	0	0
Arapiraca	(9:45'00"S 36:39'00"W)	95000	0	95	5	0	0
Aureliano Leal	(14:19'00"S 39:20'00"W)	35000	0	40	60	0	0
Baluarte	(9:28'00"S 43:32'00"W)	40000	0	30	70	0	0

Figure 8: A portion of the **Cities** spreadsheet.

Five different kinds of populations visible in the above example. First are the rural districts of the six Areas of Operation (AOs) that were defined by the force commander (a player). Each is the responsibility of a battalion (hence the names ARGBAT, etc.). The location of each region is, of course, not a point; therefore the location in the spreadsheet

is given simply as "Region." The population of each rural district was estimated at 200,000, in the absence of more accurate information. The region labelled "Exterior" is important: it represents the portion of the map that is not included in any AO. This is where refugees will appear if and when they flee the country. Do **not** include the native population of the Exterior region, unless they are explicitly of interest in the exercise.

Following the six regions are three IDP (internally displaced person) camps. These are locations that are predicted in advance as natural places where people will collect when they have been forced to leave their homes. In some exercises these camps already exist at the start of the game, with potentially huge numbers of people.

The next three entries are QA (quartering area) camps, where militia units are disarmed, demobilized, deloused, reclothed, fed, and eventually resettled. Not every game will involve such locations. DEXES does not make special provisions for such camps, but they are easily implemented in this way.

The next two entries are refugee camps. There is an important distinction in international law between an "internally displaced person," who by definition has not left his country, and a "refugee," who has. It is far more difficult to resettle refugees, therefore DEXES (and all players) must carefully and consistently distinguish these two classes of civilians.

The list of principal cities and towns follows. For the purposes of a useful DEXES simulation, the list of cities should be at least 20 and no more than about 200 in length. More than 200 leads to a map that is filled with too many little icons and labels. Less than about 20 defeats the purpose of the simulation, which is to show the distribution of characteristics across broad regions.

The location column in the Cities spreadsheet may be filled with either UTM codes or traditional latitude-longitude pairs. UTM4 codes (four digits preceded by two letters) do not give an accurate enough position, so use UTM6 or UTM8 instead. If you want to use latitude and longitude, then you must be careful to adhere precisely to the format:

```
(dd:mm'ss"S;dd:mm'ss"W)
```

Use degrees-minutes-seconds, always give the direction of the measurement (e.g. **N** or **S** for north or south latitude, and **E** or **W** for east or west longitude), and always surround the location in parentheses. Any deviation from this format will result in the city being located elsewhere on the globe, almost certainly outside the map area. There is a way to move cities back onto the map, or to adjust their positions on the map — see the section on Administration for details.

The two population columns are for specifying the numbers of residents and displaced persons in each location. Although these numbers can be changed at the last moment, it is always a good idea to try to get these figures well in advance of the exercise. Not having accurate population data causes great uncertainty in testing the overall scenario.

Four columns are allocated with which to specify the factional percentages in each location. It is possible and convenient to set up the spreadsheet so that it automatically calculates the final percentage, based on the fact that they must sum to 100.

The next three columns specify the initial levels of ethnic distrust, civil unrest, and armed conflict that are found in each location. Each of these is measured on a scale from 0 to 100. Use armed conflict sparingly — it should be nonzero only if the scenario actually states that there is factional fighting on day D+0. A figure of 100 means full-scale civil war.

Next in the spreadsheet are up to four blocks of 3 columns each. Each block is for one faction. If there are no factions, then use one block for the entire population. The three columns are for public opinion variables: the average support given by the people who identify with this faction for the national government and the international military forces, and the perceived bias of the international military forces. The first two are measured on a scale from 0 (no support) to 100 (full support). The bias variable is measured on a scale from -100 (biased against the faction) to +100 (biased in favor of the faction). From the point of view of the military command, of course, any perceived bias other than zero is a danger sign. The bias variable must be used to describe perceived, not actual bias. From the political point of view, the perception of bias is always more important than the fact of bias, since people take action based on their perception.

Any spreadsheet columns that may be found to follow the last block of public opinion are ignored by DEXES. These columns are frequently used for scenario designer notes.

A final note on spelling: the cities, towns, camps, and rural districts listed in the Cities spreadsheet are often referred to in other spreadsheets. For example, a scripted event may occur in one of the cities. The spelling must match! In all cases the spelling in the Cities spreadsheet is the one that DEXES considers definitive, and all other references to the city must match exactly — same capital letters, same spaces, same diacritical marks. To make an accented vowel on the Macintosh keyboard, e.g. é, type option-e before the vowel. To make a letter with a tilde, e.g. ñ, type option-n before the letter. To make a vowel with an umlaut, e.g. ü, type option-u before the letter. To make a letter with a circumflex, e.g. î, type option-i before the letter. Many other special characters are easy to make — use the KeyCaps desk accessory (in the Apple Menu) for details. These special letters must be the same in every reference to a place name.

1.7 The Script

The written script for an exercise typically specifies the particulars about the events to which players must respond: what happened, where it happened, and when it happened. Unfortunately for DEXES, in the past the script has seldom specified who caused each event to happen. A properly written script should always include the actor who initiated the event, the teaching objectives that the event is designed to meet, the players that are expected to respond, and the desired "correct" responses. If all of these elements are included, then it is a relatively straightforward process to create a DEXES spreadsheet that encodes the script in a form that is useful for simulation.

143.0	170	Fighting breaks out among members of RENACRA already quartered at the Vitória da Conquista QA (40 - 14).One man has been killed and three injured.One has a serious head wound that urgently needs specialized surgical treatment.	0930	1030	QA Vitória da Conquista
144.0	170	Two British citizens from OXFAM (NGO) have been kidnapped by gunmen in the Jeremoabo area (38 - 10). There is information that the gunmen are heading for ARVONIA along the Jeremoabo - Carira Highway (37 - 10).	0930	0945	Jeremoabo

Figure 9: A portion of the **Script** spreadsheet.

The first column of the Script spreadsheet is simply an ID number for each event. Use the same ID numbers that are used in the written script, with an added decimal that can be used if necessary when a written script event must be broken into several DEXES events.

The second column gives the day (since deployment) on which the event occurs. In the above example the two displayed events occur on day D+170.

The third column is an English language text of the event. The fourth column (not shown in the figure) is used for a translation of the script text into Spanish, or any other language that is useful for the purposes of the exercise.

The fifth and sixth columns specify the range of times, in military 24-hour format, within which the event occurs. If the two numbers are equal, then the time of the event is fixed. If a range is given, then DEXES picks a time at random within the range.

The seventh column gives the location ***in which the effects of the event are felt.*** This may be quite different from the actual location of the event. For example, the effects of an assassination in the capital will be felt throughout the entire country. The name entered as the location must be one of the named cities, towns, camps, or rural districts in the Cities spreadsheet, spelled exactly as written there, or it may be one of the following:

Location	**Where the effects are felt**
Countrywide	throughout the country
Region	throughout an AO chosen at random
City	in a city chosen at random
City in <region>	in a random city within the named AO
Rural	a rural point located at random
Rural in <region>	a random rural point located in the named AO
<UTM code>	at the specified map location, in UTM coords
(Lat-Long)	at the specified map location, in degrees-mins-secs
[Lat-Long]	at the specified map location, in decimal degrees

Thus DEXES offers the scenario designer substantial flexibility as to when and where the effects of each scripted event are felt. Script-writing committees do not, in general, realize that this flexibility exists, so it has seldom been exploited in past exercises.

During the course of an exercise, script events are injected into the game by the "script master," subject to approval or modification by the game controllers. The script master is usually a person, but in some exercises DEXES itself has performed this function. When a game is set up with DEXES as the script master, then each event occurs when it is printed out by DEXES on the printer located in game control. This is appropriate when either event times or locations are being randomized by DEXES, and is neither necessary nor advisable when randomization is not used. DEXES provides a mechanism with which game controllers can review upcoming events, and cancel or delay any that are felt to be inappropriate under the immediate circumstances.

The last nine columns of the Script spreadsheet are for describing the direct effects of the event, if any. The nine columns provide space to describe effects on three of the DEXES state variables. If more than three effects are needed, simply duplicate the event, and fill in the additional effects in the second event. The state variables themselves are listed in the **PopVars** spreadsheet. When you enter the index of the variable affected, the spreadsheet will automatically look up its name in the **PopVars** spreadsheet, and show it in the "Variable Name" column. Then enter its effect size. Figure 10 shows an example, taken from an event in which a military vehicle ran over a citizen, causing popular support for the the UN to decline in both factions.

Variable Index	Variable Name	Effect Size	Variable Index	Variable Name	Effect Size
21	MNLCRA Support for UN	-1	26	RENACRA Support for UN	-1

Figure 10: Two effects of an event, from the **Script** spreadsheet.

The effect size must be an integer between -10 and +10. The effect size is a standardized scale that applies to all variables regardless of how they are measured. If the variable is bounded (as most are), then an effect size of +k means that the value of the variable will (if nothing else changes) eventually rise from its current level to a level that is 5k% of the distance to its maximum. Here is a graph that shows how this works when the effect size is +3 and the current level is 20:

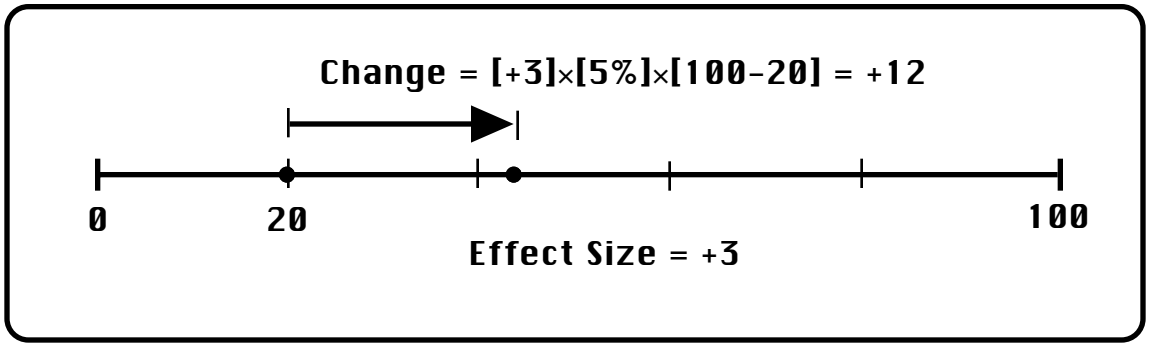

Figure 11: An event with effect size of +3 acts on a variable whose value is 20.

Thus the actual change caused by an event depends on how close the variable is to its maximum. The closer it is to its maximum, the less change occurs. This principle is illustrated in the following table:

Current Level	Maximum	Effect Size	New Level	Change
0	100	+4	20	20
15	100	+4	32	17
30	100	+4	44	14
45	100	+4	56	11
60	100	+4	68	8
75	100	+4	80	5
90	100	+4	92	2
100	100	+4	100	0

For negative effect sizes, the formula works in reverse: an effect size of -k means that the value of the variable will (if nothing else changes) eventually decline from its current level to a level that is 5k% of the distance to its minimum.

For unbounded variables (e.g. economic growth rate, or inflation rate), an effect of size +k will (if nothing else changes) cause the variable to increase to a level that is higher by 5k% of the scale parameter given in the **PopVars** spreadsheet.

The public opinion variable in DEXES are distributions, rather than single values. This means that they show the frequency distribution of opinions in the population, rather than a single value for the entire population. These distributions follow the "Beta" formula, which means that they behave on average exactly like bounded variables. In other words, the mean of the Beta distribution responds to events in just the same way that a

bounded variable would. Beta distributions were used in DEXES because they have the wonderful flexibility: they can represent highly polarized opinion distributions just as easily as bell-shaped or exponential distributions.

The two epidemic disease variables (cholera and dysentery) are slightly more complex than all other variables. The charted value is the **actual** fraction of the population that has an epidemic disease, but the internal variable that is changed when an event occurs is not the actual fraction but the **potential** fraction of the population that could become infected if the disease were allowed to follow its natural course. Thus, when the cholera variable is hit with a +3, e.g. from a breakdown in a village sanitation system, then the potential size of a cholera epidemic in the village is increased. The actual number infected responds very slowly at first, then gathers speed in a classic epidemic curve, and finally burns itself out as the supply of uninfected people decreases to zero.

There is one variable that does not follow the above rules at all: the mortality variable. Generally speaking, the scenario designer should not encode any event effects on this variable unless the event actually directly kills a lot of people. In order to allow a very wide range of calamities, from the minor to the absolutely cataclysmic, DEXES uses a logarithmic scale for determining the numbers of people who die when such an event occurs. The scale is similar in concept to the Richter scale, but the damage increases by factors of three, rather than 10 as in the Richter scale. Here is how it works:

Effect Size	Percent Killed
+1	0.01 %
+2	0.03 %
+3	0.09 %
+4	0.27 %
+5	0.81 %
+6	2.43 %
+7	7.29 %
+8	21.87 %
+9	65.61 %
+10	100.00 %

To kill 0.01% of a town in one single scripted event, for example, give the event an effect size of +1 on the mortality variable. To kill two-thirds, use an effect size of +9. Negative effect sizes for this variable are invalid, because this would cause people to be created (theologians might object).

Lastly, here are some general tips on assigning effects to events:

- Not every scripted event needs to have effects on the DEXES variables. In fact, many scripted events are implied by current social conditions, and therefore do not require effects of their own (assuming the model is performing correctly). Other events are merely informational. In fact, the only events that really require explicit scripted effects are events that describe something new, that neither society nor players are yet aware of.

- Encode only the direct effects of an event. Leave the calculation of indirect effects to DEXES. For example, an event in which a town's water system breaks down has a direct effect on the percent of townspeople that lack clean water. DEXES will take care of the indirect effects on cholera and dysentery. Do not encode the latter in the Script spreadsheet.

- Events that are restricted to a single town can safely be given large effects, but beware of countrywide events! It is possible to send the entire simulation down the drain with an ill-considered powerful effect that operates upon every single person in the nation. Study the impact of the effect sizes that you use by running the DEXES simulation forward and looking carefully at the progression of the key variables over periods of weeks and months.

- If DEXES is not the script master, and if neither game controllers nor game players are depending upon DEXES for printed event reports, then it is okay to simply delete all events that have no effects from the spreadsheet. This results in a much smaller and more manageable spreadsheet, with many benefits for testing and polishing the scenario.

- To encode a complex event that takes place only in selected cities, you may have to duplicate the event in the spreadsheet over and over again, once per city. This is cumbersome, but at present this is the only way to do it. An improvement in this area is planned for 1998.

1.8 Units

Units and what they can do are defined in five separate spreadsheets:

ObjectTypes Assigns an ID number to every type of entity that can be the object of an action by a unit. This spreadsheet must not be changed.

Actions Describes each action that any unit can ever perform, the type of object for the action, and its effects (described in the same way as the **Script** spreadsheet).

Categories Defines action categories. Each category is simply a list of actions that belong to the category. The categories do **not** have to be mutually exclusive.

UnitTypes Describes the characteristics of every known type of military unit, whether or not deployed in any particular exercise. These characteristics include some features that are not active parts of DEXES, and can be ignored. The most important characteristics are: type ID, name, speed, personnel, vehicles, and the action categories (as defined in the **Categories** spreadsheet) that this type of unit can perform.

Units This spreadsheet describes actual units that are to be deployed (as opposed to theoretical types of units as in **UnitTypes**). Each unit is given an ID, name, icon resource ID, deployment location, player, and unit type ID. The change of command is defined here also: every unit is given a superior unit, to which it reports, and (optionally) an area of operations (AO) for which it is responsible. The supply characteristics can be ignored. Lastly, each unit is assigned an efficiency (100% for a fully equipped unit with good morale).

The icons that are displayed for units are found in the Unit Icons file, which looks like a jack-in-the-box. These icon resources may be viewed and edited using ResEdit, a free utility from Apple whose purpose in life is to edit resources. The icons used in DEXES are of type "cicn". To edit an icon with ResEdit, open the file, double-click the icon that needs changing, and use the tools provided. Do not forget to make sure that the icon has the correct mask! The mask is used by DEXES to erase an outline of the icon from the background bitmap, so it is normally one pixel wider that the icon itself. Figure 12 below shows ResEdit's cicn editing window. Note the shape of the icon's mask.

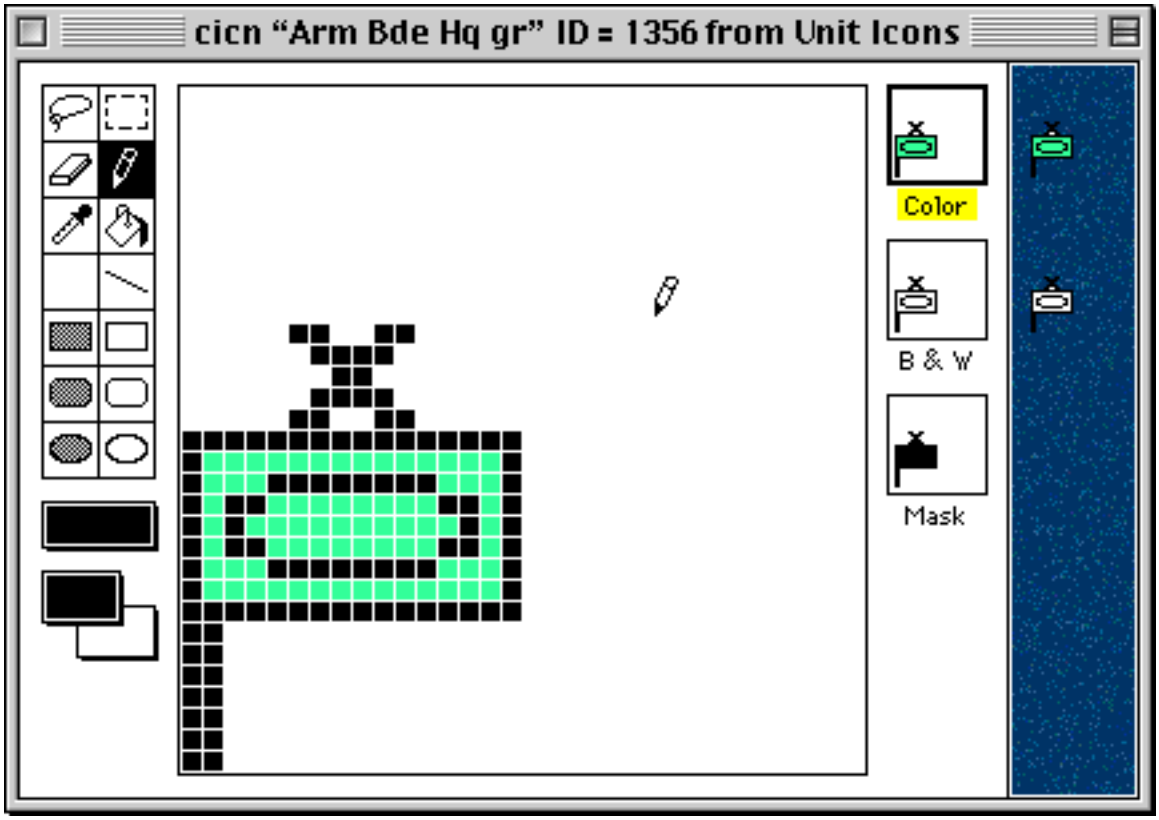

Figure 12: The “cicn” (color icon) editing window in ResEdit.

1.9 Regions

The **Regions** spreadsheet exists only to give a unique ID number and a player to each AO (Area of Operation) that will used in the exercise. Other columns that may be found in this spreadsheet are not read by DEXES. Here is an example of the **Regions** spreadsheet:

Region Index	Region Name	Player ID	Player Name
0	<ninguno/none>	0	<ninguno/none>
1	ARGBAT	1	UNAFORCRA
2	BOLBAT	1	UNAFORCRA
3	BRABAT	1	UNAFORCRA
4	PARBAT	1	UNAFORCRA
5	URUBAT	1	UNAFORCRA
6	USABAT	1	UNAFORCRA
7	Exterior	80	IO & NGO
*			

Figure 13: The **Regions** spreadsheet.

The geographic boundaries of each AO are found in the spreadsheet **Bounds.csv**, but these are generated by DEXES based on boundaries that have been defined by mouse clicks, not painfully typed in, coordinate by coordinate. Here is the procedure that must be followed to define Areas of Operation:

1. First make sure that the **Factions** and **Cities** spreadsheets are in final form, and that every military player that will have responsibility for an AO is defined in the **Players** spreadsheet. It is not necessary for the **Units**, **UnitTypes**, **Actions**, or **Categories** spreadsheets to exist.

2. Make sure that the overview and detailed maps are close to final form. In particular, it helps to have already marked the AO boundaries on the detailed map. These markings will serve as a guide so that the AO boundaries can be accurately specified for DEXES.

3. Start DEXES from scratch, with existing spreadsheets and maps.

4. Enter administrative mode, and choose the detailed map. Suppress the display of units if any are visible. Select the Area mouse tool.

5. Start the definition of an AO by clicking on its boundary while holding down the option and command keys. A dialog will appear asking whether this is really what you intend to do. Answer yes.

6. Continue clicking points on the boundary until you arrive back at the original point (which will now be drawn red). When the original point is clicked, DEXES will display a dialog showing the details of the AO as they are currently known. If desired, use the popup menus to change the name of the AO, the name of its responsible military player, or the color that should be used when drawing this AO.

Some tips for successful boundary drawing:

- If three or more AOs share a single point, then be very sure to click on this shared point. It is all too easy to omit such a point if the boundary of the first AO is straight at this shared point. Once a point has been omitted, it cannot be added later (except by editing the Bounds.csv file, which is quite hard).

- The maximum number of points that can be used to draw the boundary of an AO is 100. Be careful not to exceed this number.

- A point that is badly placed can be moved later (but be sure to save the game setup after moving the point, so that the change will be saved). If moving a boundary point results in one or more cities changing from being within one AO to being within another, then DEXES will automatically re-aggregate all affected AOs .

1.10 Other Spreadsheets

This section covers the remaining spreadsheets that must be created for a DEXES scenario.

Players This spreadsheet gives a unique ID number to each player. It has no other purpose.

Trigger This spreadsheet defines "triggered events." These are events that occur only when specified conditions in the DEXES state variables are met.

In the original design of DEXES, triggered events were supposed to be used far more frequently than scripted events. In fact, DEXES was designed to demonstrate that it is possible to create an entire exercise without a fixed script in the traditional style. In practice, however, triggered events have been used for only one nontrivial purpose: to define a theoretical failure state for the game. Even this application is seldom used, because multinational exercises are often so politically sensitive that failure is simply not an acceptable outcome.

A triggered event is defined as follows. Just as with the **Script** spreadsheet, give the triggered event an ID number and text descriptions in English and Spanish. If the event is to be attributed to a player, then fill in the player code in the next column. The location of the event must be specified in the next column. This location may be any of the named locations in the **Cities** spreadsheet, or it can be a randomly chosen location (specified using the same scheme as in the **Cities** spreadsheet).

The condition that triggers the event occurs when a weighted sum of three state variables exceeds a maximum threshold, or falls below a minimum threshold. The lower and upper thresholds are given in the next two columns, followed by up to three weights for up to three state variables. The weights may be either positive or negative.

Suppose that the three given weights are **a**, **b**, and **c**, and that the corresponding state variables are X, Y, and Z. Suppose further that the two thresholds are L and U. The event is triggered when either

$$\mathbf{a}X + \mathbf{b}Y + \mathbf{c}Z > U, \quad \text{or}$$

$$\mathbf{a}X + \mathbf{b}Y + \mathbf{c}Z < L, \quad \text{whichever comes first.}$$

Throughout the period of time that the trigger condition is satisfied, DEXES will revisit the event to decide when it should actually occur. This decision is based on the frequency parameter. If zero, then the event will exactly once, at the first moment when the trigger condition is met. If non-zero, then the event will occur at random with a daily frequency equal to this parameter. For example, if the frequency is given as 2.5, then the event will occur, on average, 2.5 times per day.

1.11 Summary

During the design phase of a DEXES-supported exercise, the following questions need to be answered:

- How many factions are involved?
- Which military forces are involved, with what command structure?
- Which NGOs are involved, with what equipment and responsibilities?
- What maps will be in use? Will MGRS or lat-long coordinates be used?
- What is the time schedule of real and simulated days?
- Does the written country story give enough economic, social, and medical details to properly set up a DEXES scenario?
- Is DEXES to be the script master?
- Is DEXES output required for each day's After Action Review? If so, is there enough time after the close of action to prepare and test the accelerated run through the "time jump" interval? Is there enough time to prepare the required charts and graphs?
- Is DEXES output required for the sitrep briefing at the start of each day? Is this output required the previous evening?
- Does the written script specify, at least in a broad sense, what is supposed to happen during each time jump?
- What is the order of battle, and which of all these units are truly necessary for the DEXES simulation?
- What are the special capabilities of each of the units in the order of battle?
- What unit actions are critical to the training objectives? Are all of these actions represented in the DEXES scenario?
- Does the simulation, when run through from beginning to end without any unit actions at all, exhibit a sensible development of the key state variables? If there is a defined failure state in the exercise, can the simulation appropriately fail in this way? If there is a defined success state in the exercise, can the simulation appropriately succeed in this way?

2.0 The DEXES State Variables

Table 1 (below) summarizes the state variables of the DEXES model. A brief description of each variable is given in the sections that follow.

Table 1: State Variables

Var	Description	Type	Min	Max	Regional *
	Social Conditions				
1	% Displaced	Bounded	0	100	√
2	% Without Water	Bounded	0	100	√
3	% Without Food	Bounded	0	100	√
4	% Without Electricity	Bounded	0	100	√
5	Ethnic Distrust	Bounded	0	100	√
6	Civil Unrest	Bounded	0	100	√
7	Armed Conflict	Bounded	0	100	√
	Public Health				
8	% With Dysentery	Bounded	0	100	√
9	% With Cholera	Bounded	0	100	√
10	Daily Civilian Mortality	Unbounded	0		√
	Political				
11	Govt Corruption	Bounded	0	100	
12	Govt Competence	Bounded	0	100	
	Economic				
13	Economic Growth Rate	Unbounded			
14	Inflation Rate	Unbounded			
15	Tax Rate (% annual)	Bounded	0	100	
16	Unemployment Rate	Bounded	0	100	
17	Trade Surplus/Deficit	Unbounded			
18	Underground Economy	Bounded	0	100	
	Public Opinion - Ethnic Group #1				
19	Support for Government	Beta	0	1	√
20	Support for Own Militia	Beta	0	1	√
21	Support for PK Forces	Beta	0	1	√
22	Perceived Bias of PK Forces	Bounded	–1	1	√
23	Political Participation	Bounded	0	1	
	Public Opinion - Ethnic Group #2				
24	Support for Government	Beta	0	1	√
25	Support for Own Militia	Beta	0	1	√
26	Support for PK Forces	Beta	0	1	√
27	Perceived Bias of PK Forces	Bounded	–1	1	√
28	Political Participation	Bounded	0	1	
	Public Opinion - Ethnic Group #3, ...				
	(additional ethnic groups as needed, up to a maximum of 4 groups)				

*A variable is "regional" if the model maintains a distinct value for every city and rural district. Variables that are not regional are national in scope: only one value is stored, which describes the entire nation.

2.1 Displaced Person Percentage

This is the percentage of the total current population in a location (city, camp, or region) that is now displaced and homeless. For every day of full-scale armed conflict, 1% of the non-displaced population become displaced, and proportionately fewer given lower intensity of armed conflict. This variable includes people that are temporarily homeless and people that are "permanently" homeless, e.g. refugees living in a camp.

This variable quantifies an aspect of the conditions specified in section C 3.3.2 of the UJTL, version 2.5, (Refugee Impact).

2.2 Percent Without Water

This is the percentage of the total current population in a location (city, camp, or region) that is without access to supplies of clean water. This variable is the primary determinant of the course of water-borne epidemic diseases: the population that is assumed to be at risk for cholera and dysentery is never less than the percent without clean water.

This variable quantifies an aspect of condition C 3.3.1.4 of the UJTL, version 2.5 (Health Risk).

2.3 Percent Without Food

This is the percentage of the total current population in a location (city, camp, or region) that is without access to supplies of food. People without food are assumed to be more susceptible to deaths from all causes.

This variable quantifies an aspect of condition C 3.3.4.1.1 of the UJTL, version 2.5 (Self-Sufficiency in Food).

2.4 Percent Without Electricity

This is the percentage of the total current population in a location (city, camp, or region) that is without access to electrical power. This variable is used primarily in disaster relief scenarios. Important note: this variable should not include people who normally have no electricity.

This variable quantifies an aspect of condition C 3.3.4.1.2 of the UJTL, version 2.5 (Self-Sufficiency in Fuel).

2.5 Ethnic Distrust

This is a key state variable. High levels of ethnic distrust will cause violent incidents, suspicion of the government, and a possibility of civil war. The Ethnic Distrust variable is bounded: a value of 0 means no distrust between ethnic groups, while 100 means that the mutual distrust is total.

Left entirely alone, ethnic distrust declines logistically to zero, but only very slowly and with random fluctuations. Distrust is fed by unemployment (30%), government corruption (30%), and armed conflict (60%). Increases in ethnic distrust directly cause increases in civil unrest and armed conflict, with potentially devastating indirect effects on every other state variable.

This variable addresses several conditions in section C 3.2.3 of the UJTL, version 2.5 (Religious Beliefs).

2.6 Civil Unrest

Civil Unrest is a state variable that attempts to measure the frequency and severity of unorganized disturbances, random acts of violence, and riots. This variable does **not** measure the severity of organized acts of civil war, such as "disappearances" or "ethnic cleansing" undertaken by police, militia groups, or military units. A value of 0 for Civil Unrest implies a society at peace with itself. A value of 50 indicates a society in which large-scale riots are occurring cities. A value of 100 indicates that the government has broken down completely or ceased to exist (as happened, for example, in Somalia).

This variable exactly quantifies condition C 3.3.1.6 of the UJTL, version 2.5 (Civil Unrest).

2.7 Armed Conflict

Armed Conflict is a state variable that attempts to measure the extent to which a condition of civil war exists. A value of 0 indicates that no groups are armed and mobilized in opposition to the central government. A value of 50 indicates full mobilization with some actual fighting. A value of 100 indicates a state of full-scale civil war.

This variable quantifies an aspect of condition C 3.1.3.2 of the UJTL, version 2.5 (Mobilization Level).

2.8 Percent with Cholera

This variable quantifies the percentage of the population that has cholera (i.e. the *prevalence* of cholera). DEXES uses a standard mathematical model for the evolution of

this epidemic process. The charted value is the **actual** size of the epidemic, but the internal variable quantifies the **potential** maximum size of the epidemic (i.e. the percentage of the population that could become infected). Thus any action or event that has an effect on Cholera either raises or lowers the potential size of the cholera epidemic. The actual progress of the epidemic depends on how many people are infected and how many are susceptible to infection during each day of the simulation. DEXES assumes the following *daily* rates for cholera in displaced civilian camps: 1% of the at-risk population becomes infected, 25% of those infected recover, 10% of those infected die.

This variable quantifies an aspect of condition C 3.3.1.4 of the UJTL, version 2.5 (Civil Health).

2.9 Percent with Dysentery

This variable quantifies the percentage of the population that has dysentery (i.e. the *prevalence* of dysentery. The DEXES model of dysentery is based on the characteristics of *shigella*, a form of dysentery that is almost always the single most important infectious disease in displaced person camps. DEXES uses a standard mathematical model for the evolution of this epidemic process. The charted value is the **actual** size of the epidemic, but the internal variable quantifies the **potential** maximum size of the epidemic (i.e. the proportion of the population that could become infected). Thus any action or event that has an effect on Dysentery either raises or lowers the potential size of an epidemic. The actual progress of the epidemic depends on how many people are infected and how many are susceptible to infection during each day of the simulation. DEXES uses the following *daily* rates for shigella in displaced civilian camps: 1% of the at-risk population becomes infected, 3% of those infected recover, 0.1% of those infected die.

This variable quantifies an aspect of condition C 3.3.1.4 of the UJTL, version 2.5 (Civil Health).

2.10 Daily Civilian Mortality

This variable simply counts the number of civilians who die every day, from all causes.

This variable quantifies an aspect of condition C 3.3.1.4 of the UJTL, version 2.5 (Civil Health).

2.11 Government Corruption

This variable quantifies the extent of official corruption on a subjective scale from 0 to 100. On this scale, a value of 0 means no corruption at all, 50 indicates a government

that is seriously corrupted, and 100 indicates a government that is corrupt from top to bottom.

Government corruption is influenced by the size of the underground economy (i.e. transactions that are neither reported nor taxed). If the underground economy is large for an extended period of time, then governmental corruption trends upwards too. Increases in corruption lead in turn to lower governmental competence, and may lead to sharply higher ethnic distrust (if the government is controlled by one dominant ethnic or religious group, leaving all others out of power).

2.12 Government Competence

Government Competence is a measure of the overall effectiveness of the official bureaucracy, expressed on a subjective scale from 0 (total incompetence) to 100 (maximum competence). As competence declines the government gradually loses the ability to control public health, the economy, civil unrest, and the resettlement of displaced persons. Therefore this is a key variable for civil-military affairs.

2.13 Economic Growth Rate

This variable quantifies the annual growth rate of the national economy, expressed as a percentage of Gross Domestic Product. This variable is unbounded, but its normal range extends from –20 to +20. Economic Growth Rate is updated weekly.

This variable quantifies the rate of change in condition C 3.3.3 of the UJTL, version 2.5 (Gross Domestic Product), and is closely related to condition C 3.3.5.2 of the UJTL, version 2.5 (Industrial Growth Rate).

2.14 Inflation

This variable quantifies the annual rate of inflation in consumer prices in the national economy, expressed as a percentage. This variable is unbounded, but its usual range extends from 0 to 40. Inflation is updated weekly.

2.15 Tax Rate

This variable quantifies the total taxation rate, defined as the percent of personal income that is paid annually in taxes of all kinds. The scale extends from 0 to 100. Tax Rate is updated weekly, but changes very slowly unless affected by a player action.

2.16 Unemployment

This variable quantifies the annual rate of unemployment in the national economy, expressed as a percentage of the workforce. The scale extends from 0 to 100. Unemployment is updated weekly.

2.17 Trade Surplus/Deficit

This variable is available but seldom used in the current DEXES model.

2.18 Underground Economy

This variable quantifies the size of the underground economy, expressed as a percent of the gross domestic product. Economic transactions, including barter, are considered to be "underground" if they are unreported and untaxed by the central government. The scale extends from 0 to 100%. Underground Economy is updated weekly.

2.19 Support for Government by an Ethnic Faction

This variable describes the frequency distribution of support for the host nation government, on a scale from 0 (strongly oppose) to 1 (strongly support). Like all public opinion variables in the DEXES model, it is assumed to have a beta distribution (see section 2.24 for a description of the beta distribution).

For each ethnic faction, this variable quantifies an aspect of condition C 3.1.1.1 of the UJTL, version 2.5 (Domestic Public Support).

2.20 Support for its own Militia by an Ethnic Faction

Every ethnic group in DEXES may have a militia. If a group does have a militia, then this variable describes the frequency distribution of support for this militia from members of this ethnic group, on a scale from 0 (strongly oppose) to 1 (strongly support). Like all public opinion variables, this is assumed to have a beta distribution (see section 2.24 for a description of the beta distribution).

For each ethnic faction, this variable quantifies an aspect of condition C 3.2.3.2 of the UJTL, version 2.5 (Religious Militancy).

2.21 Support for Peace-Keeping Forces by an Ethnic Faction

This variable describes the frequency distribution of support for the Peace-Keeping forces by a particular ethnic group, on a scale from 0 (strongly oppose) to 1 (strongly support). Like all public opinion variables, this is assumed to have a beta distribution (see section 2.24 for a description of the beta distribution).

For each ethnic faction, this variable quantifies an aspect of condition C 3.1.1 of the UJTL, version 2.5 (Domestic Political Support).

2.22 Perceived Bias of Peace-Keeping Forces by an Ethnic Faction

This variable quantifies the bias of the Peace-Keeping forces as it is perceived by each ethnic group. A value of 0 means that the PKF are perceived to be neutral towards the ethnic group. A value of +1 indicates that the PKF are perceived to side consistently with the ethnic group, while a value of –1 indicates the reverse. Any deviation from zero in this variable is a serious danger sign for international peace-keeping forces.

2.23 Political Participation by an Ethnic Faction

This variable describes the extent to which the members of an ethnic group participate in the political process. This variable does **not** measure or depend upon the extent to which the political process is democratic. *It only quantifies the extent to which the ethnic group participates in politics.* A value of zero indicates that the ethnic group has withdrawn entirely from the political process: it has no power to affect policy, and it has no representation in government. A value of one indicates that the ethnic group is fully engaged, and has members holding power in government. If only one group has full participation, and all others have very low participation, then the first group effectively controls the government of the country. If two or more groups are fully participating, then they are sharing power.

2.24 A Note on the Beta Distribution

The DEXES state variables that describe public support within a given group for various entities (the national government, the peace-keeping forces, or the group's own militia) are distributions, rather than single-valued functions, because public opinion is almost always "distributed" over the full range of its values. DEXES does not use the "normal" bell-shaped distribution that is ubiquitous in the social sciences, because this distribution cannot represent polarized public opinion. Instead, DEXES uses the so-called "Beta" distribution. The Beta has finite range, by convention the bounds are 0 and 1. It can have an approximate bell shape, but it can also adopt many additional shapes: it can have an "exponential-declining" appearance, illustrated in the distribution of Cazerk support for the government shown in the top graph of the following figure, or

an “exponential-increasing” appearance, as in the middle graph of the figure, or a “polarized” appearance, as in the distribution shown at the bottom of the figure. Thus the Beta is a remarkably versatile statistical distribution that serves well for capturing the various shapes of public opinion distributions.

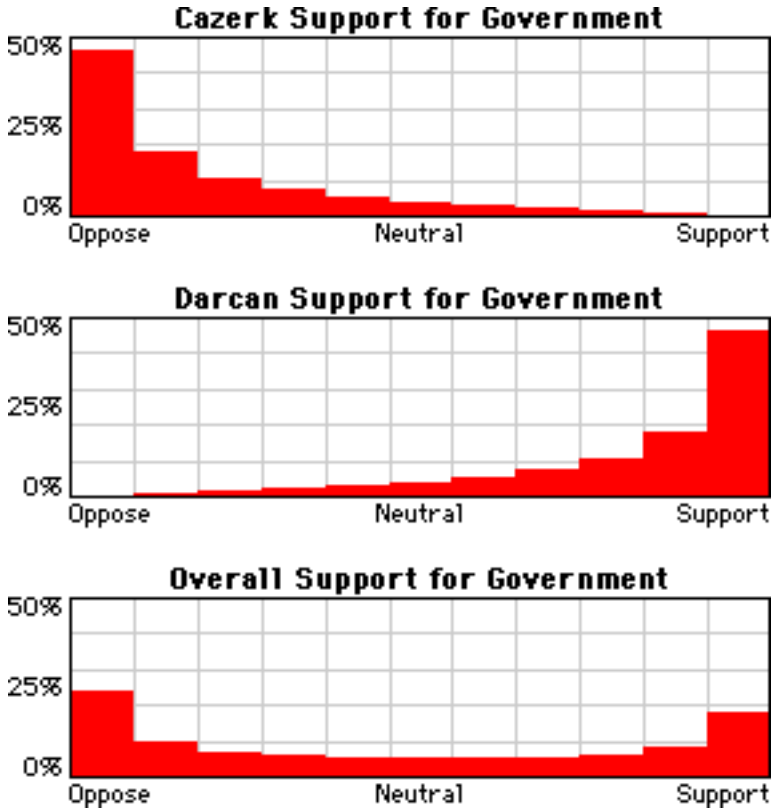

Figure 14: Beta distributions for Public Opinion by Ethnic Faction.