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5 January 1970

III. Information Processing and Exploitation

C. Imagery

1. Overhead Photography

Background

The NPIC Research, Development and Engineering effort primarily supports the Center in carrying out the responsibilities assigned to it by the approved JIIRG recommendations. Additionally, in accordance with NSCID No. 8, it serves the imagery exploitation community as a whole. The COMIREX Subcommittee on Exploitation Research and Development provides a forum for exchange of information among the agencies concerned with respect to their imagery R&D programs; NPIC can also call upon the Subcommittee for advice and recommendations as appropriate.

Objectives

The broad objectives of the Center's program for the next five years are:

- to increase the efficiency of the exploitation process and the quality of the product;
- to improve the Center's capability and capacity to receive, reproduce, store and retrieve imagery and imagery-related materials.
- to develop concepts for exploitation of new imagery acquisition systems and to develop the equipment and procedures necessary to the implementation of these concepts.

Implicit in these objectives is the aim of enabling the Center to perform more and better work without significant increases in manpower.



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C. Imagery

1. Overhead Photography

a. Imagery Interpretation Research/Human Factors

25X1 Objective: To develop an understanding of the specific inherent or acquired human characteristics involved in the various aspects of the imagery exploitation process and to apply that understanding to such activities as recruitment and training of personnel, modification of procedures, redesign of equipment, alteration of working environment, and adaptation of personnel to exploitation of new systems (e.g. [REDACTED])

Progress:

a) A comparison of the achievements and skills of analysts receiving on-the-job training and of those who attended the 12-week Defense Sensor Interpretation and Application-Training Program clearly showed the superior benefits of the Defense training program; as a result all new imagery analysts are scheduled for this program.

b) A preliminary validation of an Agency-administered imagery interpretation test battery for use in evaluating applicants was made, and development of an Imagery Analyst Target Knowledge Inventory was initiated. This inventory will serve as the basis for developing an in-house training course to supplement the Defense Training Program.

c) Comparative tests to measure the performance of imagery analysts and photogrammetrists were designed and administered; the results showed that imagery analysts could satisfactorily perform a number of mensuration tasks which had previously been thought to require the services of a skilled photogrammetrist.

d) A Technology Integration Check-Out Facility has been developed for gathering imagery analyst performance data under controlled conditions.

[REDACTED]

[Redacted]

e) Through a controlled test of mensuration performance, a statistically sound approach to mensuration accuracy statements was developed; this approach has increased the level of confidence of NPIC dimensional error statements.

Program Plans:

During FY 1970 the development of the supplementary in-house training program should be completed. Research to determine the effect of the convergence angle of optical instruments on visual performance will be initiated in FY 1970 and completed in FY 1972. During FY 1971-73, the "human engineering" aspects of exploiting [Redacted] will be examined, with a view to utilizing the findings in the development of procedures and equipment for exploiting this type of film. By FY 1973, the basic system design for [Redacted] imagery is expected to be sufficiently firm and detailed as to permit identification and investigation of some of the human characteristics which will affect exploitation of [Redacted]. A large degree of flexibility is inherent in this project, since many areas of human-equipment, human-imagery and human-human interface which affect the efficiency and quality of imagery interpretation can not be recognized in advance of actual experience.

Resources

It is planned to maintain this project during FY 1972-76 at about the level of effort programmed for FY 1971.

FY 1969 1970 1971 1972 1973 1974 1975 1976

[Redacted]

[Redacted]

C. Imagery

1. Overhead Photography

a. Imagery Interpretation Research/Additive Info

Objective: To identify and evaluate the unique or additive information extractable from unconventional imagery and determine the quality of imagery needed to meet requirements for this information.

Progress: In FY 1969 a project was initiated to obtain [Redacted] at different resolutions [Redacted] together with the corresponding ground truth information. This effort will correlate ground truth with the imagery obtained, and provide data which should enable conclusions to be drawn as to the additive or complementary information which an [Redacted] could provide, as compared with black and white imagery. In-house studies on the intelligence value of [Redacted] were begun in FY 1969.

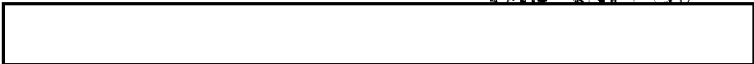
Program Plans: During FY 1971 and 1972, the studies of [Redacted] will continue with emphasis on various selected target types and on the level of resolution needed to meet requirements for additive information. During FY 1972, the in-house study of [Redacted] will be supplemented by contractual studies directed toward precise determination of the [Redacted] which are most significant in reading out certain types of targets and meeting selected requirements. During FY 1973-1975, studies will be initiated on other unconventional systems.

Resources:

FY 1969 1970 1971 1972 1973 1974 1975 1976

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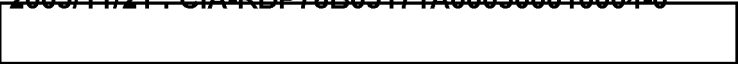
1. Overhead Photography

b. Imagery Information Technology

Objective: For obvious reasons, the consumers of imagery-derived information wish to have such information made available to them with the minimum possible delay. At present, however, the processes of reporting information derived from imagery and of updating data files, graphics, and collateral files are cumbersome and time consuming. The objective of this project is to develop and have in operation by FY 1976 a cost effective, integrated automated system for storage, retrieval, manipulation and display of imagery, information derived from imagery, collateral materials and graphics used in the analysis and reporting cycles of the exploitation process. This system will have the capability for on-line editing of both textual and graphic material.

Progress: Certain portions of the proposed integrated system have been or are being developed. NPIC has an Integrated Information System (IIS) scheduled for implementation in July 1970 which will provide the imagery analyst on an automated on-line basis, with existing imagery-derived and collateral data on any given target with which he may be concerned. Parts of the National Data Base of Imagery-Derived Information (NDB) are now maintained on an automated basis (Installations Data File, Mensuration Parameters File, and Exploitation Products Data File.) Various aspects of the man-machine interface involved in an automated information system have been investigated as part of the Imagery Interpretation Process Research Project. A completed contractual effort comprising the development of certain computer programs and techniques, has demonstrated the feasibility of a cathode ray tube graphics and textual display system.

Program Plans: A study contracted for in FY 1969 will be completed in FY 1971 and provide NPIC with several alternative plans for using Photo-Chips as an informational



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medium and to assist in the exploitation and reporting processes. In FY 1970-71, prototype, automated on-line textual and graphic display consoles embodying an editorial capability will be developed and operationally evaluated. During this phase, advantage will be taken of any applicable developments underway in ORD. Based upon evaluation of these prototypes, operational models will be developed as required in FY 1972-73. Amalgamation and integration of the overall system is planned to take place in the FY 1974-76 time period.

Alternatives: In view of the intensive activity and rapid pace of developments in the field of information management, storage and retrieval both in private industry and government, consideration was given, as an alternative, to postponing action by NPIC in the expectation that a suitable system would become available and could be obtained at less expense. In view of NPIC's unique requirements, however, it is believed highly unlikely that any system meeting then would become available during the next five or six years. NPIC will, however, be alert to developments elsewhere in government and in industry, to take advantage of any equipment or techniques applicable to this project.

Resources:

FY 1969	1970	1971	1972	1973	1974	1975	1976
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C. Imagery

1. Overhead Photography

c. Image Analysis and Manipulation/Quality Evaluation

Objective: There is in general use today a set of objective standards by which the quality of conventional imagery and the efficiency of various optical and photographic equipment are measured. The application of these standards, however, often brings results which do not coincide with the "subjective" judgments of imagery analysts who are concerned with the effectiveness of imagery and equipment in conveying information. The objective of this project is to identify and correlate objective and "subjective" criteria and standards, and to develop a revised set of objective standards for evaluating quality and efficiency of film and equipment from an intelligence point of view.

Progress: A contract study completed in FY 1969 has analyzed the present state of the art in photo-optical image evaluation and recommended a program of fundamental and applied research to establish a quantitative relationship between the most promising of the objective measures of merit and subjective quality criteria developed through psychological experiments.

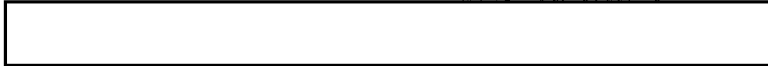
Program Plans: In FY 1970, a contract study will be completed which seeks to establish the basic conditions for evaluating optical components, applying the recommendations previously developed on the relationship of subjective and objective criteria. During the same year another study will be completed establishing requirements for microdensitometric analysis of color and black and white photography for use in objective assessment of quality. Other milestones are: FY 1972, complete the study of objective evaluation techniques; FY 1974, complete the study of subjective evaluation measures; FY 1975, determine the correlation procedures for relating objective and subjective evaluation.

Alternatives: Objective evaluation of photography involves an understanding of the basic, fundamental and theoretical nature of imagery, on which relatively little significant research has been accomplished. Similarly little fundamental research has been done on the mechanism of subjective evaluation. The two obvious alternatives, therefore, are (1) limit work in these areas to the pace of fundamental research taking place in the scientific community or (2) embark on a thorough and extensive program of fundamental research. NPIC has rejected both alternatives in favor of a pragmatic approach, relying largely on outside basic research, but supplementing it with contractual studies in specific areas of particular concern to the Center's activities.

Resources:

FY 1969	1970	1971	1972	1973	1974	1975	1976
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C. Imagery

1. Overhead Photography

c. Image Analysis and Manipulation/Image Enhancement

Objective: To develop by FY 1976 an integrated operational image manipulation system with the capability to compensate for image-degrading factors which occur during acquisition and/or processing of conventional imagery by digital, optical, photographic or electronic techniques, at the option of the imagery-analyst.

Progress: The techniques of optical, photographic and electronic manipulation are fairly well understood and are now being applied on a limited scale to conventional imagery by NPIC. Fundamental research in the area of digital manipulation, using non-operational photography and experimental computer programs is proceeding satisfactorily.

Program Plans: During FY 1970-71, experiments will be undertaken in NPIC on digital enhancement and restoration of operational photography, utilizing computer programs already developed and equipment made available by ORD. In-house experimentation on optical, photographic and electronic manipulation techniques will continue. By FY 1972, it is anticipated that the operational applications of all four techniques can be determined and evaluated. During FY 1973-75 the necessary equipment for an integrated operational system will be developed.

Resources:

FY 1969	1970	1971	1972	1973	1974	1975	1976
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C. Imagery

1. Overhead Photography

d. Image Interpretation Instruments and Techniques/ATR

Objective: To develop by FY 1974 a capability for automatically recognizing, counting and detecting changes in man-made objects on black and white imagery.

Progress: Investigations into the feasibility of developing the capability were initiated late in FY 1966. As a result of these studies, it was decided that the first concrete step should be the fabrication of a Target Indexing Device which would provide automatically a yes or no decision as to whether a specified target is or is not cloud covered. In FY 1969, the feasibility of two techniques for cloud screening -- an optical and an electronic -- was demonstrated. Of the two approaches, the optical could be more immediately developed into a working system, while the electronic technique offered greater potential for further development to perform target recognition and counting functions. After a careful review early in FY 1970, it was decided: (a) a system using the optical technique, but improved to provide cloud cover data both for specific targets and general area coverage, should be fabricated and delivered to NPIC for test and evaluation; (b) an improved electronic screening breadboard to perform both cloud screening modes should be built and demonstrated.

Program Plan: The optical cloud screening device will be delivered to NPIC early in FY 1971. Late in FY 1971 the electronic breadboard should be completed. Dependent upon the results of experimentation with the electronic device, a capability to automatically identify man-made objects on imagery should be established by the end of FY 1972. Techniques for automatically detecting target changes and scanning for specific types of targets should be developed by FY 1974.

Resources:

FY 1969 1970 1971 1972 1973 1974 1975 1976



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C. Imagery

1. Overhead Photography

d. Image Interpretation Instruments and Techniques [Redacted]

Objective: It is anticipated that during the latter half of the planning period there will be a significantly increased use of [Redacted] in overhead reconnaissance. The objective of this project is to develop the equipment needed to exploit effectively and economically the increased volume of these types of imagery.

Progress: The limited amount of [Redacted] currently being received provides some experience with the practical problems involved in its exploitation. Studies are now underway with respect to [Redacted] at different resolutions.

Program Plan: By the end of FY 1971, sufficient experience and data will have been acquired to permit the development during FY 1972 of basic [Redacted] equipment. During FY 1973, special [Redacted] equipment and experimental [Redacted] equipment will be developed.

Resources:

FY 1969 1970 1971 1972 1973 1974 1975 1976



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C. Imagery

1. Overhead Photography

d. Image Interpretation Instruments and Techniques/Modifications

Objective: To develop modifications and improvements in existing imagery interpretation equipment.

Progress: When new equipment becomes operational, additional development or modification needs are frequently surfaced, sometimes arising from practical working experience with the equipment, sometimes resulting from concepts originating with imagery analysts. Over the past years, NPIC has maintained a fairly steady effort in modifying and improving imagery analysis equipment on hand.

Program Plan: A general level of effort is planned for this project. Specific modifications and improvements will be undertaken as the need for or advantages of them are identified.

Resources:

FY 1969	1970	1971	1972	1973	1974	1975	1976
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C. Imagery

1. Overhead Photography

e. Reproduction/Dry Processing

Objective: Dry process reproduction of image materials offers a number of advantages over conventional wet processing methods, including savings in space, elimination of handling of bulk chemicals, greater flexibility and speed, and reduction in the amount of silver used. The objective of the NPIC effort in the field is to develop by FY 1972 a satisfactory dry process system applicable to black and white imagery, and by FY 1976, a system applicable to other types of imagery.

Progress: Dry diazo film and paper capable of good quality positive to positive reproduction have been developed and will be available in quantity during FY 1970. Diazo, however, meets NPIC needs only in part, primarily because it is not possible to alter or adjust the density with diazo film and paper. Dry silver paper has reached a commercially useable level of development, and by FY 1971 should meet NPIC's quality requirements. Roll film dry processors have been developed and are now undergoing evaluation.

Program Plans: By FY 1971, development of two types of dry film processors will be completed, a 12-inch processor for use by individual PI's in making density cuts and transparent file copies and a 40-inch processor for making enlargements. By the end of FY 1972, development of a satisfactory dry silver positive acting film should be completed. During FY 1971 and 1972, it is probable that requirements for additional new processing equipment will be identified and developmental work initiated. In FY 1972, the feasibility of applying dry processing to other types of imagery (e.g. ) will be examined. If feasibility studies are favorable, work in this direction will be initiated in FY 1973.

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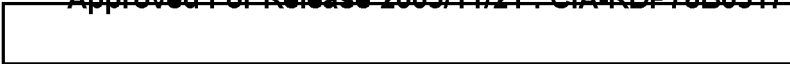
Resources:

FY 1969 1970 1971 1972 1973 1974 1975 1976



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C. Imagery

1. Overhead Photography

e. Reproduction/Wet Processing

Objective: At least through FY 1976 and perhaps beyond, it will be necessary for NPIC to retain considerable wet film processing capability, in order to deal with color and other unconventional film and meet certain specialized reproduction needs. It is unlikely that industry will develop equipments for commercial uses which will meet all the standards of resolution, speed and flexibility required for intelligence exploitation. It is NPIC's objective to adopt and upgrade, where possible, commercial equipment to meet its requirements, and to develop its own equipment in those cases where commercial equipment is unavailable.

Progress: Because of the very limited and highly experimental employment of unconventional imagery in overhead reconnaissance up to the present, NPIC is using standard commercial equipment.

Program Plans: In view of the likelihood that use of [redacted] will be expanded with the advent of the [redacted] late in FY 1971, it is planned to up-grade NPIC's capability for processing [redacted] beginning early in FY 1971. Development of equipment for processing [redacted] will be initiated in FY 1972.

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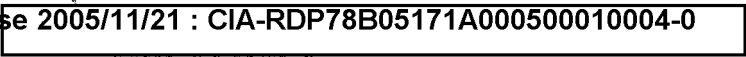
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Resources:

FY 1969	1970	1971	1972	1973	1974	1975	1976
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C. Imagery

1. Overhead Photography

f. Mensuration

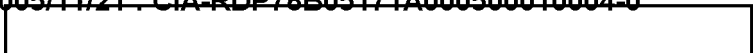
Objective: To improve the precision of mensuration accuracy statements and the efficiency of the mensuration process. This involves isolating and defining the relative and absolute values of those factors which contribute to mensuration error, minimizing their effects, and automating certain aspects of the process. Error factors can relate to the source material, the collection vehicle, the mensuration equipment, and the operator.

Progress: A high-precision stereo comparator, now in late stages of development, will be delivered in FY 1971. Mensuration equipment for efficient use by the imagery analyst on both cut and roll film is also in the later stages of development. In-house studies were made to identify the various sources of mensuration errors; this information will be used as a foundation for further study of their effect upon mensuration procedures and equipment.

Program Plans: Commencing in FY 1971, in-house study, supplemented by contractual assistance, will be directed toward further understanding of mensuration error factors. Effort will be expended toward developing medium-accuracy stereo mensuration equipment to fill a current gap between ultra-precise and course-accuracy instruments and toward adapting instruments for color materials. Emphasis will be placed upon automation of mensuration tasks and quick response, high reliability, and easily maintained mensuration instruments.

Resources:

FY 1969 1970 1971 1972 1973 1974 1975 1976



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C. Imagery

1. Overhead Photography

g. Test and Evaluation

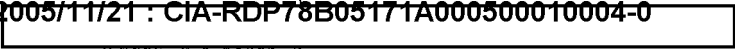
Objective: NPIC has developed or has under development equipment and instruments of a high degree of sophistication and accuracy. There are no devices or techniques available which are capable of determining the functional acceptability (i.e. fulfillment of contract specifications) of some of these equipments when they are delivered by the manufacturer. The objective of this effort is to develop the required instrumentation, techniques and standards to make such determination when they are not available from industry.

Progress: Over the past few years, NPIC has developed a small in-house test and evaluation laboratory, whose efforts have been supplemented by contractual assistance and the development of specialized test equipment and techniques. During FY 1969, arrangements were made with the National Bureau of Standards to develop resolution test equipment for the dry process reproduction materials now under development. As part of this effort, a special sensitometric processor is being developed in FY 1970. During FY 1970, a special target is being developed for use in making objective measurements of the performance of optical components as it relates to resolution.

Program Plans: During FY 1972 and 1973, special calibration devices will be developed and performance evaluation standards established for the High Precision Stereo Comparator and the Automated Stereoscanner.

Resources:

FY 1969	1970	1971	1972	1973	1974	1975	1976
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C. Imagery

[REDACTED]

Program Plans:

a) Alternatives and Approaches

The Center recognizes that the future of [REDACTED] or similar collection systems is uncertain at this point in time. The [REDACTED] concept, however, involves a major departure from exploitation procedures and equipment now in use or contemplated, and its implementation will require long research and development lead times. It is necessary therefore, that early investigations be undertaken, with contractual support, to develop the exploitation system concept and alternative approaches to system design. As the investigations progress, procedural, equipment, and staffing alternatives will be developed, providing choices with respect to costs, technical risk, degree of automation, etc.

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b) Plans

The preliminary plan for research and development in this area comprises the following:

(1) System Definition (FY 1970)

Develop several alternative [Redacted] exploitation system concepts based upon current knowledge of acquisition system performance and intelligence requirements.

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(2) System Design (FY 1971-1972)

Based upon these system concepts, investigate two exploitation systems utilizing significantly different technological approaches - one emphasizing advanced technology and the other, off-the-shelf components and existing state-of-the-art techniques.

(3) Equipment Design (FY 1972-1973)

Based on the system concept and technological approach selected, initiate development of [Redacted] exploitation system equipment.

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(4) Equipment Development (FY 1973-1974)

Develop prototypes of new equipment items necessary, and test and evaluate such prototypes.

(5) System Modification (FY 1975-1976)

Following evaluation under operational conditions, modify system components and procedures and develop additional equipment as required.

Resources:

FY 1969 1970 1971 1972 1973 1974 1975 1976

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