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JOINT IMAGERY INTERPRETATION REVIEW GROUP

JIIRG

# APPENDIX P

# AUTOMATIC DATA PROCESSING (ADP) AND AUTOMATION

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# APPENDIX P

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# AND

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# AUTOMATIC DATA PROCESSING AND AUTOMATION

## I. Introduction

This appendix is focused primarily on the unique problems of imagery interpretation to which automatic data processing capabilities and techniques may be applied. Consequently an attempt is made in the ensuing paragraphs to relate the capabilities inherent in the automatic data processing field to the potential value of their application in support of imagery interpretation. Little emphasis is placed in this discussion on the application of ADP to the organization and management of tasking, improved access to collateral data, report preparation and distribution, and other functions which are identical to, or are closely related to ADP applications characteristic of intelligence data handling within the intelligence processes.

At the outset it is important to recognize that during recent years the state of the art developments in the field of intelligence data handling and automation have reflected advances no less significant and dramatic than those which have characterized the field of reconnaissance. It is equally important to realize that the timeliness and effectiveness with which the exploitation of the imagery to be acquired by reconnaissance systems in the future depends to a significant degree on the efficacy with which foreseeable developments in automatic data processing and automation are planned for and utilized to provide responsive support to imagery exploitation activities undertaken in support of national and departmental needs. While many and diverse contributions can be made by

intelligence data handling and automation in assisting the intelligence community to cope with the challenge presented by projected reconnaissance capabilities, two are particularly important. They can:

a. Significantly improve the timeliness, quality, quantity, and utility of the imagery interpreters' output, and

b. Enable valuable things, now largely undone, to be accomplished in a timely, effective, and efficient manner as a result of structuring the ADP support potential of the intelligence community to meet not only the present and future needs of the imagery exploitation system, as well as the finished intelligence producers and related activities which it designed to serve.

II. Computer Functions

The tasks which can be performed by computers may be categorized several different ways. However, these basic capabilities as applied to imagery interpretation may readily be considered as:

a. Storage and retrieval

b. Processing

c. Computing

d. Communications, display, and report preparation

e. Management functions

These various capabilities will be discussed in terms of their relationship to the imagery exploitation function.

III. Applications of ADP to Imagery Interpretation

A. Direct Assistance - Storage and Retrieval

Automatic data processing can improve and extend the accessability of information derived from reconnaissance imagery as well as provide essential library services for the imagery

interpreter. Rapid and complete access to collateral information or to imagery data which has been stored as a base can be provided as a service. Generally, this material may be made available through a selective subject index, a geographical index, or various other indices which may be suitable for the intelligence support function which is being performed. There does not appear to be a technical impediment to providing any degree of storage and retrieval capability which may be desirable and economically worthwhile. Unfortunately, this very straightforward application of ADP has been obscured in the past by technically interesting but operationally trivial differences in points of view of various individuals and organizations. The difficulty in reaching an agreement on film chip size to be used in imagery interpretation typifies this problem-- in the absence of agreement on chip size,decisions on the engineering design of equipment to handle these film chips have not been made. The technical aspects of this problem may be simple, and far less significant than the necessity for a decision on the size, or sizes, of film chips for automatic storage and retrieval systems or the actual value of the chip concept. CIA, DIA and NPIC have extensive on-going ADP efforts in this field and are generally aware of new developments. All three organizations are represented on CODIB and its Task Forces.

B. Direct Assistance - Processing

Direct assistance to the imagery interpreter is currently provided in making measurements. A computer can readily be programmed to provide mensuration data on a near-real time basis taking into account the several necessary factors. The process of mensuration, like that of storage and retrieval, is technically straightforward and poses no particular problems. In addition to performing the relatively straightforward calculations which are required, including the look-up in the storage of information to obtain the particulars of the reconnaissance flight which are required for the calculation, hybrid configurations of equipment may be devised for improving the accuracy with which the cross hairs are placed, which is critical in the mensuration process. NPIC has programmed extensive R&D efforts in this field over the next five year period.

Automatic data processing techniques may be designed so that the various parameters of imagery may be adjusted to enhance the imagery interpretation processes. For example, changes in the height and density (H&D) curve, latitude, etc., may be adjusted in near-real time along with scale and other dimensional factors. This may be done by using automatic data processing techniques coupled with electronic display devices which are currently available and compatible with digital systems. This is especially significant for

third-phase exploitation. NPIC has on-going R&D programs for non-automatic parameter adjustment equipment. This area of automatic processing should be investigated.

It is possible to view, automatically, new imagery and compare it with the data in the imagery base to determine whether or not changes in the imagery have occurred. The threshold or sensitivity to change can be adjusted to the particular problem. For example, changes may be restricted to variations in lengths of lines, variations in the sizes of built up areas, and similar changes in dimensions, configuration, and orientation.

Techniques which are adaptable to imagery exploitation have been highly developed and tested in optical and radar missile guidance systems, and are generally referred to as automatic map-matching.

Numerous techniques for automatic target recognition have been developed in the past which are applicable to imagery interpretation. Like change detection, the threshold for recognition may be adjusted to any desired value. As confidence increases that all of a particular type of target is recognized the probability of false alarm and the requirement for imagery interpreter time decreases. Consequently, these techniques may assist in detection, recognition and enumeration of various types of objects over very large areas. NPIC has programmed extensive R&D efforts in this field over the next five year period.

A significant function for which automatic data processing equipment is highly effective, but not now used in imagery exploitation, is image correlation, especially multi-sensor image correlation, to provide additional confidence in the identification or the assessment of the functional characteristics of particular types of targets. In addition to improving the probability and certainty of target detection, such techniques may be programmed along adaptive lines which will provide information on changes and trends in target characteristics.

Ultimately, automatic data processing systems may be adapted to handle new imagery data against a vast reference store based on several different types of sensors. This, could be accomplished by photo digitizing and represents the most powerful interpretation application which is foreseen at this time. It is also a technique well beyond the scope of the unaided human because of his limitations in handling the quantity of information involved. The USAF is developing equipment in this field.

C. System Assistance - Computing

Through automatic processing techniques the effectiveness and efficiency of the collection systems may be improved in a way which will result in directly reducing the imagery interpretation work load. A sophisticated operational capability now exists for automatic indexing and plotting of reconnaissance imagery acquired by satellites. This also

can be accomplished for imagery acquired by airborne reconnaissance platforms by a combination of accurate automatic plotting of the navigational data with subsequent refinement of geographical coordinates through imagery matching against the existing store of information.

Image quality may be considered in two ways: from a purely physical point of view which takes into account the physical characteristics of the object viewed, the intervening optical path, the camera mechanism, and the processing; and from a subjective viewpoint which relates factors such as contrast, "snap" or "crispness" which will vary considerably, depending upon the personal preferences of the image interpreter involved. Although complex, the physical parameters should be, and can be, readily assessed in concrete terms. Data on these physical characteristics of image quality are important so that meaningful data for equipment design can be derived from interpreter performance. Although the subjective assessment of image quality will involve a number of different parameters, these may be readily related, in a meaningful way, through automatic data processing techniques to the physical measurements of image quality.

D. Communications, Display and Report Preparation

The efficiency of the imagery interpreter may be improved through improved communications and display devices so that direct communication between imagery interpreters as well as between image interpreters and intelligence analysts is possible via common communications links. Hopefully, this will permit analyst access to the imagery store. Although this will not reduce the imagery interpreter's time for basic work, an increase in efficiency once this material has been classified and stored may be envisioned. Techniques for the accelerated preparation and dissemination of imagery interpretation reports have been in use for some time. Improvements are currently being studied.

E. Management

Executive management decisions now determine the extent of imagery exploitation. The efficiency of the manpower available for imagery exploitation may be improved through near-real time control of tasking, and control of production so that duplication of effort is precluded. The technology for accomplishing this is relatively simple, but requires development of an appropriate vocabulary so that a reasonable number of descriptors can adequately define the work in process.

The automatic data processing equipment suitable for performing the various functions described above may also be used to perform a number of "bookkeeping" tasks so that statistics may be readily derived to permit further evaluation and refining of the imagery interpretation process.

IV. Summary

The types of imagery interpretation tasks in which automatic data processing techniques may significantly assist have been discussed. Some tasks may require on-line equipment and a central computer, but others may require only small computers and programming support. Annex A differentiates those functions which are common to many activities in addition to military or intelligence tasks, those which are unique to intelligence and those which are unique to imagery interpretation. In addition, the Table indicates those functions which are of primary interest for national uses, and those which may have an additional use in strategic or tactical military processes.

Several factors are immediately apparent. Most of the tasks which demand high storage capacity are not peculiar to imagery interpretation, but are similar to other national and military intelligence tasks.

The Government has extensive ADP programs directed toward the problems of massive data manipulation and management applications. It is expected that adaptations of this equipment and software will suffice for the library service, pattern recognition, vast information manipulation,

coverage indexing and plotting, tasking and production control, communications and display, and the normal business functions associated with imagery interpretation. The effort required to adapt the software to support the imagery interpretation process, while straightforward, may be large and fairly expensive.

In the military ADP projects, of which those associated with intelligence are a significant part, it is evident that the intelligence and imagery interpretation community must assume responsibility and take the initiative in defining the ADP and automation support required in mensuration, parameter adjustment, change detection, pattern or target recognition, and must participate in the structuring of library services - both input and output.

Mensuration equipment generally should be designed to operate on a time-sharing basis with the main facility computer or an available tactical computer. The input-output devices associated with mensuration are not so demanding as to require identical computers among those facilities which may be engaged in this work. Consequently, the coordination of design of common measurement devices and the dissemination of information on software would tend to avoid duplication and result in the application of the best techniques in this area.

Parameter adjustment refers to an electro-optical ADP device, which can change scale, contrast and various other parameters as desired during the viewing process in order to enhance interpretation of the image. Such equipment may be generally independent of any facility or tactical computer

installation. Tactical equipment may allow variation of only a few parameters, whereas equipment in permanent installations should be very flexible. A common design effort for equipment for permanent installations is obviously desirable, and equipment designs for tactical use could derive design criteria from the more complex equipment. Coordination of design and procurement of tactical equipment may readily be accomplished by normal Committee on Photographic Exploitation Equipment (COPE) activities.

Target recognition equipment is generally similar to parameter adjustment equipment from the standpoint of coordination of design characteristics and a similar recommendation is made for these devices.

V. Findings

As a result of its investigation of the field of ADP and automation support to imagery exploitation, the JIIRG considers the following findings to be pertinent and deserving of further consideration by the proposed national imagery exploitation instrumentality. With respect to finding No. 9, the JIIRG developed the concept of a national image-derived information base as discussed in Annex B. This concept has been incorporated into the National Tasking Plan.

1. In developing responsive and effective ADP and automation support to imagery exploitation serving national and departmental needs emphasis should be focused on those functional areas which are unique to the exploitation of multi-sensor imagery.

2. In those areas of intelligence data handling and automa-

tion support which imagery exploitation organizations have in common with the intelligence community, they should participate with and seek expeditious support from those assigned responsibility for structuring effective ADP and automation support of intelligence production.

3. ADP and automation design and development undertaken in other related areas should be closely monitored for possible application to imagery exploitation and efforts should be aggressively sponsored to adapt progress in other fields to the needs of imagery interpretation serving national and departmental needs.

4. The appreciable ADP and automation support potential currently available to or programmed either for those imagery exploitation organizations serving national and departmental needs, or their parent organizations, should be viewed in a systems context and utilized to the maximum extent practicable to support the exploitation of imagery in consonance with the National Tasking Plan for the Exploitation of Multi-Sensor Imagery.

5. Emphasis should be placed upon achieving at an early date the ADP and automation support required to facilitate the automated transmission, storage, retrieval, and manipulation of high resolution imagery and image-derived information in both human readable and computer processable form.

6. ADP and automation support programs should be accelerated and expanded in areas of mensuration, automated indexing, target recognition,

change detection, parameter adjustment, image digitization, and composite unit record storage and retrieval. The latter encompasses on a single record, in standard formats, high resolution imagery and digitized operational data and image-derived information.

7. Emphasis should be placed during peacetime to insure that ADP and automation research and development activities are undertaken which will provide a high confidence factor that imagery exploitation will be able to provide timely, accurate, and high quality information inputs during crisis, limited, and general war situation.

8. Automatic data processing and automation undertaken in support of imagery exploitation serving national and departmental needs should be approached in a systems context, fully coordinated and directly responsive to the imagery exploitation management authorities.

9. Immediate and continuing emphasis should be directed toward the establishment and maintenance of an automated national image-derived information base (see Annex B) which is fully responsive to both the state of the art and the current and changing needs of finished intelligence producers, and other organizations concerned with reconnaissance collection and exploitation.

Annex P-1

COMPARISON OF ADP FUNCTIONS

| | Common | Intel Peculiar | P. I. Peculiar | Primary Nat'l Use | Supplemental Tactical Use |
|---|---|---|---|---|---|
| LIBRARY SERVICE | X | | | X | |
| MENSURATION | | | X | X | X |
| PARAMETER ADJUSTMENT | | | X | X | X |
| CHANGE DETECTION | | X | | X | |
| TARGET RECOGNITION | | | X | X | X |
| PATTERN RECOGNITION (CORRELATION) | X | | | X | |
| VAST STORE MANIPULATION | X | | | X | |
| DIRECT COVERAGE PLOT | X | | | X | |
| IMAGE QUALITY MEASURE | | | X | X | |
| TASKING & PROD CONTROL | X | | | X | |
| COMM. & DISPLAY | X | | | X | X |
| MANAGEMENT FUNCTIONS | X | | | X | |

Annex P-2

NATIONAL IMAGE-DERIVED INFORMATION BASE
(NIDIB)

I. Introduction

Centralization of an image-derived information data base is essential if the data required on a timely basis by the intelligence analysts, the imagery collectors, and the imagery interpreters is to be managed effectively. The imagery interpretation organizations of the intelligence community should exploit the capabilities of existing and oncoming generations of computers which offer "on-line", rapid access to comprehensive information files from remote locations. A National Image-Derived Information Base (NIDIB) can significantly assist intelligence collection and production activities at the national level.

This data base is important to finished intelligence analysts and is critical to the imagery interpreter during all phases of his exploitation process. A central computer-based bank of imagery and image-derived or related information is required to provide more timely and accurate reporting and at the same time cope with the increased volumes of film inputs. First- and second-phase reporting can be accomplished within the framework of a human-readable, machine-processable system. New information now can be related to the accumulation of past reporting, but because an automated base is not established, products being disseminated as a result of first- and second-phase reporting do not reflect the interplay with the total imagery interpretation base. Future reporting should place less reliance upon cumbersome hard copy dissemination practices, and strive for full

utilization of automated processes of information handling.

Additionally, imagery collection managers and programmers require timely access to data on the status of target and area coverage as well as the status of exploitation in order effectively to plan collection missions and programs.

II. Organization of A National Image-Derived Information Base (NIDIB) and Its Composition

The National Image-Derived Information Base, automated to the fullest extent practicable and primarily designed to support the production of finished intelligence, should be structured to serve additional purposes. It is intended that to the maximum extent feasible, this base will satisfy the interdependent needs for imagery-derived information which exists laterally and vertically at all echelons of command from the National Command Authorities to Commanders of major command components in the field. It provides an authoritative and historical base of image-derived information essential to timely and effective imagery exploitation. This base also will support the essential information needs of collection management authorities at the national level; help to insure the effective and timely programming of individual reconnaissance missions; and be of assistance in the development of short and long-term reconnaissance programs.

Such a data base of imagery-derived information initially should be comprised of six basic files, namely:

(1) The Installations Data File (maintained by NPIC) which con-

tains all the information derived from reconnaissance imagery under this plan, as well as the outstanding elements of information (EEI's) to be derived from future missions on each installation of intelligence interest contained in the National Imagery Exploitation Target Base (NIETB). Included also would be data required by reconnaissance collection management pertaining to targets covered and the quality of such coverage.

(2) The Object Data File (maintained by NPIC) which contains specific mensural and narrative data on equipment and objects of intelligence interest.

(3) The Area Coverage Data File (maintained by DIA) which contains indexed information on the geographic areas imaged and the quality of imagery acquired as a result of the U. S. reconnaissance effort.

(4) The Mensuration Parameters File (maintained by NPIC) which contains specific technical information on vehicle performance and sensor design specifications required in support of on-line mensuration conducted by imagery interpretation organizations.

(5) The Exploitation Products File (maintained by NPIC) which contains information on products produced and disseminated as a result of imagery exploitation accomplished under the National Tasking Plan.

(6) The Imagery Interpretation Resource Information File (coordinated by COMEX) which contains basic information on the application of resources subject to direct tasking under the National Tasking Plan.

The details as to the specific organization of files, format, and procedures to be employed in the establishment and maintenance of these data base files will be developed in consonance with the needs of agencies and departments represented on the U. S. Intelligence Board, with the assistance of CODIB, and coordinated by the COMEX. The following general concepts of operations, however, should apply:

1. Immediate inputs to the various files would be made by the NPIC, CIA/IAD, DIAAP-1P, and selected imagery interpretation elements of the DOD through DIA, based on information derived from the exploitation of imagery during all three phases of exploitation, in accordance with a program developed by the COMEX.

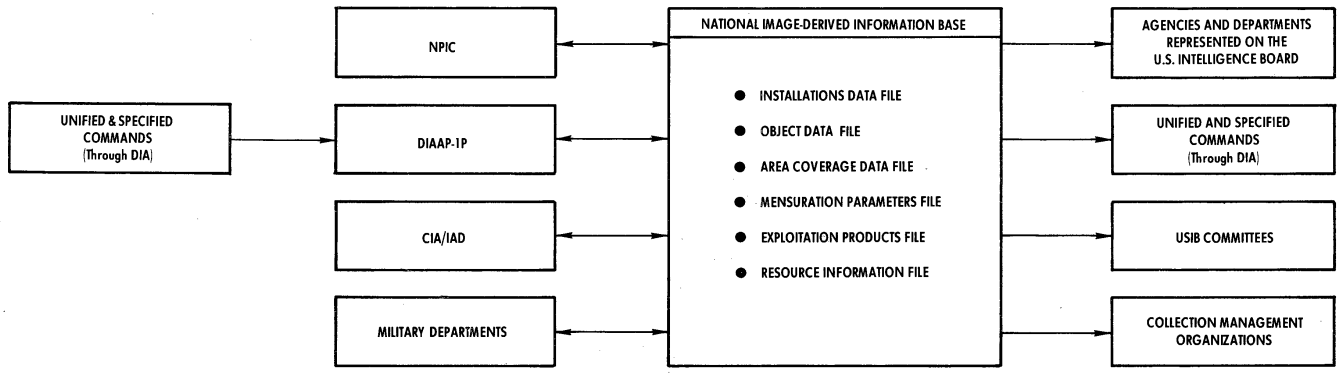
2. A standardized national format for data input is required and should be structured to incorporate the best features of the current NPIC and DOD reporting systems.

3. File coordinators should be established by COMEX who will be responsible for exercising input and output control over the use of the six basic files (comprising the National Image-Derived Information Base) in serving national needs for image-derived information.

4. Each entry should be clearly identified as being the product of the originator. Conflicting information would be referred back to the originator(s) for validation; thereafter should disagreement continue to exist, both views will be incorporated in the file, but such disagreement would be clearly noted.

5. Tab P-1 depicts the proposed flow of data to and from the National Image-Derived Information Base (NIDIB). This flow is compatible with the COINS system.

## NATIONAL IMAGE-DERIVED INFORMATION BASE




*NOTE: COINS will provide a direct communications capability between selected organizations, such as CIA, NSA, DIA, State, and NPIC.*