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NPIC/TSSG/RED  
25 November 1969

IMAGERY INTERPRETATION INSTRUMENTS & TECHNIQUES

OBJECTIVES:

1. Automatic Target Recognition

a. FY-69 - Objective - to develop a fully automatic Target Indexing Device (TID) for use on high volume output collection systems and to maintain a sustaining research effort on related Automatic Target Recognition (ATR) techniques.

Rationale - In order to cope with the increasing output of future high volume collection systems, it is imperative to automate those tasks that are tedious, repetitive, and time-consuming. The TID will expedite the Phase II exploitation of photographic missions as well as provide a capability for reprogramming and the accurate determination of the percent of cloud cover per mission.

b. FY-71/72 - Objective - to develop the capability to automatically and rapidly scan imagery for man made objects and to investigate the feasibility of applying ATR techniques to   systems.

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Rationale - the capability to machine-scan photographic coverage of large areas of relatively sterile imagery and indicate only those portions containing man made objects will greatly reduce PI time spent in search operations. With  systems, the possible application of ATR techniques to solve such problems ~~or as~~ cloud and/or detail screening and target identification by operating

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and interpretation time.

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c. FY-73/74 - Objective - to develop machine capability to rapidly rescan for specific types of targets and to develop techniques to determine change detection.

Rationale - The rescanning of numerous missions for start of missile site construction, initial operations, etc. constitute a very time-consuming operation that could be alleviated by developing an automatic rescanning capability. Automation of the change detection function could be a significant time saver by eliminating the need for analysts to look at any target except those showing significant change.

d. FY-75/76 - Objective - To further apply techniques developed in previous phases to permit the fabrication of a device that can automatically and rapidly detect, identify, and count objects for order of battle.

Rationale - This development would result in significant time savings by automating the tedious and time-consuming order of battle compilation. This development would be another "module" leading eventually to an integrated automatic target system that could relieve the analyst of those important but very time-consuming operations and permit the bulk of this time to the specialized and detailed analysis for which machines are not suited.

## 2. Imagery Interpretation Instruments

a. FY-70 to FY-72. Provide the necessary imagery interpretation equipment to accommodate  format material. 25X1

b. FY-71 to FY-76. Develop and fabricate imagery interpretation instruments that will enable the interpreters to extract the  maximum intelligence information from planned systems. Produce 25X1

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viewers, light sources, optics, and human engineered instruments to <sup>incorporate</sup> reflect the results of earlier research contracts.

c. FY-70 to FY-76. Support the operational personnel in the design and development of specialized instrumentation and modifications to equipment. Provide quick response support to the types of equipment requested by the interpreters.

Rationale - [redacted]

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and other planned acquisition systems will require changes in the basic working instruments of the interpreters. New viewing equipment will have to be developed to handle the new formats and to provide the proper lighting to [redacted] as well as high quality black and white imagery.

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PROGRESS (during the past year) - The feasibility of building a fully automatic TID (cloud screener) was demonstrated using both optical and electronic techniques. Breadboards were constructed which proved feasibility in the dynamic mode using roll film of operational imagery. The decision was made to construct an engineering prototype, using the optical approach, with delivery of the device scheduled for September 1970.

In FY-69 and early FY-70 work was undertaken to produce equipment to accommodate the format of the [redacted] material when it becomes operational. Advanced rhomboids for microstereoscopes, 1540 Light Tables, and PI Search and Scan Stations are presently under development or design contracts.

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PROGRAM PLANS

Late in FY-70 a contract will be awarded to fabricate a PI Search and Scan Station based on the results of the design contract. From FY-71/76 the planned approach is to improve the basic interpretation instruments and to provide instruments that will be able to exploit  and other high performance systems.

a. Alternatives - The alternative to automating the various ATR tasks are to hire more analysts and/or increase the exploitation time. As far as technical risks are concerned "double tracking" will be used whenever possible, in order to assure success.

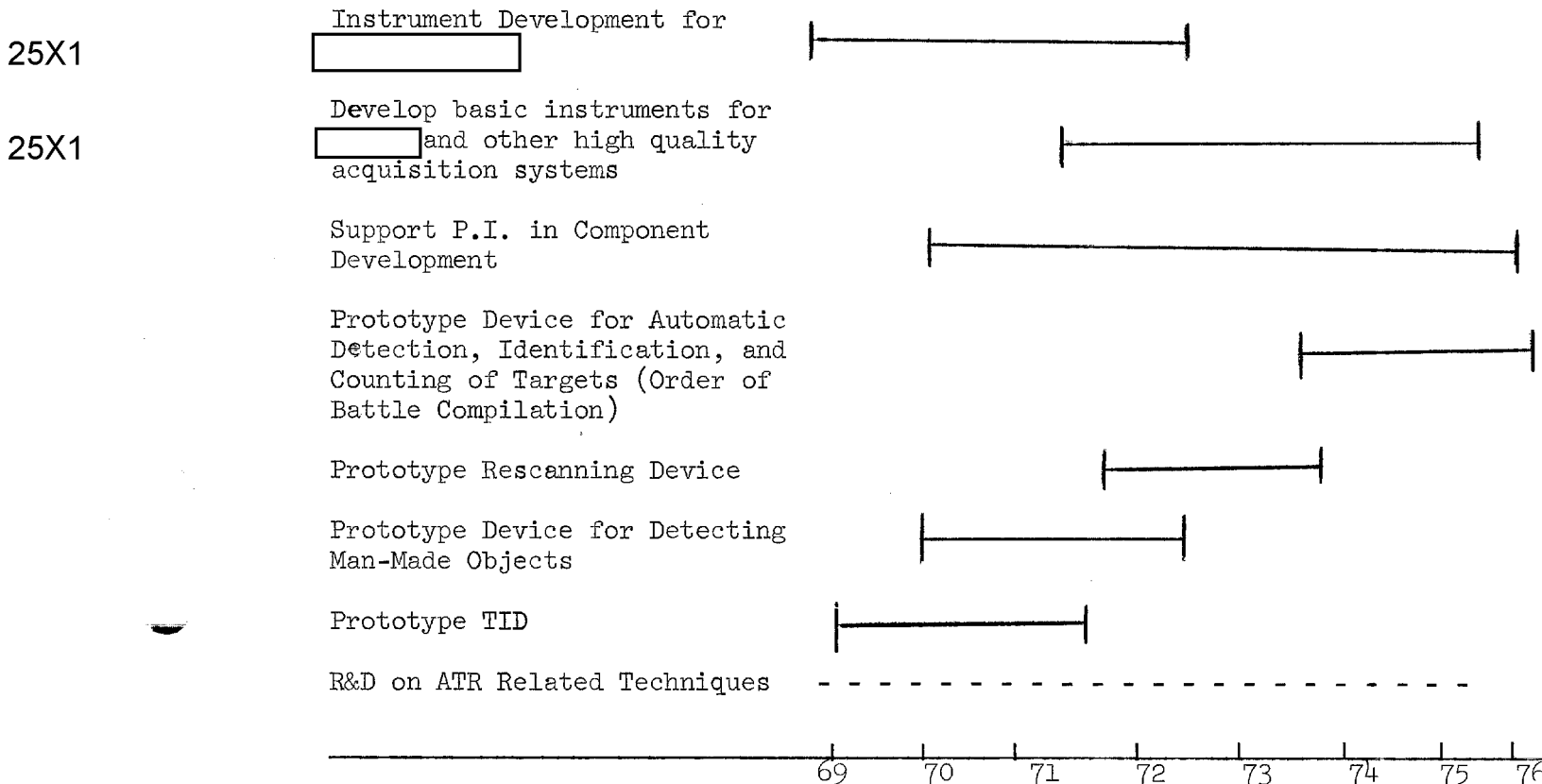
The alternative to developing individual new light tables, microstereoscopes, viewers, and light sources is to undertake the development of interpretation cells for the interpretation

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b. SELECTED APPROACH (Milestones)



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IMAGE ANALYSIS AND MANIPULATION

I. OBJECTIVES:

A. Unconventional Imaging Systems (FY-71 -- FY-76)

Determine the fundamental parameters, techniques, and equipment necessary to realize the intrinsic imagery potential of unconventional

[REDACTED]

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[REDACTED] to specify the quality of this imagery and to enhance it as required.

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RATIONALE

NPIC imagery sources are not restricted to conventional photography and, with the advent of [REDACTED] the exploitation of unconventional imagery will play an increasingly significant rôle. The development and execution of this program will assure the capability to extract the maximum amount of information from these new systems. It will furthermore establish a flexible base from which to proceed to undefined systems, yet maintain continuity of developments, definitions, and relationships with conventional systems.

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B. Image Manipulation (FY-69 -- FY-74)

Achieve an automated image manipulation system by FY-74. (~~FY-71 -- FY-74~~)

RATIONALE

Such a system will provide a capability for improving image quality (through enhancement and other manipulation techniques) to

the point where the PI will be able to extract information from imagery he would otherwise have been unable to consider exploiting.

C. Image Analysis (FY-70 -- FY-76)

Develop an improved photo-optical image quality measurement & specification capability that correlates objective and subjective performance criteria. (~~FY-70 -- FY-76~~)

RATIONALE

Present objective image evaluation techniques do not correlate adequately with subjective judgements of quality, and one is left with the question of just how good was the mission. In the case of equipment design, viewing devices, *for example,* cannot now be built with assurance that they will meet the interpreter requirements. Consequently, the design and subsequent analysis of image producing systems is less a science and more an art than is desirable. The photo-optical image evaluation program will provide a capability to objectively detect, specify, and measure system performance in terms which agree with subjective judgement. While these problems have been attacked in the past, they have not been resolved and now [ ] must be considered.

II. PROGRESS

FY-69 -- First Half FY-70

A. Unconventional Imaging Systems

1. Literature Search Begun
2. State of the art capabilities being explored
3. Limited feasibility experiments performed with existing equipment:

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- a. Analog
- b. Digital
- c. Photographic
4. Development of overall program in planning stage.

B. Image Manipulation

1. Digital Image Manipulation being investigated under contract
  - a. Hardware developed
  - b. Software developed
  - c. Image Enhancement Performed for defocus, image motion, and atmospheric effects.
  - d. Experiments designed and tested to obtain objective measure Intelligence value of enhanced imagery -- preliminary results very favorable.
2. Analog (Optical) Image Manipulation being investigated in-house with contractual support
  - a. Hardware being assembled
  - b. Experiments being designed and performed
3. Photographic Image Manipulation, "Ring-Smear" being investigated under contract.
  - a. Equipment breadboard
  - b. Experiments performed
4. Program being developed to consider electronic enhancement
  - a. Equipment under evaluation
  - b. Proposals under evaluation

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5. Plan initiated to perform enhancement in-house on operational imagery:
  - a. Hardware under development
  - b. Software under development
  - c. Best-method to attack operational problems considered
  - d. Coordination with ORD/DD/S&T/Optics and NPIC/PSG/AID to obtain computer support
  - e. Physical location for equipment determined
  - f. Personnel requirements determined:
    - i. coordination with NPIC/IEG
    - ii. coordination with NPIC/TSSG/RED/ATB/EL
6. Future operational equipment requirements being explored
  - a. Input/output devices
  - b. Computer hardware requirements
7. Phased plan for evolution from experimental to operational status under development
  - a. Responsibilities
  - b. Personnel requirements
  - c. Organizational location

C. Image Analysis

Progress (FY-69 -- ~~1969~~ **FIRST HALF FY-70**)

Three contracts have been concluded during this period. One was a study that defined the present state-of-the-art in photo-optical image evaluation; it recommended a general approach to finding a solution to the problem of relating subjective quality estimates to objective measurements. The second sought to apply the theory developed and establish basic conditions for evaluating optical components. The third contract developed general requirements for microdensitometric analysis of photographic imagery --  and black and white. Collectively, these contracts have taken a first step, identifying the areas where further effort will be best directed. From them has come the development of a comprehensive series of

accomplish the long range objective.

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~~2. Comprehensive expanded program under development.~~

III. PROGRAM PLANS

Second Half FY-70 -- FY-76

A. Unconventional Imaging Systems

1. Procedure

- a. Obtain clearances and receive briefing for planned operational collection systems to be used through FY-76.
- b. Establish priorities and needs.
- c. Attack specific problems with projects
  - i. In-house
  - ii. Under Contract
- d. Report results to exploitation community
- e. Brief in detail APSD
- f. Recommend:
  - i. Operational procedures
  - ii. Operational equipment

2. Alternatives

- a. ~~Assume system developers will also develop (and report) exploitation required parameters--maintain an awareness only, rely on user experience with system product.~~
- a. <sup>Employ only</sup> ~~Restrict program to utilizing~~ in-house resources -- build onto existing equipment and techniques.
- b. Rely solely on contractual support, ~~for program execution.~~
- c. <sup>Develop</sup> ~~Anticipate need, build onto~~ existing equipment and techniques <sup>internally,</sup> enlist contractual support where appropriate.

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3. Approach Selected

- a. <sup>Develop</sup> ~~Anticipate need, build onto~~ existing equipment and techniques, <sup>internally,</sup> enlist contractual support where needed.
- b. Milestones:
  - i. Establish needs and priorities
  - ii. Program definition
  - iii. Program execution
  - iv. Report
  - v. Integrate into operational environment
  - vi. Recommendations

4. Resources

- a. Contractual support totalling  over a six year period is anticipated.
- b. In-house equipment and man-hours will be required.
- c. Coordination with TSSG/RED/ATB/ELS and TSSG/APSD will be necessary.
- d. Computer support will be required, source and quantity as yet undetermined.
- e. Follow-on of undetermined amount (to be recommended)

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B. Image Manipulation

1. Procedure

- a. Establish in-house capability to perform digital, optical, photographic, and electronic enhancement.
- b. Perform enhancement techniques on operational imagery.
- c. Demonstrate utility and value of an Automated Image Manipulation System

- d. Report results and make recommendations.
- e. Procure operational equipment and personnel.
- f. Train personnel to operate system.
- g. Integrate into organizational structure.

2. Alternatives

- a. Evolve from in-house systems.
- b. Request contractual development and installation.
- c. Issue requirement for performance of these operations under external contract.
- d. Issue requirement for these operations to an appropriate military facility.

3. Approach Selected

- a. Establish in-house capability in the preceding areas.
- b. Develop in-house systems from in-house work.
- c. Request contractual support if and where needed
- d. Milestones
  - i. In-house DIM capability established (JULY 1970)
  - ii. In-house AIM capability established (FEB 1970)
  - iii. In-house PIM capability established (JUNE 1970)
  - iv. Determine the best operational applications for digital, optical, electronic, and photographic enhancement techniques. (END FY-72)
  - v. Operational equipment requirements determined and contract for development initiated.
  - vi. Personnel and organizational requirements determined.
  - vii. System turned over to operational personnel for
  - viii. Integration into organizational structure accomplished.

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4. Resources

- a. Funding required, FY-70 through FY-76,  25X1
- b. PI support from IEG
- c. Computer support
  - i. Initial phase of in-house work to be supported by DD/S&T/ORD has been coordinated
  - ii. Further work requirements to be determined
- d. In-house personnel to manage projects and run equipment
- e. Additional personnel to man operational facility (estimate for (4))

C. Image Analysis

1. Procedures

- a. Identify need
- b. Establish priorities
- c. Initiate projects
- d. Report results
- e. Make recommendations

2. Alternatives

- a. Retain and refine the present objective measurements and expand the subjective evaluation phase by more carefully explaining to the P.I. the nature of the judgments he makes.
- b. Establish a program of basic research designed to quantify the fundamental physical and psychophysical interrelationship. On the basis of these results, develop practical mission

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oriented evaluation procedures and equipment.

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- c. Implement an integrated program to optimize existing procedures, while developing new objective evaluation techniques. As a parallel effort, psychophysical studies will be initiated to provide a basis for determining the correlation between subjective and objective evaluation parameters.

3. Approach Selected

- a. The third alternative offers the greatest pay-off at the least risk and is therefore selected. Alternative two would provide the firmest scientific foundation with the lowest level of risk; however, it would cost considerably more and require too much time to be practical. The first alternative is the least attractive in that it has the highest risk and would not allow consideration of the new evaluation procedures available.

b. Milestones

- i. Completion of study of evaluation techniques
- ii. Objective measure identified
- iii. Subjective experiment complete, testing procedures developed
- iv. Correlation procedures determined
- v. Operational implementation

4. Resources

- a. Funding --  FY-70 through FY-76
- b. Support from and coordination with TSSG/RED/ATB/HFS
- c. Coordination with and support from TSSG/APSD
- d. Computer support (quantity and source to be determined)

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