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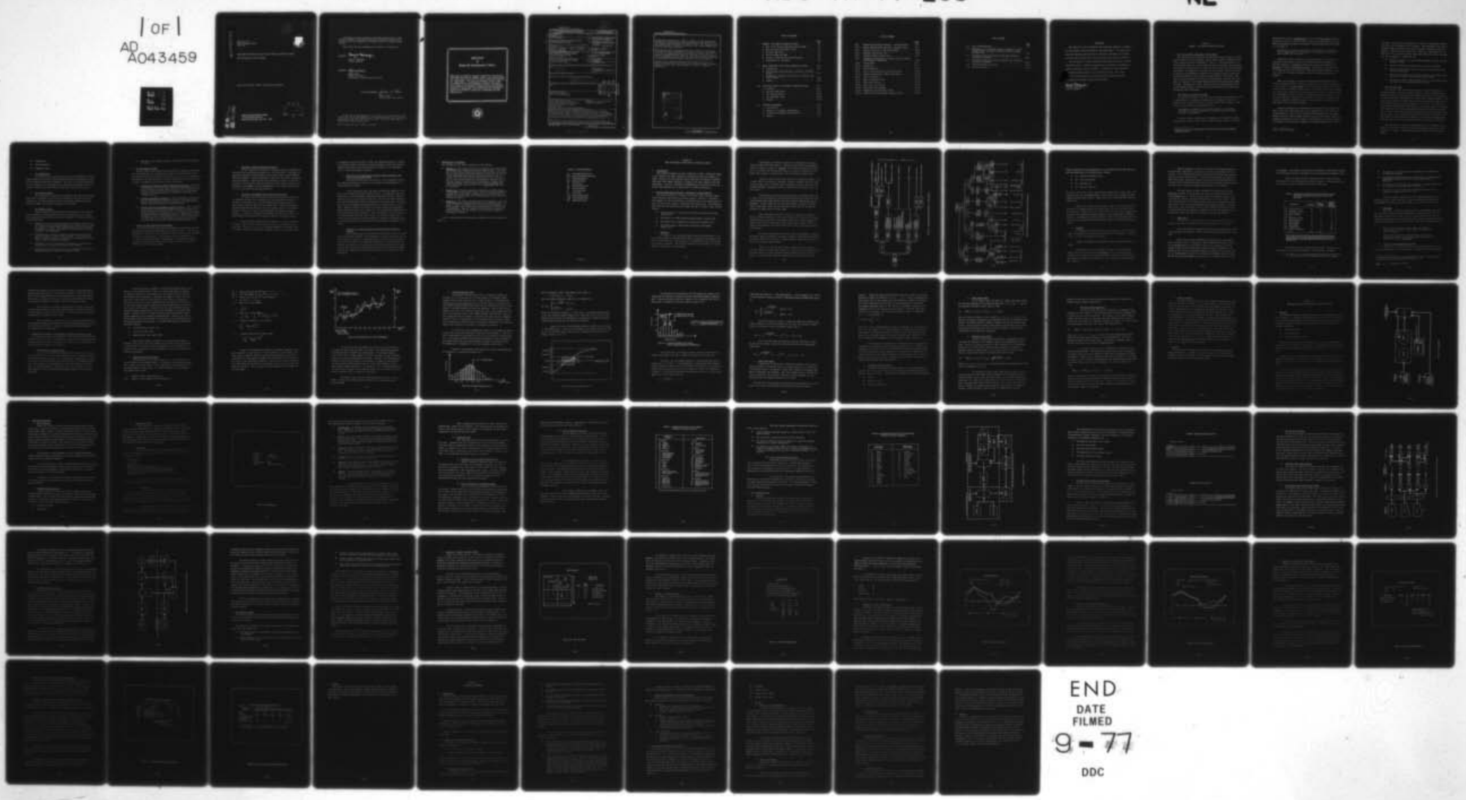

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Final Technical Report
July 1977

PRELIMINARY FUNCTIONAL DESIGN FOR THE EVENTS DIAGNOSTICS SYSTEM

PRC Information Sciences Company

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ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, New York 13441

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This report describes the preliminary functional design for The Events Diagnostics System (TEDS). TEDS has evolved from a series of studies begun in 1972 focused on computer assisted ways by which an Indications and Warning (I&W) analyst may be helped to draw inferences concerning the likelihood occurrences of noteworthy and significant military-political events.

TEDS current design is intended for use at a dual screen terminal that may be manipulated by the analyst with cursive devices to include a light pen and

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several generic function keys. After the coding of incident reports, TEDS processes its regression based models and presents its event predictions to the analyst in both alpha-numeric and graphic formats. The analyst may query these presentations to include the data base and the original messages upon which the calculations were based.

TEDS features an event classification structure consisting of 26 military, political, diplomatic and economic event classes. Each event class consists of a number of *a priori* indicators as selected from official literature, historical analysis and expert testimony. When these indicators are matched with an *a posteriori* incident report, TEDS performs its processing functions and generates the several diagnostic displays for use by the analyst.

Periodic multiple regression analyses are performed with the aid of the analyst and after-the-fact event evaluations to adjust the model by specific indicator and event class, thus providing for systematic feedback and improvement.

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EVALUATION

The objective of this program was the functional design of a system to aid intelligence analyst personnel in analyzing events. The event class structure described groups military, political, diplomatic and economic indicators into classes that can be associated with conflict situations.

The utilization of linear regression techniques is utilized to derive quantitative data. Predictive equations are calculated in attempting to evaluate potential conflict scenarios. Validation of these prediction algorithms has been conducted at a feasibility level. This report outlines the description of a prototype event analysis system that is required to evaluate operational usefulness.

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Chapter I

SUMMARY: THE EVENTS DIAGNOSTICS SYSTEM

A. What Is the Events Diagnostics System (TEDS)?

This technical report describes the functional design concepts for TEDS, developed under Rome Air Development Center (RADC) Contract F30602-76-C-0267, titled "Events Occurrence Methodology." TEDS is a functional design for a computer-based system to aid intelligence analysts responsible for diagnosing international military-political events and forecasting their likely progress and outcome. As summarized in section E of this chapter, TEDS is the result of research and development conducted on the characteristics of events and quantitative methods by which their occurrence might be forecasted. This report represents progress of research and development conducted since 1972 under the auspices of the Defense Advanced Research Projects Agency (DARPA) and RADC. Throughout the effort, TEDS has focused on applications for use by intelligence analysts responsible for event analysis in an Indications and Warning (I&W) environment.

B. What Needs Are Satisfied by TEDS?

The functional design of TEDS for use by I&W analysts parallels the need of physicians for a systematic classification of symptoms so that their diagnosis may be quickly focused to a class of most likely diseases. Diagnosis, is this context, may be defined as the

> investigation or analysis of the cause or nature of a condition, situation or problem; a statement or conclusion about the nature or cause of a phenomenon.[1]

Given an orderly, indexed array of symptoms in a diagnostics manual, a physician may scan the lists, direct certain laboratory tests to be taken,

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[1] Webster's Third New International Dictionary of the English Language Unabridged, 1967.

and narrow the scope of possibilities to one or more most likely diseases. The doctor is now in a better position to make an outcome forecast. In the medical proression the doctor's forecast is called a prognosis and defined as a statement of

> the prospect of survival and recovery from a disease as anticipated from the usual causes of that disease or indicated by special features of the case in question.[1]

Applying the medical analogy to the I&W environment, an I&W analyst is required to read reports each day on military-political occurrences to identify symptoms, or indicators, which when present are considered as incidents of possible conflict situations. These conflict situations may be of many varieties and intensities. Many have similar indicators. However, there is no "diagnosis manual" to which the analyst may turn for guidance.

TEDS, as now designed, features an Events Classification Structure (ECS) that groups military, political, diplomatic, and economic indicators into one or more of 26 event classes each of which may be associated with potential conflict situations whenever they are reported to have been observed. The total system, therefore, may be used by the I&W analyst in much the same way as diagnostic manuals are used by physicians to make a prognosis. Given the usual indicators associated with conflict situations in geographic and historic perspective, TEDS will equip the analyst with systematic ways to make future event occurrence analysis

Analysts responsible for performing event analysis have recognized the need to deal with intelligence data in an organized way. All systems reviewed during the course of TEDS research and development have one common primitive feature--they optimize retrieval functions with little regard for diagnostic potential on the one hand or the opportunity to record, evaluate, and quantify the intellectual judgments and inferences made by the users on

[1] Ibid., Underscore added.

the other. The history of knowledge is the history of hypothesis testing, trial and error, adjustment, and refinement. Much knowledge in the I&W environment today is stored in the minds of persons recognized as the best analysts. TEDS has features specifically designed to systemitize the I&W process in such a way that several other event prediction needs of the analyst may be augmented. Among these are:

- Provide a record of all event prediction made by either the user-analysts or TEDS
- Present to analysts an ordered range of event likelihoods
- Present flexible ways in which the analysts may test their own diagnostic hypotheses
- Provide an organized way to classify incidents of a similar kind over time to create a quantifiable historic record
- Increase the speed of data compilation and the processing or relationships that exist among many event classes

C. How Will TEDS Work?

The design of TEDS is based on principles of probability theory, regression analysis, linguistic content analysis, various findings from experimental psychology associated with inference processes, decision theory, and visual and motor interactions of a person with a graphics terminal. The underlying assumption of TEDS design is that past particular events are useful in analyzing future event occurrences. No scenario of a past event ever predicts the identical characteristics of a future event. For example, a military conflict in one month and place may involve only selected army units, while in the following month and same place involve mixed army, navy, and air units. Yet, the generic class of event--military conflict--may be anticipated with some degree of probability if relevant intelligence data from the previous event were carefully collected, collated, and analyzed.

TEDS consists of a series of related processes each designed to contribute to the whole resulting in a series of graphic displays to be presented to the analyst. These processes may be divided into three broad phases:

- Coding Phase
- Processing Phase
- Diagnostic Phase

1. The Coding Phase

The Coding Phase is guided by the protocols established by the ECS which describe the 26 event classes (potential conflict situations) in terms of their possible indicators (symptoms). Once data are received suggesting that the indicator has been observed, the incident is assigned to all event classes to which it has been known to have been associated in the past.

2. The Processing Phase

As incidents are collected in each event class, they are processed and related as incidents to each other as defined by the event class characteristics. The more indicators that are satisfied, matched, and correlated, the higher likelihood is presented to the analyst.

3. The Diagnostic Phase

After the analyst reviews the generated displays, he may exercise several options by interrogating the data base through the use of a light pen and assorted function keys on his console keyboard. The major functions he may perform are:

- Evaluation of the relative importance of incidents reported across all event classes for periods ranging from a single day to 21 days. An Incident of Interest (IOI) display presents all event classes as grouped in a range of likelihood values designated as Routine, Noteworthy, and Significant.
- Obtainment of the historic frequency of reports received on particular incidents, by event class on demand. This feature permits the analyst to judge the regularity of reporting and, if necessary, request additional information.
- Performance of his own hypothesis and prognostic testing by substituting his own values in the event class formulae.
- Recording his own forecasting record and comparing it with TEDS at periodic intervals to adjust the regression models.

- Retrieval of the original messages upon which all coded incidents are based.

D. Who Else Might Use TEDS?

Although TEDS has been specifically designed for diagnostics associated with I&W evaluations, it is generically suited for any user who must cope with forecasts of the likelihood of events as a part of his job. Appropriate adjustment of the basic data base, ECS event class labels, and formulae may be made to accommodate other fields of event forecasting.

- Scientific and Technical (S&T) Intelligence Forecasts. The ECS may be stripped of its current event class labels and replaced with those associated with particular aspects of S&T forecasting. Time windows now used by TEDS could be extended to yearly increments and data base loading would focus exclusively on relevant technological topics.

- Economic Intelligence Forecasts. Similar adjustments as described for S&T forecasts may be made for economic forecasting problems. Specific data dealing with specific economic trends and their indicators would be processed by the TEDS software.

- Current and Basic Intelligence Topical Forecasts. TEDS is designed for use by I&W analysts whose primary concern is to alert senior decision-makers of a potential conflict situation. However, detailed analysis of those situations, once in progress, is provided by Current and Basic Intelligence analysts. TEDS models may be developed to focus on specified subsets of indicators with greater or lesser detail on any sociological, cultural, political, or military event class to suit a particular organizational need.

E. History of TEDS Research and Development

This section presents an unclassified summary of the evolution of TEDS from initial research and development to the present report. The historic background is provided to assist readers who may not have had the opportunity to review the previous work. This summary is based on RADC-TR-73-92, "A Concept for the Application and Evaluation of Quantitative Techniques for the Indications and Warning Process" dated December 1972, Contract F30602-72-C-0376 and other reports.

1. <u>1972-1973: Examine Quantitative Methods</u>

Initial research was conducted to evaluate techniques available for inferential decision-making processes in an I&W environment. Techniques examined and evaluated included models based on game theory, factor analysis, Bayesian probability, multiple regression techniques, and various statistical application models. These methods were evaluated in reference to the I&W processing cycle beginning with the analyst's initial receipt of data to his assessment, and judgment to final dissemination. The study focused on ways to aid in data reduction and quantification.

2. <u>1973-1974: Preliminary Test of Quantitative Method</u>

The next research effort was devoted to testing the capabilities of regression analysis and to examining the problems associated with it. The goal of this phase was to use the regression technique to derive a quantitative predictive model for a selected event. Warsaw Pact military training exercises were chosen as the event because they are structurally similar to events of interest to decision-makers and data were readily available. A predictive equation of measurable accuracy was derived, thus demonstrating the potential for regression analysis in broader contexts.

After regression analysis proved feasible as a predictive method, additional types of events and the need to build an event data base were identified. The future utility of the method depended on defining a range of military, political, and economic incidents that could be classified to be amenable for data collection, coding, and regression analysis. The ECS was created to define the range of current incidents so that they could be compared with those of past events which were similar to an anticipated event an analyst may desire to predict.

3. 1974-1975: Test Regressions, Evaluate Coding Procedures, and Refine Classification System

The third research effort was aimed at a more exhaustive test of the regression technique as well as an evaluation and improvement of the coding procedures and ECS.

For the regression test, data were collected and coded for a subset of the indicators and event classes defined. In particular, selected descriptors in the DIA Advanced Indications Structure (AIS) data base were used as a source of some military data while the DIA Intelligence Summaries were used for additional military, political, and economic data. More than 900 events were identified and classified into 24 event classes to run the tests. Empirical models for several of the event classes were developed using stepwise multiple linear regression. The correlation coefficients for the various models showed variation. This was expected, since the AIS data is oriented towards military event classes. For military cases, the R^2 values were high enough to show the promise of regression techniques for use in event prediction across the military-political-economic spectrum of incidents.

4. 1975-1976: Develop Functional Design and Analyst Diagnostic Displays

Having demonstrated the feasibility and potential utility of applying the regression technique to I&W functions, the work described in the following chapters focuses on a functional design. The functions that must be performed by TEDS before the regression analysis may be performed deal with formally structured ways in which data are collected, coded, and processed. The functions that must be performed by TEDS at all times deal with graphic displays that summarize the data and may be used by the analysts for their diagnostics.

F. Organization of the Report

The remainder of this report consists of three chapters:

- Chapter II. This chapter describes the theoretical decision-making and mathematical foundations upon which TEDS is based. The first part of the chapter reviews key terms associated with the forecasting of likely events and briefly reviews the structure of the ECS. (A more exhaustive discussion of the terms and the ECS may be found in the last three reports cited in section E). The second part of this chapter defines three mathematical formulae that provide the form by which data will be quantified to produce three numerical indexes. These indexes will represent *a priori* event class forecasting models upon which the *a posteriori* regressions are performed.

- Chapter III. Given the theoretical principles for TEDS, Chapter III presents the functional design. While the design represents an integral whole, the chapter is divided into three major parts to describe the coding phase, the processing phase, and the prototype diagnostic displays.

- Chapter IV. The report concludes with a basic estimate of the computer and terminal configurations required to implement TEDS. In general, TEDS is intended for use with a dual-screen graphics terminal equipped with a light pen and function keys to be hosted by a minicomputer. However, changes to the diagnostic displays presented in Chapter III may be made for use on a more primitive alphanumeric terminal.

A list of abbreviations used frequently throughout the report appears in Table 1-1.

Table I-1. List of Abbreviations

AIS	DIA/Advanced Indications Structure
DARPA	Defense Advanced Research Projects Agency
DIA	Defense Intelligence Agency
DOD	Department of Defense
ECI	Event Class Index
ECS	Event Classification Structure
I&W	Indications and Warning
III	Incident-Indicator Index
IOI	Index of Interest
RADC	Rome Air Development Center
TEDS	*The Events Diagnostic System*
WECI	Weighted Event Class Index

Chapter II

BASIC PRINCIPLES OF THE EVENTS DIAGNOSTICS SYSTEM

A. Introduction

This chapter discusses the basic principles of TEDS. During the period of the current work, major portions of the previous work were largely refined. Section B of this chapter briefly describes the theoretic relationships that exist among indicators, incidents, and event classes in the I&W environment. Section C discusses the mathematical principles by which the various relationships may be quantified for computer processing.

B. Relationships Among Indicators, Incidents, and Event Classes

The terms "indicator," "incident," and "event class" have been exhaustively discussed and defined in previous reports. However, a discussion, with examples of their definitions, is presented here so the reader need not refer to the earlier reports to understand the present work. The discussion and definitions are compatible with those that may be found in these official sources:

- JCS Publication 1, Dictionary of Military and Associated Terms, January 1973
- DIA Manual 57-6, DOD Indications System Manual, October 1973
- DIA Manual 58-5-1 Indicators of Hostilities, November 1973
- DIA School Manual, Indications and Warning Intelligence, January 1975

1. Indicator

An indicator is a postulated before-the-fact pronouncement or act by a foreign leader or organization believed to represent one necessary step prior to the initiation of some other act or pronouncement that could result in a conflict situation. The conflict situation may be internal to a single nation or involve two or more nations.

Governmental and academic literature on indicators has formally evolved largely since World War II. Indicator lists have been assembled as based on a generic analysis of incidents (see below) associated with World War II, the Korean and Vietnam wars as well as conflict situations in the Middle East, Hungary, Czechoslovakia, and the USSR-China border areas.

Indicator lists are most often based on a mobilization model. Such a model seeks to catalogue all plausible incidents national leaders in time and place might take to mobilize their diplomatic, economic, political, and military materiel, and human resources to make their will prevail over another nation.

Intelligence services within the Department of Defense (DOD) tend to issue lists that emphasize those indicators reflecting military acts and pronouncements that might precede provocative military deployments and engagements. Typical indicators of this kind include a call-up of reserve forces, high alert status for each military service, and the unusual deployment of combat units to border areas.

Other intelligence services, such as the Central Intelligence Agency and the Departments of State and Treasury, tend to issue lists emphasizing diplomatic, political, and economic indicators. Typical among such indicators are verbal threats by foreign leaders and diplomats, efforts to impose trade embargoes, and sundry restrictions placed on foreign travelers and diplomats.

The Events Classification Structure (ECS) was designed to classify the entire range of diplomatic, political, economic, and military indicators. As shown in Figures II-1 and II-2, indicators may be classified into one or more of 26 different event classes.

Figure II-1, Internal Event Classes, shows those event classes that most often occur within the borders of a nation but can eventually have a serious impact on another nation's foreign policies and use of military forces. As will be shown under the discussion of the term "event class"

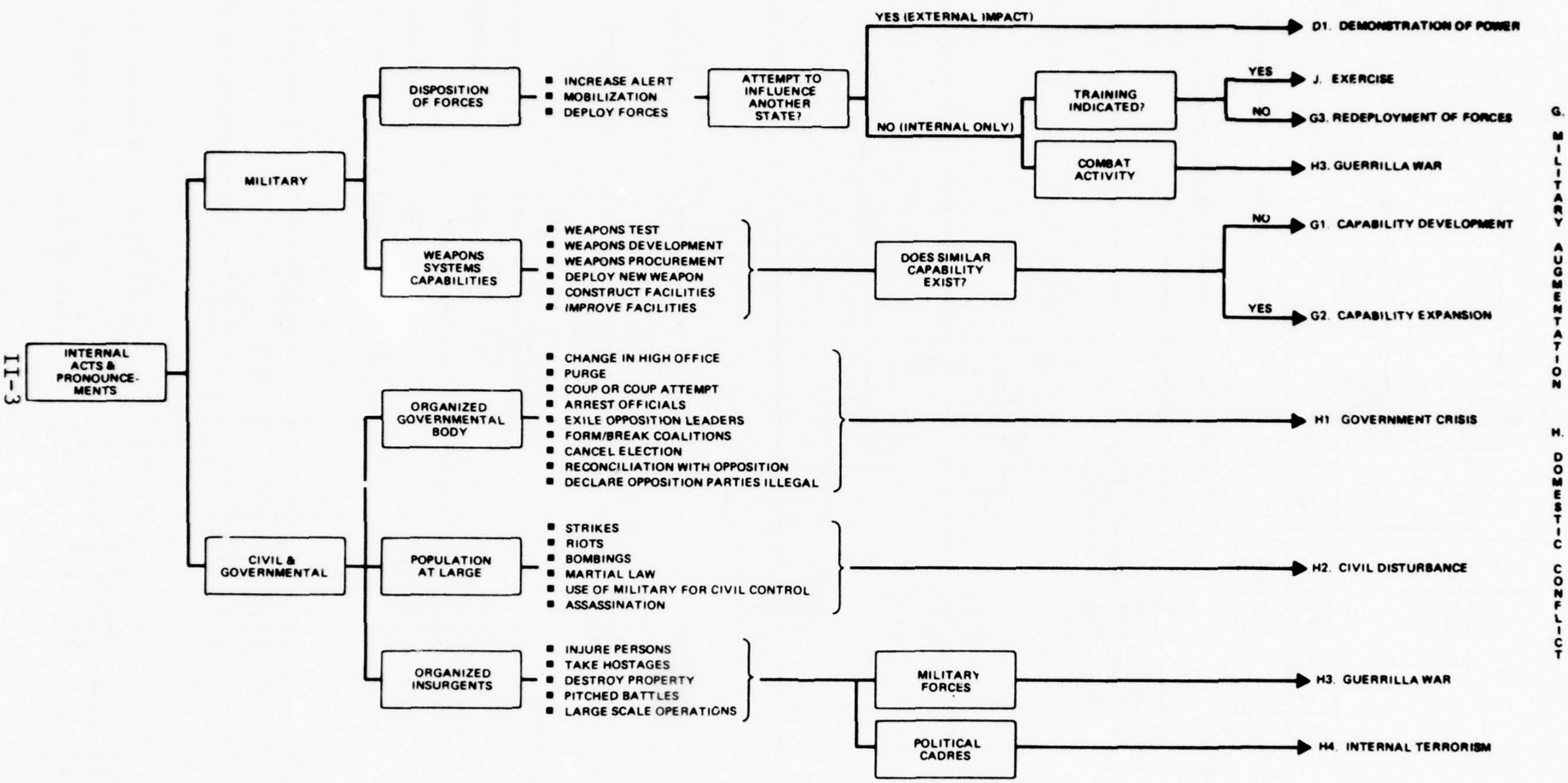

Figure II-I. Events Classification Structure: Internal Events

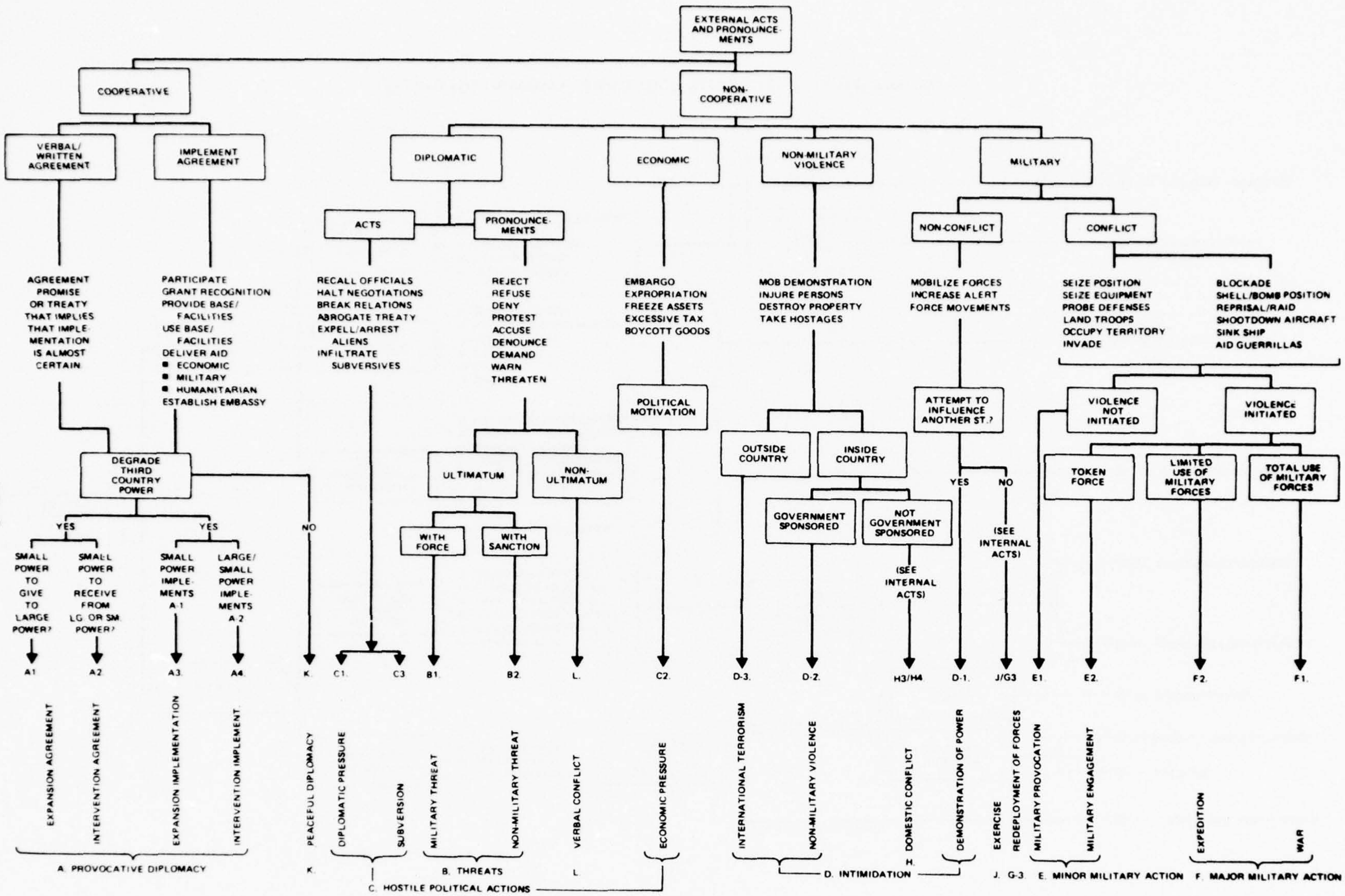

Figure II-2. Events Classification Structure: External Events below, 50 percent of the deployments by U.S. military forces since 1946 have been associated with four internal event classes:

- H1: Foreign Government Crisis
- H2: Civil Disturbance
- H3: Guerrilla War
- H4: Internal Terrorism

Moreover, other event classes, particularly Demonstration of Power (D1), some Exercises (J), and some Redeployment of Forces (G3) can be examples of more complex external event classes. These three event classes are also shown on Figure II-2.

Figure II-2, External Event Classes, shows event classes that most often have an immediate impact on relations with at least one other nation. At the bottom of Figure II-2 are the titles for each event class ranging from diplomacy and economics and verbal threats to four intensities of military conflict. Representative keyword examples of indicators associated with each event class are shown above the event class titles in a simple decision-tree array.

2. Incident

An incident is an after-the-fact pronouncement or act by a foreign leader or organization that has been reported to have occurred, is believed likely to be true, and matches an indicator.

Briefly, an incident is an indicator that is believed to have occurred.

The writers of the official DOD literature cited in section B usually refer to an incident as an indication. Due to the great visual similarity and equally great confusion between an indicator and indication, this report has elected to substitute the term "incident" as being somewhat more concrete.

TEDS was designed to serve as an overall classification matrix for before-the-fact indicators, as well as a sorter of all incidents by event classes. Each incoming I&W incident will be filed in at least one, but more often two or more, event classes. In this way, for example, the same incidents reflecting a Diplomatic Pressure (C1) event may be simultaneously associated with an Economic Pressures (C2) event both of which events may also correlate with a Non-Military Threat (B2) event yet to be reported.

The basic design of TEDS is founded on the principle that past particular incidents as grouped by event class are useful forecasters of future generic events. No specific past group of incidents, however, ever forecasts the identical incident characteristics of a future event. Military Provocation (E1) in one month and place may involve incidents by army units only, while in the following month also include incidents by air and naval units. Yet, the generic class of event--Military Provocation--could be anticipated with some degree of probability if relevant indicators that presaged the event were carefully collected, collated, and analyzed.

3. Event Class

An event class is the cumulation of incidents sufficient to describe an event whose occurrence would have been desirable to forecast.

A key consideration associated with any event classification scheme is to respond to the question: "What class of events are desirable to forecast?"

While there are many methodological approaches for determining what is and what is not of interest to senior DOD decision-makers, the ECS as now designed has been structured to focus on the collection of those incidents most often associated with potential conflict situations. One method to tie the clause "potential conflict situations" to a concrete reality of decision-maker interest is to examine the worldwide events in which DOD and other decision-makers elected to use U.S. military forces as a tool of diplomacy. This method clearly ties the interests of many senior persons of the Executive Branch of government to the operational environment of DOD.

Table 2-1 shows 215 events during the past 30 years that have moved senior U.S. decision-makers to deploy elements of the Army, Navy, and Air Force as a part of foreign policy goals at the time.

Table 2-I. Deployment of U.S. Military Forces in Response to International Events Arranged by Event Classes (January 1946-May 1975)[1]

Event Class Title		U.S. Deployments	Percent of Total Events (Rounded)	Cumulative Percent of Total Events (Rounded)
H1:	Foreign Government Crisis	48	22	22
H3: H4:	Guerrilla War, Internal Terrorism } Civil War	48	22	44
F2: F1:	Military Expedition, War	40	19	63
D1: E1:	Demonstration of Power, Military Provocation	24	11	74
K:	Peaceful Coexistence	20	9	83
E2:	Military Engagement	17	8	91
H2:	Civil Disturbance	12	6	97
C2:	Economic Pressure	4	2	99
A4:	Intervention Implementation	2	1	100
	Total	215	100	

[1]The 215 events involving the use of U.S. military forces are those presented by the Brookings Institution report, "The Use of Armed Forces as a Political Instrument," sponsored by Defense Advanced Research Projects Agency, ARPA Order No. 2820, Amendment No. 2, Contract N00014-75-C-0140, 1 August 1976-31 December 1976. The report does not use the Event Class Structure titles.

Many inferences may be drawn from the table. Relevant to the efficiency of the ECS and interests of the I&W analyst are these:

- 100 percent of all analyzed events involving the deployment of U.S. military forces are accommodated by 12 event classes.

- 74 percent of U.S. military force deployments are accommodated by seven Event Classes.

- The unlisted 14 Event Classes are contributors to a more detailed anticipatory description of the 12 event classes shown in Table II-1.

- 50 percent of U.S. military force deployments are associated with four internal event classes (H1, H3, H4, H2).

- 27 percent of U.S. military force deployments result in some exchange of weapons fire (F2, F1, E2).

Given the concrete association of U.S. military deployments as a criteria to select events that are of interest, noteworthy, significant, and desirable to forecast, the ECS provides a valid set of event classes.

4. Descriptor

This term is commonly associated with the DIA Advanced Indications Structure (AIS) developed by Radio Corporation of America (RCA). The term descriptor is used later in this report in a generic way to refer to the data base now available in the AIS and as being relevant to selected military indicators and incidents for inputs to TEDS. About 160 AIS descriptors serve as

> . . .monitors [of] a specific, narrow aspect of activity for a potentially hostile force element or command and control apparatus.[1]
>
> The activity data itself, the mathematics, and the numerical presentation of the results derived from the activity data is called a descriptor.[2]

5. Summary of Relationships Among Terms

An indicator is a before-the-fact postulated pronouncement or act an analyst might expect to see executed by a foreign leader or organization

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[1]As described in an April 1976 DIA/ARPA/RADC/RCA report titled, "Advanced Indications Structure Descriptive Material," p. 2-2.

[2]Ibid., p. 1-3. Underlined as shown.

before moving toward the conclusion that an internal or external conflict situation may come to pass. If an analyst receives a report that one or more of the postulated indicators have been observed, he has received evidence that an incident has occurred. Indicators are postulated variables to search for; incidents are reports that the variables now exist.

The cumulation of incidents through time sufficient to describe an event whose occurrence would have been desirable to forecast for senior decision-makers constitutes an event class. Incidents provide the specific description of the generic event classes.

TEDS is designed to classify, collate, and analyze through multiple regression analysis and other statistical techniques, specific incidents of similar characteristics to produce a likelihood statement regarding the occurrence of an event class.

C. Mathematical Treatment of Indicators, Incidents, and Event Classes

This section discusses the mathematical principles upon which the TEDS statistical model is based. The discussion forms the basis for the TEDS processing subsystem discussed in Chapter III, section C, and the Analyst Displays discussed in Chapter III, section D.

1. TEDS Approach to Quantification

One of the most difficult problems in the prediction of events is the quantification of the erratically reported, partial evidence upon which the predictions must be based. In the intelligence environment, the degree of difficulty of quantification varies with the type of information considered. Data gleaned from the monitoring of electronic signals of various types is readily quantified. An embassy report of a VIP visit to a foreign country or of an anti-American propaganda campaign is not so easily quantified.

Given this range of variables, the TEDS system design takes a dual approach to the quantification of data. In those cases where an incident is regularly reported in a quantified form, that quantity will be used as the raw data for the indicator. Otherwise, the number of reports per incident will be used; that is, three reports of VIP visits to a country is entered as a 3 for the raw data associated with the indicator "VIP Travel." In time, this measure would be modified to include some measure of the intensity level of the incidents. Although intensity assessments have been investigated during previous work, they are not included in the present TEDS design. Intensity levels are highly subjective and would introduce unwarranted complexity into the present coding procedure. However, the current system design anticipates inclusion at a later date so that modifications to the coding procedure could be made. The present TEDS design includes three quantified indexes:

- Incident-Indicator Index (III)
- Event Class Index (ECI)
- Weighted Event Class Index (WECI)

Each of these indexes is based on a concept called a "window." Throughout this report, the term "window" will be used to denote the length of time in days over which raw data are aggregated. The description of a window follows in paragraph 2 with descriptions of the III, ECI, and WECI in subsequent paragraphs.

2. Window Definition and Lengths

TEDS design will use "window" sizes of 1, 7, 14, and 21 days to calculate both raw and indexed values. For example, a 1-day window includes only a single day's data, while a 7-day window sums a week's data and a 14-day window sums two week's data. For a given indicator I, the following definitions will be used:

n = number of days in the history file
n-6 = number of 7-day windows in the history file

X_i = report level for the i^{th} day, $i = 1, 2, \ldots, n$

W_j = the 7-day window for the j^{th} day, $j = 7, 8, \ldots, n$

Y_j = report level for the j^{th} 7-day window W_j

$= X_j + X_{j-1} + \ldots + X_{j-6}$

μ_1 = mean of all 1-day windows

$$= \sum_{i=1}^{n} \frac{X_i}{n}$$

μ_7 = mean of all 7-day windows

$$= \sum_{j=7}^{n} \frac{Y_j}{n-6} = \sum_{j=7}^{n} \frac{X_j + X_{j-1} + \ldots + X_{j-6}}{n-6}$$

σ_1 = standard deviation for 1-day windows

$$= \left\{ \sum_{i=1}^{n} \frac{(X_i - \mu_1)^2}{n} \right\}^{1/2}$$

σ_7 = standard deviation for 7-day windows

$$= \left\{ \sum_{j=7}^{n} \frac{(Y_j - \mu_7)^2}{n-6} \right\}^{1/2}$$

Figure II-3 represents the history of the daily report level for a given indicator I on the basis of a 1-day window and a 7-day window. The 7-day graph is computed from the 1-day graph by beginning at the day in question on the 1-day graph and summing the daily report level for each of the 7 days in the appropriate window W_i. Note that the vertical scale for the 7-day window (on the right of the graph) is only 1/7 that of the 1-day graph (on the left). This is simply to allow comparison of the graphs in the same figure.

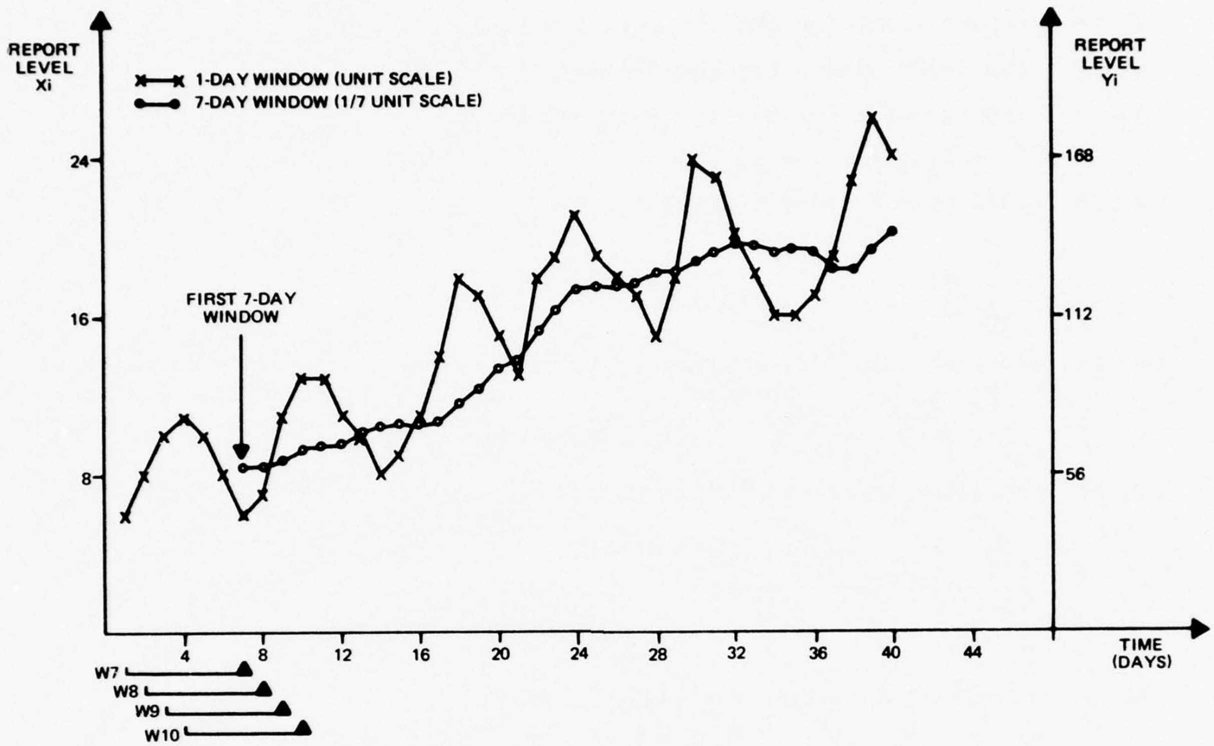


Figure II-3. Raw Data Level for 1- and 7- Day Windows

As can be seen from the graphs, the effect of the 7-day window is to smooth the day-to-day variation in the data. This smoothing eliminates the variation due to weekends and nonuniformity of reporting schedules. Overall the 7-day or longer window is useful to analysts to show the general slope of a trend by averaging daily variables. However, such averaging also reduces any short-term reaction of the measure to changes in report levels. For these reasons, TEDS includes both the 1- and 7-day windows as well as other windows deemed appropriate. For instance, a 21- or 28-day window might be used to give a measure of the seasonal variation in an indicator since it would be sensitive only to longer run variations.

The means μ_1 and μ_7 and the standard deviations σ_1 and σ_7 will be used to compute the Incident-Indicator Index (III) as described in the next paragraph.

3. <u>Incident-Indicator Index</u>

The Incident-Indicator Index (III) is an index to measure the deviation of the current period's incident reports (of whatever window length) from the usual reporting for a single indicator. Throughout this discussion, the term report will refer to either the level of activity for the regularly reported quantifiable data such as reported by the AIS, or the number of incidents reported to match the indicator. The III value is designed to be zero if the observed reports are equal to the average value and will rise in absolute value as the reports deviate from the norm. Here we have recognized that the absence or reduction of reports may be a "negative indicator" and be as significant as an increased level of activity. Moreover, deviations in reporting levels on particular indicators can provide the analyst with insights on the status of collection activities.

To specify the III in mathematical terms, it is necessary to define several basic statistics which will be kept for each indicator I. The following formulation is illustrative of the III as calculated on a daily basis for a 7-day window although the length may be adjusted to suit the needs of any analyst whose data may dictate periods of longer or shorter duration. The definitions of paragraph C.2 are used throughout this section.

Suppose a 7-day frequency distribution for reports associated with the indicator I is described by Figure II-4:

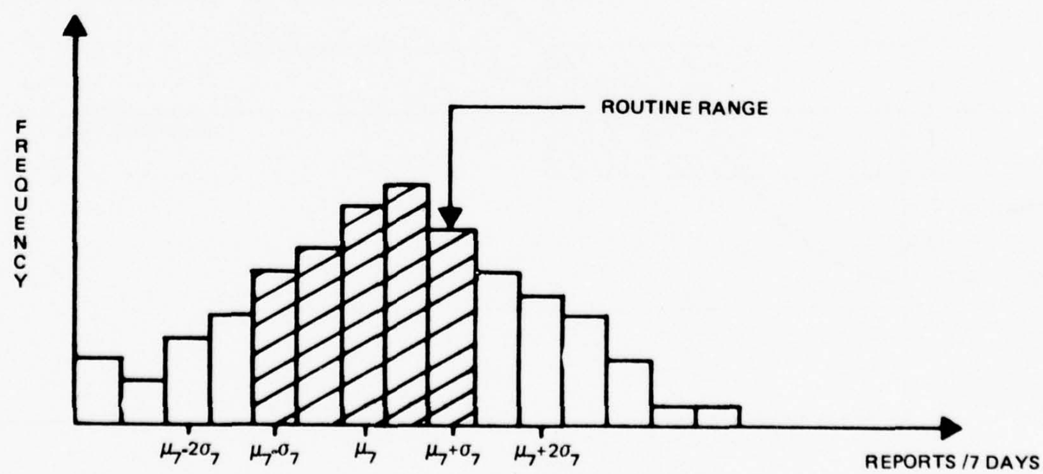


Figure II-4. Frequency Distribution for I

Then if Y denotes today's 7-day report count, that is,

$$Y = X_n + X_{n-1} + \dots + X_{n-6}$$

then the Incident-Indicator Index for I is defined to be

$$\text{(1)}\quad III_7 = \begin{cases} 1 - e^{-\alpha\left(\frac{X-\mu}{\sigma}\right)} & \text{for } X \geq \mu \\ e^{\alpha\left(\frac{X-\mu}{\sigma}\right)} - 1 & \text{for } X < \mu \end{cases}$$

where e is the Euler constant, e = 2.718, and α is a positive constant used to set the "routine" range in Figure II-4. Note that in (1) the III varies between plus and minus one, depending on the positive or negative deviation from the mean reporting for the particular indicator.

Figure II-5 shows the relationship between the III and the frequency distribution above. Note that the parameter α in formula (1) will be used to set the "routine" range so that it will consistently correspond to the numeric values -.33 to .33.

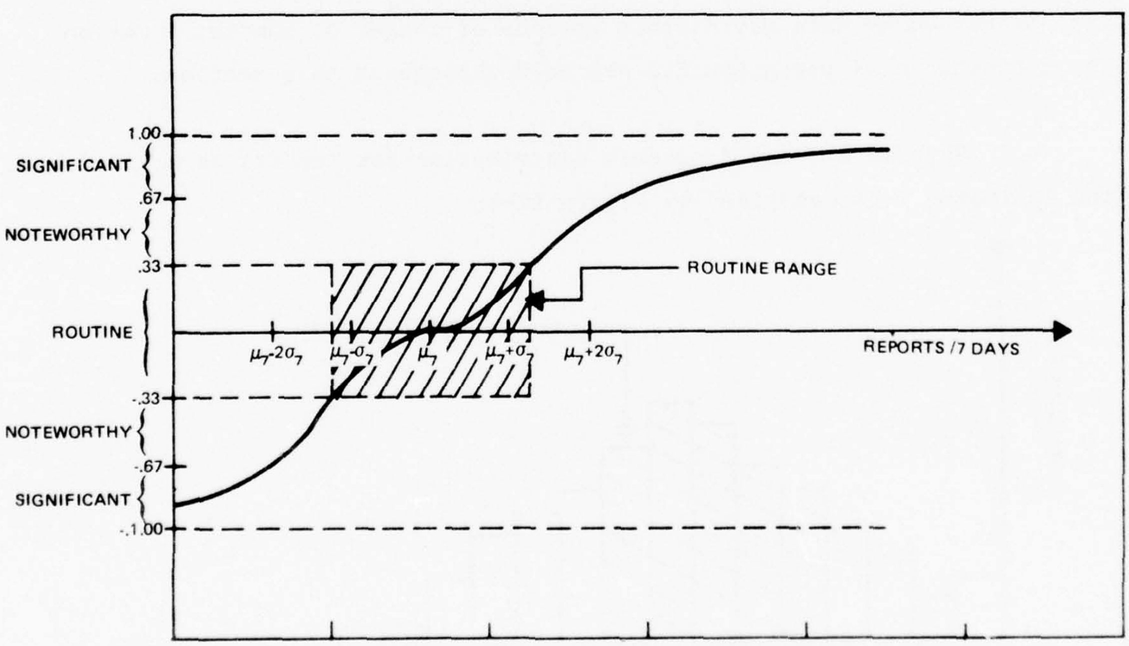


Figure II-5. Incident-Indicator Index (III)

To illustrate the properties of the III suppose an analyst is concerned with the indicator "Unusual Political Leadership Movements USSR/Warsaw." From the historical data file suppose it was determined that the indicator has a frequency distribution shown by Figure II-6:

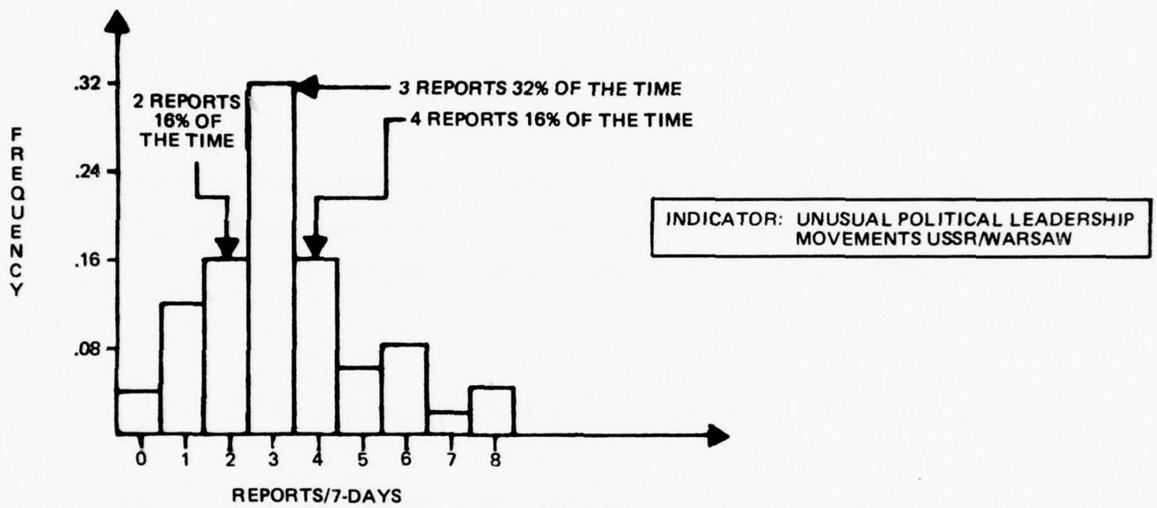


Figure II-6. Frequency Distribution for Unusual Political Leadership Movements USSR/Warsaw

The figure shows he receives 2 reports 16 percent of the time, 3 reports 32 percent of the time, 4 reports 16 percent of the time, etc.

The mean μ and the standard deviation σ computed from the distribution are $\mu = 3.25$ and $\sigma = 2.5$ approximately. Suppose that after considering the particular indicator and its distribution in Figure II-4, the analyst decides that he would want both 2 and 4 reports in 7-days to be considered "routine." This decision determines the appropriate value of $\propto$, since he has implicitly set the requirement that

$$III = e^{\propto\left(\frac{2-3.25}{2.5}\right)} - 1 = -.33$$

which sets the value of α = .80 approximately. In this example then, the III for the indicator "Unusual Political Leadership Movements USSR/Warsaw" would be

$$III = \begin{cases} 1 - e^{-.8\left(\frac{X-3.25}{2.5}\right)} & \text{when } X \geq 3.25 \\ e^{+.8\left(\frac{X-3.25}{2.5}\right)} - 1 & \text{when } X < 3.25 \end{cases}$$

Now if the analyst receives 5 reports matching this indicator this week, x would be 5 in the III formula and the index value would be approximately .434 which is in the "noteworthy" range; that is,

$$III = 1 - e^{-.8\left(\frac{5-3.25}{2.5}\right)} = 1 - e^{-.56} = 1 - .571 = .429$$

If on the other hand, he received no reports this week, X would be zero in the formula, and the III value would be near the "significant" range since

$$III = e^{+.8\left(\frac{0-3.25}{2.5}\right)} - 1 = e^{-1.04} - 1 = .35 - 1 = -.65$$

4. Event Class Index

A high value of the III for a particular indicator, alone, would alert an analyst to an unusual level of activity related to it. While this is certainly a help to the analyst, he must still monitor and interpret hundreds of indicators and incidents. One of the primary aims of the TEDS system is to help focus the analyst's attention to those incidents that are associated with the imminent occurrence of an event.

The basis for the association of indicators and incidents with an event class is the event classification system developed under the previous contract. Using this classification scheme, each event class, E, is associated with a subset of indicators $\{I_1, I_2, \ldots, I_m\}$. Thus, an aggregate measure of the level of the indicators in the subset is a measure of the level of activity associated with the type of event represented by the subset. The simplest aggregate index of this type is an arithmetic average of the individual III's for the indicators in the subset. The Event Class Index (ECI) for a given event class E associated with the subset of indicators $I_1, \ldots, I_m$ is defined as

$$(2) \quad ECI_E = \frac{1}{m} \sum_{i=1}^{m} III_i$$

where III_i is the Incident-Indicator Index for indicator I_i. Note that similar to the III index, the ECI varies between plus and minus one. Further, retaining the "routine-to-significant" terms, the ECI has the property that when all the indicator indexes are in the "routine" range, then so is the ECI; similarly, the "noteworthy" and "significant" ranges carry over.

The ECI has been included in the system because it is an objective assessment of the activity associated with any event class E. However, the usefulness of the ECI, alone, in the prediction of events is severely limited by the fact that it treats indicators in an event class linearly and in equal proportion to every other indicator in the same event class. The primary use of the ECI is to serve as a measure of the success of the more involved Weighted Event Class Index (WECI).

5. Weighted Event Class Index

The WECI is a measure designed to adjust for the deficiencies of the ECI and to allow some freedom in formulating the relationships among indicators and event classes. The WECI may be expressed in one of three forms:

- Linear
- Nonlinear Joint
- Nonlinear Substitute

a. Basic Linear Index

In its simplest form, the WECI is a linear index which allows for relative weighting of the different indicators. If $I_1, I_2, \ldots, I_m$ are the indicators related to event class E, then,

$$(3) \qquad WECI_E = \alpha_1 \, III_1 + \alpha_2 \, III_2 + \ldots + \alpha_m \, III_m$$

where the relative weights α_i must satisfy $|\alpha_1| + |\alpha_2| + \ldots + |\alpha_m| = 1.00$. Ideally, the weights assigned to each indicator would be the regression coefficients determined through an empirical analysis of data processed by the system. In the prototype system, these weights would be based on the limited regressions previously run and on a priori estimates of the relative significance of the individual indicators.

b. Nonlinear Joint Effect

The basic linear index is modified to accommodate the situation where the presence of one indicator adds to the significance of the other. That is, the joint occurrence of two indicators is the significant forecaster of an event rather than the single occurrence of either. To simplify notation, suppose that I_1, I_2, I_3 are related to event class E, then the linear index modified by a joint effect has the form

$$(4) \qquad WECI_E = \alpha_1 \, III_1 + \alpha_2 \, III_2 + \alpha_3 \sqrt{III_1 \, III_2} + \alpha_4 \, III_3$$

where $|\alpha_1| + |\alpha_2| + |\alpha_3| + |\alpha_4| = 1.00$ and the third term indicates the joint effect of indicators I_1 and I_2.

To illustrate the use of this joint effect, consider the relation between two indicators--"Troop Movements" and "Commanders Moving to Field Positions"--first alone, and then jointly. If a report implying the occurrence of an exercise is based solely on an unusual level of troop movement, then this might convey routine interest. If, on the other hand, we have no evidence of unusual troop movement but had evidence of commanders moving to field positions, interest might be somewhat above routine.

However, if both unusual troop and commander movements are reported then interest might increase significantly.

c. Nonlinear Substitute Effect

The basic linear index is also modified to accommodate those situations in which either of two indicators would suffice to determine that a certain type of effect was present. For instance, in the above example, evidence of VIP's moving to the field area might substitute for (that is, produce the same effect as) commanders moving to the field. If I_1 and I_2 are the substitutable indicators, the form of the index would be

$$(5) \qquad WECI_E = \alpha_1 \max \{III_1, III_2\} + \alpha_2 III_3 + \ldots + \alpha_{m-1} III_m$$

where $|\alpha_1| + |\alpha_2| + \ldots + |\alpha_{m-1}| = 1.00$. Here the maximum function indicates that we would take the larger of the two indexes III_1 or III_2 to compute the WECI for this event class. In this way, an unusual level of activity for either one will add the desired effect.

The above detail serves to illustrate the structure of the proposed weighted index. Obviously, the several effects may be combined in any number of ways and may be applied to more than two indicators if judged appropriate. Further, since some event classes are believed to be precursor to others, the III s might be supplemented by the weighted event class index for another event class in some circumstances to create an index of the form:

$$WECI_{E_2} = \alpha_1 WECI_{E_1} + \alpha_2 III_2 + \ldots + \alpha_n III_n$$

The basic properties of the WECI are similar to those of the ECI in that the index varies between plus and minus one and the intensity level of the indicators carries over to the event class. That is, if all the III's are in the "routine" range, then so is the WECI; similarly, the "noteworthy" and "significant" ranges are preserved.

6. Index of Interest

The Index of Interest (IOI) is not a distinct measure of the likelihood of an event occurrence. It is the name given to the ordered pair in which the first element is the WECI and the second element is the ECI. It is this ordered pair that is presented to the analyst in the first visual display designed to give him a summary of the day's activity and to serve as a starting point for his investigation of the data. (See Figure III-6, for illustration.) If the IOI is known to be high on the ECI scale but low on the WECI scale, the analyst would be alerted to the fact that there was an unusual amount of reports related to a particular event class, but that the reports were associated with indicators not judged very significant by the TEDS model. On the other hand, a high WECI but low ECI value would point out a few messages related to indicators judged very significant by the TEDS model. Thus, the IOI is an index of the likelihood of an event occurrence with values in the square (-1, 1) x (-1, 1) where the first dimension is a measure of the significance of the reports received and the second is a measure of the amount of reports received.

D. Summary

This chapter has discussed the hypothetical relationships that exist among I&W indicators, incidents, and event classes; and the mathematical treatment of each relationship. The next chapter will discuss the computer processing phases in the TEDS functional design.

Chapter III

FUNCTIONAL DESIGN OF THE EVENTS DIAGNOSTICS SYSTEM

A. Overview

The functional design for TEDS is described in the subsequent sections of this chapter. A functional design simply sets forth what the system must do to satisfy the requirements to provide diagnostic aids to an I&W analyst. The major functions of TEDS have been divided into three major phases for expository purposes:

- Data Coding Phase
- Processing Phase
- Analyst Diagnostic Phase

Section B describes the data coding phase. This phase establishes the protocols to be followed for coding reports of significance to an I&W analyst so that the data are amenable to computer processing during the Processing Phase.

Section C describes the Processing Phase. This phase involves the programming requirements associated with the calculations of the three major indexes to be used to create displays for use during the Analyst Diagnostic Phase.

Section D describes the Analyst Diagnostic Phase. This section illustrates and discusses graphic displays that can be derived from the methods described in section C and be presented to an analyst to aid his inferential processes concerning the likelihood outcomes of I&W events. The representative displays shown in section D are intended for use on a dual-screen graphic terminal. They could be adapted for use on a dual or single screen alphanumeric terminal. Analytic and diagnostic trade-offs associated with a less sophisticated terminal will be discussed in Chapter IV.

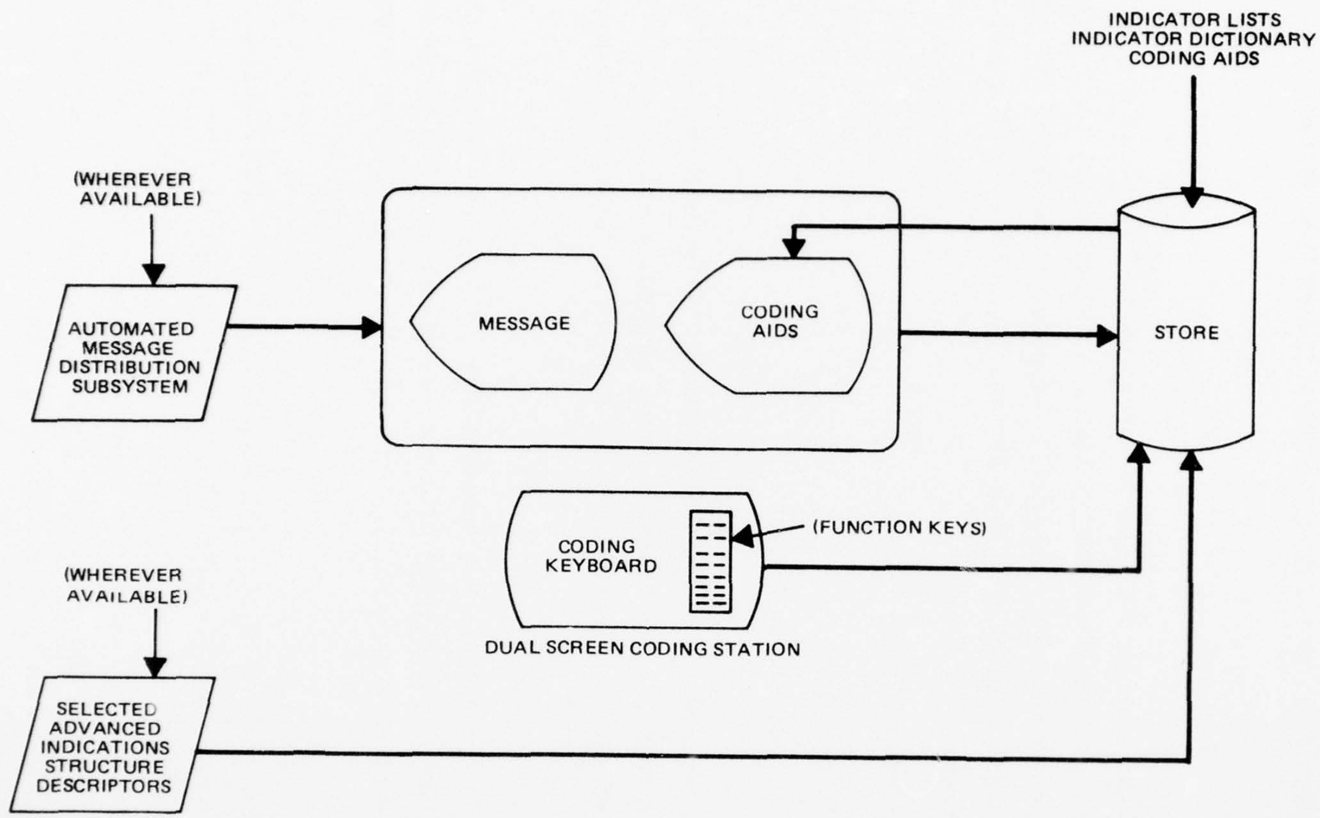


Figure III-l. Coding Phase

B. The Data Coding Phase

1. Major Functions

Figure III-1 shows the major functions associated with the Data Coding Phase. Wherever available, an automated message distribution system would provide report inputs to a dual-screen coding station. Within the DOD intelligence community such automated distribution systems are now in the process of being installed in the DIA National Military Intelligence Center with similar plans envisioned for Headquarters U.S. European Command, Strategic Air Command, and other locations. When available, such automated message distribution systems would be provided with the topic-of-interest profiles of the TEDS coder so that messages would be routed to him directly.

TEDS, however, is not dependent on such a distribution system. Coding experiments have demonstrated that the daily coding of reports of I&W interest can be accomplished manually.

The coder would have a series of coding aids to assist in the identification of incidents reflected in the reports, indicator titles and numbers that are matched, geographic abbreviations, and the like. (Specific aids are discussed in the next paragraph).

In addition to the review and coding of clear-text reports, TEDS will store selected and relevant AIS descriptor data wherever these data may be available.

2. Coding Protocols and Aids

Based on research from previous efforts coding protocols are straightforward and have been shown to be about 95 percent consistent among various coders. The 5 percent error rate does not significantly impact the outcome of statistical calculations discussed in section C. There are two basic needs for an efficient coding operation:

- Selection of Coder
- Coding Aids

a. Selection of Coder

A coding function is sometimes perceived by those familiar with the computer environment to be among the more menial tasks. In the case of TEDS, such perceptions would be grossly in error as the report inputs represent a critical first link in the long chain of functions discussed in this chapter. Accordingly, a coder for TEDS must be a judicious reader who can discriminate among words on a report that reflect the raw description of an incident and those that reflect speculation.

b. Coding Aids

To illustrate the coding aids, assume the coder should read the following message either as received manually or via the left screen at a dual-screen console:

```
101500Z Oct 76
FM: DAO/MOS
TO: DIA
INFO: INDIC Z
UNCLASS. EFTO. SUBJ: STRATEGIC AIR EX
IN FEATURED PRAVDA ARTICLE TODAY SOVDEFMIN ANNOUNCED
LRAF WAS ON WIDE ALERT TO PARTICIPATE IN FORTHCOMING
EX ON UNSPECIFIED DATE. WILL FOLLOW WITH DETAILS AS
AVAILABLE. END.
```

With this example in mind, the following subparagraphs describe coding aids that a coder would use to place the report data into TEDS.

(1) Coding Form

Upon receipt of the report, the coder would begin by depressing a function key on his keyboard (shown in Figure III-1) labeled "Coding Form." With the message on the left screen, a blank coding form would appear on the right screen as shown in Figure III-2. (This example assumes a dual-screen terminal coupled to an automated distribution system).

Atop the coding form is the entry "Item 234." This is a number automatically assigned to each new form to be completed. The number identifies every incident coded and serves as a tag to audit all computer

ITEM: 234	
INCIDENT DATE:	101500Z OCT 76
ACTOR(S):	(1) UR (2) (3) (4)
OBJECT(S):	(1) (2) (3) (4)
LOCATION:	UR
MIL/POL INDICATOR:	M0301
REMARKS:	POSSIBLE FUTURE LRAF EX.

Figure III-2. Coding Form

transactions concerning that particular item to include message retrieval. The remaining lines shown in Figure III-2 are coded as follows:

- Incident DTG. No internal dates are mentioned in the message. With a light pen, the coder transfers the message date-time-group to the Coding Form as being the closest documented time for the incident.

- Actor(s). The term "actor" refers to the country of origin of the act. In this case, it is the Soviet Union whose standard computer abbreviation is "UR." If two or more states were acting against another state, three additional blanks are provided to enter their two-letter abbreviations.

- Object(s). The term "object" refers to a country towards which the actor is directing its action. The message did not specify an object. The alert of the LRAF is assumed to represent internal training only. This line is left blank.

- Location. This is the country in which the incident takes place. In this case, it is the Soviet Union--"UR."

- Indicator. The indicator number that matches the incident is used. This is the most difficult part of the coder's task and aids are provided, as discussed below, to assist him. In Figure III-2, M0301 stands for "Announced Strategic Air Alert."

- Remarks. The coder types his plain text summary of the message content. As shown in Figure III-2: "Possible Future LRAF Ex." This is, of course, speculative as based on the DAO report with indicator M0301 as one substantiating bit of before-the-fact evidence.

The coder would proceed through all messages at his station extracting the pertinent incident content from each message. More than one incident may be contained in a single message and an incident may, during the processing phase, be associated with one or more event classes. As in the case of the strategic air alert, an association with event class J, Exercise, is a possible choice but association with G3, Redeployment of Forces, is also pertinent. As explained in the Processing Phase, the indicator M0301 would be filed in both event classes--a process which is of no concern to the coder.

After a message has been coded, the coder would press a function key, "File," at his keyboard. The coding form and the message from which it was derived would be filed together for subsequent retrieval when requested by the analyst from his console.

(2) <u>Additional Aids</u>

Four additional coding aids would be available for use by the coder. Depending upon the configuration of the computer and terminal upon which TEDS is implemented, these aids are amenable to automated presentation or assembly into a brief, indexed manual. The same aids used by the coder would also be available to the analyst when he begins to interact with TEDS to test hypotheses and make diagnostic assessments.

(a) <u>Alphabetic List of Country Abbreviations</u>

Several "standard" alphabetic lists of country abbreviations have been used within the intelligence community. The list selected for illustration in this report is that used by the DIA. However, any list designated by a user organization may be used. The major criteria for list selection, of course, would be the one that is most familiar to users within the organization. The list would be presented in both Abbreviation-Country and Country-Abbreviation formats.

(b) <u>List of Countries by Geographic Region</u>

Lists of countries by geographic region would also be provided. Agains, such lists often vary amont intelligence organizations as a function of how analysts are assigned their analytic responsibilities. For example, U&S Commanders have intelligence staffs organized to focus on the Commander's geographic area of responsibility wherein regional terms such as "North Africa," "Middle East," "Northern Europe," etc., do not always list identical countries as those contained in a Department of State list. The purpose of regional lists in TEDS is to provide an analytic capability at a very general, regional level of event classes whenever the need may arise and be deemed pertinent to a special problem. As currently designed, TEDS acquires data by individual country. Aggregation of the country data by region may have some utility for particular users.

(c) <u>List of Military Indicators</u>

Offical indicator lists now published usually describe indicators of interest in text form and in general terms. A list of 200 indicators may be presented in only 10 pages of text but this still tends to constrain any potential for quick reference to mutually exclusive and mutually inclusive indicators. Analysis of various indicator lists shows that it is possible to select key action verbs and nouns from the texts and arrange these in columns to permit quick identification of generic meaning of each indicator. Table 3-1 shows a representative arrangement of this kind.

The left-hand column in Table 3-1 shows the force that is acting with each force assigned an arbitary number to be preceded by the letter "M" to distinguish military indicators from political-economic ("P") indicators. The right-hand column shows the action that has been reported to have occurred. These actions have also been assigned an arbitrary number. Any combination of the left-hand column number with the right-hand column number provides the military indicator number. For example, from the left hand column, under "Air Forces," is "M-03 Strategic," which when combined with "01 Announced" under the "Alert" keyword, yields M0301 Announced Strategic Air Alert.

After several coding days, a competent coder will have acquired facility with the number-word associations since they remain constant. An M03 in the first two positions will always represent a Strategic Air Force while the last two positions will always represent the reported action as listed.

Table 3-1. Illustrative Two Column Array of Military Indicators and Number Assignment

Military Force Acting[1]	Reported Action
AIR FORCES	ALERTS
01 Tactical	01 Announced
02 Air Defense	02 Inferred
03 Strategic	03 Observed/Reported
04 Military Airlift	CLOSURES
05 Civil Air	10 Military facilities
06 Paramilitary	11 Civilian facilities
NAVAL FORCES	12 Training areas
10 Surface Combatants	13 Sea areas
11 Offensive Submarines	CONFLICT ACTIONS
12 Attack Submarines	20 Armed Raids
13 Surface Support	21 Destroy Property
14 Special Purpose	22 Injure Persons
GROUND FORCES	23 Take hostages
20 Infantry	24 Occupy territory
21 Artillery	25 Blockade
22 Tank	26 Shoot, Shell, Fire, Bomb
23 Airborne	27 Shoot down aircraft
24 Support	28 Sink ship
MISSILE FORCES	29 Pitched battle
30 Intercontinental missiles	PERSONNEL
31 Medium/Intermediate missiles	30 Commander move to field
32 Tactical missiles	31 Change in Senior commander
PARAMILITARY	32 Command reserve callup
40 National Police	33 Cancel leaves
41 Local Police	DEPLOYMENTS
42 Security Police	40 Disperse to field positions
43 Border Guards	41 Depart permanent station
44 Guerrilla Unit	42 Establish defensive position
45 Terrorist Unit	43 Increase Weapon System inventory
50 UNIDENTIFIED	

[1]The force list is presented for illustration only. Not all countries possess all forces shown.

There are several advantages in presenting indicator lists in this fashion:

- Several hundred indicators appear on a single page for quick reference look-up.
- All forces for a particular country may be specified.
- The lists are flexible and may be tailored to meet the concensus vocabularly of a user's organization.
- All indicators are easily tagged for computer processing in response to an analyst query to list all reports pertaining to single or multiple indicators that may be of particular interest to an analyst.

(d) List of Non-Military Indicators

Non-military indicators may be treated in the same way as discussed for the military indicators. Non-military indicators would include those derived from political, diplomatic, and economic actors and actions and be designated with the letter "P." An abbreviated list showing more than 200 possible indicator combinations appears in Table 3-2.

As in the case of the terms used for military indicators, not all possible combinations in Table 3-2 are likely to be used as common expressions describing an incident. Some obvious examples of these would include P0109 Accept Criticism, P1712 Threaten Humanitarian Support, and P1615 Suspend Warning.

C. The Processing Phase

1. Overview

This section describes the daily processing cycle undertaken by TEDS after all reports have been encoded. As shown in Figure III-3, the processing phase results in the calculations of III, ECI, and WECI and the presentation to the analyst of the first in a series of graphic displays. The theoretical concepts and mathematical indexes discussed here were defined in Chapter II, section C. A discussion of the graphic displays will be presented in the next section.

Table 3-2. Illustrative Two Column Array of Non-Military Indicators and Number Assignment

Form of Act or Pronouncement		Substance of Act or Pronouncement	
01	Accept	01	Arbitration
02	Announce	02	Agreement/Treaty
03	Cancel	03	Accommodation
04	Consent	04	Accusation
05	Decrease	05	Assurances
06	Demand	06	Apology
07	Delay	07	Cooperation
08	Deny	08	Compromise
09	Implement	09	Criticism
10	Increase	10	Cultural Support
11	Issue	11	Economic Support
12	Offer	12	Humanitarian Support
13	Postpone	13	Military Support
14	Reject/Refuse	14	Veto
15	Request	15	Warning
16	Suspend		
17	Threaten		
18	Withdraw		

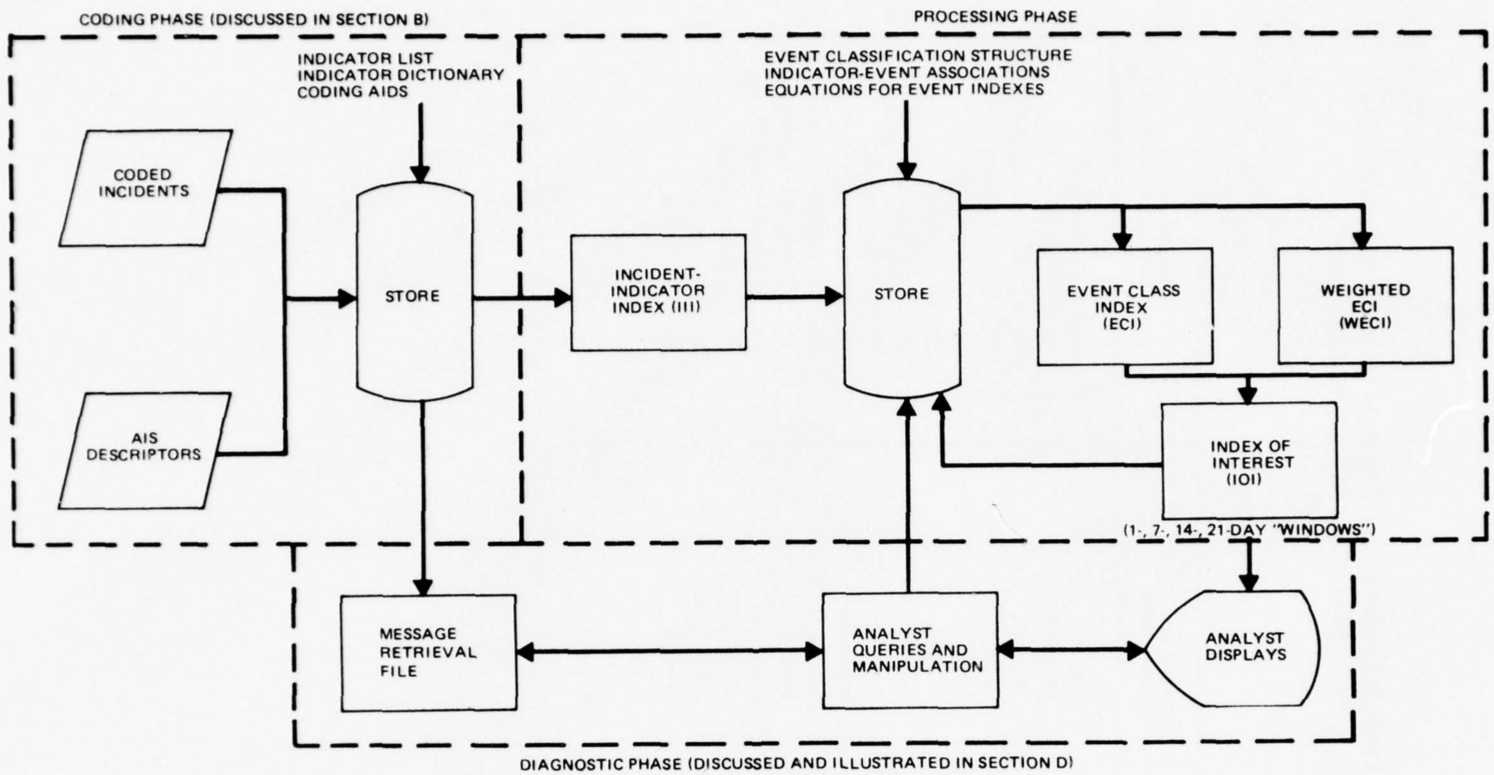


Figure III-3. Processing Phase

The processing will be carried out through a series of programs, each of which supports the next step in the mathematical formulations and the generation of graphic displays. The major programs to be discussed separately in subsequent paragraphs are:

- The Reported Indicator Count Program
- The III Value Program
- The Event Class Index Program
- The Weighted Event Class Index Program
- The Model Updating Procedure

The first four programs are used to support the creation of the fifth in step fashion to yield the ECI and WECI that reflect the before-the-fact likelihood of event occurrences. The fifth item--the Model Updating Procedure--deals with the generation of an after-the-fact regression file to evaluate and adjust the WECI's through time to bring the TEDS model closer to the reality of evaluation as perceived by the primary users.

2. The Reported Indicator Count Program

The first step of the processing phase is the tabulation of the number of reports coded by relevancy to a particular indicator in a particular country. The tabulation is made for the current day on the basis of a 1-, 7-, 14-, and 21-day window. The resulting count is stored in the Reported Indicator Count File which is generically described for a single indicator for a particular country by Table 3-3.

Table 3-3 shows the number of reports for Indicator M0301 in the Soviet Union for n days. After 7 days of reports have been assembled, the 7-day window may be calculated. The 14-day and 21-day windows would be calculated as the data are accrued. The 7-day data is simply the sum of the daily reports matched against a specific indicator for a sliding 7-day window. Distribution statistics, that is, a mean and standard deviation for each window size, would be updated each day.

Table 3-3. Reported Indicator Count File

INDICATOR: M0301/UR

NO. OF DAYS AGO	0	1	2	3	4		N-20		N-13							N-6				N-2	N-1	N
DAILY REPORT DATA	2	0	1	0	0				1	0	1	2	3	1	0	0	2	3	0	0	2	1
7-DAY DATA	5	4	5	6	5				8	7	9	11	9	6	7	8						
14-DAY DATA	12	15	13	12	10				16													
21-DAY DATA	20	18	19	17	15		24															

Table 3-4. The III Value File

INDICATOR: M0301/UR

NO. OF DAYS AGO	0	1	2	3	4		N-20		N-13						N-6					N-2	N-1	N
III 1-DAY	.10	-.25	.10	-.25											-.25	-.25	.10	.25	-.25	-.25	.10	-.10
III 7-DAY	-.60	-.71	-.60	-.31					0	-.17	.17	54	.17	-.31	-.17	0						
III 14-DAY	-.20								.12													
III 21-DAY	-.10						.34															

3. The III Value Program

The values generated by the Reported Indicator Count Program are now used as imputs for formula (1) as presented in Chapter II, section C.3. The resulting computations produce the III values for a given indicator/ country code for each window size. These four values are stored as the current day's entry in the III Value File which takes the same form as the Reported Indicator Count File and is illustrated in Table 3-4. The values in the table are illustrative of the III values for the example indicator. Note that the high values for the 7-day III would indicate unusual activity for the indicator during the past week, while the low value for the 1-day III would reflect a return to normal activity on the last day.

4. The Event Class Index Program

Given the III values, the processing now moves to the generation of event class indexes. The first of these is the ECI, the arithmetic average of those indicators judged relevant to the particular event class. The association between indicators and event classes is contained in the Indicator-Event Class Relational File, which is the embodiment of the Events Classification Structure (ECS) discussed in Chapter II, section B.

5. The Weighted Event Class Index Program

The Weighted Event Class Index Program includes the primary processing of the TEDS model for event prediction. As depicted in Figure III-4, the III's for the indicators which are related to a given event class will be weighted and combined to give the WECI. Note that a given III may be used to predict more than one event class and will be weighted differently in each case. For example, a bitter accusation by a foreign leader might contribute significantly to the event class B2, Verbal Threat. The same accusation however, might also represent a small portion of the explanation for the more serious event class C1, Diplomatic Pressure, at some future date. Thus the indicator would be associated with both event classes but would be weighted higher in the first case than the latter.

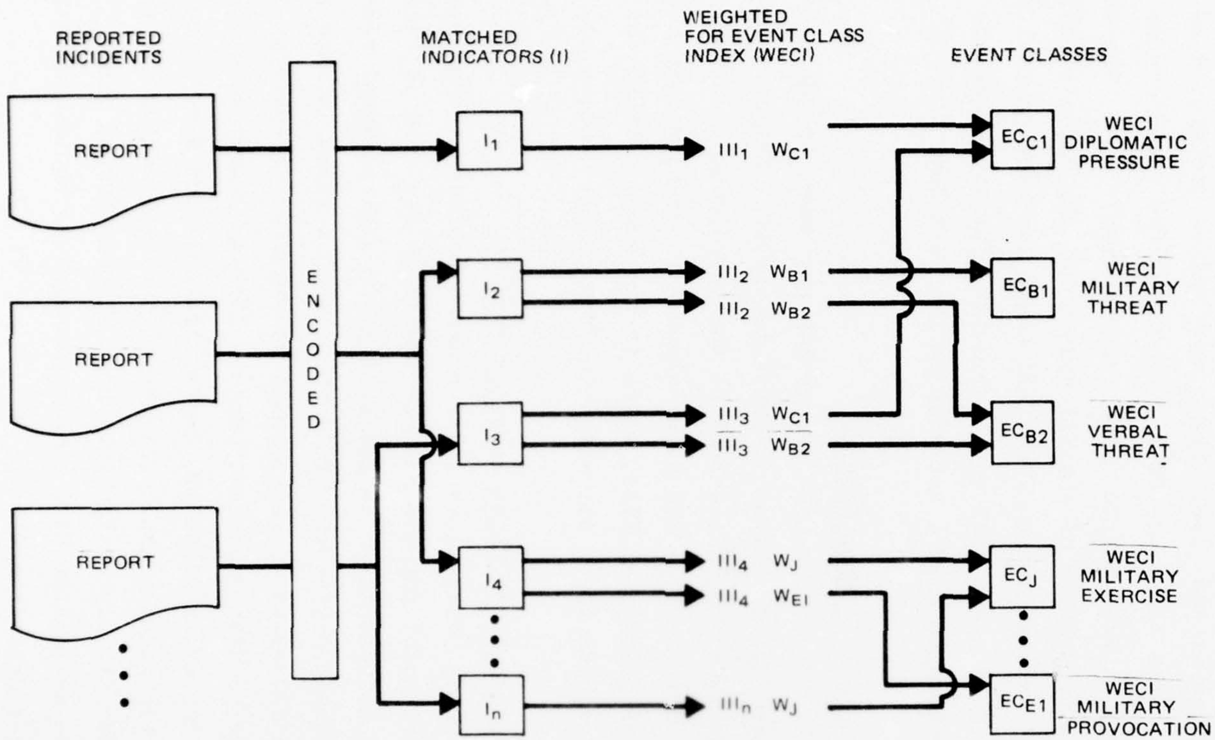


Figure III-4. Flow of Indicator-Event Class Associations

The formulas necessary to do these computations would be derived from the Indicator-Event Class Relational File. In addition to containing the association between indicators and event classes, this file would also include the weight of a particular indicator as related to each event class and the form of its contribution, that is, a code to distinguish between linear, joint, and substitute effects (see Chapter II, section C.5).

All computations in the WECI Program will be scoped to a particular country. As such, there would be Indicator-Event Class Relational Files for each country code, and the weights in them would vary with the political and military characteristics of each country. These relational files would contain the body of the TEDS models and would be changed only as part of the model updating procedure.

6. The Model Updating Procedure

The previous files will form the basis for the graphic displays to be presented to the analyst. These displays, discussed in section D, are designed to show the analyst the relationships that exist among indicators, incidents, and event classes, and to help him formulate and test his hypotheses regarding the likely occurrence of events (see Figure III-5). If for any reason during this process, the analyst decides that the output of the TEDS model is unrealistic, he will be provided with coding aids to systematically record his findings and save them. This record constitutes his file of events he would have desired to predict. His event file will be created through the use of a coding form and automatic print function key following procedures similar to those described for the coder. These recorded discrepancies will be used to periodically analyze the TEDS model and to improve its predictive capability.

In parallel with the routine processing shown in the top part of Figure III-5, the analyst will be asked for his event file reflecting events that are known to have occurred after-the-fact. His file, together with the incident file, will be used to run regressions periodically to improve the predictive model. The analyst's records described above will also be used

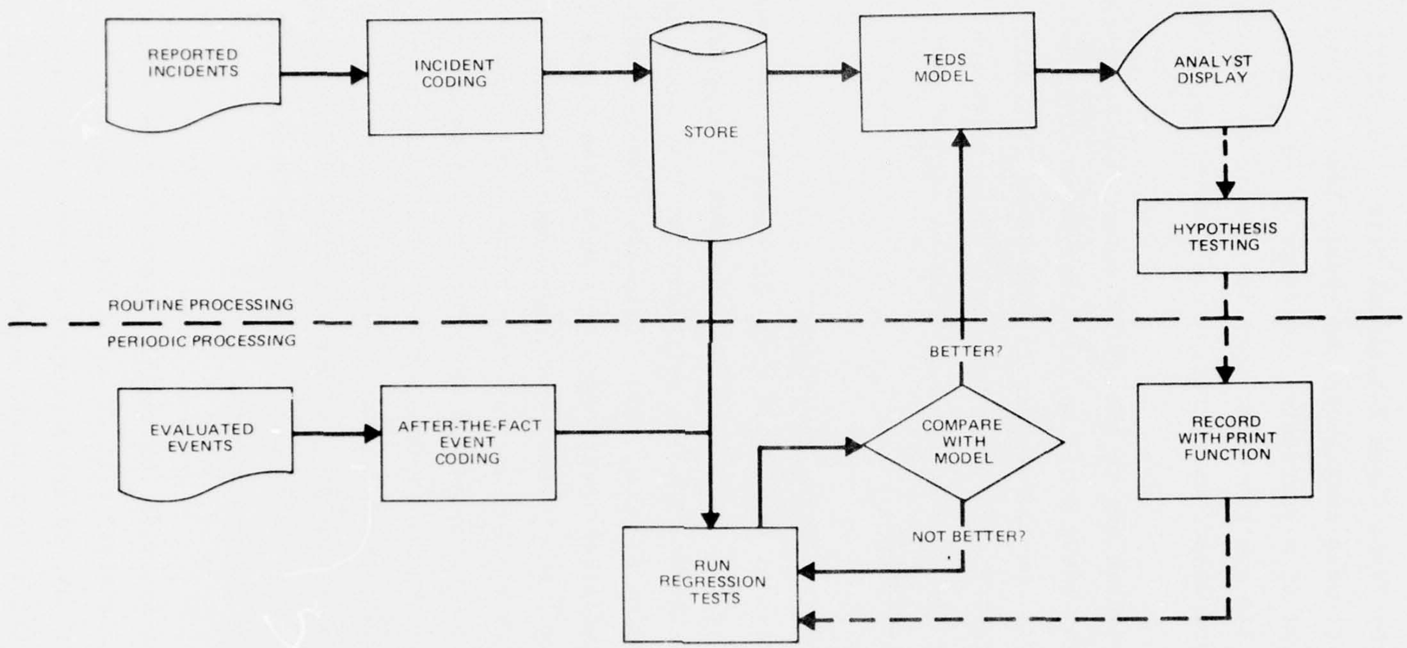


Figure III-5. Periodic Processing for Model Improvement to determine what form the regression equation should take, what additional indicators should be used, and what weights should be assigned to indicators with sufficient data to give reliable regression coefficients.

The period selected for model updating will most likely vary with the nature of the event and event classes under inspection for model improvement. For example, a change in the senior leadership of a particular country could dramatically change the value of indicators associated with diplomacy, economics, and general politics. The very style of one leader would not send the same "signals" as the style of another. In such a case, three or four months might pass before sufficient evidence is collected to adjust the indicators. On the other hand, selected routine military operations associated with training patterns are not so heavily impacted with a change in political leadership. Introduction of a new weapon or construction of a new military base would have a direct impact. In any event, it is not envisioned that the updating procedure would occur more frequently than once a month and once the model has stablized, probably less often.

Once the statistical processing has been completed and a new model developed, parallel testing with the old model would determine if an improvement could be made and if so to what extent a historic time trend adjustment would be required.

D. The Diagnostic Phase

This section describes the prototype diagnostic graphic aids to be presented to the analyst to aid his assessments and likelihood forecasts of an occurrence of an event.

The discussion on graphic aids assumes the presence of an analyst terminal with these capabilities:

- The graphics may use orthographic projections including directed line segments.
- Textual material in rows and columns may be displayed 30 lines deep and 80 characters wide.

- Terminal displays may be manipulated by the analyst with cursive devices to include a light pen and several generic function keys.
- Display contents should be able to be positioned under analyst control on either of two parallel CRT's.
- Both graphic and textual content of the displays may be transformed under user control to a local hard copy printing device.

This assumption has been made to optimize the potential for diagnostic displays. However, all of the prototype displays discussed in the following paragraphs could be redesigned to accommodate terminals with less flexible capabilities. For example, displays using lines could be converted to histogram form using standard keyboard symbols as substitutes for the lines. This approach, while feasible, would most likely sacrifice the facility with which an analyst could perceive major trends, averages, and other smoothing techniques that may be portrayed with the input data. Screens of smaller size would result in excessive crowding and severely constrain the amount of data that could be displayed in readable format. In some cases, historic displays showing six-month trends would be cramped and inhibit the analyst from making approximate interpolations of index values for specified dates.

While the following discussion presents each display singly in a sequential illustrative set, the reader is asked to bear in mind that any two displays would be available to the analyst for comparison purposes at any one time. It is not possible to forecast which two displays an analyst might wish to compare during the course of his work. With the exception of the first display, the Index of Interest, which is always the start point for interactive query, all other displays may be called up on either screen on demand.

In the discussion to follow, possible interpretations of each display are presented to illustrate a few plausible conclusions. Other interpretations are certainly possible and would be made as a matter of course.

1. Display 1: Index of Interest (IOI)

Figure III-6 shows the IOI. By pressing a function key labeled "IOI" the display will appear on his left screen. The display represents a summary of all index computations and reports on file during the past 24 hours that qualified as noteworthy and significant events. The IOI was designed to simulate the substantive interest of one analyst replacing another when reporting for duty on shift work.

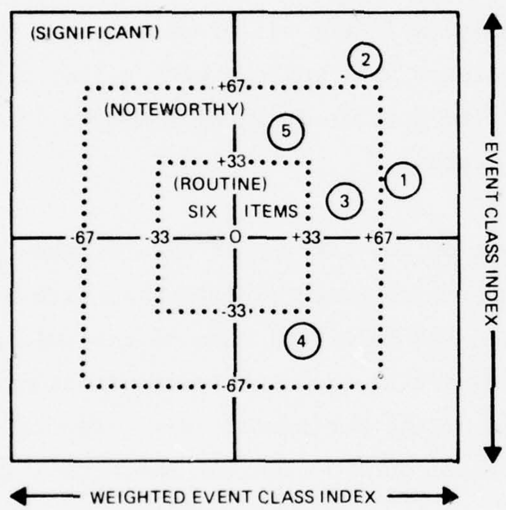
Typically, an incoming I&W analyst will ask his predecessor: "What's going on?" Typically, his predecessor will respond with a few, short, generic sentences and add: "You'll find the details in those messages in the box. I've also made a few notes in the journal."

The five items of interest shown on the right-hand side of the IOI simulate generic human descriptions of the major event classes that have been reflected in reports. The grid display on the left-hand side of the IOI is arranged in a Cartesian two-dimensional square to show the index values of the ECI on the vertical axis and the WECI on the horizontal axis. The values for each of the five event classes listed on the right of the screen are shown as plotted on the grid.

Scanning the grid, the analyst sees that the outer one-third represents significant events and most likely should be examined first. The middle one-third represents noteworthy events and may be examined next. The center portion of the grid represents routine events. These may be queried for specifics after the other five IOI items have been inspected.

Also from the grid, the analyst may draw two basic inferences for any event class in which he is interested. The five items of interest in Figure III-6 are plotted first along the horizontal, or WECI axis, then along the vertical, or ECI axis. In this way the analyst may visually sense that the greater distance from the vertical axis signifies event classes with greater and lesser weights while the greater distance from the horizontal axis signifies event classes with higher or lower reporting deviations.

INDEX OF INTEREST



SOVIET UNION

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ITEM	ACTOR/ OBJECT	EVENT CLASS
1	UR/US	B2 VERBAL THREAT
2	UR/US	C1 DIPLOMATIC PRESSURE
3	UR/–	J1 AIR EXERCISE
4	CH/UR	B2 VERBAL THREAT
5	UR/–	J2 NAVAL EXERCISE

DIAGNOSTIC AIDS? ●

Figure III-6. Index of Interest

For example, in Figure III-6, Item 1 is in the "Significant" range because it is reflecting a WECI beyond .67 even though reports on the event class (reflected by the ECI) are in the "Routine" range. Conversely, Item 2 is in the "Significant" range because a high level of reporting beyond .67 has been noted in the ECI, while the WECI is in the "Noteworthy" range at somewhat less than .67.

The following descriptions of the displays assume the analyst would wish to investigate the relationships between the first two items on the IOI--Verbal Threat and Diplomatic Pressure event classes. To proceed with the investigation, the analyst would light-pen the query "Diagnostic Aids?" as shown at the lower right-hand corner of Figure III-6. This would cause Display 2, Diagnostic Aids, to appear.

2. Display 2: Diagnostic Aids

The Diagnostic Aids display, Figure III-7, shows a list of additional displays available for the analyst's inspection. He may obtain the IOI, Number 1, and the Status of Soviet Strategic Offensive Forces, Number 6, by directly light-penning either number. Displays 2, 3, 4, and 5 may be obtained by following the tutorial procedures after each as signified by the symbol "▲."

The procedure for obtaining Event Class History (2) and Event Class Calculations (4) are the same. At the bottom of Figure III-7, under the heading "A," are four blanks to be completed by the analyst. Of these, "Location" is an optional one where the location of interest is either larger or smaller than a single country area. For example, he may wish to see trends by a region consisting of several countries, or he may wish to see trends as recorded for a specific area.

If he wished to compare two event class trends by obtaining the Dual Event Class History display (3), he would complete the blanks under both columns "A" and "B" at the bottom of Figure III-7.

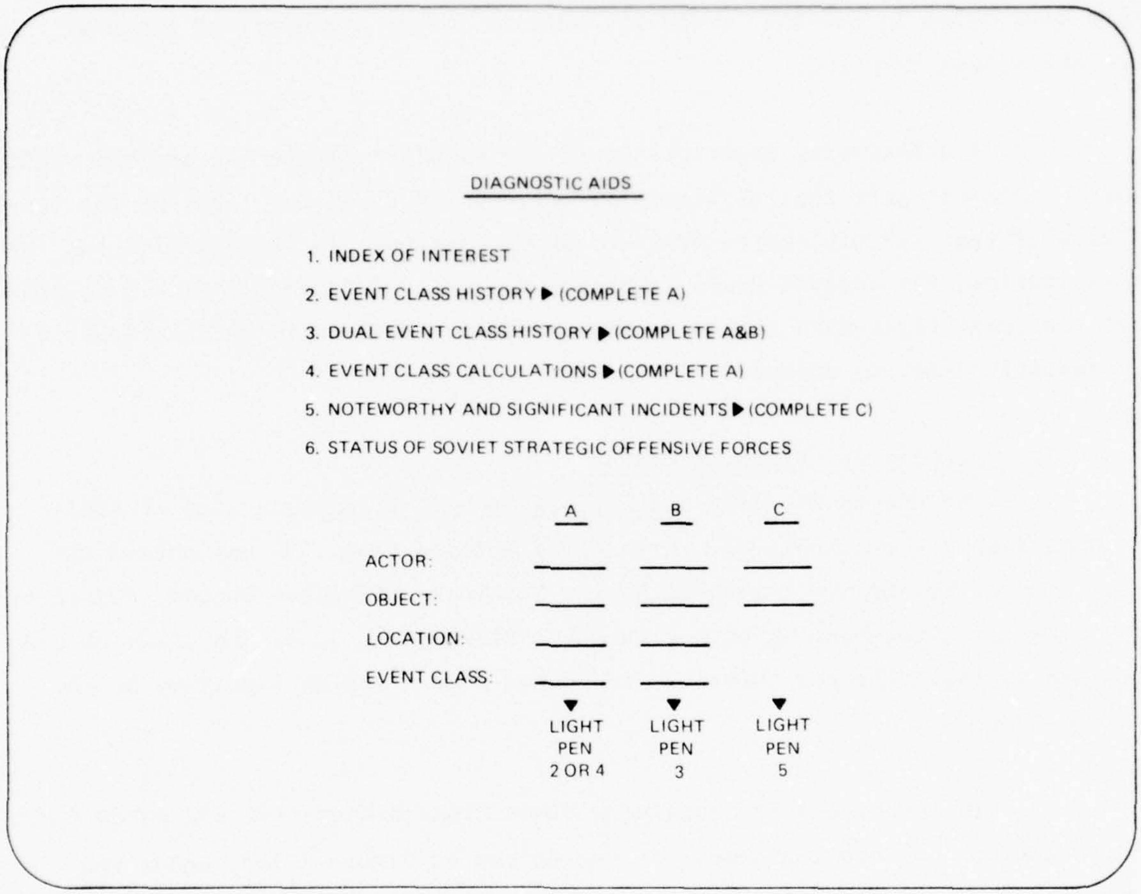

Figure III-7. Menu of Diagnostic Aids

Finally, if he wished to ignore the suggestions provided by his first display--the IOI--he may call up all noteworthy and significant incidents by their raw values regardless of event class relationships by selecting Number 5. In this case, he would complete column "C" and light-pen item 5.

For expository purposes only, assume the analyst wishes to see the Event Class History for the Soviet Union presenting Verbal Threats to the U.S., event class B2. He would complete column "A" with these entries:

Actor:	UR
Object:	US
Location:	--
Event Class:	B2

then light-pen item 2 on the menu. Display 3 would appear.

3. Display 3: Event Class History

The Event Class History display is shown in Figure III-8. Identification of the data to include the window size and period are shown at the top of the display. The WECI is shown in a solid line with the ECI shown by a dotted line. The bottom line of this display is reserved for post-facto entry of events that occurred and were judged to have high correlations with the event class peaks-and-valleys displayed by the WECI and ECI. Recall from the IOI, Display 1, that the analyst is working on diagnosis of event class B2 for 10 October 1976. Figure III-8 is the history of that event class with the current date appearing as the last entry at the right edge of the screen.

Reading from left-to-right, the analyst can see that WECI and ECI both peaked in late March. At the bottom of the aid he also sees this was attributed to the U.S. giving support to Angola. The indexes began to fall after March with the reporting index (ECI) moving into negative values in early June. He notes this was attributed to the U.S. Vice President making

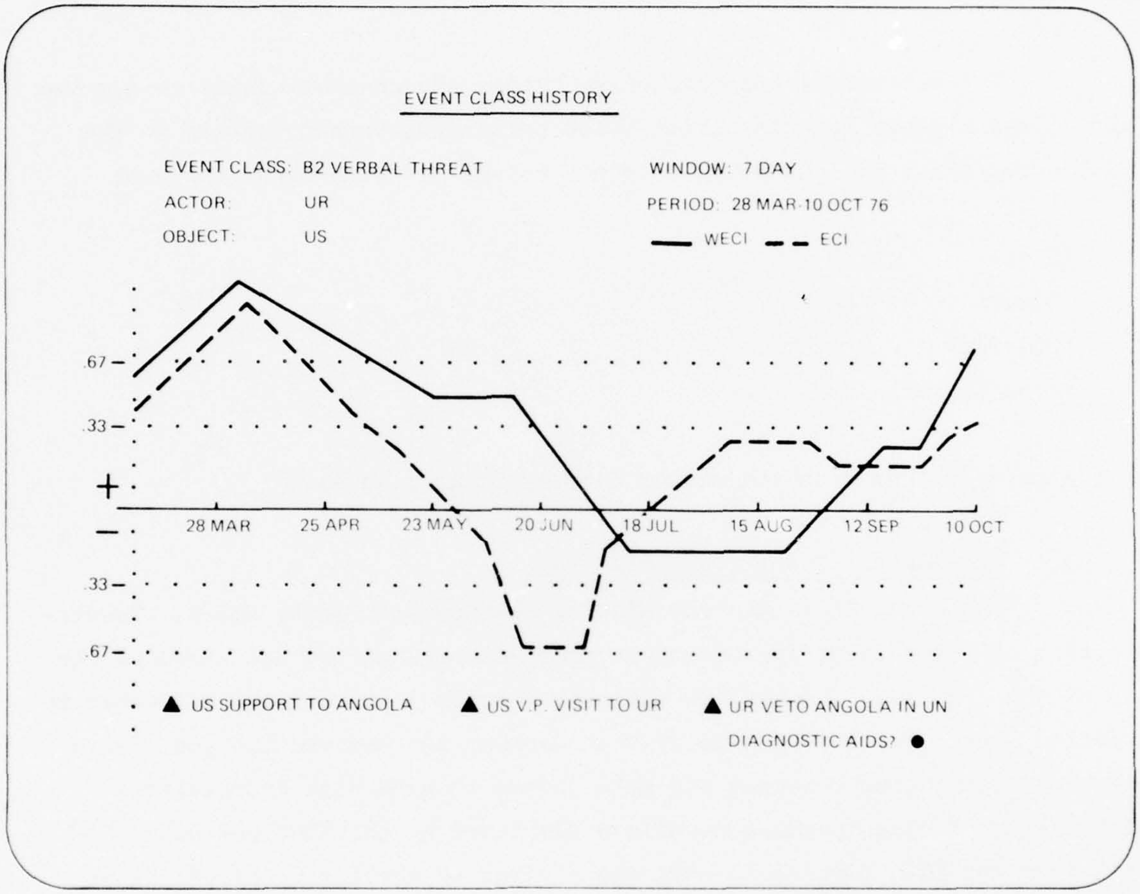

Figure III-8. Event Class History

a visit to the Soviet Union. He could conclude that one would not expect many verbal threats to be reported while a senior leader of one nation was visiting another. After the visit, however, the ECI began to rise. It is possible that the WECI remained high during this period reflecting a time lag in the perception of report writers. However, the rise in the ECI as well as the drop in the WECI remained in the routine range for July, August, and September. In mid-August the Soviets vetoed an Angola issue in the UN with the WECI beginning to rise sharply since that time. The analyst may now suspect some similar pattern is beginning to form as he sees the trend lines moving to 10 October are of similar slope as those noted back in March.

Since event class C1, Diplomatic Pressure, was also high on the IOI display, he decides he would like to compare the two event classes, B2 and C1. To do this, he would light-pen "Diagnostic Aids" which would reappear on his screen and follow the procedures previously described to obtain the Dual Event Class History display.

4. Display 4: Dual Event Class History

Figure III-9 shows the Dual Event Class History display. This display shows identifying data at the top as in the previous display. Since this compares the WECI's of two event classes, an additional line of post-facto events is added just above the graph proper for the second event class, in this case, C1: Diplomatic Pressure.

The analyst now notes that shortly after the U.S. had supported Angola in March, the USSR halted African talks. Moreover, in general, Diplomatic Pressure WECI's parallel the Verbal Threat WECI's. He believes he may expect both of these event class trends to continue for the near term.

Having inspected the general trends of these event classes, assume the analyst now wishes to see what specific indicators were matched by recently reported incidents. He proceeds, paging through the Diagnostic Aids as described for the last display. This time he light-pens Number 4, Event Class Calculations.

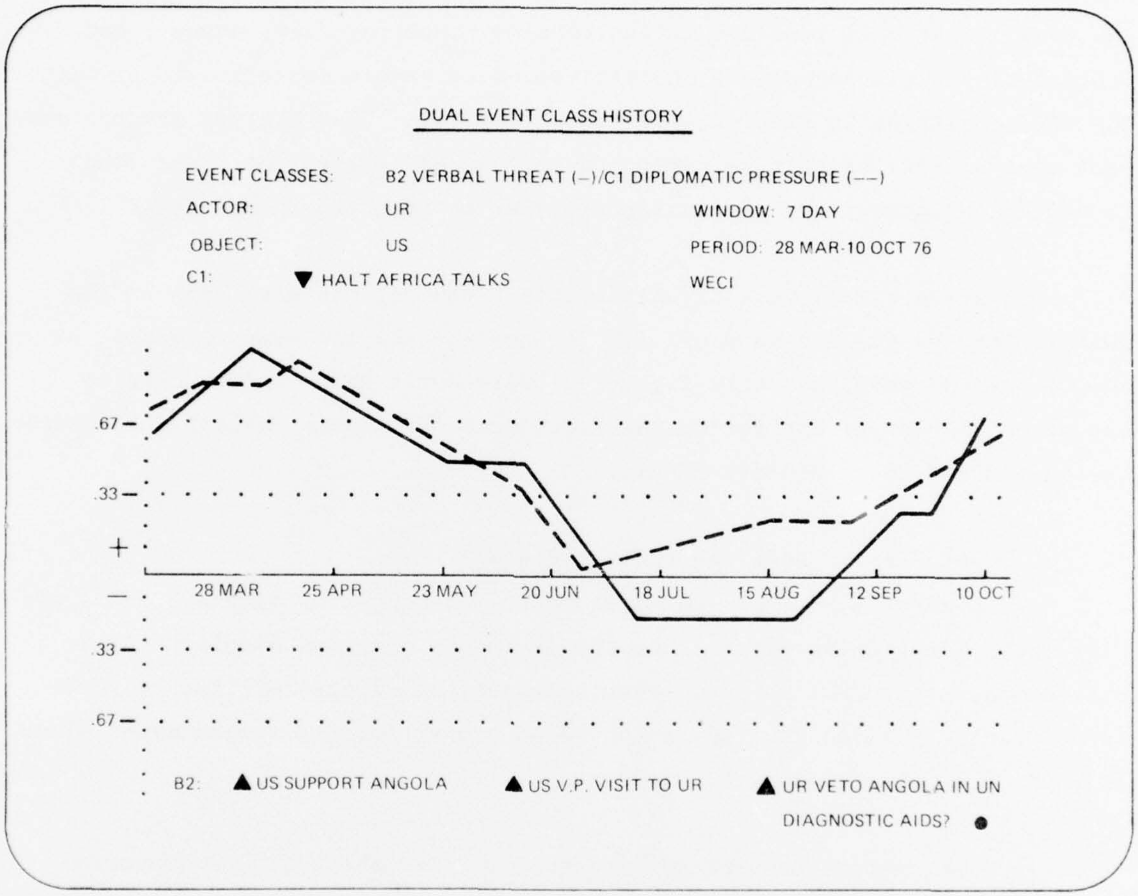

Figure III-9. Dual Event Class History

5. Display 5: Event Class Calculations

Figure III-10 shows the Event Class Calculations display. As shown, this display reveals all indicator numbers, their titles, number of reports on file for each, their III weights, and WECI's. Now, the analyst has more concrete information upon which to base his judgments. He may inspect the indicators that have been matched with reported incidents and judge if they are sufficient in his perception to warrant the significant (.68) evaluation.

If for any reason he elects not to accept TEDS calculations, he may redistribute the number values for any of the indicators shown. The blanks under the "Change" column in Figure III-10 are provided for this purpose. He then presses a "Compute" function key. His values will be used to recalculate the equation with the results presented to him on a printer device. (His values do not change TEDS values at this time.)

As discussed in section C.6 these printouts constitute the analyst's event file. He may retain them for a period while he audits ex-post facto incidents to see if his values are more appropriate than those programmed in the TEDS model. Regressions will be applied to his event file periodically to determine which values, if any, should be changed.

This display also permits the analyst to inspect the specific messages from which all coded incidents were taken. To obtain these messages, he light-pens the indicator number.

Assume that the analyst has exercised all the above options and read all the messages concerning event classes that were initially presented to him in the first IOI displays. He now decides that regardless of event class associations, he would like a display of any indicator that qualifies as noteworthy or significant. Once again, paging through the Diagnostic Aids display he may obtain Display 6.

EVENT CLASS CALCULATIONS

EVENT CLASS: B2 VERBAL THREAT WINDOW: 7 DAY
ACTOR: UR PERIOD: 3 OCT-10 OCT 76
OBJECT: US

INDICATORS	REPORTS	III	CHANGE	WT	CHANGE	WECI
P1408 REFUSE COMPROMISE	2	.30	—	.20	—	.06
P0106 ACCEPT APOLOGY	2	-.40	—	-.20	—	.08
P1714 THREATEN VETO	6	.90	—	.60	—	.54
		ECI=.27				.68

REVIEW REPORTS? ▶ LIGHT PEN INDICATOR NUMBER

TEST VALUE CHANGES? ▶ ENTER VALUES--PRESS "COMPUTE" KEY ●

DIAGNOSTIC AIDS? ●

Figure III-10. Event Class Calculations

6. Display 6: Noteworthy and Significant Incidents

Figure III-11 shows the Noteworthy and Significant Incidents display. It simply lists all indicators that have been matched with incident reports regardless of event class associations. He may combine these in any way he wishes to form hypotheses on the day's activities and what future events they may portend. He may retrieve all reports upon which incident coding was based in the same way as described for the previous display.

7. Display 7: Status of Soviet Strategic Offensive Forces

Whatever crisis situation an I&W analyst may be monitoring, he has a continuous need to respond to questions regarding the status of the Soviet Strategic Offensive Forces. Figure III-12 shows the status of forces display.

This display uses both factor analysis and regression analysis techniques to obtain the numeric values illustrated. Factor analysis techniques are used to select the most descriptive indicators associated with each of the four major columns headed "Alert," "Deployment," "Signals," and "Exercise." Each of these four groups of indicators is then weighted as a function of how significant they are judged to be in relation to the overall combat status of each force shown in the rows of Figure III-12. This value is a "factor" that is then used in formulas associated with the indicators as processed from the data collected for the other displays. (The column headed "Signals" would consist of incidents as drawn from relevant AIS descriptors wherever these are available.)

This display, unlike the others, does not suggest likely future states. It represents an organized presentation of estimated "combat ready status" for the designated forces similar to status boards now maintained manually.

An extension of this display, not illustrated, would include a graphic display of all four groups of indicators over time so that the analyst may compare the peaks and valleys of each indicator group.

NOTEWORTHY AND SIGNIFICANT INCIDENTS

ACTOR: UR OBJECT: US DATE: 10 OCT 1976

INDICATOR	INCIDENT TITLE	OBJECT	III
P1714	THREATEN VETO	US	.90
P1602	SUSPEND AGREEMENT	US	.53
M0301	ANNOUNCED STRATEGIC AIR ALERT	—	.40
M1013	SURFACE COMBATANTS CLOSE SEA AREA	—	.40
P1408	ACCEPT APOLOGY	US	-.40

REVIEW REPORTS? ▶ LIGHT PEN INDICATOR NUMBER.

DIAGNOSTIC AIDS? ●

Figure III-11. Noteworthy and Significant Incidents

102400Z OCT 76

STATUS OF SOVIET STRATEGIC OFFENSIVE FORCES

GENERAL INDICATORS

FORCES	ALERTS	DEPLOYMENT	SIGNALS	EXERCISE	OVERALL
ICBM	.20	FIXED	.20	.00	.13
MR/IRBM	.10	FIXED	.30	.30	.23
TOTAL ROCKET FORCE	.15		.25	.15	.18
SUBMARINE BALLISTIC MISSILE FLEET	.35	.50	.90	.85	.82
LONG RANGE AVIATION	.72	.50	.20	.35	.65

.0-.33 = ROUTINE .34-.66 = NOTEWORTHY .67+ = SIGNIFICANT

Figure III-12. Status of Soviet Strategic Offensive Forces

E. Summary

This chapter has described the major functions of TEDS in three phases--the Coding Phase, the Processing Phase, and the Diagnostic Phase. A generic estimate of the hardware requirements to implement TEDS along with trade-offs associated with various combinations of the requirements is discussed in the next chapter.

Chapter IV
COMPUTER REQUIREMENTS

A. Introduction

While the previous three chapters have provided a functional design for TEDS as based on empirically well-founded research since 1972, TEDS has yet to be demonstrated as an operating whole. This chapter postulates the systemware estimated to be required to support an operating prototype TEDS.

Section B discusses equipment and software that were used during several phases of the work since 1975. The discussion provides the basis for the estimates regarding the most efficient configuration of TEDS.

Section C discusses various trade-offs in TEDS hardware and software configurations pointing out those considerations which should lead to an eclectic operating prototype.

Section D summarizes the feasibility of implementing an operational prototype TEDS.

B. Estimate of Systemware Requirements

The estimate of systemware requirements presented here is based on two primary considerations:

- The functions to be performed by TEDS
- Existing equipment and software available at DOD I&W Centers

These considerations, in turn, were influenced by experience gained during research in 1975 and 1976 when experimental scenarios were prepared to operate on a subset of the DIA NMIC/Support Subsystem.

1. Experimental Equipment Used

The equipment used to test visual acuities, graphic layouts, use of function keys and light-pens consisted of:

- An AN/GYQ-21(V) minicomputer, with BR-1535/6 disk controller and drives

- An OJ/389(V)/G dual-screen CRT alphanumeric display, with BR-1569 interface

- The User Support System (USS) software, including terminal support paging, and workfiles

- The NMIC Control System (NCS) software, including sign-on and queuing protocols and management

- The OJ/389 software, including editing and light-pen functions, and variable and fixed function key support

The experiment did not use online, analyst profile-driven receipt of messages nor effect a connection with the AIS, which is planned for integration within NMIC. The experiment was necessarily limited to alphanumeric presentation of simulated receipt of information at the terminal screens as the OJ/389 graphics circuit boards and software were not yet implemented in the NMIC.

Based on critiques by project team members who participated in the experiment, several findings are relevant to any implementation of TEDS operational prototype:

- Some extant constraints on image sizes (number of available horizontal text lines) which vary on the left and right screens of the NMIC OJ/389 dictated that the position of the desired display must be deterministic. That is, the analyst would be constrained from calling-up the displays on the screen of his choice. These constraints are amenable to solution through programming so far as TEDS displays are concerned.

- The use of stacked "X's," dots of variable spacing, dashes, asterisks, slashes, and "O's" to create visual graphic images on the alphanumeric terminal was of marginal utility. While some histograms were judged to be satisfactory by project team participants, others were not. Some smoothing and averaging trend lines over time could not be displayed with any type of symbol at other than 45° angles. Clearly, some of the displays discussed in Chapter III could not be used. These constraints illustrate the need for a true line-segment (vector) graphic capability, with perhaps minimum acceptability of raster (dot) graphics capability.

In spite of these critiques, the legacy of the NMIC Systemware in terms of direct applicability to a TEDS prototype development is significant.

2. Estimate of Systemware Generic Requirements

Based on the foregoing considerations, PRC estimates the systemware generic requirements for TEDS prototype would include the following:

- Hardware
  - -- Moderate size minicomputer with disk storage
  - -- Dual screen, graphics-capable, intelligent terminal with 30 rows of 80 character positions on each screen
  - -- Graphics capable printer (or plotter)

- Software
  - -- Filing or data management system
  - -- Graphics programs
  - -- Terminal support programs, including editing and paging services if the terminal memory cannot accommodate 40,000 character physical records (largest AUTODIN record)
  - -- Mathematical and statistical routines, including factor analysis and multiple linear regression

- Other Systemware
  - -- Convenient electrical or machinable-form data access to a profile-driven message dissemination system
  - -- Convenient electrical interface to any available quantified descriptor data systems such as the Advanced Indications Structure

C. Alternative Systemware Configurations

The estimate presented in section B gives full consideration to extant equipment and software available in a generic sense at several of the larger DOD I&W Centers. Such centers include those at the DIA/NMIC, Strategic Air Command, North American Aerospace Defense Command, the European Command, and the Atlantic and Pacific Commands. It would be misleading, however, to leave the impression that TEDS as discussed in this report could be implemented precisely as described without consideration of alternatives and their impact on any design specification. This section discusses some of the alternatives that could impact TEDS implementation at various locations in terms of:

- Terminals
- Filing Systems
- Computational Support
- Message Source Input

1. Terminal

a. Graphics versus Alphanumeric

As discussed in section B.1, true graphics, vice histograms or other pseudo-graphical constructs, serve to portray information more effectively than is otherwise possible. A raster graphics circuit board, with new software, as an addition to the OJ/389 terminal would probably be an adequate compromise between the high quality, but expensive, graphics of the Vector General variety, and lesser quality, but less expensive raster graphics. A raster graphics capability appears to be an especially attractive alternative for installations with several terminals, and where much of the existing terminal software were to be employed. Nevertheless, graphics applications would have to be written for either type of equipment.

On balance, so-called "intelligent" terminals are the only choice, as they cost little more than their nonprogrammable predecessors. They also permit offloading from the host computer of a significant fraction of housekeeping and application software. This is particularly the case if adequate memory, either Random Access Memory (RAM), or inexpensive rotating memory, such as a floppy disk, is provided for each terminal. Fixed and variable function keys are assumed present, to simplify the user interface.

b. Number of Terminals

Another key terminal issue concerns the number of screens to be used. Two have been recommended for TEDS as far superior to one, at a minor cost penalty.

Designers can construct examples and scenarios whereby if a user has access to an n-screen CRT terminal, there is an application which is best handled via n + 1 screens, ad absurdem. Nonetheless, the two-screen vice one case has been convincingly argued and demonstrated in both government and commercial literature. The argument follows naturally from commonly observed work patterns by users employing one screen as a reference/source while composing, editing, or computing on the other screen. The electronic capabilities of the CRT's and support software have the added benefit of bilateral properties, if desired, i.e., the user can employ either or both screens as convenient to the diagnostic problem of the moment.

2. Filing Systems

The filing and data management support operations for TEDS are not trivial. Both data files and display files must be retrieved, manipulated, and stored as required. If AN/GYQ-21(V) hardware is used, the NMIC USS software provides a nearly adequate base. Large data files could be managed effectively by augmenting the USS with software such as is provided by the Storage and Retrieval Processor (SARP) file system and the required interactive interface developed for it in the NMIC/SS environment.

3. Computational Support

Convenient, interactive-initiated access to mathematical functions is required. Both factor and multiple linear regression programs are essential, and neither are available from the AN/GYQ-21(V) equipment vendor. However, it is reasonable to assume that such statistical programs are available though a users' group of the PDP-11/45 minicomputer (AN/GYQ-21(V) equivalent) family. An alternate method to preclude investment in a statistical package programming effort would be the selection of a computer mainframe with existing, appropriate software. A less attractive alternative to either of the above could be achieved via offline interface to such programs for model updating.

4. Message Source Input

As was pointed out in Chapter III, an automated message dissemination system, such as the Message Support Subsystem in the NMIC, is not an absolute requirement. Nevertheless, such a system provides three important benefits. First, it disseminates the messages properly in the first place, as well as supporting retrospective retrieval. Second, having the messages in a convenient electrical form on one CRT terminal screen considerably facilitates what might be a moderately labor-intensive form-completion process on the other CRT terminal screen by using the light-pen and terminal editing features. Third, for certain routine types of traffic, activity data base records may be semi-automatically or fully automatically generated by extensions to the extant dissemination technology.

D. Summary

On balance, implementation of an operational prototype for TEDS is well within the state-of-the-art in terms of both software engineering and extant equipment now available at large I&W Centers. It is estimated that a prototype TEDS could be installed in a facility possessing a suitable mainframe and dual-screen terminals as estimated in this chapter during a two-year period. This effort would include design and specification of the particular data bases for the designated analysts, programming, display generation, emperical checks on all mathematical paradigms, and model modification as recommended by users. The design specification for the prototype would be intimately linked to the specific availability and configuration of the user's computer support facilities and equipment.