TITLE: Developments In Air Targeting: Data Handling Techniques

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# STUDIES IN INTELLIGENCE

A collection of articles on the historical, operational, doctrinal, and theoretical aspects of intelligence.

*Some problems common to the intelligence community and some particular to Air Targets find their not flawless solution in the use of machine methods.*

# DEVELOPMENTS IN AIR TARGETING: DATA HANDLING TECHNIQUES

**Outten J. Clinard**

The production of any kind of finished intelligence rests upon processes which require the handling of data in large quantities. When the finished intelligence is global and encyclopedic, as in air targeting, these quantities assume massive proportions, and their management requires substantial resources in time and people or machines. Since more than storage and recall of documents or even basic intelligence information is involved in air targeting, data-handling techniques have perforce developed in a complex rather than straightforward pattern.

## *Responsibilities of Air Targets*

Air Intelligence has the responsibility for providing defense staffs and commanders the intelligence necessary to enable them to get the best possible results from the employment of airpower in the event of hostilities. As a part of this responsibility, the Director of Targets is charged with producing for the Department of Defense the common target intelligence base for joint staff and command plans and for the development of weapon systems. Specifically, the Director of Targets must determine enemy vulnerabilities to air attack, estimate weapon requirements and effects, plan and coordinate the production and distribution of data on target systems, and produce estimates of best opportunities for U.S. and allied offensive air action.

A fundamental difficulty in dealing with air weapons and the required operational and supporting systems is their dynamic development, their constantly changing capabilities. This is true both of our own weapons and their delivery vehi-

cles and of those of our potential enemy. Changes in the values of the great number of variables involved could be largely ignored when the United States had an overwhelming superiority in atomic weapons, but intelligence estimates must now take them minutely into account.

With present-day weapon systems it is no longer sufficient to focus on target categories—airfields, for example—as target systems or to assume that our weapons are delivered to the bomb release line. Targets must now be rated according to the immediacy of their potential threat to the United States and its allies, and target systems may consist of a number of different categories, depending on the situation and the objectives to be achieved. For example, a target system may include not only all long-range air bases in an area, but also missile launch sites, weapon storage, liquid fuels, transportation, and control centers. To measure the effects of an attack on such a target system, moreover, we need to know how many weapons would be actually delivered to the target area and where they would fall. We also need measurements of enemy net capabilities at frequent intervals to determine at what stage the attack would have achieved the desired objectives.

Targeting, like the development of weapon systems, has become a swift-moving, ever-changing process. A sampling of the types of questions asked of the Director of Targets during the past year will illustrate its complexity:

*Where can I best apply such and such forces available at present? Available in the future?*

*From what points can I reach the greatest number of priority targets?*

*How much damage is necessary to eliminate airfields for varying time periods?*

*What is the operational effect of using such and such alternative damage criteria in calculating the forces necessary to achieve certain ends?*

*With a given-sized weapon at bomb release line, what are the probabilities of damage and of contamination to the target?*

*If we attacked this or that target category, how much damage would we effect in other categories?*

*What would be the effect of fallout in the initial phase on troop movements in certain areas?*

*What capability would be left the enemy after this strike for atomic weapon delivery, air defense, war production, and general economic activity?*

Although it is not impossible to solve most of these problems by manual calculations, the time requirement and cost of manual solution would be prohibitive. Some sort of machine methods have therefore become necessary.

Data handling in the Directorate of Targets may logically be broken down into three distinct processes—*document handling*, or the extraction of individual data from source materials; *data manipulation*, or the consolidation and organization of data in various arrangements; and *data integration*, or the synthesis of data in application to operational problems.

*Document Handling*

Since research on source materials for the extraction of basic data is an operation common to all intelligence components, a detailed presentation of the procedures used in the Directorate of Targets is not necessary here, but some mention of past difficulties and the still current effort to solve them may be useful. Most of these difficulties, as would be expected, are library-type problems. In the Directorate of Targets there is no central repository where *all* incoming materials may be found, nor is there a reference service where the existence and location of a needed document may be ascertained. Comprehensive documentation is therefore extremely difficult: an analyst can never be sure he has seen all of the available documents pertinent to his study. Not knowing what is available and where makes difficult also any effective control of the collection effort. Other aspects of the same problem turn up in excessive document handling, effort devoted to management of files, and difficulty in making available to all analysts the work of each.

Most of these shortcomings lend themselves to mechanized corrective measures. In Air Intelligence the corrective effort over the past five years has centered on the development of the Minicard System, primarily for document retrieval. The tiny Minicards of film, only 16 x 32-mm, can record photo-

graphically up to 12 legal-sized pages, along with sufficient digital information to index the contents. They can be manipulated by machines in any desired order or selection by content and can be reproduced either as film miniatures or as paper prints enlarged to original size.

The Minicard System has recently undergone a full operational 30-day test in Air Intelligence and has proved itself mechanically satisfactory. The official report on this test, noting that the system requires a few more personnel slots, emphasizes that its justification lies in providing a fast and accurate system of document retrieval and an automatic means for consistent and accurate dissemination of Air Intelligence information reports.

A solution to the document-handling problem thus appears to be in sight, even though this particular equipment is still in the experimental stage and may eventually be replaced by an entirely different system. If recent plans are realized, a new Air Force Intelligence Data Handling System will include an Air Targeting sub-system with a much broader capability both for document retrieval and for other kinds of data handling.

*Data Manipulation*

Meanwhile, the closely related problem of data manipulation has been receiving attention. In the early days of air targeting, most of the evaluated intelligence on individual targets was maintained in "Phase I Lists." These were simply lists of targets in each category and country arranged alphabetically or by importance. Although they were kept current by analysts as new information was received, formal revisions were published only infrequently. A complete up-to-date set of these lists was seldom available.

The chief defect of the Phase I List system, however, was that the data could not be manipulated easily. This defect has been accentuated by the growth of the target lists. The increase in the destructive potential of weapon systems has made it necessary to extend the range of targeting into areas and installations not previously included. The *Bombing Encyclopedia*, a listing of all identified targets, has grown from some 2,000 entries in 1946 to over 78,000 at present. The *Target Data Inventory*, a compilation used as a basis for war

plans, now has over 14,000 entries, including over 9,000 installations and 4,500 populated places. Air Target Materials, a collection of maps, charts, and mosaics produced for operational use, now cover some 15,000 targets, as against 9,300 just a few years ago.

Although presented in different forms, essentially the same information is used in all these publications; at least, it all comes out of a common fund of target information. So also does the information required to answer numerous individual questions and to solve the equally numerous targeting problems posed to Air Intelligence. This common fund of target information is in short the primary working base for all air target intelligence production. To be effective for these purposes, it requires careful management in all phases of compilation, organization, control and use.

The targets publications, for all they may seem overlapping and duplicative, are required in their various tailorings to meet the needs of particular customers or for a particular mix of information. Consolidation of some publications with others would have alleviated the data manipulation problem somewhat but would not have solved it, and would have created new problems for the consumer. For what might appear to be a large amount of duplication was actually not so much duplication of product as it was a duplication of effort required to produce a variant product. This was where too much valuable analyst time was being expended in repetitive clerical activities like checking, tabulating, arranging, and verifying lists.

Aside from the waste of personnel time in the tedious compilation of data for a variety of products, manual manipulation provided no effective means for controlling the quality of information in the fund, for preventing losses through change in emphasis, functions, or personnel, for providing other headquarters with current information, for supplying quick answers to spot questions of an urgent nature, or for extracting masses of data in preparation for the data integration processes discussed later.

The problem assumed more formidable proportions early in 1957, when the Joint Chiefs of Staff designated the *Target Data Inventory* as the basis for atomic annexes to Command Plans. All codes, reference numbers, and other tar-

get identification elements in the *Inventory* now had to agree with those in other targets publications. It seemed desirable and feasible to standardize the format of publications and information files at the same time, and the outcome was the development of what is now known as the Consolidated Target Intelligence File (CTIF).

*The CTIF Solution*

The primary element of the CTIF is the standard form herewith illustrated, which is filled in for each target listed in the *Bombing Encyclopedia*. The form's five parts, separated by the heavy horizontal lines, respectively contain:

I. Codes for machine processing and hand processing.
II. Information identifying and locating the target.
III. Information on the category of the target and its individual characteristics within the category.
IV. References to graphic coverage on the target.
V. Sources.

Much of the information is entered on the form uncoded and may be read directly, for example the target's name (02), location (06), elevation in tens of feet (20), roof cover in thousands of square feet (23), and output in thousands of pounds (57). Some of it is entered in a simple code for which the IBM 705 is keyed. On the form shown, in the *country* block (09) "UR" represents the USSR; under *command interest* (28) the figure 2 in the *E* block indicates that the target has been nominated by the U.S. European Command; and under *category requirements* (68) the letters C and F indicate that additional information is needed on capacity/output and labor force, respectively.

Two subsidiary forms are also used to feed information into the CTIF. One of these, a Graphic Materials Data Sheet, carries the information given in section IV of the major form plus additional detailed data describing the maps, charts, and photo mosaics which cover the target. The other, called Category Data File Corrections, is used as a corrective supplement to capacity and output figures on target categories where these data elements apply. It is designed to give the figures on capacity and output, over and above those attributed to known plants and installations, required to arrive at a total national estimate. Such estimates are necessary for

# CTIF FORM

SECRET — CLASSIFICATION | TDI — PROCESSING | I

03 TAB NUMBER | 04 10 MIN WAC GRID

ET ENGINE PLANT

07 SOURCE OF COORDINATES: MATERIALS IDENTIFICATION | 08 SHEET NOS. | CNTRY | TDI

| B.E. NUMBER | SERIES | PROD | SHEET NO. | EDIT | BASE NO.; DATE | TYPE | HDLG | 200 | 50 | 09 | 10 ZN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0013009987 | 100 | E | 01 | 2 | 20007 58 | CA | | | | UR | |

II

| 21 DIMENSIONS E | LENGTH | WIDTH | HT | DEPTH | E | 22 ORI | E | 23 ROOF COVER | E | 24 FLOOR AREA | E | 25 LABOR FORCE | E | 26 ROUTE CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 1 | | | | | | | | 00800 F | | | | | | |

| 32 ACC POS CARTO | 33 DATUM | 34 ATTBL | 35 PHOTO REQS V | O | S | G | R | I | 36 | 37 TGT REVIEW INDEX; DATE OF REVIEW DAY | MO | YR | 38 10 MIN GEOREF | 39 RECON PRIORITY | 40 OLD ECON REG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | S 23 | 11 | 58 | | | |

| UNITS/MEASURE | 57 OUTPUT/ POPULATION | 58 TIME PERIOD; DATE | 59 % OUTPUT/POP NAT | BLOC | 60 OUTPUT/POP EVAL; DATE OF INTEL | 61 CAPACITY | 62 TIME PERIOD; DATE |
|---|---|---|---|---|---|---|---|
| 000LBS | 25570 | YR57 | 13.7 | 10.4 | A0758 | | |

| F | X | 69 INTEL CUTOFF DATE | 70 CAT REVIEW INDEX; DATE OF REVIEW DAY | MO | YR | PRINCIPAL CATEGORY COMPONENTS 71 STRUCTURE TYPE | 72 LATITUDE ° ' " N/S | LONGITUDE ° ' " E/W | 73 R-95 |
|---|---|---|---|---|---|---|---|---|---|
| F | | 0656 | | | | | | | |

III

| 76 MILITARY SUBORDINATION | 77 | 78 | 79 | 80 | 81 | 82 |
|---|---|---|---|---|---|---|
| | | | | | | |

| 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

97 CATEGORY REMARKS (CONT.) | 98 CATEGORY REMARKS (CONT.)

| B.E. NUMBER | SERIES | PROD | SHEET NO. | ST | I/O | TAC CAT | S | DEGREE SQUARE B.E. NUMBER | TAC SERIES SERIES | PROD PROD | PROD SERIES SHEET NO. | ST ST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |

IV

V

101 ANALYST'S NAME | UNIT | DATE

SECRET — CLASSIFICATION | John Doe | 3A2 | 1 DEC 58

| B.E. NUMBER | PURPOSE TARG | PURPOSE CAT | ALT | MINOR REF NO. CATEGORY CODE | PART |
|---|---|---|---|---|---|
| 0013001234 | C | | | 61241 | |

| 01 B.E. NUMBER | 02 B.E. NAME |
|---|---|
| | YARLINSK AIRCR |

| 05 TDI REFERENCE NOS. MAJOR | MINOR | 06 COORDINATES LATITUDE | N/S | LONGITUDE |
|---|---|---|---|---|
| 99995 | | 81°45'17"N | | 112°29'3 |

| 11 CEIR REG | 12 AIR DEF REG | 13 NEW ECON REG | POLITICAL SUBDIVISION & SUBORDINATION 14 SSR | 15 ASSR | 16 DBL | 17 N.O. | 18 RAYON | 19 STAT OR MIN | 20 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | C |

| 27 ATMP PRIORITY | 28 COMMAND INTEREST S | E | P | L | A | J | R | V | C | G | TDI 29 STAT | B.E. STAT; 30 DATE | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2 | | | | | | | | | A | A58 | |

| 51 CATEGORY CODE | PART 52 NO. | SUB-53 CAT | 54 ENTRIES B.E. | TDI | ATM | 1001 | AOJ | 55 |
|---|---|---|---|---|---|---|---|---|
| 61241 | | | AA | | | | | |

| 63 % CAPACITY NAT | BLOC | CAPACITY EVAL; 64 DATE OF INTEL | 65 PRIORITY | JCS 66 PRI | TDI 67 RMK | 68 CAT RE L | C | D |
|---|---|---|---|---|---|---|---|---|
| | | | 22001 | | 01 | | C | |

| 74 VN-T-K SEVERE | MODERATE | 75 PHYSICAL CHARACTERISTICS |
|---|---|---|
| 152Q132Q | | |

| 83 | 84 | 85 | 86 | 87 |
|---|---|---|---|---|
| | | | | |

96 CATEGORY REMARKS

99 IDENTIFICATION OF GRAPHIC MATERIALS WHICH COVER TARGET

| A/D | B.E. NUMBER | SERIES | PROD | SHEET NO. | ST | A/D |
|---|---|---|---|---|---|---|
| | | | | | | |

100 SOURCES OF INFORMATION

NOTE: TARGET IS FICTITIOUS

AFHQ FORM

calculating percentages and for evaluating the relative importance of individual installations in each category.

The Consolidated Target Intelligence File is maintained in three sets. Working copies of the CTIF form are held by each category analyst in the appropriate target jackets of his own files. Then a complete and up-to-date collection of CTIF forms is maintained centrally as a handy tool for answering numerous questions of some urgency and of limited scope. This collection must be manipulated by hand. If the CTIF stopped here, it would still be very much worth while; for even here it saves much valuable analyst time formerly spent in digging out the same information over and over for different purposes. The CTIF contributes much more, however: its third set is on magnetic tapes and is susceptible of rapid and complex manipulation in electronic data-processing machines for a wide variety of purposes.

The flexibility of the machine-manipulated CTIF is illustrated in the programs now carried out, for example:

Floor space/capacity printouts for specialized installations by type. These lists are required for effects analysis and for input data for military resources models.[1]

Listing of significant installations in any category along specified transportation routes. These lists are used for travel briefs and other collection purposes.

Listings and plottings of airfields situated within range of specified types of aircraft. These lists are required for the air battle model[2] and other types of effects analysis.

Lists of major components plants within a specific industry, for example airframe, engine, electronics, and other components plants in the aircraft industry. Construction of such lists is useful in showing the dependence of certain plants upon the products of others and for pointing up methods of disrupting production.

Numerous routine listings by category, function, capacity, location, priority, *Bombing Encyclopedia* number, or *Target Data Inventory* reference number. These are useful for coordinating target lists, locating interdiction lines,

[1] See *Studies in Intelligence*, Vol. II, No. 1, p. 51, for a description of these models.

[2] See *Studies*, Vol. II, No. 2, p. 13, for an account of the air battle model.

and analyzing needs for such utilities as transportation, electric power, water, and fuels. Probably their most important use, however, is the production of the printer's copy of the *Bombing Encyclopedia*, the *Target Data Inventory*, and other targets publications.

Against the evident advantages of the CTIF, certain difficulties must be ranged. The preparation of the CTIF forms entails coding much of the information and translating it into the precise language required for machine handling. Training analysts in these new techniques is a continuing requirement. To promote uniformity in reporting and exchange of data between Air Force Headquarters and the major field commands, there is being developed a special reporting form keyed to the CTIF but allowing for variations from command to command. Analysts will integrate information reported on these forms with other available data and enter it into the CTIF. In performing these more or less mechanical functions, they will have to guard against a mechanical approach to the information and keep alert not only to the facts they are recording but also to their meaning in association with other facts known to them. Otherwise they will be in danger of losing the feel for the intelligence on which so many of their judgments must be based.

In machine manipulation of data, programing is required for even the smallest requests. Programers trained in translating target data into machine language must be available, and time must be allowed for designing, testing, and if necessary correcting the program. In due course, however, a library of stock programs will be built up for most uses and should alleviate the programing problem. Another problem is the availability of machine time. The larger, high-speed machines such as the IBM 704 and 705 must serve many Air Staff offices, and time on them is not always available when needed. This situation will in large measure be remedied when Targets acquires an expected magnetic tape facility and can process many of the less complex requirements on its own IBM 650.

Despite these shortcomings, the CTIF still marks a significant advance in data-handling techniques. It provides an up-to-date, comprehensive file of target information; it facilitates the manipulation of great volumes of data; it pro-

duces answers to complex problems quickly; and it makes positive control of target data possible. An electromechanical plotter, soon to be added to the data-processing equipment, will allow rapid recording or plotting of information in a wide variety of formats and should greatly increase the scope and utility of target compilations. The CTIF will assume additional importance as a major input source for the new Air Force Intelligence Data Handling System when it becomes operational.

*Data Integration*

The third data-handling process is data integration, in which the data are applied to an operational problem and are altered in form or lose their identity completely in the solution. Consider, for example, the Damage and Contamination Model described in the Summer 1958 issue of *Studies*.[3] This is a large and complex program, involving 58,000 targets and geographic "cells" and 700,000 to 900,000 computations. With requisite inputs from a war plan, that is, a pattern of ground zeros, weapon types, etc., this program is capable of calculating the probabilities of blast damage to some 9,000 targets, the radiation dose and contamination pattern from the weapons which were ground burst, and the fatalities and other casualties in 40,000 geographic "cells." It will also give damage and casualty summaries by categories and by regions. The Air Battle Model and the Military Resources Model discussed in previous articles[4] are programs of similar magnitude and complexity.

In addition to these major programs, the day-to-day operations of the Directorate of Targets have led to numerous special techniques for the solution of data integration problems. A number of manuals and memorandums present in graphic or tabular form the results of complex and extensive calculations. In one of these, for example, a probability chart was developed for calculating contamination effects when a ground zero is offset from the center of the target area. Another example is a slide calculator which permits rapid estimates of damage probabilities for various yields, heights of bursts, distances from aiming point, etc. Another is an anal-

[3] Vol. II, No. 3, p. 23.
[4] See footnotes 1 and 2.

ysis of the effects of topography upon atomic blast waves, showing the enhancement or attenuation of blast pressures on hills, ridges, slopes, and valleys.

*A Look Ahead*

Although significant progress has thus been made in data-handling techniques, the development effort is continuing. This effort is directed at the areas of greatest potential benefit, namely those where large amounts of technical and professional manpower are required to do basically clerical tasks, where many manhours are required to redo things previously done, where human ability to assimilate, integrate, differentiate, and remember is swamped by the volume or complexity of data, and where hand methods are too slow to be effective.

Improvement in these areas is essential if the targeting effort is to keep abreast of developments in weapons and delivery systems. The requirement will be accentuated with the introduction of new reconnaissance systems whose contribution in volume and types of additional data cannot now be predicted. If the Director of Targets is to continue to discharge his responsibility to provide defense staffs and commanders with timely and accurate target intelligence, he must be prepared to meet the problems of the future. The development of these data-handling techniques is a significant part of the effort to meet that challenge.