

file 50010

SECRET

fr

**PROPOSAL FOR EXTENSION IN SCOPE ON
THE EFFECTS OF
PHOTOGRAPHIC GROUND RESOLUTION
ON PHOTOINTERPRETATION**



25X1

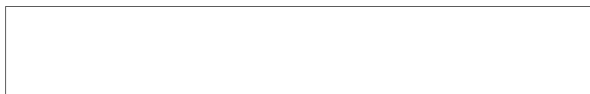


25X1

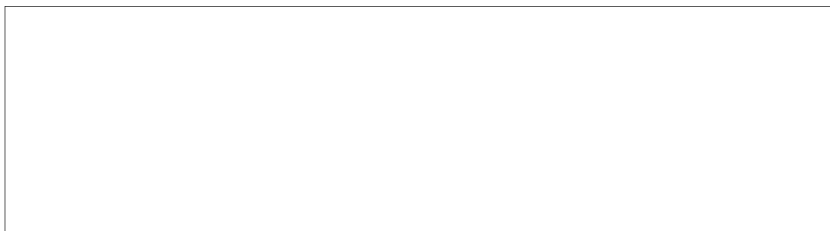
SECRET

SECRET

PROPOSAL FOR EXTENSION IN SCOPE ON
*THE EFFECTS OF PHOTOGRAPHIC GROUND RESOLUTION
ON PHOTOINTERPRETATION*



25X1



25X1

24 February 1970

SECRET

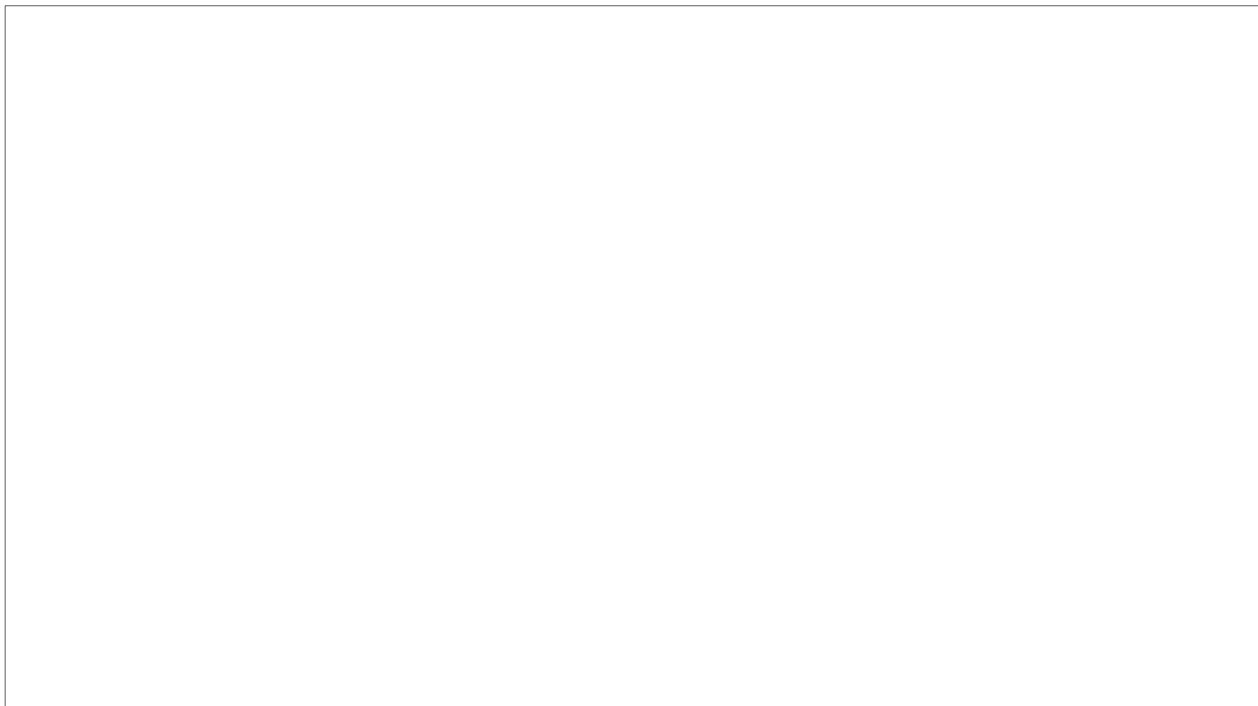
SECRET

ABSTRACT

This is a proposal for an extension in scope of Contract *The Effects of Photographic Ground Resolution on Photointerpretation*. The purpose of the extension will be to conduct an experimental study of the effects of photographic ground resolution on the identification of ground order-of-battle targets. The high resolution photography of Aberdeen Proving Ground already obtained under the contract and other targets in other areas, if they are available, will be used to prepare photographs representing six appropriate ground resolutions and scales. Professional photointerpreters will view them for the purpose of identifying the targets. A report and briefing describing the results will be prepared.

25X1

The estimated costs are as follows:



25X1

SECRET

SECRET

TABLE OF CONTENTS

	Page
ABSTRACT	iii
INTRODUCTION	1
TECHNICAL DISCUSSION AND METHOD	4
Experimental Photographs	5
Targets	6
Experimental Design	6
Subjects	8
Data Collection	8
Data Analysis	8
WORK STATEMENT	9
SCHEDULE	9
DELIVERABLE ITEMS	10
PERSONNEL	10
ESTIMATED COSTS AND FEE	11
NOTES	12

SECRET


SECRET

PROPOSAL FOR EXTENSION IN SCOPE ON
*THE EFFECTS OF PHOTOGRAPHIC GROUND RESOLUTION
ON PHOTOINTERPRETATION*



25X1

INTRODUCTION

Contract  *The Effects of Photo-graphic Ground Resolution on Photointerpretation*, was written primarily for the purpose of obtaining high-resolution, aerial photographs of ground order-of-battle targets to be used subsequently in an experimental study of the effects of ground resolution on photointerpretation. The specific tasks to be performed were as follows:

25X1

- Task 1. Selection and procurement of the required aircraft and camera.
- Task 2. Selection, procurement, and placement of appropriate targets.
- Task 3. Construction or procurement and placement of test targets.
- Task 4. Collection of "ground-truth" information.
- Task 5. Collection of photography.

The contract thus called only for the collection and preparation of photographic and other materials required for an experimental study in which professional photointerpreters (PIs) would serve as subjects. Most of that preparatory work has been done: an aircraft/camera system was obtained from the sponsor's parent organization; arrangements were made to photograph the tank/artillery museum at Aberdeen Proving Ground; test targets were prepared and placed adjacent to the museum; test flights were flown to determine the altitude and camera settings required to

SECRET

SECRET

achieve the desired ground resolution; and the photographic acquisition flights were flown while luminance measures of the targets and their background were being made on the ground. In addition, part of the required ground-truth information was obtained.

This proposal for extension in scope is to conduct and report the experimental study. In it, the effects of photographic ground resolution on PI identification of ground order-of-battle targets will be investigated.

The relevance of the work was described in the original proposal as follows:

Modern photographic reconnaissance systems are enormously expensive, and the attainment of better ground resolutions implies greater expense. The relation between resolution and expense probably is not a linear one; improving ground resolution by a factor of two, for example, probably means an increase in system expense by much more than a factor of two. Furthermore, improvements in ground resolution may imply a decrease in area coverage.

For these reasons, the intelligence community should continue the effort to determine what additional significant intelligence information is obtained with improvements in ground resolution. Such knowledge is vital to the evaluation of proposed systems.

No one has yet been able to develop an objective relation between intelligence information and dollars. For one reason, the value of intelligence information varies over time and it is difficult, if not impossible, to foresee entirely what information will be valuable in the future. Nevertheless, the effort to determine *what* information better ground resolutions permit the photointerpreter to obtain should continue, so as to provide the people responsible for designing and evaluating systems with an additional source of relevant data.

Thus far, four studies of the effects of ground resolution on the interpretation of targets have been completed.

SECRET

The targets in the first were aircraft; the targets in the second were domestic, offensive ICBM sites; the targets in the third were scale models of mobile radars; and the targets in the fourth were models of tanks and other military vehicles. Technical reports describing these studies have been submitted to the sponsor. In addition, briefings on these studies have been given to both the sponsor and other organizations in the intelligence community.

Aircraft were selected as targets in the first study primarily because of practical considerations: a large number of different types of aircraft were located in a small area and an aircraft/camera system was immediately available in the area. The results showed the ground resolution required for aircraft identification. In addition, the experimenters learned a great deal about conducting such studies, another valuable result.

Domestic, offensive ICBM sites were selected as targets for the second study because of the significance of that type of target to the intelligence community. The results showed that because of their relatively simple external configurations, "very good" ground resolutions were not required to exploit fully the intelligence in overhead photographs of them.¹

The fact was recognized then, and still is, that the effects of ground resolution on interpretation is "target specific." One class of targets requires better ground resolution than another for the complete exploitation of overhead photography.

For that reason, a similar study was done with models of mobile radars serving as targets. They were selected

¹The specific results are not presented here because of security.

SECRET

because of the greater detail in their external configurations--the antennas, horns, feeder lines, and so on. The results showed that significantly better ground resolutions are required for radars than for missile sites to exploit fully the intelligence information available in overhead photography.

It was suggested by representatives of the sponsor and other intelligence organizations that ground order-of-battle targets might require even better ground resolutions than radars for the complete exploitation of photography. Consequently, a third study of the effects of photographic ground resolution was conducted using scale models of tanks and other military vehicles as targets.² The dependent measure was percent correct target identification.

TECHNICAL DISCUSSION AND METHOD

In general, the experimental study proposed here will be an extension of the previous photographic ground resolution studies. However, real ground order-of-battle targets will be used.

The method will be essentially the same as that used in the previous studies. Experienced PIs will view the targets at each ground resolution, starting with the poorest and ending with the best. At each resolution, they will attempt to identify each target by comparing its image in the photographs with "ground-truth" information. The data will be analyzed to determine the mean, standard deviation,

²In this study, the effects of line-scan images that varied in signal-to-noise ratio and number of scans per target were investigated simultaneously. This phase of the study was a replication of a study previously done [] and []. A comparison of the results of the two studies showed that the experimental methods yielded very reliable data.

25X1.
ZJA1

SECRET

and standard error of the mean of percent correct identifications at each ground resolution. Tests of the statistical significance of differences in identification performances between and among ground resolutions will be made. A description of the method and the results plus their implications will be presented in a technical report.

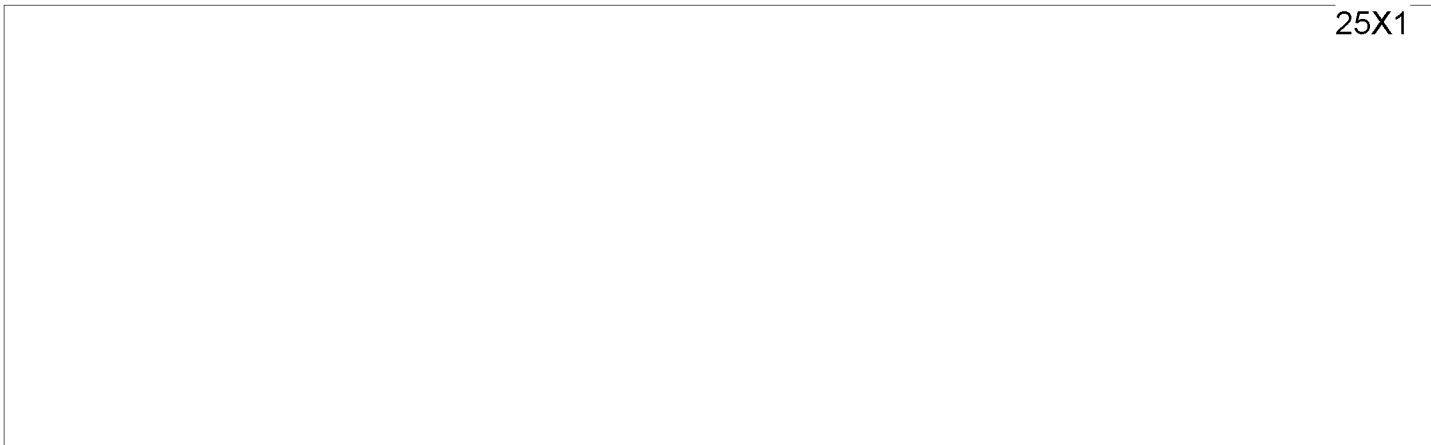
Following is a more detailed description of the method.

Experimental Photographs

The ground resolution of the Aberdeen photography is as determined from three-bar target readings. If additional appropriate targets can be found and additional missions can be flown, an effort will be made to obtain an equivalent ground resolution.

25X1

The original negatives will be processed to obtain six ground resolutions and scales that are relevant to existing and proposed systems:



25X1

In producing positive transparencies to simulate the different ground resolutions and scales, the modulation transfer function (MTF) will be simulated. MTF's will be determined for each ground resolution from traces of a test target edge located in a frame adjacent to the frame containing the target images.

25X1

SECRET

SECRET

Targets

As previously mentioned, representatives of the sponsor and other intelligence organizations suggested that the effects of ground resolution on the identification of ground order-of-battle targets should be investigated. Consequently, a study was done of the effects of ground resolution on the accuracy of identification of military vehicles, tanks, and other types of vehicles. The targets were scale models.

The sponsor requested that an additional study with real ground order-of-battle targets be conducted. So photographs of the WW II tank/artillery museum at Aberdeen were obtained and additional target areas are currently being examined to determine whether or not they should be included in the study.

There may be a question concerning whether or not these targets are representative of the ground order-of-battle targets that PIs seek to identify today. They appear to be. First, some of the WW II tanks and artillery pieces at Aberdeen are still in use today; second, the external configurations of the tanks and artillery pieces developed since WW II, and being used today, are not significantly different from those used in WW II; and, third, the visual discriminations required to identify WW II ground order-of-battle targets are not different from the visual discriminations required to identify modern ground order-of-battle targets.

Experimental Design

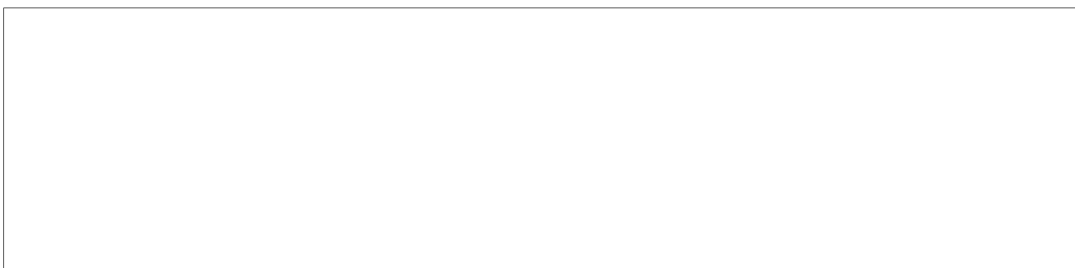
The major question in designing a study such as the one proposed here is whether to use a *within-* or *between-subjects* design. In the within-subjects design, the subjects view the imagery at all ground resolutions and thus serve as their own controls. The advantage of such a

SECRET

design is that, because the subjects serve as their own controls, some experimental control is maintained over relevant variables such as knowledge, experience, aptitude, motivation, and so on. There are both practical and experimental disadvantages. The primary practical disadvantage is that the number of hours required per subject is much larger. The primary experimental disadvantage is uncontrolled "order effects," and the order effect of greatest concern is the learning that takes place during the course of the experiment.

In the between-subjects design, a different group of subjects views the imagery at each ground resolution. Thus, when a comparison is made among the performances at the various ground resolutions, not only are the effects of ground resolution being compared, individual differences in knowledge, experience, and so on, are also being compared.

In the previous experiments, within-subjects designs have been used. The same type of design will be used in the experiment proposed here if the task is not too time consuming. A pilot study will be done to determine how long it takes a subject to complete the entire target identification task working from the poorest imagery to the best. If the time taken is considered reasonable, a within-subjects design will be used. If the time required is considered too long, a combination within- and between-subjects design will be used:



25X1

SECRET

25X1

comparisons will be between subjects. Obviously, a pilot study must be done before final design decisions can be made.

Subjects

Professional PIs with a minimum of one year of recent operational experience will serve as subjects and an effort will be made to use only ground order-of-battle specialists. However, previous results have shown that it is probably not necessary to use only specialists. From 10 to 15 subjects per ground resolution should be enough to achieve adequate reliability, yet not seriously interfere with operations.

Data Collection

The data collection will be conducted A room with three viewing stations comparable to operational stations will be set up and an effort will be made to have three subjects perform at a time. Each station will include a light table, a B and L microscope, and a tube magnifier.

25X1

Data Analysis

Means, standard deviations, and standard errors of the mean of percent correct target identifications at each ground resolution will be computed. Different classes of targets will be treated separately. Analyses of variance will be performed to determine the statistical differences among means. Additional statistical tests of the differences between pairs of means will be made as required. Other analyses will be performed if they appear possibly to reveal relevant information.

The data analysis will be done on the IBM 1130 computer.

25X1

SECRET

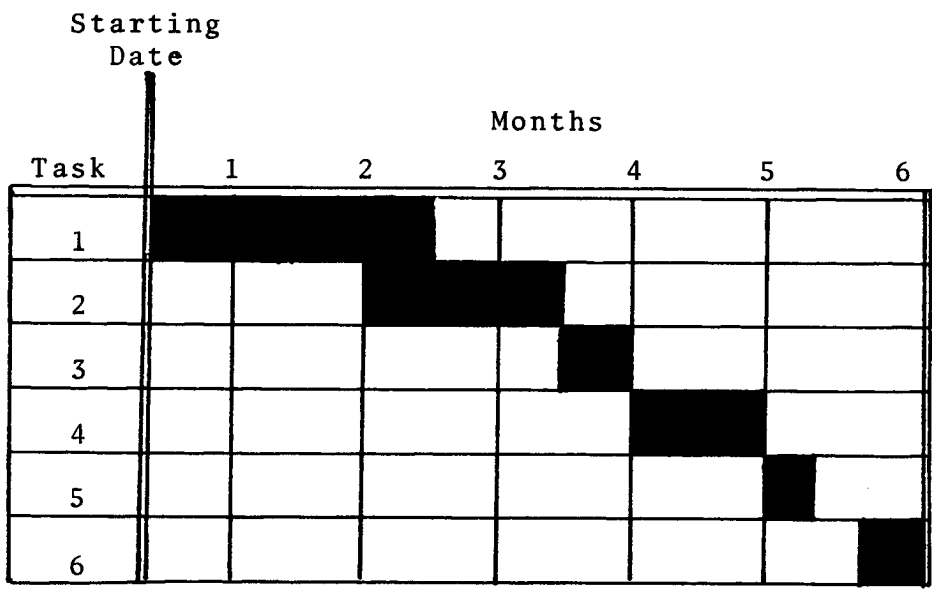
SECRET

WORK STATEMENT

The work in this proposed ~~extension in scope~~ ^{new contract} would include the following tasks:

- Task 1. ^{Finalization} ~~Preparation~~ of the experimental and statistical design, books containing the "ground-truth" information, subject requirements and instructions, and data collection forms.
- Task 2. Collection of the experimental data using the customer's facilities and PI personnel as subjects.
- Task 3. Analysis of the experimental data.
- Task 4. Preparation of a ^{final} technical report and briefing describing the methods, the results, and their implications.
- Task 5. ^{Delivery of} Briefings, ^{as} requested by the Project Officer.
- ~~Task 6. Preparation of the final report.~~

SCHEDULE



SECRET

It is expected that the expenditure rate will be

[Redacted]

25X1

However, the rate during the execution of Task 1 could be somewhat less due to delays in preparing the photographic materials. It could be somewhat greater during the execution of Task 2 due to possible conflicts with operations.

DELIVERABLE ITEMS

1. The photographic stimulus materials.
2. A book containing the "ground-truth" data.
3. Bimonthly progress reports.
4. A technical report.
5. Briefings, if requested by the sponsor.
6. A final, summary report.

PERSONNEL

[Redacted]

25X1

Page Denied

SECRET

NOTES

1. Formerly, [redacted] has had one overhead pool. Effective 1 January 1970 our accounting system was changed to provide for a breakdown of indirect expenses in the same format as is reflected in this proposal. The Defense Contract Audit Agency, 11099 South La Cienega Boulevard, Los Angeles, California 90045, has audit responsibility for HFR's Government contract work and a review by them of our new system and the basis for allocations have been approved.
2. Bidder is not dominant in its field of operations and with affiliates employs fewer than 500 employees.
3. The prices of the items covered do not exceed those paid by any other purchaser from the contractor and the Government is placed in the most favored price category.
4. Prices are based on straight time.
5. Bidder represents that he has not employed or retained a company or person (other than a full-time employee) to solicit or secure this contract and agrees to furnish information thereto as requested by the Contracting Officer.
6. Bidder is incorporated in the State of Nevada.
7. Bidder is a profit institution as determined by the Bureau of Internal Revenue.
8. Government contract administration is handled by

25X1

[redacted]

25X1

[redacted]

25X1

24 February 1970

SECRET

SECRET